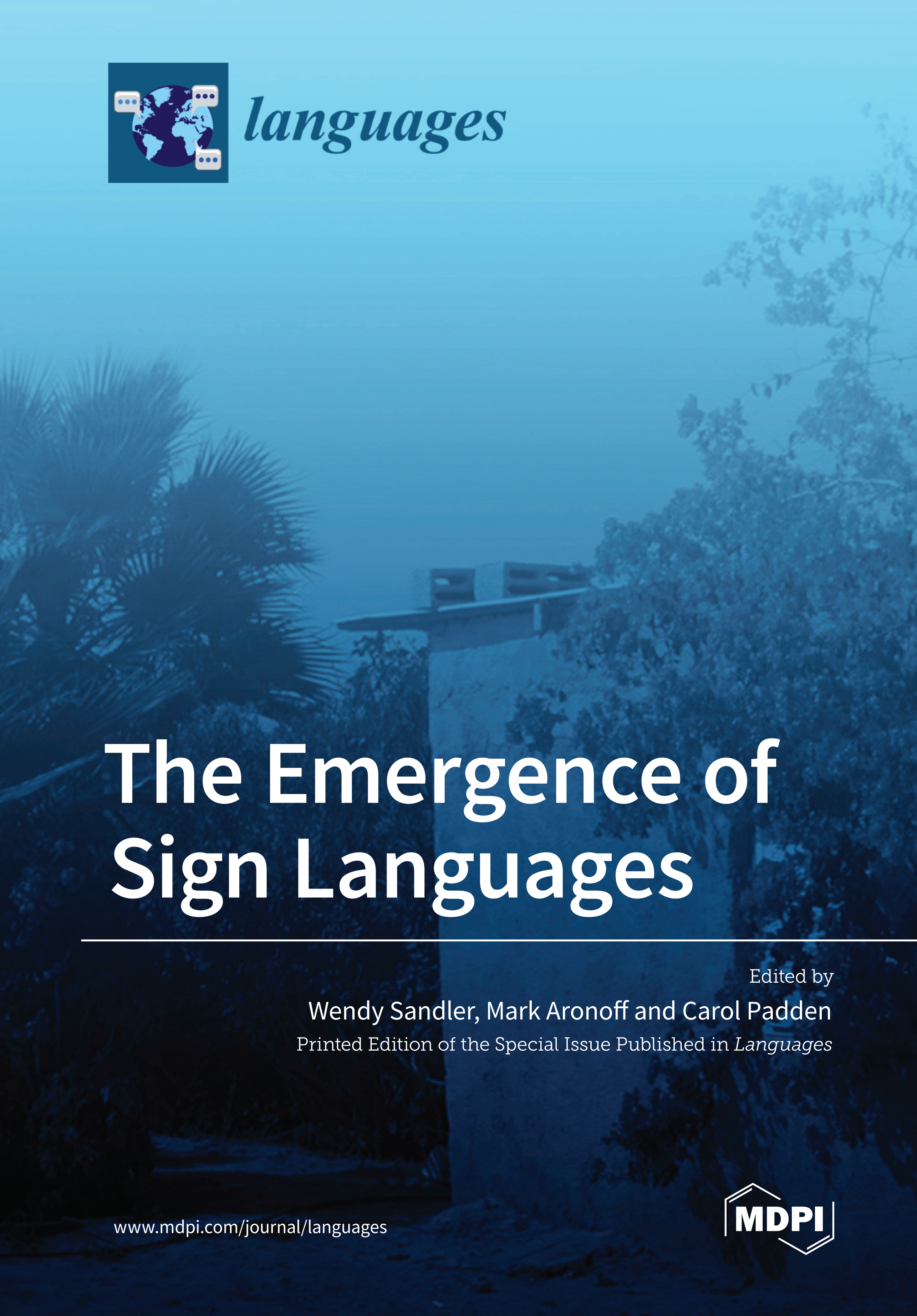


languages

The Emergence of Sign Languages

Edited by
Wendy Sandler, Mark Aronoff and Carol Padden

Printed Edition of the Special Issue Published in *Languages*

www.mdpi.com/journal/languages

MDPI

The Emergence of Sign Languages

The Emergence of Sign Languages

Editors

Wendy Sandler
Mark Aronoff
Carol Padden

MDPI • Basel • Beijing • Wuhan • Barcelona • Belgrade • Manchester • Tokyo • Cluj • Tianjin

Editors
Wendy Sandler
Sign Language Research Lab,
University of Haifa,
Haifa, Israel

Mark Aronoff
Department of Linguistics,
Stony Brook University,
Stony Brook, NY, USA

Carol Padden
Department of Communication,
University of California San Diego,
La Jolla, CA, USA

Editorial Office
MDPI
St. Alban-Anlage 66
4052 Basel, Switzerland

This is a reprint of articles from the Special Issue published online in the open access journal *Languages* (ISSN 2226-471X) (available at: https://www.mdpi.com/journal/languages/special_issues/Emergence_Sign_Languages).

For citation purposes, cite each article independently as indicated on the article page online and as indicated below:

LastName, A.A.; LastName, B.B.; LastName, C.C. Article Title. *Journal Name* **Year**, *Volume Number*, Page Range.

ISBN 978-3-0365-6245-2 (Hbk)
ISBN 978-3-0365-6246-9 (PDF)

Cover image courtesy of Carol Padden.

Contents

About the Editors

Wendy Sandler

Wendy Sandler has developed models of sign language phonology and prosody that exploit general linguistic principles to reveal both the similarities and the differences in natural languages in two modalities. With colleagues Carol Pasdden, Mark Aronoff and the late Irit Meir, her work has turned to the emergence of new sign languages. Sandler focuses on ways in which the body is recruited to manifest increasingly complex linguistic form within a community of signers. In her multi-disciplinary research project, The Grammar of the Body, supported by the European Research Council, she studied how actions of the body illuminate the evolution and emergence of linguistic structure in human language and its precursors. As part of that project, she founded a unique sign language theatre company named 'Ebisu'. Sandler has authored or co-authored three books on sign language: *Phonological Representation of the Sign* (Foris); *A Language in Space: The Story of Israeli Sign Language* co-authored with Irit Meir (Hebrew version: University of Haifa Press; English version: Lawrence Erlbaum Associates/Taylor Francis); and *Sign Language and Linguistic Universals*, coauthored with Diane Lillo-Martin (Cambridge University Press). She is a member of the Linguistic Society of America, the Israel Association for Theoretical Linguistics, and the American Academy of Arts and Sciences.

Mark Aronoff

Mark Aronoff has taught at Stony Brook University since receiving his Ph.D. from MIT many years ago. The central focus of Prof. Aronoff's research has always been on morphology, the internal structure of words, a topic that he has approached from many angles and using many methods over the length of his career. For the last two decades, he has worked on sign languages, with a special interest in the emergence of structure in new sign languages. Besides his research, he has served as Editor of the journal *Language*, President of the Linguistic Society of America, and Chair of the section on Linguistics and the Language Sciences of AAAS. He is a Fellow of the Linguistic Society, the American Academy of Arts and Sciences, and the American Association for the Advancement of Science.

Carol Padden

Carol Padden's research focuses on the structure and evolution of sign languages and cultural life in deaf communities. Over the last 20 years, Padden and her research colleagues have studied an emergent sign language that continues to be used today by deaf and hearing Bedouins in Al-Sayyid, a village in the Negev in southern Israel. Padden and her husband, Tom Humphries, co-authored two landmark books in sign languages and deaf studies, *Deaf in America: Voices from a Culture* (1988) and *Inside Deaf Culture* (2005), and two textbooks on American Sign Language for students in high schools and universities around the country. She was awarded a MacArthur Fellowship in 2010, a Guggenheim Fellowship in 1992 and she holds two honorary doctorate from the University of Haifa, Israel in 2015, and Swarthmore College in 2016. As Dean of the School of Social Sciences, she oversees 11 departments, 5 programs and several Centers which carry out research on educational equity, social mobility, immigration policy and post-civil-rights Black Studies. An advocate for deaf communities, Padden is active in promoting research on sign languages around the world and in shaping policy and practices that advance the full participation of deaf people in society.

languages

MDPI

Editorial

Emerging Sign Languages

Wendy Sandler [1,*], Carol Padden [2] and Mark Aronoff [3]

[1] Sign Language Research Lab, University of Haifa, Haifa 3498838, Israel
[2] Department of Communication, University of California San Diego, La Jolla, CA 92014, USA
[3] Department of Linguistics, Stony Brook University, Stony Brook, NY 11794, USA
* Correspondence: wendy.sandler@gmail.com

The emergence of sign language is of special interest because sign languages are the only human languages that can emerge de novo at any time. This means that the path they take is a good source of information about the emergence of language in human populations. There are probably hundreds of emerging sign languages around the world; however, we do not have enough information about them all, and this hampers the formation of robust generalizations. Linguists rarely have the chance to catch emerging sign languages in the act of being born, and small emerging sign languages are often quickly subsumed by larger national sign languages, which are used in education and formal interpreting.

This Special Issue presents rare data and analyses about eleven different emerging sign languages around the world. The articles deal with the following key topics of language emergence, with some overlap: (1) the relationship between language and culture of the larger society, including both ambient manual gestures and facial expressions; (2) the role of iconicity in the emergence of sign language; (3) the relationship between shared context in a small signing community and the degree of variation in the vocabulary; and (4) the vulnerability of budding sign languages. Spoken creole languages are also young, but are different from emerging sign languages, in that the speakers of pidgins from which creoles are assumed to have descended already had native languages. Topic number (5) in this collection is a comparison of features of creoles and of emerging sign languages.

Citation: Sandler, Wendy, Carol Padden, and Mark Aronoff. 2022. Emerging Sign Languages. *Languages* 7: 284. https://doi.org/10.3390/languages7040284

Received: 19 October 2022
Accepted: 2 November 2022
Published: 7 November 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. The Influence of Culture on Language Emergence

Yasamin Motamedi, **Kathryn Montemurro**, **Natasha Abner**, **Molly Flaherty**, **Simon Kirby**, and **Susan Goldin-Meadow** explored the basis of the action–object distinction in natural language, in the laboratory rather than in the field. Using the *silent gesture paradigm* with hearing non-signers, they ask whether the dyads of gesturers can innovate distinctions between objects and actions in an experimental communication task. They presented dyads with video scenes showing target objects being used by an actor in either typical or atypical contexts. The most significant distinctions found in the study were between typical and atypical situations. An example of a typical context would be using a camera to take a photograph; an atypical context would be using a camera to dig in the soil. In contrast to the typical context, where the object can be incorporated into the action (holding the hands in the shape of a camera as if to take a picture), an atypical context compels the participant to explicitly distinguish between an object and its action. The authors find that, despite having little experience in using gestures for a task such as this, dyads are more likely to gesture the object by itself, followed by a gesture for the action. Coders recorded whether the participants' used the base hand, whether the location of the gesture was on the body or in neutral space, the size of the gesture, and whether the gesture had repetitions in movement. Dyads formed gestural distinctions between objects and actions in their use of the base hand and with repetitions, but they did not consistently use locations on or around the body, nor did they vary the size of the gesture. The laboratory-produced forms show important similarities with the kinds of noun–verb distinctions described in naturally emerging languages such as Nicaraguan Sign Language (Abner et al. 2019). This indicates that distinguishing between objects and actions is an essential feature of human communication (Supalla and Newport 1978), as has been shown for two emerging sign languages (Tkachman and Sandler 2013), and likely provides a basis for the emergence of nouns and verbs in nascent sign languages in general. Motamedi et al. also found convergence on forms within dyads (irrespective of iconicity), implicating cultural transmission as a relevant factor in the emergence of language.

Rabia Ergin's study contributes to a growing body of research studying how signers select and regularize gestural strategies for the purpose of building linguistic structure. Her field study also dealt with objects and actions, focusing on whether objects and actions are consistently differentiated in an emerging sign language used in Turkey. Five older and five younger Central Taurus Sign Language (CTSL) signers were shown two tasks: the first involved naming a photograph of an object in isolation; the second involved identifying the same object as used in an action by an actor. Ergin found that both cohorts preferred first depicting an action associated with the object, then describing the form and shape of the object. Older signers were more likely to use single signs or shorter strings when naming an object in isolation, compared with younger signers who used longer sign combinations and compounds in their responses.

When viewing a short video of an actor using objects in several atypical actions, such as dropping a pair of sunglasses, a hat, or a jacket (as opposed to putting them on), both cohorts chose one of two strategies. Either they ignored the actions in the array and referred only to the object, using object-based strategies such as shape and size, or they used object and action strategies together simultaneously. Ergin describes iconic strategies for actions and objects that become more consistently differentiated in signers of this emerging sign language. The patterning of responses within each of the signing cohorts shows not only that their strategies are shaped and regularized, but that their responses are consistent within their cohorts, a finding which is compatible with the cultural transmission factor supported by Motamedi et al., described above. Additionally, the younger cohort's preference for longer strings in their responses suggested to Ergin that they are more aware of the communicative pressures in the task, and acted to identify the target object separately from the other potentially confusing choices.

John B. Haviland presents a close analysis of the emergence of a grammatical marker in the language of a young, second-generation signer of a family sign language (which he dubbed Z), whose first cohort consisted of three deaf siblings, a hearing sibling, and a hearing niece. This child was the hearing son of the first deaf signer of Z. Haviland follows in detail an original conventionalized gestural emblem requesting attention (COME), which is ubiquitous among speakers of the spoken Tzotzil Mayan language of the surrounding community. The sign is first adopted in Z in the form of a more brief sign (HEY1), which calls for an interlocutor's visual attention. HEY1, in turn, is reduced in Z to HEY2, which signals that a signer is about to start a new signed utterance or to transition to a new conversational topic, when they have already secured their interlocutors' visual attention.

The bulk of the article is devoted to showing how Victor, the youngest signer of Z, beginning at 11 months, gradually acquires all three of these signs in order, while simultaneously acquiring both Z and Tzotsil. Victor's acquisition of pragmatic signs in Z, such as the one tracked in this study, demonstrates how the grammar of a language, including an emergent sign language, is built upon the practices of a language community and the basic parameters of local social life.

Olivier Le Guen tackles a topic that is much-studied and somewhat controversial in established sign languages: verb agreement. His study is based on his research on the emerging Yucatan Maya Sign Language. Agreement consists of moving the hands from a spatial locus established for the subject to that established for the object of a verbal sign. Early research suggested that this system takes time to develop in young sign languages, both in the Al-Sayyid Bedouin village sign language and even in the young national deaf community sign language, Israeli Sign Language (e.g., Padden et al. 2010). In contrast, Le Guen's study shows that the use of space in verb agreement does emerge early in

Yucatan Maya Sign Language; he attributes this to the gestures of the ambient culture described in his own earlier work. The article links cultural gestural patterns to sign language grammatical rules, and is commensurate with the view that culture contributes to the structure and emergence of language, a view put forth in the laboratory work of Smith and Kirby (2012), supported in Meir and Sandler (2020), and further supported by many articles in this Special Issue.

Anne-Marie Kocab, **Anne Senghas**, and **Jennie Pyers** turn to nonmanual signals. They ask whether Nicaraguan Sign Language (LSN) non-manual markers for WH-questions might have been based on the gestural and facial expression repertoire of hearing non-signers in the same culture. It has been claimed in the past, but without the benefit of empirical diachronic data, that linguistic facial expressions in sign languages derive from expressions that occur in general culture (e.g., Janzen and Shaffer 2003). It has also been rigorously demonstrated that particular linguistic facial expressions and head positions and their scope take time to emerge in young Israeli Sign Language (Dachkovsky 2018). Kocab et al.'s study in this collection is the first to systematically compare wh-question facial expressions of deaf signers with those of hearing non-signers in the same culture, and to track this signal's emergence in a young sign language, LSN. Using data collected from the first cohort of signers of LSN (the first to attend a recently established school for deaf children in Managua), they examined how the non-manual forms of the first cohort of signers compare with those of hearing non-signers of a comparable age. They then compared the first cohort of signers with second and third cohorts to track whether there are systematic changes in their non-manual productions. They report that although there is similarity in the types of non-manual markers used by hearing non-signers and the first cohort of LSN signers, the second and third cohort of signers exhibit greater selectivity with respect to which markers are used most frequently and which are used less frequently. Second and third cohorts of signers use significantly more brow furrows in their questions than hearing non-signers, and they make less use of head tilts. Furthermore, the authors report that the duration of these markers is longer in the later cohorts, implicating the scope of linguistic constituents as a determining factor. Unlike facial expressions used by hearing gesturers, the nonmanual forms of later cohorts of LSN signers possibly exhibit a narrowing of expressive options as well as an increase in frequency and duration of these forms.

Hannah Lutzenger, **Roland Pfau**, and **Connie de Vos** discuss the transition from gesture to sign in the history of the marker for negation in Kata Kolok, a rural language isolate from Bali. After outlining the typology of negation in both signed and spoken languages, and discussing the sociolinguistic place of Kata Kolok and its users, the authors present the results of their study, with data garnered from signers from generations III to V of the community. They concentrate on the balance between manual and non-manual signs in the expression of negation, both in Kata Kolok and more broadly. Kata Kolok signers negate extensively with both manual and nonmanual markers; however, the language does not favor the use of one over the other, unlike most sign languages in which negation has been discussed to date.

2. Iconicity

How does communication develop, starting from the invented system of one deaf person used with their hearing communication partners (CPs—a home sign situation), along a continuum to a conventionalized language? The emergence of sign language in a deaf individual in a hearing community is the topic of the article by **Madeline Quam**, **Diane Brentari**, and **Marie Coppola**. The authors focus on handshapes in iconic signs, and study both the signs of homesigning children and homesigning adults, as well as the comprehension of hearing CPs of both groups, and of unrelated hearing and deaf people. The researchers followed Padden et al.'s (2013) work on patterned iconicity in sign languages, which showed different types of iconic motivation underlying either handling or object forms in different sign languages. Quam et al. categorized iconic signs into those that represent handling an object, those that represent the object itself, and those that represent both (typically, handling with one hand and object with the other). The authors looked for preferences according to category, and for conventionalization across homesigners and their CPs. Among other findings, the authors found that homesigners were more consistent than their CPs; that hearing family members who were exposed at a young age to the deaf homesigning family member understood the home signs better than those who were exposed older; but that American Sign Language signers, who were not CPs of the homesigners at all, understood the home signs best—a tantalizing result.

The article by **Diane Stoianov**, **Diná Souza da Silva**, **Jó Carlos Neves Freitas**, **Anderson Almeida-Silva**, and **Andrew Nevins** examines classifier constructions in Cena, a village sign language in Brazil, and compares them with those of Libras, the established national deaf community sign language. Classifier constructions exist in all known established sign languages. These constructions combine lexically specified handshapes, which classify entities in the world, with the manner of movement and path direction, which are iconic and often considered to be more gesture-like. Stoianov and colleagues address three questions, explaining how each is related to iconicity: (1) whether there is more variation/less conventionalization in the young Cena than in the established Libras, as reported for other sign languages (e.g., Meir and Sandler 2020), and as demonstrated by Mudd et al. in this collection; (2) whether the classifier handshapes are more complex in the younger language, only adhering to articulatory constraints at a later stage, as predicted by the findings of Brentari et al. (2012); and (3) whether the manner of movement and path direction elements in classifier constructions are overlaid simultaneously on one another or whether they are isolated into discrete sequential linguistic units, as reported for early Nicaraguan Sign Language (Senghas et al. 2004). The study's findings differ from expectations raised by other research, reminding us that sign languages can take different paths of emergence. The methodology provides a good model for statistical analyses and careful comparative work across sign languages.

3. Shared Context and Variability

Katie Mudd, **Connie de Vos**, and **Bart de Boer** investigate the question of whether social structure affects the degree of lexical variation in the emergence of sign language. Evidence from signing communities supports this, with smaller, more insular communities typically displaying a higher degree of lexical variation compared with larger, more dispersed, and diverse communities. These findings are in line with studies of spoken languages, where languages with fewer speakers have been shown to tolerate more lexical irregularity. They focus on how shared context, facilitating the use of iconic signs, permits the retention of lexical variation in the emergence of language. They present the results of their own computational agent-based model in detail, which encompasses both shared context and population size, to tease apart the contributions of the two factors. They take care to link the model to real-world examples. After discussing several possible improvements to the model, they conclude that it does provide support for the roles of the social factors of both population size and shared context in influencing lexical variability in a language.

4. Vulnerability of Emerging Sign Languages

Marah Jaraisy and **Rose Stamp** focus on the language contact situation between two sign languages in Kufr Qassem, Israel. At present, third-generation deaf signers in Kufr Qassem are exposed to the local sign language, Kufr Qassem Sign Language (KQSL), and the dominant sign language of the wider Israeli deaf community, Israeli Sign Language (ISL), both of which emerged around 90 years ago. The authors note that there are currently about 120 deaf Kufr Qassem signers in the community, and that the school system there adopted ISL from early on, social factors that could influence the outcome they report. Third- and fourth-generation deaf people in Kufr Qassem are also exposed to ISL in the wider deaf community, within the medical, sports, legal, and interpreting services, as well as on social media. Jaraisy and Stamp analyzed the signing of twelve deaf sign-bilinguals from Kufr Qassem whilst engaging in a semi-spontaneous task in three language conditions: (1) with another bilingual signer, (2) with a monolingual KQSL signer, and (3) with a monolingual ISL signer. The results demonstrate that KQSL–ISL sign-bilinguals show a preference for ISL in all conditions, even when paired with a monolingual KQSL signer. They conclude that the degree of language shift in Kufr Qassem is considerable. KQSL may be endangered due to the risk of social and linguistic mergence of the KQSL community with the larger surrounding ISL community.

5. Comparing Emerging Sign Languages and Creoles

John McWhorter compares what we know about the emergence of spoken and signed languages in order to find evidence for fundamental properties of language. Although no known spoken languages have emerged de novo, creole languages, whose first native speakers do not have access to native-speaker input, can profitably be viewed as cases of the re-emergence of language. Sign languages have been compared with creoles in structure (Fischer 1978); however, because the vast majority of signers have non-signing, hearing parents, sign languages have also been characterized as being re-creolized in every generation (Newport 1981).

McWhorter looks at six grammatical features that have been singled out in the literature on the transition from pidgin to creole languages, finding that three of them are also found in emerging sign languages, suggesting that these three are common to all emerging languages, regardless of modality.

Although many creoles exhibit SVO word order, McWhorter concludes that this may be heavily influenced by the source language, which, in many known instances, is an SVO European language. Emerging sign languages are less consistent, leading McWhorter to conclude that the jury is still out on this issue.

On the question of determiners, both definite and indefinite, McWhorter finds evidence for the earlier emergence of indefinites, which he suggests is due to the earlier emergence of overt marking for new information (indefinites) before the overt marking of old information (definites), although the data are admittedly somewhat sparse.

Subordinate clauses are found in all creoles and most have overt markers of syntactic complementation, although not all pidgins do. Although members of the very first generation of emerging sign languages do not always exhibit sentence embedding, it has been widely reported for most sign languages, suggesting that it emerges quickly and may be universal.

When it comes to tense and aspect, most creoles have markers for past, progressive, and future. Aspect marking is found in all but the youngest sign languages; however, tense marking is not, which leads McWhorter to conclude that aspect is more fundamental to human language.

Inflection is sparse in creole languages and slow to emerge when it does, whereas it emerges very early in sign languages. McWhorter follows the literature (e.g., Aronoff et al. 2005) in concluding that the early emergence of inflection in sign languages is a consequence of the modality.

Finally, McWhorter discusses semantic opacity in derivational morphology, and concludes that this is a function of language age and lexicalization, not of the language capacity itself.

6. Conclusions

Late in the 20th century, linguists began to suspect the possible value of sign language emergence for the study of human language in general. This Special Issue brings together research on a broader array of emergent phenomena in sign languages than has ever been assembled in one place before. The articles provide a rich spectrum of new data and new insights into emerging sign language phenomena, fulfilling the promise of that earlier suspicion.

Author Contributions: The three authors made equal contributions to this editorial. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abner, Natasha, Molly Flaherty, Katelyn Stangl, Marie Coppola, Diane Brentari, and Susan Goldin-Meadow. 2019. The noun-verb distinction in established and emergent sign systems. *Language* 95: 230–67. [CrossRef]

Aronoff, Mark, Irit Meir, and Wendy Sandler. 2005. The paradox of sign language morphology. *Language* 81: 301–44. [CrossRef] [PubMed]

Brentari, Diane, Marie Coppola, Laura Mazzoni, and Susan Goldin-Meadow. 2012. When does a system become phonological? Handshape production in gesturers, signers, and homesigners. *Natural Language & Linguistic Theory* 30: 1–31.

Dachkovsky, Svetlana. 2018. Grammaticalization of Intonation in Israeli Sign Language: From Information Structure to Relative Clause Relations. Ph.D. dissertation, University of Haifa, Haifa, Israel.

Fischer, Susan D. 1978. Sign language and creoles. In *Understanding Language through Sign Language Research*. Edited by Patricia Siple. New York: Academic Press, pp. 309–31.

Janzen, Terry, and Barbara Shaffer. 2003. Gesture as the substrate in ASL grammaticalization. In *Modality and Structure in Singed and Spoken Languages*. Edited by Richard P. Meier, Kearsy Cormier and David Quinto-Pozos. Cambridge: Cambridge University Press, pp. 199–223.

Meir, Irit, and Wendy Sandler. 2020. Variation and conventionalization in young sign languages. In *Linguistic Contact, Continuity and Change in the Genesis of Modern Hebrew*. Edited by Edit Doron, Malka Rappaport Hovav, Yael Reshef and Moshe Taube. Amsterdam: John Benjamins, pp. 337–63.

Newport, Elissa L. 1981. Constraints on Structure: Evidence from American Sign Language and Language Learning. In *Aspects of the Development of Competence*. Edited by W. Andrew Collins. Minnesota Symposia on Child Psychology Series. Hillsdale: Lawrence Erlbaum, vol. 14, pp. 93–124.

Padden, Carol, Irit Meir, Mark Aronoff, and Wendy Sandler. 2010. The grammar of space in two new sign languages. In *Sign Languages: A Cambridge Survey*. Edited by Diane Brentari. New York: Cambridge University Press, pp. 573–95.

Padden, Carol, Irit Meir, So-One Hwang, Ryan Lepic, Sharon Seegers, and Tory Sampson. 2013. Patterned iconicity in sign language lexicons. *Gesture* 13: 287–308. [CrossRef]

Senghas, Anne, Sotaro Kita, and Asli Ozyürek. 2004. Children creating core properties of language: Evidence from an emerging sign language in Nicaragua. *Science* 305: 1779–82. [CrossRef] [PubMed]

Smith, Kenny, and Simon Kirby. 2012. Compositionality and linguistic evolution. In *The Oxford Handbook of Compositionality*. Edited by Wolfram Hinzen, Edouard Machery and Markus Werning. Oxford: Oxford University Press, pp. 493–509. [CrossRef]

Supalla, Ted, and Elissa Newport. 1978. How many seats in a chair? The derivation of nouns and verbs in American Sign Language. In *Understanding Language through Sign Language Research*. Edited by Patricia Siple. New York: Academic Press, pp. 91–132.

Tkachman, Oksana, and Wendy Sandler. 2013. The noun-verb distinction in two young sign languages. *Gesture* 13: 252–86. [CrossRef]

languages

MDPI

Article

The Seeds of the Noun–Verb Distinction in the Manual Modality: Improvisation and Interaction in the Emergence of Grammatical Categories

Yasamin Motamedi [1,*], Kathryn Montemurro [2], Natasha Abner [3], Molly Flaherty [4], Simon Kirby [1] and Susan Goldin-Meadow [5]

1 Centre for Language Evolution, University of Edinburgh, Edinburgh EH8 9AD, UK; simon.kirby@ed.ac.uk
2 Department of Linguistics, University of Chicago, Chicago, IL 60637, USA; kathryn.montemurro@gmail.com
3 Department of Linguistics, University of Michigan, Ann Arbor, MI 48109, USA; nabner@umich.edu
4 Department of Psychology, Davidson College, Davidson, NC 28035, USA; moflaherty@davidson.edu
5 Department of Psychology, University of Chicago, Chicago, IL 60637, USA; sgsg@uchicago.edu
* Correspondence: yasamin.motamedi@gmail.com

Citation: Motamedi, Yasamin, Kathryn Montemurro, Natasha Abner, Molly Flaherty, Simon Kirby, and Susan Goldin-Meadow. 2022. The Seeds of the Noun–Verb Distinction in the Manual Modality: Improvisation and Interaction in the Emergence of Grammatical Categories. *Languages* 7: 95. https://doi.org/10.3390/languages7020095

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 1 October 2021
Accepted: 22 March 2022
Published: 11 April 2022

Abstract: The noun–verb distinction has long been considered a fundamental property of human language, and has been found in some form even in the earliest stages of language emergence, including homesign and the early generations of emerging sign languages. We present two experimental studies that use silent gesture to investigate how noun–verb distinctions develop in the manual modality through two key processes: (i) improvising using novel signals by individuals, and (ii) using those signals in the interaction between communicators. We operationalise communicative interaction in two ways: a setting in which members of the dyad were in separate booths and were given a comprehension test after each stimulus vs. a more naturalistic face-to-face conversation without comprehension checks. There were few differences between the two conditions, highlighting the robustness of the paradigm. Our findings from both experiments reflect patterns found in naturally emerging sign languages. Some formal distinctions arise in the earliest stages of improvisation and do not require interaction to develop. However, the full range of formal distinctions between nouns and verbs found in naturally emerging language did not appear with either improvisation or interaction, suggesting that transmitting the language to a new generation of learners might be necessary for these properties to emerge.

Keywords: silent gesture; interaction; improvisation; grammatical categories; sign language emergence; iconicity

1. Introduction

The majority of the world's languages distinguish between the grammatical categories of noun and verb[1]. Indeed, the grammatical distinction between nouns and verbs has long been considered a fundamental feature of human language (Hockett 1977; Hopper and Thompson 1985; Jackendoff 2002), thought to emerge early on in the evolution of language (Bickerton 1990; Heine and Kuteva 2007).

More recently, studies of emergent linguistic systems offer support for the fundamental nature of the noun–verb distinction. Research on homesign systems, communication systems created by deaf children without a language model, suggest that such children distinguish between nouns and verbs (Goldin-Meadow et al. 1994). Furthermore, research on emerging sign languages suggests that differences in how noun and verb forms are produced can emerge even in the earliest stages of language creation (Abner et al. 2019; see also Goldin-Meadow et al. 2014). However, this body of work has also noted that systematic noun–verb distinctions do not emerge fully formed, but become increasingly systematised and conventionalised through the development of a linguistic community.

It is difficult to study the factors that lead to systematization and conventionalization in a naturally emerging language, simply because we have no control over the conditions under which the language is developing. We turn here to an experimental paradigm that has the potential to allow us to model the emergence of noun–verb distinctions in the manual modality. To the extent that our experimental paradigms reveal a picture of language emergence that resembles the picture we get from naturally evolving languages, we will have evidence that these artificial language experiments are good models for the study of naturally emerging languages. We can then use the paradigms to experimentally explore factors that influence emergence. We focus on two processes that have the potential to shape the evolution of noun–verb categories in emerging communication systems: (i) improvisation and (ii) interaction. We examine how individual participants improvise and innovate novel gestural signals for events in which the target object is the focus (noun context) and events in which the target action is the focus (verb context), and then investigate how those gestures change when used in interaction.

1.1. Noun–Verb Distinctions in Natural Sign Languages

The grammatical categories of nouns and verbs are almost universally present across languages and modalities, and are thought to be based on pre-linguistic conceptual categories (Hurford 2007)—namely, the need to communicate about objects in the world (i.e., nouns) and the properties/actions of those objects or the relations between them (i.e., verbs). Nouns and verbs differ in how they are used in a simple proposition, with nouns typically heading subjects and objects (or other participant roles), and verbs typically heading predicates in a proposition. In addition to this functional distinction, nouns and verbs can also differ in form, either in the base form itself (e.g., *sing/song*, *procéss/prócess*), or in other formal properties that can map onto these functional contrasts. In spoken languages, for example, constituent order can distinguish verbs from nouns, and nouns and verbs can carry different inflections—nouns are often marked for gender, number and person, and verbs for tense, aspect and mood.

In sign languages, constituent order, syntactic distribution, and morphosyntactic marking also distinguish between nouns and verbs. In addition, sign languages frequently signal grammatical categories by altering the sign form in nouns and verbs that have similar underlying forms (see Abner 2021 for an overview). For example, verb and noun signs can be distinguished by size or length of movement: verbs tend to be articulated with a larger movement (Kimmelman 2009; Pizzuto and Corazza 1996), or longer duration (Hunger 2006; Pizzuto and Corazza 1996) than nouns. They can also be distinguished by the manner of movement: verbs may be articulated with continuous movement while nouns are articulated with more restrained movement in both American Sign Language (ASL) and Australian Sign Language (Auslan) (Johnston 2001; Supalla and Newport 1978). In addition, nouns in both ASL and Auslan, as well as Russian Sign Language, tend to be articulated with repeated movements, whereas verbs exhibit variability based on their meaning (Johnston 2001; Kimmelman 2009; Supalla and Newport 1978). Finally, sign languages such as British Sign Language (BSL) can borrow mouthings from the ambient spoken language, and use these mouthings to distinguish nominal and verbal forms, with noun forms more likely to be accompanied by mouthing than verb forms in some languages (Hunger 2006; Johnston 2001; Kimmelman 2009; Tkachman and Sandler 2013). There are, however, cross-linguistic differences in how some of these strategies are implemented; for example, evidence from Turkish Sign Language (TİD), Sign Language of the Netherlands (NGT) and homesign shows that, in at least these cases, repetition is *less* likely to occur in nouns than verbs (Goldin-Meadow et al. 1994; Kubus 2008; Schreurs 2006).

Nevertheless, most documented sign languages demonstrate a set of noun–verb pairs distinguished by altering properties of a shared underlying form and display striking cross-linguistic commonalities in how these distinctions are made (Tkachman and Sandler 2013). Such distinctions have been shown primarily to operate over subsets of noun–verb pairs associated with concrete objects and instrumental actions (e.g., WINDOW/CLOSE-

WINDOW) where the base form is iconically motivated (e.g., the two hands representing two panes of a window), though Abner (2017) provides evidence that this alternation is not limited to concrete object nouns in ASL but is also available to derive abstract, result-denoting nouns (e.g., ACCEPTANCE derived from ACCEPT). For practical reasons, experiments eliciting this contrast (including those detailed in the current manuscript) are limited to the concrete object portion of this paradigm, as these are easier to depict in video and pictorial stimuli.

Within sign language research, researchers have suggested that some of the strategies used to mark the noun–verb distinction—in particular, differences in the manner of movement and repetition—are based on iconic affordances of the categories (Abner et al. 2019; Aronoff et al. 2005; Johnston 2001; Kimmelman 2009; Tkachman and Sandler 2013; Wilbur 2008; Wilcox 2004). This iconic relationship has been suggested in particular to relate to the event structure of the verb (Wilbur 2003). Supalla and Newport (1978) observed that, while nouns in noun–verb form pairs are consistently distinguished in the same way, the specific form of the verb will depend on the properties of its event structure, consistent with the *Event Visibility Hypothesis*, which states that formal properties of predicates in sign languages reflect the semantics of event structure. For example, Tkachman and Sandler (2013) suggest that the continuous/restrained mapping for the manner of movement to verbs and nouns, respectively, represents a mapping of continuous and temporal aspects of the event structure of verbal forms. Similarly, Kimmelman (2009) suggests that verbal forms exploit embodied iconicity to signal events (i.e., that differences in sign movement might signal a difference in the movement of the event itself), which is less inherent in the noun mapping. In this way, systematic noun–verb distinctions that evolve over time may be seeded by the iconic properties of the underlying event descriptions. To further understand how these grammatical distinctions emerge, we turn to the evidence offered from studies of emerging linguistic systems.

1.2. The Emergence of Grammatical Categories

If the grammatical categories of nouns and verbs are fundamental to human languages, then we might expect them to emerge early in the creation of a novel linguistic system (Bickerton 1990; Heine and Kuteva 2007). Currently, homesign systems and emerging sign languages provide some of the only natural examples of language creation and emergence, allowing us to observe novel linguistic systems through their earliest generations.

Homesign systems are gestural communication systems developed by children who do not have access to a conventional language model (i.e., profoundly deaf children born to hearing, non-signing parents). These systems are typically used within the immediate family and allow the child to communicate with other hearing family members (albeit with limited shared understanding; (Carrigan and Coppola 2017)). The homesign systems developed by children demonstrate properties found in natural languages—stable lexicons (Goldin-Meadow 2003), grammatical roles (Coppola and Newport 2005), displaced references (Morford and Goldin-Meadow 1997), and relational marking (Goldin-Meadow and Feldman 1977). Studying homesigns can inform us about the distinctions that language creators introduce into languages without the benefit of a conventional language model. For instance, Goldin-Meadow et al. (1994) studied David, a deaf homesigner, who initially distinguished nouns from verbs by using completely different sign forms, even for related meanings. For example, he used *twist* for the verb form (twist-open), and *round-shape* for the noun form (jar). Later he used *twist* for both the verb and noun form, but marked the distinction in gesture form; he placed the *twist* serving the role of verb near an object (similar to inflecting a verb), and produced only one rotation for the *twist* serving the role of the noun (abbreviating the noun).

Homesign systems can be studied alongside emerging sign languages to further understand the impact that having a linguistic community has on marking grammatical distinctions. For example, Nicaraguan Sign Language (NSL) began to develop in the late 1970s when a new government policy established a school for deaf students in Managua.

The school allowed deaf children, who had developed homesign systems with their hearing families and had no access to other deaf individuals, to come together for the first time and share their homesign systems. Nicaraguan Sign Language (NSL) was born in this first cohort. As new deaf children entered the school, they learned the language (which changed in the course of learning) from the older children, thus forming a second cohort of NSL users.

Goldin-Meadow et al. (2014) analysed the consistency of handshape forms used for nominal and predicate constructions in Nicaraguan homesigners and the first and second cohorts of NSL. Overall, handshapes in nominal signs were less variable than handshapes in predicate signs, and the variability played different roles in the two types of signs. There was no variability across grammatical contexts (e.g., an agent vs. no-agent context) in nominals but considerable variability in predicates. Moreover, the variability in predicates was systematic across agent vs. no-agent contexts, suggesting that handshape functions as a productive morphological marker on predicate signs, even in homesign. In nominals, there was no variability across grammatical contexts (agent vs. no-agent). All of the groups, including homesigners, thus distinguished between forms playing nominal vs. predicate roles.

Similarly, Abner et al. (2019) analysed differences in form between nouns and verbs in three groups: ASL users, NSL users, and Nicaraguan homesigners, focusing on pairs of nouns and verbs with the same underlying form (e.g., camera vs. taking a photo). They analysed signs based on some of the properties that have been previously shown to mark noun–verb distinctions in natural sign languages (e.g., size, repetition). All three groups marked a distinction between nouns and verbs using utterance position (verbs were placed at the end of an utterance, nouns earlier in the utterance) and movement size (verbs were made with bigger movements, nouns with smaller movements).

There was, however, variation in whether a base hand and movement repetition were used to mark the noun–verb contrast. This variation offers insight into the pressures that influence the development of a linguistic system, and into cross-linguistic variation in the signed modality (ASL vs. NSL). The first cohort of NSL uses movement repetition and base hand just like homesigners do, but different from the second cohort who entered the NSL community later and learned a *pre-existing* system. This finding suggests that intergenerational transmission to new learners (not just sharing a language with other signers) plays a key role in the development of these particular devices. These results demonstrate not only the importance of the noun–verb distinction in human communication, but also how this distinction emerges and develops in a new (sign) language.

The evidence thus far suggests that distinctions between nouns and verbs are present in the earliest stages of novel linguistic systems. However, these distinctions may not initially be fully conventionalised or codified, but may instead become conventionalised through use with communication partners in the linguistic community. We present two experimental studies that aim to explore how the improvisation of novel signals by individuals, and the interaction between users of an emerging system, affect the noun–verb distinction. Using a silent gesture task in which hearing, non-signing participants are asked to communicate using only their hands, we assess whether participants spontaneously improvise distinctions between forms playing noun-like and verb-like roles, and whether those distinctions reflect those found in naturally emerging sign languages. We also introduce shared communication into our paradigm to explore whether communicative interaction affects the development of the distinctions. In this way, we investigate the extent to which distinctions between nouns and verbs in naturally emerging languages represent natural conceptual categories, and the extent to which they do and do not depend on shared communication.

1.3. Experimentally Modelling the Noun–Verb Distinction

Previous experimental research has demonstrated how methods such as silent gesture, artificial language learning, and experimental semiotics can be used to investigate the pressures that shape language—specifically, pressures from the cognitive biases of individuals, and pressures from the social forces within a linguistic community (Beckner et al. 2017; Fay et al. 2010; Kirby et al. 2015; Motamedi et al. 2019; Nölle et al. 2018; Raviv et al. 2019; Silvey et al. 2019; Verhoef et al. 2014). These experiments elicit novel forms from participants across different media—gestures, drawings, non-linguistic vocalisations—to understand how participants create signals, how participants produce and interpret signals in the presence of a partner, and how signals evolve as they are used in interaction. For example, experiments investigating the creation of novel signals have shown that, in the absence of existing conventions, participants may rely on highly iconic forms to ground shared reference, but that these forms can become increasingly symbolic as they are used and conventionalised through communication (Fay et al. 2010, 2013; Garrod et al. 2007; Perlman et al. 2015; Sulik 2018; Theisen et al. 2010).

The experiments we present use the silent gesture paradigm to explore the evolution of a communication system in the manual modality. Hearing participants with no knowledge of sign language are asked to communicate using only gesture (without speech), a paradigm that has been shown to have limited influence from participants' existing linguistic knowledge (Gershkoff-Stowe and Goldin-Meadow 2002; Goldin-Meadow et al. 2008; Özçalışkan et al. 2016; Singleton et al. 1995). Silent gesture is a paradigm that has been widely used to understand the preferences participants have when creating novel signals. For example, a number of silent gesture studies have investigated word order in speakers of languages that exhibit different word order patterns, asking hearing participants who know no sign language to describe a series of events. Goldin-Meadow et al. (2008) found that participants with different linguistic backgrounds all produced verb-final word orders that mapped onto a Subject-Object-Verb (SOV) order when describing events in which an animate agent acts on an inanimate patient (e.g., MAN-GUITAR-PLAYS). More recent studies suggest that the preference for SOV may be mediated by a variety of factors, such as the semantics of the events (Schouwstra and de Swart 2014), the reversibility of the events (Gibson et al. 2013; Hall et al. 2013), or the possibility of iconic representation (Christensen et al. 2016; Meir et al. 2014).

Silent gesture is also a valuable tool to model the emergence of linguistic properties in the manual modality because it allows comparison with data from naturally emerging sign languages. By embedding silent gesture into an interactive framework in which participants use the gestures they create to communicate with a partner, we can model the processes enacted in the early emergence of sign languages—when signers bring their own homesign systems to a community of deaf individuals, each of whom also has their own homesign system. Previous experimental research that has embedded silent gesture into an interactive framework has shown that novel manual systems adapt to the pressures involved in interaction, and result in conventionalised and communicatively efficient signals (Fay et al. 2013; Motamedi et al. 2019; Nölle et al. 2018; Schouwstra et al. 2016).

Here, we model the processes of improvisation (the creation of novel signals) and interaction (use of signals with others who are also using signals) to understand how conventionalised noun–verb distinctions emerge in a manual communication system. We compare the systems resulting from these processes to two stages in the emergence of Nicaraguan Sign Language: (1) homesign, where children without a language model improvise their own communicative systems, and (2) interaction in the first cohort, where the formation of a linguistic community leads to the conventionalisation of signals from the improvised communicative systems. We asked participants to improvise gestures for a set of event scenes devised by Abner et al. (2019), and then use those gestures in interaction with a partner. We analysed the gestures participants produced using the coding system developed by Abner et al. (2019). We predict that the strategies used to distinguish nouns and verbs that have been found in the earliest stages of language creation (i.e., in homesign: the preference for verb-final ordering) will be present in the gestures that our participants create. However, the strategies that are found only in later cohorts of NSL and in ASL may be absent from the gestures that our participants create. We further predict that the distinctions participants improvise will rely on the iconic affordances of the modality, as suggested by Wilbur (2008) and Kimmelman (2009), for example, with gesture size and repetitions iconically representing properties of individual items.

2. Experiment 1

2.1. Methods

2.1.1. Participants

Experiment 1 was conducted at the University of Edinburgh and recruited participants from the university's Careers Hub website. Forty participants (aged 18 to 27, median age = 20; 13 male) took part in a study that required them to produce and interpret gestures for a set of video scenes that depicted objects being used either in a scenario that was either typical or atypical for the object. Participants were paid GBP 7 to take part in the experiment. All participants were self-reported to be right-handed "native" English speakers, with no knowledge of any sign language. Participants took part in the experiment concurrently with another participant, who acted as their communication partner in stage 2 of the task (see Section 2.1.3), giving a total of 20 pairs. Data from 5 pairs were not included in the analyses due to technical errors in video recording.

2.1.2. Materials

We used a set of video scenes designed to show target objects used in either a typical or atypical context. For example, a scene in which a man takes a photo with a camera shows a camera being used in a typical context; a scene in which a man digs with a camera shows a camera being used in an atypical context (Figure 1). Typical scenarios are expected to elicit gestures for typical actions ('take picture with camera'), and thus more verb-like productions. Atypical scenes are expected to elicit gestures related to the target object ('camera'), and are thus more noun-like productions. We selected a set of 24 vignettes, showing 12 objects used in typical contexts and 12 used in atypical contexts. The video scenes we used were a subset of those used in the study reported by Abner et al. (2019), for which objects were selected that would be familiar to participants in the United States and in Nicaragua and which would elicit different types of movements. The subset of vignettes was selected such that each type of atypical use (e.g., drop in bin, drop in water glass) was used with at least 2 objects[2].

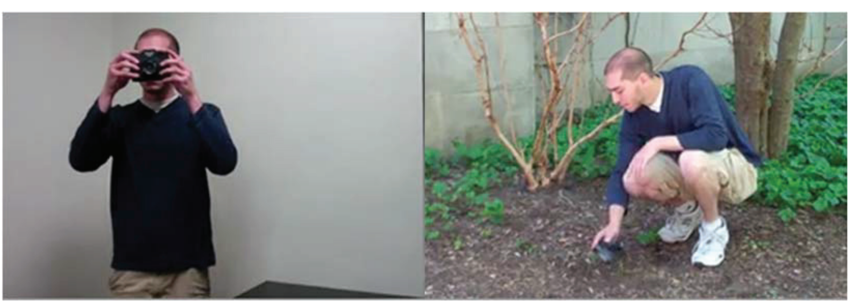


Figure 1. Example of scenes used in the study. (**Left**) a typical-use scene showing a person taking a photo with a camera. (**Right**) an atypical-use scene, showing a person digging with a camera.

Participants completed the experiment in individual experiment booths for the duration of the experiment. The experiment was run on an Apple Thunderbolt monitor, attached to an Apple Macbook Air laptop. Video recording was done using a Logitech webcam, also attached to the laptop, and the experiment ran using Psychopy (Peirce 2007). Video streaming and recording used VideoBox, custom software designed to enable streaming and recording between networked computers (Kirby 2016).

2.1.3. Procedure

The experiment comprised three stages. In the first stage, the *improvisation* stages, participants produced gestures for each vignette individually, without communicating with another participant. In the second stage, termed the *interaction* stage, participants communicated with their partners, producing and interpreting a gesture for each vignette. In the third stage, another *improvisation* stage, participants again produced gestures individuallya so that we could see whether any changes introduced in stage two were retained in stage 3 (Figure 2). Throughout the experiment, participants communicated using only manual gestures. Participants were instructed not to use speech when gesturing (audio was not recorded), nor to use fingerspelling of any kind. Participants were also asked to remain seated throughout the task.

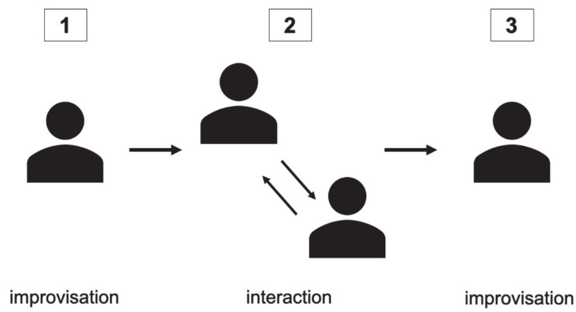


Figure 2. Stages in experiment 1. Participants take part in 3 stages: first, they take part in an improvisation stage, producing gestures to describe each vignette. They then take part in an interaction stage, producing and interpreting gestures in interaction with a partner. Finally, they complete a second improvisation stage.

In the first and third stages, participants were presented with each vignette, in random order, and asked to produce gestures to communicate each scene. One vignette was shown and a gesture was elicited at each trial. Participants were given a 3 s countdown to prepare them for the beginning of each trial. The vignette was shown on the screen, playing through twice, before participants were instructed to communicate the scene they had watched to the camera, using only gestures. Participants were again shown a 3 s countdown, this time to prepare them for recording. When recording began, participants saw themselves onscreen (mirrored) in the VideoBox window. Instructions were shown onscreen throughout the trial, informing participants to press the space bar to stop recording and move on to the next trial. Participants completed trials for all 24 vignettes. The procedure was identical for both improvisation stages.

In the intervening interaction stage, participants took turns with a partner to produce and interpret gestures, in a director–matcher task. Participants both produced and interpreted gestures for each vignette, giving a total of 48 trials in the interaction stage (i.e., each participant acted as director and receiver for all 24 vignettes). Participants switched roles at each trial, and the presentation of the scenes in each trial was randomised. Participants remained seated in individual experiment booths, and communication was enabled by streaming video between networked computers.

As director, the participant was asked to produce a gesture to communicate the vignette to their partner. After a 3 s countdown, participants were shown a vignette, twice through, as in the improvisation stages. They were then instructed to communicate the scene they had just watched to their partner. A 3 s countdown prepared them for recording and streaming to their partner. The participant's gesture was streamed to the networked computer operated by the matcher; the director saw themselves mirrored onscreen at the same time. Either director or matcher could stop the recording and streaming by pressing the space bar. When streaming was terminated, the director had to wait for the matcher to guess what the gesture meant. Both participants were given feedback, and the experiment continued to the next trial.

As matcher, participants were given a 3 s countdown to signal the start of the trial, but were shown text on the screen reading "Waiting for partner" whilst the director watched the vignette. The matcher then received a synchronised 3 s countdown to prepare them for the start of streaming and recording. The matcher saw their partner's gesture, unmirrored, on screen. The matcher could terminate streaming by pressing the space bar when they felt they had understood their partner's gesture. Once streaming had been terminated, the matcher saw a set of 4 vignettes and made their guess. The 4 vignettes were chosen from vignettes used throughout the experiment, and comprised the target vignette (correct response) and three foils, determined as follows:

1. **Target object–foil context**: a vignette sharing the target object but showing the non-target action. For example, if the target vignette shows the typical camera context (taking a photo), then this foil would show an atypical camera context (e.g., dig with camera, shown in Figure 3, image 2).
2. **Foil object–target context:** a vignette sharing the target context (typical or atypical) for a different object. For example, if the target vignette shows the typical camera context, this foil would show the typical context for another object (e.g., cut with scissors, shown in Figure 3, image 3).
3. **Foil object–foil context:** a vignette that does not match the target vignette on either object or context, but does match the other foils. For example, if the target vignette shows the typical camera context, and the first foil shows the typical context for scissors, then this foil would show the atypical context for scissors (shown in Figure 3, image 1).

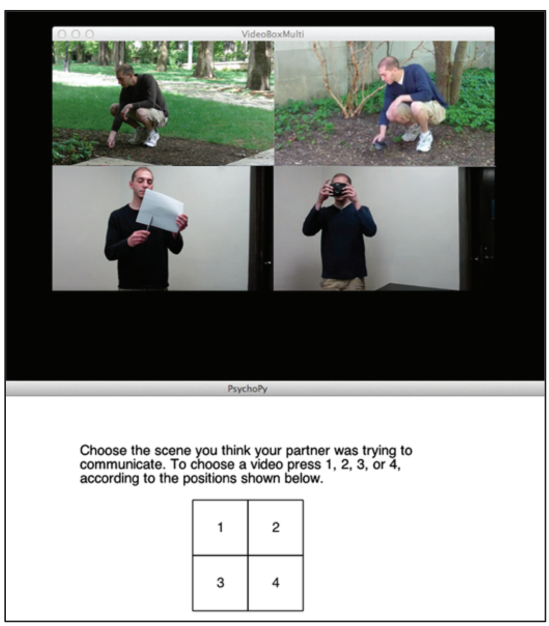


Figure 3. Example of a matching trial. The participant is shown a target and 3 foil videos playing in a loop on screen, and asked to select the video they think their partner was trying to communicate.

The target and 3 foils were presented as a grid of 4 looping videos. The matcher made their guess by pressing the number (from 1–4) of the corresponding video, as indicated in a dummy grid presented below the videos (see Figure 3). Once the matcher responded, both participants were given full feedback. If the matcher's guess was correct, they saw the target video highlighted in green, and the director saw the target video on screen. If the matcher's guess was incorrect, the selected video and the target video were highlighted on the screen in red and green, respectively. In this case, the director saw the target video and the selected video. Both participants also received text feedback on screen, reading either "Correct" or "Incorrect". Feedback showed onscreen for 8 s before the experiment software automatically continued to the next trial, giving participants enough time to see both the target and the selected videos.

2.1.4. Gesture Coding

Here, we analyse the gestures produced in the two improvisation rounds, the first round (before interaction) and the final round (after interaction). Gesture sequences produced at each trial (describing single vignettes) were glossed and coded using ELAN (Sloetjes and Wittenburg 2008) by members of the research team. Individual gestures in a sequence were given a gloss describing each gesture (e.g., take photo), and then category codes were assigned to each gesture denoting 4 main categories:

- **Target action**: gestures representing the action related to the object used in the stimulus; a functional action showing how the target object is used. For example, for the target object camera, the target action would be taking a photo with a camera
- **Target other**: gestures related to the target object, which are not the functional actions associated with that object. For example, for nail polish, a gesture showing the action of opening the nail polish bottle in order to perform the target action of painting the nails.
- **Not related**: gestures not related to the target object, but some other component of the scene, such as the glass of water or bin used in some of the videos.
- **Verb**: gestures representing the atypical verb. For example, drop, dig, cover.

Following Abner et al. (2019), our goal is to analyse some of the formal features that distinguish noun and verb signs across natural sign languages (e.g., size, number of repetitions), in gestures that share a similar underlying form. For example, in Figure 4a, the participant produces two different gestures for typical and atypical scenes featuring the target item egg: in the left-hand panel, she gestures the target action of cracking an egg; in the right-hand panel, she positions her right hand as if holding an egg. Because the participant has chosen two distinct forms to represent the egg, we cannot compare features of the gestures in the typical and atypical contexts. In contrast, in Figure 4b, the participant produces gestures that have the same underlying form for typical and atypical scenes featuring the target item hammer: the participant's hand (or hands) moves as if manipulating a hammer in both cases. By comparing gestures with the same underlying form, we can examine if, across typical and atypical contexts, participants selectively use different features to distinguish productions in contexts designed to elicit noun forms vs. contexts designed to elicit verb forms. Therefore, we take the **target action (TA)** gestures produced in a sequence to be the participant's representation of the intended target (i.e., camera), and we compare TA gestures for the same object that the participant produced in its typical and atypical context[3]. We code these TA gestures for the following formal features known to distinguish nominal and verbal signs in natural sign languages:

- **Base hand use:** the use of a non-dominant hand in a stationary gesture acting as a ground for the dominant hand (e.g., representing the wall in a hammering gesture). Only two-handed asymmetrical gestures (such as representing hammering a wall) can be coded for base hand use (i.e., symmetrical two-handed gestures cannot be articulated with a base hand).
- **Gesture location:** We note the location of the gesture as either placed on the body (specified as eyes, mouth, ear, shoulder, torso) or in neutral space (specified in different zones related to height and laterality of the gesture).

- **Gesture size:** We code gestures as comprising local movement only (articulated using the wrist, thumb or finger joints) or path movement (the elbow, shoulder and trunk are involved in the movement; note that this code subsumes local movements).
- **Repetitions:** We note whether or not there is a repetition within a single gesture unit (target action).

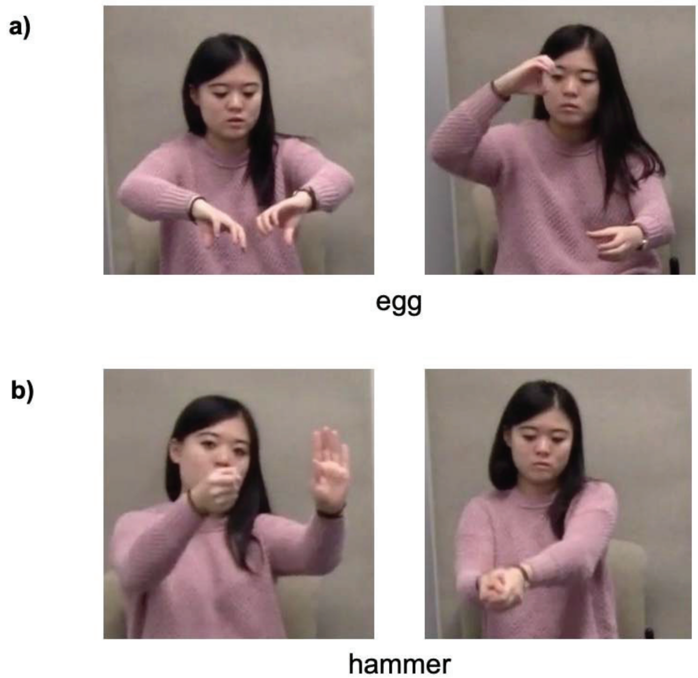


Figure 4. Example of gestures representing targets: (**a**), representing the target item egg where the two forms (left, right) have different underlying representations (**b**) representing the target item hammer, where the two forms (left, right) have the same underlying representations.

Two coders completed coding for data from study 1. A subset of 20% of the data (spanning data from each coder) was second-coded by KM and reliability between this sample and the original coding was calculated using Cohen's Kappa (Cohen 1960) for target action coding and for each of the formal parameters. We found very high agreement for our variables of interest: first target action (κ = 0.93), base hand (κ = 0.85), gesture size (κ = 0.89), gesture location (κ = 0.88) and repetitions (κ = 0.88). The full coding scheme can be found at https://osf.io/qzgjt (accessed on 21 March 2022).

2.2. Results

We analyse our measures using mixed effects models, implemented with R (R Core Team 2013) and lme4 (Bates et al. 2015), including context (typical/atypical) and round (first/final) as deviation-coded binary predictors, as well as their interaction. We use the maximal model (including all slopes and intercepts) that allows convergence, including intercepts for item and participant, nested in pairs. Where models do not converge, we (i) test model fit with different optimizers, (ii) remove correlations between slopes and intercepts, and (iii) remove slopes with the lowest variance. The full specification for each model can be found at https://osf.io/qzgjt (accessed on 21 March 2022).

Sequence length First, we analyse the overall length of gesture sequences for typical and atypical scenes (Figure 5a[4]), using a mixed effects Poisson regression model for count data. A model including both round and scene context, as well as their interaction, demonstrated a better fit than a reduced model ($\chi^2 = 8.47$, $p = 0.003$). The model revealed a significant main effect of context, such that typical scenes were shorter than atypical scenes ($\beta = -0.39$, SE = 0.08, z = -5.14, $p < 0.001$), and an interaction between round and context ($\beta = -0.21$, SE = 0.07, z = -2.92, $p = 0.003$). That is, participants produce longer gesture sequences for atypical compared to typical scenes, but this difference reduces over rounds once participants converge on conventional ways to communicate targets in the atypical contexts.

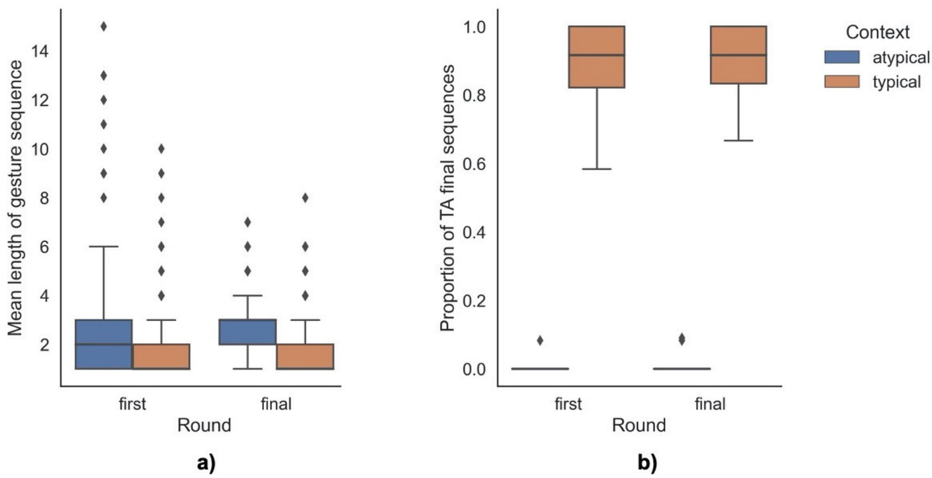


Figure 5. Mean gesture sequence length in terms of the number of individual gestures produced in a sequence (**a**) and Proportion of gesture sequences with a target action (TA) in final position (**b**), shown for each round and each context (typical/atypical).

Target action position. We assess differences in how target actions are positioned in a gesture sequence, using a logistic mixed effects model to analyse how often target action gestures appear in the final position in a sequence (Figure 5b). For example, in a camera event, does the target action gesture (taking a photo with a camera) appear at the end of a gesture sequence or elsewhere in the sequence? We present here a model including only context as a fixed effect, as including round did not improve model fit ($\chi^2 = 1.21$, $p = 0.27$). Participants show a strong preference for producing target actions at the end of the sequence in typical contexts, and rarely produced target actions at the end of the sequence in atypical contexts ($\beta = 10.97$, SE = 1.72, z = 6.36, $p < 0.001$).

In our remaining analyses, we focus on gestures that are directly comparable across typical and atypical scenes—those coded as TA gestures. Though some responses did include multiple TA gestures, we include only the first instance of each TA gesture produced in a sequence (only ~11% of all trials contained more than one TA gesture within the same sequence).

In the following measures, we analyse how often participants' productions differ between typical and atypical contexts based on the four formal properties of gestures we coded: base hand use, gesture location, gesture size, and repetitions. If participants produce distinctions based on scene type, we expect typical contexts to elicit verb-like gestures and atypical contexts to elicit noun-like gestures, varying the gesture properties in ways similar to those found in natural sign languages (i.e., more base hand use for verbs, more repetitions for nouns).

Base hand use. The proportion of scenes in which participants use a base hand for each round and context is illustrated in Figure 6a. We analysed the presence of base hand gestures at each trial using a logistic mixed effects model; the model including round did not show improved fit over the model including only context ($\chi^2 = 0.79$, $p = 0.37$). The model revealed a significant main effect of context, with base hand use more common in typical than atypical scenes ($\beta = 3.19$, SE = 0.96, z = 3.32, $p < 0.001$).

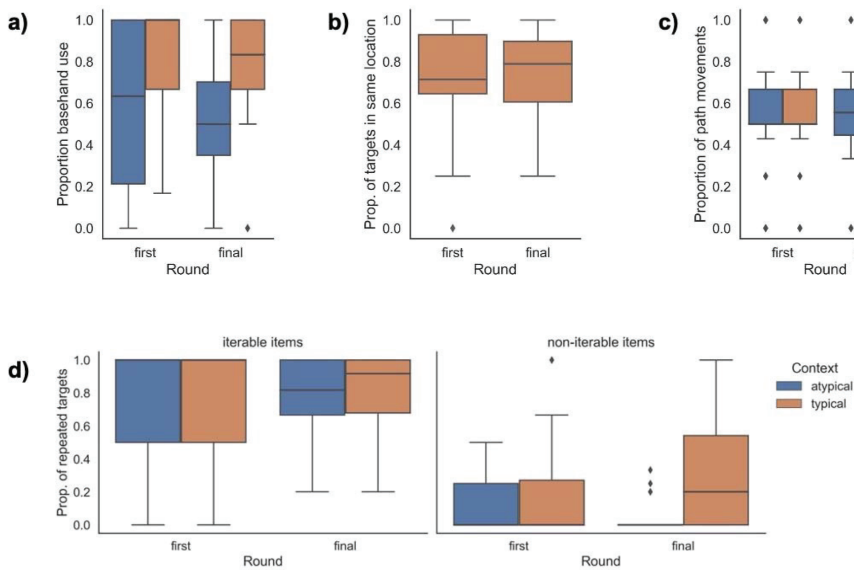


Figure 6. Gesture form analyses for experiment 1, showing base hand use (**a**), proportion of target action gestures produced in the same location for typical and atypical contexts (**b**), gesture size (**c**) and repetitions shown for iterable and non-iterable target actions (**d**).

Location. We used a logistic mixed effects model to analyse whether at each trial participants gesture target actions in the *same* location across typical and atypical contexts (see Figure 6b). Model comparison indicated that including round did not improve fit compared to the null model ($\chi^2 = 0.49$, $p = 0.48$). The model revealed a significant intercept ($\beta = 1.39$, SE = 0.44, z = 3.17, $p = 0.002$), suggesting that, on average, participants gesture TAs in the same location across contexts.

Size. We analyse gesture size as how often participants produce target action gestures with path movements (shown in Figure 6c), using a logistic mixed effects model. Models including only context ($\chi^2 = 0.25$, $p = 0.61$) and only round ($\chi^2 = 0.48$, $p = 0.49$) did not improve fit over a null model. The grand mean from the model intercept did not suggest a reliable preference for path movements overall ($\beta = 1.28$, SE = 1.81, z = 0.71, $p = 0.48$).

Repetitions. We analyse how often target actions are repeated in gestures across typical and atypical contexts using a logistic mixed effects model, adding an additional deviation-coded predictor (including all interactions) of iterability. Some of the events can elicit target actions that can be, and typically are, iterated (e.g., a hammering gesture); other events typically achieve their goal with one movement and thus are not usually iterated actions (e.g., putting on a ring). Our findings are illustrated in Figure 6d. A model including all 3 main effects without interaction terms suggested improved fit over a reduced model without round ($\chi^2 = 5.97$, $p = 0.01$). We found a significant main effect of scene type, such that gestures for typical scenes were produced more often with repetitions than gestures for atypical scenes ($\beta = 0.92$, SE = 0.35, z = 2.65, $p = 0.008$). We also found a main effect of iterability, with non-iterable items demonstrating fewer repetitions ($\beta = -4.23$, SE = 0.77, z = -5.47, $p < 0.001$).

Convergence. Finally, we analyse the extent to which communication between partners has affected the gestures they produce between the first and final production rounds.

We compare gestures produced across pairs of participants (paired in the interaction stage) with pseudo-pairs, matching pairs of non-interacting participants, to assess the specific role communication has in shaping the systems participants produce. We compared the pairs on the four formal properties (base hand, location, size, and repetitions) for target action gestures, and calculated the proportion of those properties that pairs converge on for each target scene (illustrated in Figure 7). We analyse the proportion of form parameters that are the same for paired participants using a logistic mixed effects model, with the proportions weighted by the number of parameters, including fixed effects of round and pair type (both deviation-coded). We include by-pair and by-item random intercepts with a random slope of round for the by-item intercept (including a random slope with the by-pair intercept led to singular fit). The model including the interaction term did not improve fit over the model without ($\chi^2 = 0.24$, $p = 0.63$). Inspection of the model indicated main effects of round ($\beta = 0.10$, SE = 0.04, z = 2.41, $p = 0.02$) and pair type ($\beta = 0.19$, SE = 0.06, z = 3.13, $p = 0.002$)—participants produce more similar gestures to other participants in the final round than in the first but, importantly, similarity is greater for interacting pairs than for pseudo-pairs.

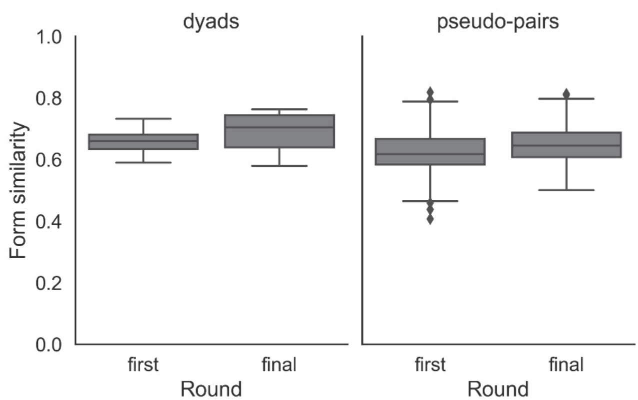


Figure 7. Similarity in form parameters across rounds for real-paired dyads and pseudo-dyads (i.e., who did not interact during the experiment).

2.3. Experiment 1 Summary

In experiment 1, we examined gestural production in contexts aiming to elicit noun-like and verb-like gestures for target objects, investigating how participants' improvised gestures change after interaction with a partner. Our findings suggest that, even in improvised gestures, participants make distinctions between descriptions of targets designed to elicit nouns and targets designed to elicit verbs. Gesture sequences describing typical scenes tended to be shorter than those describing atypical scenes. Gestures for target actions were primarily produced in final position for typical (i.e., verb-eliciting) contexts, but were rarely produced in final position for atypical (i.e., noun-eliciting) contexts. We also found that target action gestures for typical targets were more frequently produced with a base hand gesture than target action gestures for atypical targets, and typical targets were more frequently repeated than atypical targets. Our findings for target position and base hand use reflect distinctions found in ASL, NSL and those made by Nicaraguan homesigners, as reported by Abner et al. (2019). These patterns suggest that some features distinguishing nominal and predicate forms can emerge even in the earliest stages of a communication system. However, we do not find distinctions based on the features of gesture location, gesture size, nor do we see further systematisation of the distinctions following communication. Analysing the convergence between interacting dyads and pseudo-pairs of participants reveals the role interaction plays. We find some patterns of convergence across pseudo-pairs, highlighting general pressures (i.e., iconicity) that may affect gesture similarity. However, interacting participants produce gestures that are more similar to each other's than pseudo-pairs of participants, suggesting that similarities between the gestures produced by interacting participants cannot be attributed solely to iconic representations that would be similar across all participants.

In experiment 2, we further explore how communicative constraints affect the distinctions between gestures produced to signal typical and atypical contexts. In experiment 1, we used a constrained model of communication, a reductionist operationalisation in which participants take set turns to produce and interpret gestures, and receive comprehensive feedback on their successes and errors. As discussed by Kocab et al. (2018), it is possible that some of the constraints in operationalisations of communicative behaviour do not always map well onto natural language use, and that currently, such operationalisations do not account for the full range of behaviours that comprise communication in situated, face-to-face interactions. Such interactions in the real world involve conventions related to turn-taking (Stivers et al. 2009), alignment (Garrod and Pickering 2009) and repair (Dingemanse et al. 2015) that are not possible to enact in the reduced operationalisation we use in experiment 1. In experiment 2, we investigate the same research questions using a more ecologically valid operationalisation of communication, in which turn-taking and feedback about communicative success or failure are under the control of the interacting participants themselves. Furthermore, we contrast the interactive scenario with a condition in which individual participants repeatedly improvise gestures for our event vignettes, without interacting with a partner.

3. Experiment 2

3.1. Methods

3.1.1. Participants

Forty participants took part in experiment 2 (24 female), recruited from the undergraduate population at the University of Chicago. In total, 20 participants took part in the individual condition, and 20 participants took part in a dyadic condition, in which they were paired with another individual (i.e., 10 dyads). Participants were reimbursed for taking part in the study with either a payment of USD 10 or one required research course credit. All participants were self-reported "native" speakers of English with no knowledge of ASL (10 participants reported speaking languages in addition to English). A session with one dyad (two participants) was excluded and re-recorded with a new pair of participants due to a technical error in video recording.

3.1.2. Materials

As in experiment 1, participants were asked to communicate about a set of events shown in vignettes selected from the stimuli used by Abner et al. (2019). A total of 32 vignettes were selected[5], showing 16 unique items used in typical and atypical contexts. We also manipulated the iterability of the vignettes: half of the items were typically used in an iterable manner, where the action is repeated (e.g., *rocking the baby*); half were typically used in a non-iterable manner (e.g., *putting on a backpack*). The experiment took place in a private room and ran on an Apple Macbook Pro laptop using Microsoft Powerpoint. All vignettes were presented in a randomized order. Video recording was done using a Canon Vixia HF R800 camcorder mounted on a tripod. Participants were seated in the room with the laptop on a table beside them, facing the camera during the improvisation stage and facing their partner during the interaction stage.

3.1.3. Procedure

Participants took part in one of two conditions, a dyadic condition and an individual condition (shown in Figure 8). Throughout the experiment, participants were told not to speak or use mouthing, and were told to remain seated for the duration of the task.

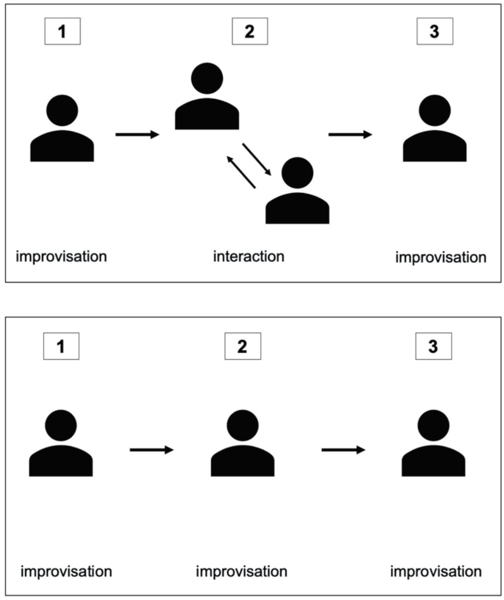


Figure 8. Stages in experiment 2, for the dyadic condition (**top**), identical to experiment 1, and the individual condition (**bottom**), where participants take part in 3 improvisation rounds.

All participants in both conditions were given 3 practice items before the main study began. Participants were shown a vignette and asked to describe it to the experimenter using gestures. Participants who did not produce an explicit gesture for the target item in the vignette (e.g., camera, baby) were instructed to do so by the experimenter. After successful completion of the practice items, the experimenter left the room. The participant controlled the progression of the experiment using the arrow keys to move from trial to trial. Participants were allowed to repeat each vignette as needed before responding. After the initial production stage, the experimenter re-entered the room only to set up the experiment for the following stage or to give instructions preceding the communication stage.

The dyadic condition largely replicated experiment 1 in structure. Participants first completed an initial improvisation stage before taking part in an interaction stage with a partner. However, in the interaction stage, participants were seated in the same room, facing each other, with the computer displaying the vignettes in sight. At each trial, both participants could see the target vignette playing on the computer. After they had watched the video, one participant, the designated gesturer, had to describe the vignette to their partner using only gestures. No feedback was required from their partner and no feedback was given from the experimenter. However, there were no other constraints on how participants could communicate with gestures during the session and paired participants were free to provide gestural feedback to each other, or enact repair strategies on their own productions. Note that this lack of constraints stands in contrast to experiment 1, where participants were physically separate and only interacted via webcam streams between computers. Once the gesturer had finished their gesture, the experiment proceeded to the next trial. Participants switched roles at each trial, producing a gesture on every other trial. Participants completed a total of 64 trials, each producing a gesture for all 32 items. Following the interaction round, participants completed a final improvisation round, identical to the first.

In the individual condition, participants completed three improvisation rounds, each using 3 different randomised sets of all 32 vignettes. Participants produced gestures to communicate each vignette to the camera without a partner, across all three rounds (i.e., no communication took place). There was a brief break period in between rounds while the experimenter set up the next stimulus set.

3.1.4. Coding

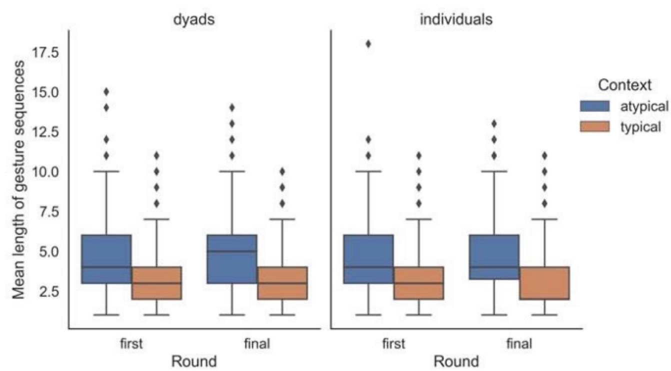
Gesture coding for experiment 2 was identical to the coding carried out for experiment 1 and coding for both experiments was carried out concurrently. As for experiment 1, two coders completed coding for the data and a subset of 20% of the data was second-coded by KM to calculate the reliability. Cohen's Kappa (Cohen 1960) indicated high agreement across our variables of interest: first target action ($\kappa = 0.93$), base hand ($\kappa = 0.84$), gesture size ($\kappa = 0.92$), gesture location ($\kappa = 0.84$) and repetitions ($\kappa = 0.92$).

3.2. Results

Analysis for experiment 2 largely follows the analysis for experiment 1, with the additional inclusion of group (individual vs. dyad) as a deviation-coded fixed effect, along with context, round, and all interaction terms. Model selection follows the same procedure as experiment 1 and a full specification for each model can be found at https://osf.io/qzgjt (accessed on 21 March 2022).

Sequence length. The model including only scene type demonstrated an improved fit over the null model ($\chi^2 = 25.20$, $p < 0.001$); adding additional fixed effects did not improve model fit. Inspection of the model suggests a main effect of context ($\beta = -0.48$, SE = 0.06, z = -7.64, $p < 0.001$), with participants producing shorter sequences on average for typical contexts, compared to atypical contexts (illustrated in Figure 9a).

a)



b)

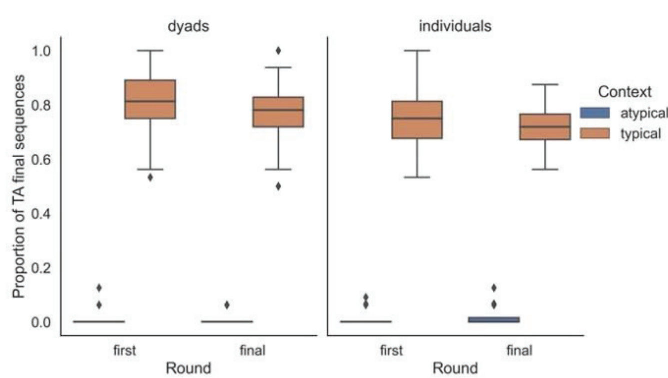


Figure 9. Mean gesture length (**a**) and Proportion of gesture sequences with target action (TA) in final position (**b**), shown for each round and each context (typical/atypical).

Target action position. Again, the model including only scene type (but no other additional fixed effects) showed improved fit over the null model (χ^2 = 41.62, $p < 0.001$), with the model demonstrating preference for more target actions at the end of the sequence in typical contexts than in atypical contexts (Figure 9b; β = 6.00, SE = 0.49, z = 12.23, $p < 0.001$).

As in experiment 1, the remaining analyses focus on the first TA gesture found in each sequence, comparing matched TA gestures across typical and atypical trials.

Base hand use. We analysed the presence of base hand gestures (see Figure 10a) at each trial using a logistic mixed effects model. The model including all three main effects, as well as an interaction between round and group, showed improved fit over the model without the interaction term (χ^2 = 5.56, p = 0.02). The model revealed a significant main effect of context, with base hand use more common in typical than atypical contexts (β = 2.30, SE = 0.63, z = 3.65, $p < 0.001$), as well as a significant interaction between round and group (β = −1.12, SE = 0.46, z = −2.42, p = 0.02), indicating an overall increase in base hand use between the first and final round for dyads only.

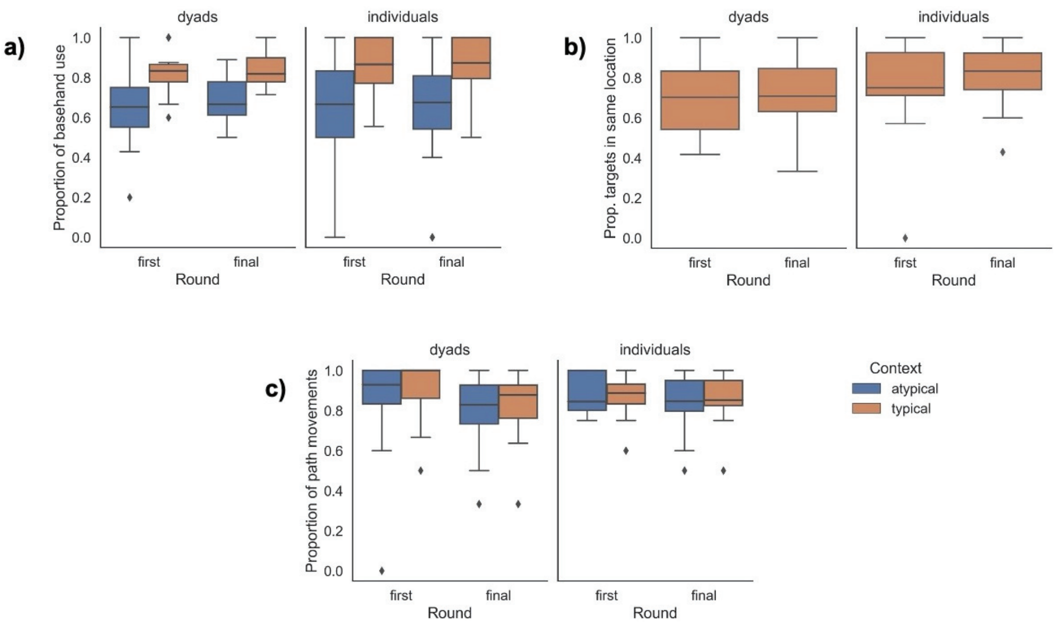


Figure 10. Gesture form analyses for experiment 2, showing base hand use (**a**), proportion of target action gestures produced in the same location for typical and atypical contexts (**b**), and gesture size (**c**) for both dyads and individuals.

Location. The proportion of typical and atypical targets gestured in the same location is shown in Figure 10b. Logistic mixed effects models including fixed effects of either group or round did not improve fit over the null model (group: χ^2 = 2.62, p = 0.11, round: χ^2 = 0.01, p = 0.90), and the model revealed a significant intercept (β = 1.88, SE = 0.49, z = 3.81, $p < 0.001$), indicating an overall preference across groups to place target action gestures in the same location in typical and atypical contexts.

Size. Figure 10c indicates that participants produce a high proportion of path gestures across rounds and contexts, for both dyads and individuals. Analysis using a logistic mixed effects model to predict path gesture production did not find an improved fit over the null model when including either context (χ^2 = 0.55, p = 0.46), or context and round (χ^2 = 1.07,

$p = 0.30$) as fixed effects, suggesting no reliable changes in the preference for path gestures across contexts and rounds.

Repetitions. We show the proportion of trials with repeated targets in Figure 11, and use a logistic mixed effects model including context, round, group, and iterability of the target action as fixed effects, along with their interactions. A model including all fixed effects and interaction terms showed improved fit over a reduced model ($\chi^2 = 26.32$, $p = 0.006$). Inspection of the model revealed a main effect of iterability ($\beta = -4.22$, SE = 0.72, $z = -5.87$, $p < 0.001$) and an interaction between round and iterability ($\beta = -1.39$, SE = 0.36, $z = -3.92$, $p < 0.001$). Participants in both groups produce more repetitions for iterable than non-iterable target actions. For iterable items, repetitions increase between the first and final round but decrease between the rounds for non-iterable items.

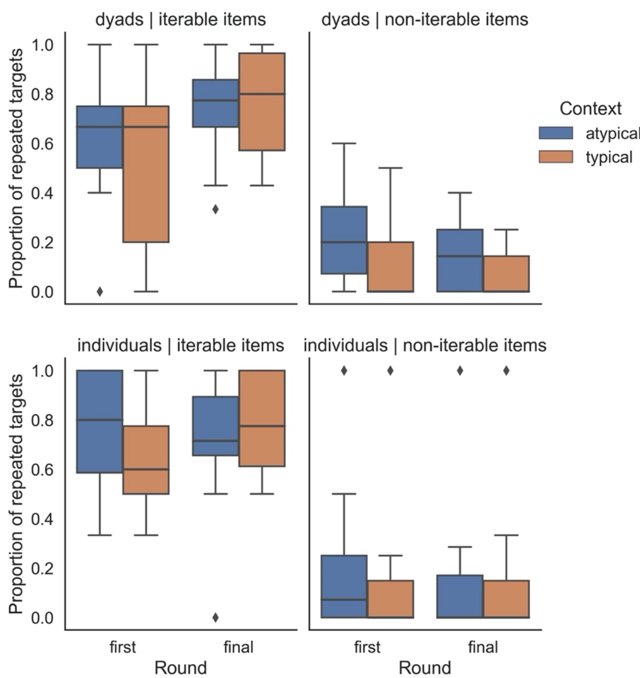


Figure 11. Proportion of repeated targets, shown for iterable and non-iterable target actions, and for participants in the dyadic and individual conditions.

Convergence. We measure convergence between pairs and pseudo-pairs on the different formal properties of gestures as in experiment 1. In addition, we include pseudo-pairs created from individual participants (who never communicate with a partner) matched with other participants in the same condition. Figure 12 shows the mean form similarity for each set of paired participants. We analyse form convergence using a logistic mixed effects model as described in experiment 1. We include round and pair type as fixed effects, with round deviation-coded. We include by-pair and by-item random intercepts with a random slope of rounds for both intercepts. Model comparison indicated that the model with the interaction between round and pair type did not improve fit over a reduced model without the interaction ($\chi^2 = 0.12$, $p = 0.94$). Inspection of the reduced model suggested a significant effect of round ($\beta = -0.13$, SE = 0.06, $z = -2.19$, $p = 0.03$), indicating that, across groups, we see a small reduction in the similarity between the first and final production rounds. We also find a significant effect of pair type for the pseudo-dyads ($\beta = -0.19$, SE = 0.07, $z = -2.78$, $p = 0.005$), but not for the pseudo-individuals ($\beta = -0.002$, SE = 0.07, $z = -0.04$, $p = 0.97$). Participants in the dyadic condition that did not interact with each other demonstrated lower form similarity than participants who did interact with each other. Individuals who only produced gestures in isolation showed similar levels of convergence as participants who communicated together in dyads.

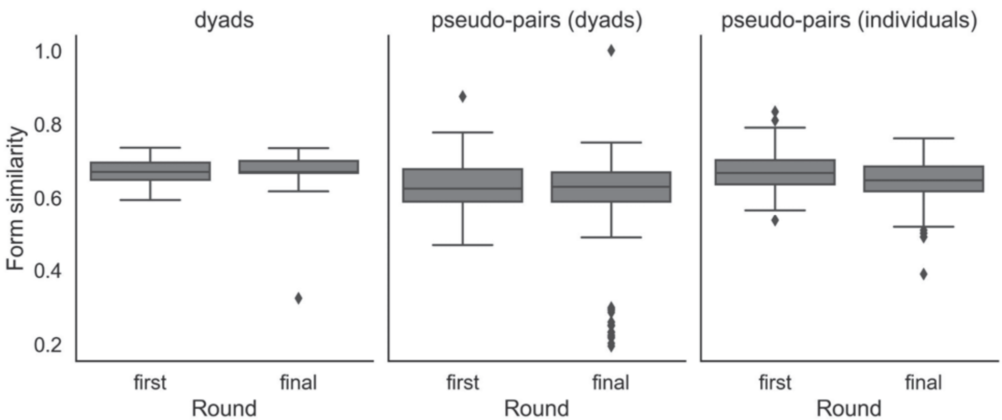


Figure 12. Similarity in form parameters across rounds for real-paired dyads (**left panel**) and pseudo-dyads, made up of participants in the dyadic condition paired with participants with whom they did not interact (**middle panel**) and participants in the individual condition (**right panel**), paired with other individuals with whom they did not interact.

3.3. Experiment 2 Summary

In experiment 2, we investigated the emergence of distinctions between gestures communicating noun-like and verb-like meanings during improvisation by individuals and following interaction between pairs of participants. We used an operationalisation of interaction that allowed for more unconstrained and organic turn-taking and repair strategies between participants than in experiment 1. We further compared productions by dyads before and after interaction with productions by individuals who repeatedly produced gestures over 3 rounds but without communicating the target scenes to a partner. We replicated findings from experiment 1. Participants produced shorter gesture sequences when describing targets in a typical context than in an atypical context. Participants were also more likely to place gestures for target actions in the final position of a sequence, and to use a base hand gesture, when describing typical (i.e., verb-like) contexts than atypical (i.e., noun-like) contexts. Finally, we found that the frequency of repetitions maps onto the iconicity of the event, with iterable items gestured with more repetitions than non-iterable items. Notably, our findings from individuals (not in dyads) align in key ways with those from dyads and from experiment 1, suggesting that, while communication allows participants in pairs to converge on a shared system, the distinctions that do emerge are not driven by communication but can emerge through improvisation alone.

4. General Discussion

The categories of nouns and verbs are among the basic elements of human language (Bickerton 1990; Hockett 1977; Jackendoff 2002). Here, we asked whether systematic formal distinctions between noun- and verb-like forms emerge in improvised gestures, and whether those distinctions further conventionalise over time and through interactions. In particular, our work closely follows that reported by Abner et al. (2019), tracking how similar features (base hand, size of movement, and repetition) distinguish noun and verb signs in ASL, NSL and Nicaraguan homesigners. Table 1 provides a summary of our findings in comparison to those reported by Abner et al. (2019).

Table 1. Summary of findings from current studies and those reported by Abner et al. (2019) for ASL, NSL and Nicaraguan homesigners.

	Silent Gesture		**Abner et al. (2019), Natural Languages**		
	Experiment 1	**Experiment 2**	**ASL**	**NSL**	**Nicaraguan Homesigners**
Utterance final position	Higher proportion of utterance-final targets for typical scenes	Higher proportion of utterance-final targets for typical scenes	Higher proportion of utterance-final verb targets	Higher proportion of utterance-final verb targets	Higher proportion of utterance-final verb targets
Base hand	Higher proportion of base hand use with targets for typical scenes	Higher proportion of base hand use with targets for typical scenes	Higher proportion of base hand use with verb targets	Higher proportion of base hand use with verb targets for more recent cohort signers	No reliable trends found.
Location	Same location used for both typical and atypical targets	Same location used for both typical and atypical targets	Not studied	Not studied	Not studied
Size of movement	No reliable trends found	No reliable trends found	Higher proportion of proximal movement with verb targets	Higher proportion of proximal movement with verb targets	Higher proportion of proximal movement with verb targets
Repetitions	Higher proportion of repetitions for iterable targets and for targets in typical scenes	Higher proportion of repetitions for iterable targets.	Higher proportion of repetitions with noun targets for iterable and non-iterable targets	Higher proportion of repetitions for iterable targets; higher proportion of repetitions for noun targets for later cohorts	Higher proportion of repetitions for iterable targets. Tendency to produce more repetitions for noun targets.

Across both experiments we report, participants make distinctions between gestures they produce for targets appearing in typical contexts (designed to elicit verb-like gestures) and atypical contexts (designed to elicit noun-like gestures). Gesture sequences for typical contexts are shorter than gesture sequences for atypical contexts. This difference in length is largely driven by the additional verb gesture used to describe the action in atypical contexts (e.g., dig, drop). The target object and target action can be conflated and articulated simultaneously for typical contexts (e.g., a *taking a photo* gesture contains information about the object, camera, and the action, taking a photo with a camera). In contrast, the atypical action must be specified separately from the target object (e.g., digging with a camera requires a *dig* gesture and also a *camera* gesture). The conflation of object and action in descriptions of typical contexts is not inevitable and, indeed, there are some examples of participants who produce gesture sequences where they specify object information in one gesture (e.g., tracing a rectangular shape to indicate the camera) before producing a target action gesture.

However, since producing object and action information in a single gesture is sufficient to describe the typical contexts in this study, object-only information is often left out of descriptions of typical contexts, rendering those descriptions shorter than descriptions of atypical contexts.

When we focus only on gestures for target actions that capture the same property in both typical and atypical contexts (e.g., pushing the button on a camera for the *taking-a-picture* event and for the digging with a *camera* event), we find that target actions tend to appear in the final position of a gesture sequence for typical contexts, but not for atypical contexts. Previous silent gesture experiments have suggested that participants from different language backgrounds show a preference for verb-final sequences for non-reversible events (Goldin-Meadow et al. 2008; Hall et al. 2013; Meir et al. 2014; Schouwstra and de Swart 2014), and verb-final order (specifically, SOV) is considered grammatical across all documented sign languages (Napoli and Sutton-Spence 2014). Finally, our results dovetail with those reported by Abner et al. (2019), who found that signers across all three groups they studied (ASL signers, NSL signers, and Nicaraguan homesigners) produced verb (but not noun) targets in the utterance-final position. Our findings are therefore consistent with an interpretation that target action gestures act like verbs in typical contexts, but like nouns in atypical contexts.

We also find that participants across experiments and conditions produce more base hand gestures for target actions in typical contexts than in atypical contexts. Abner et al. (2019) reported findings for distinctions made using base hand articulation, though their findings are somewhat complex. Their results suggested that, for NSL signers, only those who had entered the signing community relatively late (when a language model had been established), used base hand articulation more often with verb targets than noun targets. There was a tendency for a similar pattern in Nicaraguan homesigners, but only in some of the individuals. Notably, Abner et al. (2019) found that ASL signers demonstrated very limited use of base hand gestures for both verb and noun targets, suggesting that the grammatical function and role of the base hand can vary cross-linguistically. Where they are used, Abner et al. (2019) suggest, base hand gestures iconically represent additional event arguments (such as the wall being hammered against), not properties inherent to an object, and therefore we might expect them to appear in verb-like productions more frequently than noun-like productions. Indeed, many of the strategies used to distinguish nouns and verbs cross-linguistically in sign languages reflect iconic features of objects and events. These features can then be systematised to distinguish grammatical categories (Wilbur 2008). For example, repetition can iconically represent event iterability, as our participants demonstrate: more repeated gestures are used when describing iterable events than non-iterable events. Findings from Nicaraguan homesigners and NSL cohort 1 signers indicate similar patterns—repetitions do not distinguish noun from verb targets, but do (not surprisingly) signal iterability. In contrast, ASL signers and NSL signers who entered the signing community later not only use more repetition overall for iterable items, but also use repetition to distinguish noun and verb targets. Together, these findings suggest that the grammatical use of repetitions to distinguish word classes may develop over time. Abner et al. (2019) further suggest that using repetitions as a grammatical marker may emerge from the iconic use of repetitions. Some NSL signs for objects, which were associated with iterable actions, were repeated; as a result, repetition became associated with, and a marker for, nouns. In comparison, our finding from experiment 1 in which participants produce more repetitions for typical (verb) than atypical (noun) targets runs counter to this pattern, though the pattern we find is also attested in some sign languages (Kubus 2008; Schreurs 2006). This finding suggests that the grammaticalisation of repetitions into word class markers, while possibly grounded in the iconic relation to iterability, may be flexible in how it is applied to distinguish noun and verb forms. Certainly, across both experiments 1 and 2, repetitions strongly (and iconically) distinguish iterable from non-iterable events.

We do not find that participants make any distinctions based on the two remaining form properties we analysed—the size of target action gestures, or the location of target gestures. In both cases, iconic representation of events would predict that distinctions could emerge based on either property. For example, Kimmelman (2009) suggests that verb forms may be derived from embodied enactments of events, which may rely on larger, iconic movements than on more economic, reduced forms. Similarly, locations inherent to an event may be preserved in a verb or action sign (such as holding a camera to the face to take a photo) but produced in a neutral space for an object sign (as the location is not intrinsically linked to the object alone). That we do not find distinctions based on these parameters is not surprising for a number of reasons. Firstly, though common strategies such as size, location and repetitions are used across sign languages to distinguish noun and verb forms, and have been hypothesised to have their bases in shared, iconic representations, not all languages mark grammatical categories across all parameters. Indeed, the use and perception of some distinctions such as the size of the signing space can vary depending on the signer's cultural or linguistic experience (Emmorey and Pyers 2017; McCaskill et al. 2011; Mirus et al. 2001). In addition, some representations may be more flexible in earlier stages of language emergence, as our experiment aims to model. For example, although natural word order preferences are widely documented in silent gestures (Goldin-Meadow et al. 2008; Hall et al. 2013; Schouwstra and de Swart 2014), and word order preferences appear early in emerging sign languages (Napoli and Sutton-Spence 2014; Sandler et al. 2005), other properties may arise later through interaction with communities and transmission to new learners forming a linguistic community. In particular, we would expect spontaneous gestures, on the whole, to use a larger gesture space than conventionalised sign systems (Flaherty et al. 2020; Namboodiripad et al. 2016), which may obfuscate more fine-grained gesture size distinctions used across scene types. That is, size distinctions may first require a reduction in the gesture/signing space to be discernible. Indeed, in experiment 2, we find that participants show a strong preference to produce larger path gestures, regardless of context—there is little variability here with which a distinction based on context could emerge.

Across both experiments 1 and 2, we find that, although the distinctions participants produce may be grounded in iconic representations of events, participants who interact with each other converge on a shared system, producing gestures more similar to each other than would be expected if similarity was based on iconicity alone. In particular, interacting participants produce similar forms in both experiments 1 and 2 despite our two different operationalisations of communication, suggesting that the act of producing a communicative signal that is then interpreted by a partner is sufficient for conventionalised systems to emerge, regardless of the behaviours available in face-to-face interaction that might otherwise shape or facilitate the emerging communicative system (Healey et al. 2007; Roberts and Levinson 2017). However, the distinctions between typical and atypical targets that emerge across participants do so at the earliest stage of improvisation. These distinctions map most closely onto the findings reported by Abner et al. (2019) for Nicaraguan homesigners, who produce distinctions between noun- and verb- targets that are still highly variable across individuals, except for the strong preference (also found here) to place verb-like productions at the end of a sequence. Furthermore, our findings indicate that communication in itself is *not* sufficient for the further systematisation of these distinctions that we see in ASL and later cohorts of Nicaraguan Sign Language—communication in our case did *not* lead to substantial additional development of the gestures produced to signal typical vs. atypical targets. Consistent with these findings, previous work suggests that *both* using communicative signals in interaction and learning those signals by naive users of the system shape the emergence of categorical structure (Motamedi et al. 2019; Nölle et al. 2018; Raviv et al. 2019; Silvey et al. 2019). Moreover, it is the repetition of these processes over time that leads to the cultural evolution of systematic distinctions (Kirby et al. 2014; Mesoudi and Thornton 2018; Tamariz and Kirby 2016). Although communicative systems at all stages distinguish between noun-like and verb-like targets, manual communication systems evolve noun and verb *categories* marked by multiple features (see Goldin-Meadow et al. 1994, for evidence of noun–verb categories in a child homesigner in the United States). As such, future work is needed to test how preferences to distinguish noun and verb forms evolve through repeated interaction and iterated learning.

Finally, in experiments 1 and 2, we contrasted two experimental approaches to modelling communicative behaviour. In experiment 1, we operationalised interaction using a reduced director–matcher paradigm in which interacting participants took set turns to produce and interpret gestures (they selected one meaning from a restricted set of four possible interpretations), and all participants received feedback about whether their interpretation was successful. In experiment 2, the operationalisation of interaction was less restrictive, with participants free to negotiate turn-taking and repair strategies, and no limit was put on the meanings they could consider. Although there were small differences in the systems that participants produced (for example, participants in experiment 1 produced more repetitions for typical actions), our results from the two experiments closely align with each other, highlighting the robustness of the improvisation paradigm.

A final, important point is that we find similarities between the noun–verb distinctions created by participants in both experimental paradigms and the noun–verb distinctions found in the naturally emerging language studied in Nicaragua (Abner et al. 2019). For example, early distinctions were based on the order of gestures in a sequence and the use of base hand gestures to mark typical (verb-eliciting) contexts. Experimental models can rarely provide a perfect analogue of language emergence in the real world (Kocab et al. 2018), not least because the participants all know a language. Moreover, the experimental paradigm contains time- and task-related constraints that do not directly replicate language use in the real world. However, our experiments exemplify how such methods can be used alongside data from natural languages to test specific predictions about the processes and mechanisms that drive language evolution. A growing body of work uses these paradigms, informed by the available data from emerging sign languages, to explore key questions about how languages emerge (Hwang et al. 2016; Meir et al. 2014; Motamedi et al. 2019, 2021; Özyürek et al. 2015).

5. Conclusions

We investigated how participants distinguish between typical (verb-like) and atypical (noun-like) targets in novel manual communication systems across two experiments that examined the effect of communication on the emergence of the noun–verb distinction. We found that, across both experiments, clear distinctions emerged in the earliest improvisation stages. All of the participants placed gestures serving a verb role at the end of their utterances, and placed gestures serving a noun role earlier in the utterance. Participants also were biased to produce a base hand on gestures serving a verb function. The strategies used to distinguish between typical and atypical targets emerged early during improvisation, suggesting that the distinction between nouns and verbs is a basic feature of how we communicate, becoming conventionalised in languages over time. Although interacting participants converged on a shared communication system, we did not see further changes, indicating that other processes (such as the transmission of the system to new learners) are involved in the conventionalisation of noun–verb distinctions. We suggest that using experimental methods to test these hypotheses alongside data from natural languages can help to build a robust picture of how systematic grammatical distinctions emerge.

Supplementary Materials: Files including the annotations made from video data (used for analysis) and all analysis scripts can be found at: https://osf.io/qzgjt (accessed on 21 March 2022). Video data from experiment 1 is available at: https://datashare.ed.ac.uk/handle/10283/3195 (accessed on 21 March 2022).

Author Contributions: Conceptualization, Y.M., K.M., N.A., M.F., S.K. and S.G.-M.; Formal analysis, Y.M., K.M., N.A., M.F., S.K. and S.G.-M.; Funding acquisition, S.K. and S.G.-M.; Investigation, Y.M. and K.M.; Methodology, Y.M., K.M., S.K. and S.G.-M.; Validation, K.M., N.A. and M.F.; Visualization, Y.M.; Writing—original draft, Y.M.; Writing—review & editing, Y.M., K.M., N.A., M.F., S.K. and S.G.-M. All authors have read and agreed to the published version of the manuscript.

Funding: Funding for experiment 1 was awarded to YM as a Carnegie Caledonian Doctoral Scholarship from the Carnegie Trust for the Universities of Scotland (award number PHD060261). Funding for experiment 2 was provided by a grant from NSF BCS-1654154 to SGM, SK is a co-PI.

Institutional Review Board Statement: Ethical approval for study 1 was granted by the ethical review board in the Department of Linguistics and English Language at the University of Edinburgh. Ethical approval for study 2 was granted by the Institutional Review Board at the University of Chicago (IRB Study 97-074).

Informed Consent Statement: Informed consent was obtained from all participants prior to the start of the study.

Data Availability Statement: Video data from experiment 1, data files used for analysis and analysis scripts are publicly available (see Supplementary Materials).

Acknowledgments: We would also like to thank Kenny Smith, Marieke Schouwstra and Jennifer Culbertson for their contributions to the design of Experiment 1, and Destiny Gale, Nicola Lustig, Gayathri Rao and Gowri Rao, who coded the data for both experiments.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

1. While accounts exist suggesting that some languages do not have clear noun-verb categories (Kaufman 2009; Kinkade 1983), these accounts have proved controversial with others providing analysis that shows while categories may not be overtly marked, nominals and predicates are distinguished at some level (Baker 2003; Koch and Matthewson 2009).
2. The full list of items included can be found at OSF page. https://osf.io/qzgjt (accessed on 21 March 2022).
3. A list of target actions can be found at https://osf.io/qzgjt (accessed on 21 March 2022).
4. Plots throughout the manuscript were generated using the Python libraries Matplotlib and Seaborn (Hunter 2007; Waskom 2021).
5. A full description of vignettes can be found at https://osf.io/qzgjt (accessed on 21 March 2022).

References

Abner, Natasha. 2017. What You See Is What You Get.Get: Surface Transparency and Ambiguity of Nominalizing Reduplication in American Sign Language. *Syntax* 20: 317–52. [CrossRef]

Abner, Natasha. 2021. Determiner phrases—Theoretical perspectives. In *Routledge Handbook of Theoretical and Experimental Sign Language Research*. Edited by Josep Quer, Roland Pfau and Annika Herrman. London: Routledge, pp. 213–31. [CrossRef]

Abner, Natasha, Molly Flaherty, Katelyn Stangl, Marie Coppola, Diane Brentari, and Susan Goldin-Meadow. 2019. The noun-verb distinction in established and emergent sign systems. *Language* 95: 230–67. [CrossRef]

Aronoff, Mark, Irit Meir, and Wendy Sandler. 2005. The Paradox of Sign Language Morphology. *Language* 81: 301–44. [CrossRef] [PubMed]

Baker, Mark C. 2003. *Lexical Categories: Verbs, Nouns and Adjectives*. Cambridge: Cambridge University Press. [CrossRef]

Bates, Douglas, Ben Bolker, Martin Machler, and Steven C. Walker. 2015. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* 67: 1–48. [CrossRef]

Beckner, Clay, Janet B. Pierrehumbert, and Jennifer Hay. 2017. The emergence of linguistic structure in an online iterated learning task. *Journal of Language Evolution* 2: 160–76. [CrossRef]

Bickerton, Derek. 1990. *Language and Species*. Chicago: University of Chicago Press.
Carrigan, Emily M., and Marie Coppola. 2017. Successful communication does not drive language development: Evidence from adult homesign. *Cognition* 158: 10–27. [CrossRef]
Christensen, Peer, Riccardo Fusaroli, and Kristian Tylén. 2016. Environmental constraints shaping constituent order in emerging communication systems: Structural iconicity, interactive alignment and conventionalization. *Cognition* 146: 67–80. [CrossRef]
Cohen, Jacob. 1960. A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement* 20: 37–46. [CrossRef]
Coppola, Marie, and Elissa L. Newport. 2005. Grammatical subjects in homesign: Abstract linguistic structure in adult primary gesture systems without linguistic input. *Proceedings of the National Academy of Sciences* 102: 19259–53. [CrossRef]
Dingemanse, Mark, Sean G. Roberts, Julia Baranova, Joe Blythe, Paul Drew, Simeon Floyd, Rosa S. Gisladottir, Kobin H. Kendrick, Stephen C. Levinson, Elizabeth Manrique, and et al. 2015. Universal Principles in the Repair of Communication Problems. *PLoS ONE* 10: e0136100. [CrossRef]
Emmorey, Karen, and Jennie Pyers. 2017. Cognitive biases in construing iconic mappings. Paper presented at the 11th International Symposium on Iconicity in Language and Literature, Brighton, UK, April 7; Available online: https://osf.io/awyg2 (accessed on 21 March 2022).
Fay, Nicolas, Michael Arbib, and Simon Garrod. 2013. How to bootstrap a human communication system. *Cognitive Science* 37: 1356–67. [CrossRef] [PubMed]
Fay, Nicolas, Simon Garrod, Leo Roberts, and Nik Swoboda. 2010. The interactive evolution of human communication systems. *Cognitive Science* 34: 351–86. [CrossRef] [PubMed]
Flaherty, Molly, Asha Sato, and Simon Kirby. 2020. An Emergent Language Becomes Smaller as It Evolves: New Evidence From Motion Tracking in Nicaraguan Sign Language. In *The Evolution of Language: Proceedings of the 13th International Conference (EvoLang13)*. Edited by Andrea C. Ravignani, Chiara Barbieri, Mauricio Martins, Molly Flaherty, Ella Lattenkamp, Hannah Little, Katie Mudd and Tessa Verhoef. Nijmegen: The Evolution of Language Conferences. [CrossRef]
Garrod, Simon, and Martin J. Pickering. 2009. Joint Action, Interactive Alignment, and Dialog. *Topics in Cognitive Science* 1: 292–304. [CrossRef] [PubMed]
Garrod, Simon, Nicolas Fay, John Lee, Jon Oberlander, and Tracy MacLeod. 2007. Foundations of representation: Where might graphical symbol systems come from? *Cognitive Science* 31: 961–87. [CrossRef]
Gershkoff-Stowe, Lisa, and Susan Goldin-Meadow. 2002. Is there a natural order for expressing semantic relations? *Cognitive Psychology* 45: 375–412. [CrossRef]
Gibson, Edward, Steven T. Piantadosi, Kimberly Brink, Leon Bergen, Eunice Lim, and Rebecca Saxe. 2013. A Noisy-Channel Account of Crosslinguistic Word-Order Variation. *Psychological Science* 24: 1079–88. [CrossRef]
Goldin-Meadow, Susan, Wing Chee So, Asli Ozyürek, and Carolyn Mylander. 2008. The natural order of events: How speakers of different languages represent events nonverbally. *Proceedings of the National Academy of Sciences of the United States of America* 105: 9163–68. [CrossRef]
Goldin-Meadow, Susan. 2003. *The Resilience of Language*. London: Taylor and Francis.
Goldin-Meadow, Susan, and Heidi Feldman. 1977. The development of language-like communication without a language model. *Science* 197: 401–3. [CrossRef]
Goldin-Meadow, Susan, Cynthia Butcher, Carolyn Mylander, and Mark Dodge. 1994. Nouns and Verbs in a Self-Styled Gesture System: What's in a name? *Cognitive Psychology* 27: 259–319. [CrossRef]
Goldin-Meadow, Susan, Diane Brentari, Marie Coppola, Laura Horton, and Ann Senghas. 2014. Watching language grow in the manual modality: Nominals, predicates, and handshapes. *Cognition* 136: 381–95. [CrossRef]
Hall, Matthew L., Rachel I. Mayberry, and Victor S. Ferreira. 2013. Cognitive constraints on constituent order: Evidence from elicited pantomime. *Cognition* 129: 1–17. [CrossRef] [PubMed]
Healey, Patrick G. T., Nik Swoboda, Ichiro Umata, and James King. 2007. Graphical language games: Interactional constraints on representational form. *Cognitive Science* 31: 285–309. [CrossRef] [PubMed]
Heine, Bernd, and Tania Kuteva. 2007. *The Genesis of Grammar: A Reconstruction*. Oxford: Oxford University Press.
Hockett, Charles F. 1977. *The View from Language: Selected Essays, 1948–1974*. Athens: The University of Georgia Press.
Hopper, Paul J., and Sandra Thompson. 1985. The iconicity of the universal categories 'noun' and 'verb'. In *Iconicity in Syntax*. Edited by John Haiman. Amsterdam: John Benjamins.
Hunger, Barbara. 2006. Noun/Verb Pairs in Austrian Sign Language (ÖGS). Available online: https://doi.org/info:doi/10.1075/sll.9.1.06hun (accessed on 21 March 2022).
Hunter, John D. 2007. Matplotlib: A 2D Graphics Environment. *Computing in Science & Engineering* 9: 90–95.
Hurford, James R. 2007. *The Origins of Meaning: Language in the Light of Evolution*. Oxford: Oxford University Press.
Hwang, So-One, Nozomi Tomita, Hope Morgan, Rabia Ergin, Deniz Ilkbasaran, Sharon Seegers, Ryan Lepic, and Carol Padden. 2016. Of the body and the hands: Patterned iconicity for semantic categories. *Language and Cognition* 9: 573–602. [CrossRef]
Jackendoff, Ray. 2002. *Foundations of Language*. Oxford: Oxford University Press.
Johnston, Trevor. 2001. Nouns and verbs in Australian Sign Language: An open and shut case? *Journal of Deaf Studies and Deaf Education* 6: 235–57. [CrossRef]
Kaufman, Daniel. 2009. Austronesian Nominalism and Its Consequences: A Tagalog Case Study. *Theoretical Linguistics* 35: 1–49. [CrossRef]

Kimmelman, Vadim. 2009. Parts of speech in Russian Sign Language: The role of iconicity and economy. *Sign Language and Linguistics* 12: 161–86. [CrossRef]

Kinkade, M. Dale. 1983. Salish evidence against the universality of 'noun' and 'verb'. *Lingua* 60: 25–39. [CrossRef]

Kirby, Simon. 2016. VideoBox: Video Recording, Streaming and Mirroring for Experiments. Available online: http://edin.ac/2haREUz (accessed on 21 March 2022).

Kirby, Simon, Monica Tamariz, Hannah Cornish, and Kenny Smith. 2015. Compression and Communication in the Cultural Evolution of Linguistic Structure linguistic structure. *Cognition* 141: 87–102. [CrossRef]

Kirby, Simon, Thomas L. Griffiths, and Kenny Smith. 2014. Iterated learning and the evolution of language. *Current Opinion in Neurobiology* 28: 108–14. [CrossRef]

Kocab, Annemarie, Hannah Lam, and Jesse Snedeker. 2018. When Cars Hit Trucks and Girls Hug Boys: The Effect of Animacy on Word Order in Gestural Language Creation. *Cognitive Science* 42: 918–38. [CrossRef]

Koch, Karsten, and Lisa Matthewson. 2009. The Lexical Category Debate in Salish and Its Relevance for Tagalog. *Theoretical Linguistics* 35: 125–37. [CrossRef]

Kubus, Okan. 2008. An analysis of Turkish Sign Language (TİD) Phonology and Morphology. Master's thesis, Middle East Technical University, Ankara, Turkey.

McCaskill, Carolyn, Ceil Lucas, Robert Bayley, and Joseph Hill. 2011. *The Hidden Treasure of Black ASL: Its History and Structure*. Washington, DC: Gallaudet University Press.

Meir, Irit, Mark Aronoff, Carl Börstell, So-One Hwang, Deniz Ilkbasaran, Itamar Kastner, Adi Lifshitz, Ben Basat, Carol Padden, and Wendy Sandler. 2014. The effect of being human and the basis of grammatical word order: Insights from novel communication systems and young sign languages. *Cognition* 158: 1–40. [CrossRef]

Mesoudi, Alex, and Alex Thornton. 2018. What Is Cumulative Cultural Evolution? *Proceedings of the Royal Society B: Biological Sciences* 13: 285. [CrossRef]

Mirus, Gene, Christian Rathmann, and Richard P. Meier. 2001. Proximalization and distalization of sign movement in adult learners. In *Signed Languages: Discoveries from International Research*. Edited by Valerie M. Dively, Melanie Metzger, Anne Marie Baer and Sarah Taub. Washington, DC: Gallaudet University Press, pp. 103–19.

Morford, Jill P., and Susan Goldin-Meadow. 1997. From here and now to there and then: The development of displaced reference in homesign and English. *Child Development* 68: 420–35. [CrossRef]

Motamedi, Yasamin, Kenny Smith, Marieke Schouwstra, Jennifer Culbertson, and Simon Kirby. 2021. The emergence of systematic argument distinctions in artificial sign languages. *Journal of Language Evolution* 6: 77–98. [CrossRef]

Motamedi, Yasamin, Marieke Schouwstra, Kenny Smith, Jennifer Culbertson, and Simon Kirby. 2019. Evolving artificial sign languages in the lab: From improvised gesture to systematic sign. *Cognition* 192: 103964. [CrossRef]

Namboodiripad, Savithry, Daniel Lenzen, Ryan Lepic, and Tessa Verhoef. 2016. Measuring Conventionalization in the Manual Modality. *Journal of Language Evolution* 1: 109–18. [CrossRef]

Napoli, Donna Jo, and Rachel Sutton-Spence. 2014. Order of the major constituents in sign languages: Implications for all language. *Frontiers in Psychology* 5: 376. [CrossRef]

Nölle, Jonas, Marlene Staib, Riccardo Fusaroli, and Kristian Tylén. 2018. The emergence of systematicity: How environmental and communicative factors shape a novel communication system. *Cognition* 181: 93–104. [CrossRef]

Özçalışkan, Şeyda, Ché Lucero, and Susan Goldin-Meadow. 2016. Does language shape silent gesture? *Cognition* 148: 10–18. [CrossRef]

Özyürek, Asli, Reyhan Furman, and Susan Goldin-Meadow. 2015. On the way to language: Event segmentation in homesign and gesture. *Journal of Child Language* 42: 64–94. [CrossRef]

Peirce, Jonathan W. 2007. PsychoPy–Psychophysics software in Python. *Journal of Neuroscience Methods* 162: 8–13. [CrossRef]

Perlman, Marcus, Rick Dale, and Gary Lupyan. 2015. Iconicity can ground the creation of vocal symbols. *Royal Society Open Science* 2: 150152. [CrossRef]

Pizzuto, Elena, and Serena Corazza. 1996. Noun morphology in Italian Sign Language (LIS). *Lingua* 98: 169–96. [CrossRef]

R Core Team. 2013. *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing, Available online: http://www.R-project.org/ (accessed on 21 March 2022).

Raviv, Limor, Antje Meyer, and Shiri Lev-Ari. 2019. Compositional structure can emerge without generational transmission. *Cognition* 182: 151–64. [CrossRef]

Roberts, Sean G., and Stephen C. Levinson. 2017. Conversation, cognition and cultural evolution: A model of the cultural evolution of word order through pressures imposed from turn taking in conversation. *Interaction Studies* 18: 402–42. [CrossRef]

Sandler, Wendy, Irit Meir, Carol Padden, and Mark Aronoff. 2005. The emergence of grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences of the United States of America* 102: 2661–65. [CrossRef]

Schouwstra, Marieke, and Henrietta de Swart. 2014. The semantic origins of word order. *Cognition* 131: 431–36. [CrossRef]

Schouwstra, Marieke, Kenny Smith, and Simon Kirby. 2016. From natural order to convention in silent gesture. *The Evolution of Language: Proceedings of the 11th International Conference (EVOLANG11)*. Available online: http://evolang.org/neworleans/papers/67.html (accessed on 21 March 2022).

Schreurs, Linda. 2006. The Distinction between Formally and Semantically Related Noun-Verb Pairs in Sign Language of the Netherlands (NGT). Master's thesis, University of Amsterdam, Amsterdam, The Netherlands.

Silvey, Catriona, Simon Kirby, and Kenny Smith. 2019. Communication increases category structure and alignment only when combined with cultural transmission. *Journal of Memory and Language* 109: 104051. [CrossRef]

Singleton, Jenny L., Susan Goldin-Meadow, and David McNeill. 1995. The Cataclysmic Break Between Gesticulation and Sign: Evidence Against a Unified Continuum of Gestural Communication. In *Language, Gesture and Space*. Edited by Karen Emmorey and Judy S. Reilly. Mahwah: Lawrence Erlbaum Associates Publishers, pp. 287–311.

Sloetjes, Han, and Peter Wittenburg. 2008. Annotation by category—ELAN and ISO DCR. Paper presented at the 6th International Conference on Language Resources and Evaluation, Marrakech, Morocco, May 28–30.

Stivers, Tania, Nick J. Enfield, Penelope Brown, Christina Englert, Makoto Hayashi, Trine Heinemann, Gertie Hoymann, Federico Rossano, Jan Pieter de Ruiter, Kyung-Eun Yoon, and et al. 2009. Universals and cultural variation in turn-taking in conversation. *Proceedings of the National Academy of Sciences of the United States of America* 106: 10587–92. [CrossRef]

Sulik, Justin. 2018. Cognitive mechanisms for inferring the meaning of novel signals during symbolisation. *PLoS ONE* 13: e0189540. [CrossRef]

Supalla, Ted, and Elissa L. Newport. 1978. How many seats in a chair? The derivation of nouns and verbs in American Sign Language. In *Understanding Language through Sign Language Research*. Edited by Patricia Siple. New York: Academic Press, pp. 91–131.

Tamariz, Monica, and Simon Kirby. 2016. The cultural evolution of language. *Current Opinion in Psychology* 8: 37–43. [CrossRef]

Theisen, Carrie A., Jon Oberlander, and Simon Kirby. 2010. Systematicity and arbitrariness in novel communication systems. *Interaction Studies* 11: 14–32. [CrossRef]

Tkachman, Oksana, and Wendy Sandler. 2013. The noun–verb distinction in two young sign languages. *Gesture* 13: 253–86. [CrossRef]

Verhoef, Tessa, Simon Kirby, and Bart de Boer. 2014. Emergence of combinatorial structure and economy through iterated learning with continuous acoustic signals. *Journal of Phonetics* 43: 57–68. [CrossRef]

Waskom, Michael L. 2021. Seaborn: Statistical data visualization. *Journal of Open Source Software* 6: 3021. [CrossRef]

Wilbur, Ronnie B. 2003. Representations of telicity in ASL. In *Proceedings from the Annual Meeting of the Chicago Linguistic Society*. Chicago: Chicago Linguistic Society, vol. 39.

Wilbur, Ronnie B. 2008. Complex predicates involving events, time and aspect: Is this why sign languages look so similar? In *Signs of the Time: Selected Papers from TISLR 2004*. Edited by Josep Quer. Seedorf: Signum Press.

Wilcox, Sherman. 2004. Cognitive iconicity: Conceptual spaces, meaning, and gesture in signed language. *Cognitive Linguistics* 15: 119–47. [CrossRef]

languages MDPI

Article

Emerging Lexicon for Objects in Central Taurus Sign Language

Rabia Ergin †

Independent Researcher, Istanbul 34470, Turkey; rabia.ergin@gmail.com
† Native Member of the Central Taurus Sign Language Community.

Abstract: This paper investigates object-based and action-based iconic strategies and combinations of them to refer to everyday objects in the lexicon of an emerging village sign language, namely Central Taurus Sign Language (CTSL) of Turkey. CTSL naturally emerged in the absence of an accessible language model within the last half century. It provides a vantage point for how languages emerge, because it is relatively young and its very first creators are still alive today. Participants from two successive age cohorts were tested in two studies: (1) CTSL signers viewed 26 everyday objects in isolation and labeled them to an addressee in a picture-naming task, and (2) CTSL signers viewed 16 everyday objects in isolation and labeled them to an addressee before they viewed the same objects in context being acted upon by a human agent in short video clips and described the event in the clips to a communicative partner. The overall results show that the CTSL signers equally favored object-based and action-based iconic strategies with no significant difference across cohorts in the implementation of iconic strategies in both studies. However, there were significant differences in the implementation of iconic strategies in response to objects presented in isolation vs. context. Additionally, the CTSL-2 signers produced significantly longer sign strings than the CTSL-1 signers when objects were presented in isolation and significantly more combinatorial sign strings than the CTSL-1 signers. When objects were presented in context, both cohorts produced significantly shorter sign strings and more single-sign strings in the overall responses. The CTSL-2 signers still produced significantly more combinatorial sign strings in context. The two studies together portray the type and combination of iconic strategies in isolation vs. context in the emerging lexicon of a language system in its initial stages.

Keywords: Central Taurus Sign Language; village sign language; emerging lexicon; object descriptions; iconic representations

Citation: Ergin, Rabia. 2022. Emerging Lexicon for Objects in Central Taurus Sign Language. *Languages* 7: 118. https://doi.org/10.3390/languages7020118

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 12 November 2021
Accepted: 28 March 2022
Published: 11 May 2022

1. Introduction

1.1. Iconic Representations in the Manual Systems

The affordances of the body and hands allow iconic representations of linguistic information in manual systems. The non-arbitrary form-meaning mappings of the real-world entities is a ubiquitous property of sign languages that can be observed at many levels of linguistic organization (e.g., Klima and Bellugi 1979; Emmorey 2014; Lepic and Padden 2017; Perniss et al. 2010; Padden et al. 2013; and Taub 2001). For example, iconicity plays a role in the large proportion of a signed lexicon (Pietrandrea 2002); the path, manner and location of a sign are frequently iconic (Senghas et al. 2004); information delivery in the event structure, such as telicity, can be iconic (Wilbur 2003); and the way sign languages use or encode space can have iconic motivations (e.g., Padden 2016; Perniss 2007; and Vermeerbergen 2006).

The non-arbitrary nature of iconic forms may seem to be straightforward for perception and production. However, they are not readily accessible to individuals having no prior experience with communication in the manual modality (e.g., Klima and Bellugi 1979; Ortega et al. 2017; and Pizzuto and Volterra 2000). Taub (2001) proposed that there are a least several sub-processes that are essential in inventing an iconic form, such as recognizing associations between concepts and a variety of sensory (visual, auditory, and kinesthetic) images, selecting a candidate image representative of the target concept and schematizing and encoding the selected image using a phonologically valid linguistic form. From among many possible candidates as a representative image of the target concept, *which iconic forms are recognized as more salient for selection?*

Previous investigations in the lexicons of manual systems (improvised gestural systems and emerging and established sign languages) presented evidence for the systematic variation in the use of *action-based* or *object-based* iconic forms across semantic categories and event structures. These iconic forms have been discussed under a variety of terms so far, focusing on the representational role of the hands, either representing the agentive role of the signer or a salient property of the referent (e.g., Brentari et al. 2012; Ergin and Brentari 2017; Meir et al. 2013; Müller 2013; Müller et al. 2013; Ortega and Özyürek 2020; Padden et al. 2013, 2015; and Supalla 1982). Among the iconic modes of representation defined in the manual modality are, for example, *acting*, depicting how objects are manipulated (Müller 2013), and *object*-depicting entities through the shape, dimensions, or outline of an object with no action representations involved (Padden et al. 2013). Padden et al. (2013) further elaborated on the iconic patterning for lexical signs for hand-held man-made artifacts ("tool") by dividing them into two groups—*handling*, representing an agent manipulating the target tool by handling it, and *instrument*, representing the manipulated tool itself—and presenting evidence for distinct iconic patterning across semantic categories in the use of these iconic forms. For example, "hammer" in American Sign Language (ASL) is expressed with a *handling* type handshape showing how a hammer is grasped, along with the typical downward repeating movement depicting the canonical action associated with this object. "Toothbrush" in ASL is expressed with an *instrument* type handshape with the index finger extended while the hand moves sideways back and forth near the mouth, as in the action of brushing one's teeth. Padden et al. (2013) reported that in response to stimuli involving the images of common objects such as clothes, utensils, cosmetic products, and tools, the signers of ASL, Al-Sayyid Bedouin Sign Language (ABSL), and New Zealand Sign Language (NZSL) tend to produce instrument strategies more frequently as opposed to handling strategies, whereas American and Bedouin non-signing gesturers display the opposite pattern. These findings indicate that *first*, despite speaking different languages and living in different regions of the world, non-signing gesturers display similar cognitive tendencies, and the types of iconic strategies they use systematically differ from the ones used by signers. *Second*, instrument forms as iconic strategies may be an important linguistic tool to expand the lexicon of sign languages by adding more handshape distinctions as opposed to the gestural ones produced in an improvised fashion. Similar to the findings of Padden et al. (2013), in a cross-linguistic analysis on a total of eight established and emerging sign languages, including Central Taurus Sign Language (CTSL), Hwang et al. (2017) reported recurring patterns for naming entities, even if they individually varied in imagistic form: *handling* and *instrument* forms (both involve a manipulative action) are used for tools, whereas *object* forms (i.e., static forms with no action involved) are more often used for fruits and vegetables. Hou (2018) reported similar grouping of iconic strategies for tools and foods in San Juan Quiahije Chatino Sign Language. Tools, as a category of stimuli, seem to strongly elicit forms exhibiting human agency, whereas this is less prevalent in semantic categories like fruits and vegetables.

Other studies on emerging sign languages report systematic variation across event structures. For example, Ergin and Brentari (2017) reported that CTSL signers favor *object* strategies depicting the form of an object over *handling* strategies depicting an action associated with the target object in non-agentive contexts, as opposed to agentive ones. When the object is acting on its own or not acting at all in a non-agentive context, such as "The lollipop is on the table", CTSL signers tend to use object-based iconic strategies (i.e., object handshapes) to represent the form of a lollipop. When the object is being acted upon by an agent, as in "The man puts the lollipop on the table", they tend to use action-based iconic strategies (i.e., handling handshapes) more frequently. Moreover, Ergin and Brentari (2017) reported that the use of these strategies may evolve over time in that CTSL in its first generation[1] favored handling strategies over object strategies, but as of the second generation, it evolved into a system favoring object strategies over handling strategies. Using the same stimuli, Goldin-Meadow et al. (2015) also reported systematic opposition between non-agentive and agentive contexts in the use of *object* vs. *handling* strategies by Nicaraguan homesigners, the cohort 1 and cohort 2 signers of Nicaraguan Sign Language (NSL), and a group of American Sign Language (ASL) signers. All four groups, including homesigners, used object-based iconic strategies almost exclusively in non-agentive contexts and used handling strategies more frequently in agentive contexts, suggesting that systematically varying morphological constructs are fundamental properties of language that appear under a variety of environmental conditions. Another important finding of this study is the consistency of these iconic handshape types being wider for ASL and NSL signers in comparison with the homesigners. In other words, individuals using a shared sign system with others are more consistent in the type of iconic strategies they use across agentive vs. non-agentive contexts than those using a non-shared system. In addition, as in the case of CTSL, Goldin-Meadow et al. (2015) reported generational differences in the use of these iconic strategies. NSL cohort 2 and the ASL signers produced more handling handshapes than object handshapes in their predicates in agentive contexts as opposed to NSL cohort 1 and homesigners, which suggests that these iconic strategies may evolve and stabilize over time as a system matures.

An important finding of the previous studies is that sign languages exhibit cross-linguistic differences in terms of iconic patterning. For instance, in a comprehensive study conducted on 11 sign languages, Nyst et al. (2021) reported cross-linguistic differences across languages in the use of handling vs. object strategies in response to the images of 10 common objects. Adamorobe, Nanabin, and Ghanaian Sign Language exhibit a preference for object handshapes. Ivory Coast, Malian, and Portugese Sign Language exhibit a preference for handling handshapes. Kenyan, Ethiopian, Guinea-Bissau, and Boukako Sign Language as well as the Sign Language of the Netherlands, is a middle group without a strong preference for either handshape[2]. In addition, sign languages may display differences in the developmental paths they take. For example, while CTSL begins with handling strategies and evolves into a system favoring object strategies over time, NSL follows the opposite path (Ergin and Brentari 2017 and Goldin-Meadow et al. 2015, respectively). In summation, despite showing certain tendencies across semantic categories (i.e., foods elicit object-based iconic forms and tools elicit action-based iconic forms), there seem to be language-specific tendencies across languages, leading to variation.

The patterning of iconic forms across semantic categories and event structures is not only a property of emerging and established signed lexicons. Recent evidence from the improvised gestures of hearing adults shows alignments between sign languages and gestural communication in that there are systematic variations in the use of iconic gestural forms, possibly shaped by similar cognitive tendencies. For example, Schembri et al. (2005) detected similar movements and locations for the manual productions of non-signing Australians and signers of Australian Sign Language in response to a task involving classifier predicates of motion, but their choice of handshapes differs significantly. In addition, in a pantomime generation task in which participants were asked to produce gestures for written words they were presented on a computer screen, Ortega et al. (2017) showed that Dutch speakers' gestures share varying degrees of form overlap with the signs from the Sign Language of the Netherlands (full, partial, or no overlap). Moreover, hearing participants guessed the meanings of signs with full and partial overlap more accurately, and they assigned these signs higher iconicity ratings than signs with no overlap. These findings suggest that deaf and hearing adults converge in their iconic depictions for some concepts (e.g., TO-CUT, TO-SAW, or LAPTOP), possibly as an outcome of the shared conceptual knowledge and manual-visual modality. Furthermore, Ortega and Özyürek (2020) found systematicity in the implementation of iconic strategies in the gestural forms of various concepts. They showed that action-based iconic forms (i.e., *acting*) through reenacting the motion of the action associated with the target object were favored to refer to manipulable objects, whereas object-based forms such as recreation the form of an object (i.e., hand *representing* the object) and tracing its shape with the hands (i.e., *drawing*) were favored to refer to the static state and non-manipulable nature of an object, respectively.

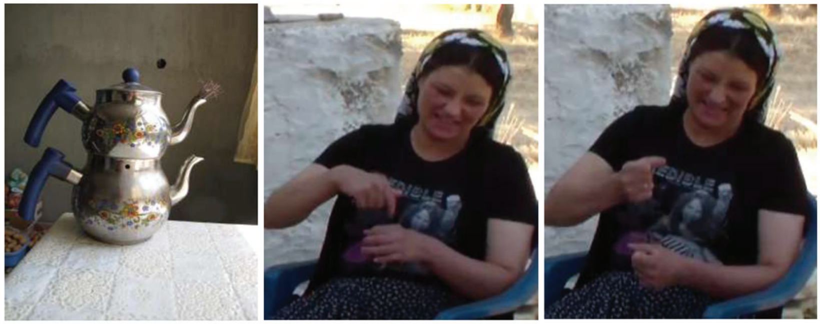
In addition, several previous studies argued that action simulations are the precursors of manual iconic forms (Cook and Tanenhaus 2009 and Hostetter and Alibali 2008), with some recent empirical support for action-based iconic representations to be the building blocks of an emerging lexicon in the manual modality. For example, Ortega and Özyürek (2020) presented evidence for an overwhelming tendency for the use of action-based forms, implying that *acting* might be a building block of an emerging lexicon in the manual modality. Similarly, Ortega et al. (2014) claimed that action-based iconic forms are developmental milestones in the language acquisition process and present evidence for action-based signs to be favored more in children-adult interactions and object-based (perceptual) signs to be favored more in adult-adult interactions.

In summation, these findings provide us with insight into the systematic tendency in the use of certain *action-based* or *object-based* iconic features to refer to a certain type of referents and possible pathways for iconic forms to become linguistic tools over time in the manual modality. Specifically, the findings in favor of the dominance of action-based iconic forms in the gestural productions are intriguing in that they trigger further questions regarding the perception of real-world referents and the invention of iconic forms representing them. *Are the object-based iconic forms or the action-based iconic forms recognized as more salient for selection for iconic representations? What forms the building blocks of an emerging lexicon in the manual modality?*

1.2. Combination of Signs and İconic Strategies

Using multi-sign strings such as compounds in order to distinguish concepts across semantic categories is a common property of sign languages (e.g., BLUE ˆ SPOT for “bruise” in ASL (Klima and Bellugi 1979)). Evidence from emerging sign languages indicates that this mechanism is present in the initial stages of a language, and some combinations of signs used for object descriptions are systematic (e.g., Ergin et al. 2021; Meir et al. 2010; and Tkachman and Sandler 2013). Ergin et al. (2021) reported that CTSL signers frequently use multi-sign strings to refer to entities from various semantic categories (e.g., everyday objects, utensils, and fruits and vegetables). While some of these multi-sign descriptions are relatively conventionalized compounds (e.g., TEA ˆ ONE-ON-ANOTHER for ”teapot”), others have the flavor of idiosyncratically longer descriptions (e.g., TEA ˆ POUR-FROM-HANDLE ˆ ONE-ON-ANOTHER, FLAME ˆ PUT-ON ˆ ONE-ON-ANOTHER). When expressing a systematic compound[3], CTSL seems to be following a certain pattern in terms of sequencing its constituents. Tea, an action involving an iconic constituent delivering information about the function of the object, frequently precedes the constituent signaling the static form or the size or shape of the target object (ONE-ON-ANOTHER) (Figure 1).

Similar results have been reported in Israeli Sign Language (ISL) and Al-Sayyid Bedouin Sign Language (ABSL): the constituents involving the size or shape (i.e., static form) information of the target object occupied the final positions in the compounds (e.g., CHICKEN ˆ OVAL-OBJECT for “egg” in ABSL or LIPSTICK ˆ SMALL-OBJECT for “lipstick” in ISL). However, in its initial stages, when a language does not have a conventionalized lexical item for a referent, longer descriptions become inevitable (e.g., WRITE ˆ ROW ˆ MONTH ˆ ROW ˆ WRITE for “calendar” in ABSL) (Meir et al. 2010; and Sandler et al. 2011). Similarly, Tkachman and Sandler (2013) reported a high tendency in both ISL and ABSL to produce compounds and longer sign strings in response to picture stimuli of unfamiliar objects which did not have a conventionalized lexical item in ISL or ABSL. Morgan (2015) also found that some compounds in Kenyan Sign Language such as BLACK ˆ PEAR-SHAPE (“avocado”) display a systematic order among their components, but other multi-sign strings involve longer sequences with constituents in variable orders and with some items repeated multiple times.



(**a**) (**b**) (**c**)

Figure 1. (**a**) A Turkish teapot. (**b**) The sign for TEA. (**c**) The sign for ONE-ON-ANOTHER.

The findings from Zinacantec Family Homesign (Z) show that compounding is present even in a first-generation language. In response to the picture of a chicken, Z signers first start with using a size and shape specifier depicting how a Zinacantec typically handles a chicken, thereby demonstrating its size and shape, followed by an action depicting how Zinacantecs kill a chicken: a quick jerk to break its neck (Haviland 2013, p. 321). Despite having conventionalized lexical items such as CHICKEN, Haviland (2013) reported that Z signers are not always consistent. For example, for a small SLEDGEHAMMER, a Z signer may produce multi-sign strings starting with a handling handshape showing how a hammer is held, which also indicates the size of the target object, followed by a pounding action and completing with four full vertical strokes. On another occasion, in response to the picture of two ordinary hammers, the same Z signer may produce three distinct vertical pounding movements.

To sum up, using more than one sign or word to refer to real-world referents is a ubiquitous feature of natural languages. Evidence from emerging sign languages and homesign systems suggests that this feature springs up quickly in the initial stages of a language. While rarely used daily objects elicit idiosyncratically longer sequences of constituents (e.g., see Ergin et al. 2021 for "gas tank" variants in CTSL), more frequently used objects (e.g., "teapot" in CTSL) tend to elicit shorter sign strings or systematically ordered compounds. Whether there are generational differences in the combinatorial use of sign strings to refer to everyday objects and whether presenting stimuli in isolation vs. context affects the combinatorial structures remain open questions.

1.3. The Focus of This Study

Previous studies mentioned in Sections 1.1 and 1.2 mainly focused on either object-based (i.e., static iconic forms with no action involved) or action-based iconic forms and presented evidence for systematic variation of them across semantic categories or distinct event structures. This study aims to investigate the *action*, *object*, and simultaneous use of *action* and *object* as iconic strategies (see the coding procedure in Section 2.1) and their combinations used for referring to everyday objects across generations in the emerging lexicon of Central Taurus Sign Language. The motivation for this investigation is to understand (1) whether a language in its initial stages favors *action*, *object*, or simultaneous production of *action* and *object* strategies as a more salient property to represent a target object iconically, (2) whether there are generational differences in the use of these strategies and their combinations, and (3) whether signers modulate their use of these strategies and their combinations in response to stimuli presented in isolation vs. context.

Section 1.4 introduces Central Taurus Sign Language (CTSL). Section 2 presents the design and results of study 1, which investigates CTSL responses when the target objects are presented in isolation. Section 3 presents study 2, which compares the CTSL responses when the target objects are presented in isolation vs. context.

1.4. Central Taurus Sign Language

Central Taurus Sign Language (CTSL) is a village sign language which emerged spontaneously over the past 50 years or so in the absence of a conventionalized linguistic model. It developed in a geographically isolated area with little or no influence from Turkish Sign Language (TiD). It is mainly used in a small village located in the Central Taurus Mountain Range of southern Turkey. The deaf individuals, comprising approximately 4.6% of the village population, are connected to each other by birth or through marriage (see Supplementary S1 for the family tree). The high incidence of deafness in the village (compared with a typical incidence of deafness of approximately 0.5%) is an outcome of recessive deafness in the community and the prevalence of consanguineous marriages in families with deaf individuals. CTSL has about 25 deaf signers today, 17 of whom use CTSL as their sole language, whereas others can use Turkish Sign Language at varying proficiency levels. In addition, there are approximately 80 hearing Turkish speakers who also have some degree of fluency in CTSL.

In order to track the developmental trajectory of the language, we identify three cohorts of signers in the community. CTSL-1 is the first cohort of signers, who were born as the first deaf child in their family and who therefore would have had little or no linguistic input early in life (n = 9; age range = 49–61). CTSL-2 is the second cohort, comprising the deaf and younger siblings of cohort 1 signers. They would have had more linguistic input because they had at least one older sibling who signed (n = 8; age range = 42–54). CTSL-3 is the third cohort of deaf signers from the younger generation: children of CTSL-1 and CTSL-2 signers (n = 4; age range = 24–30) (see Ergin 2017; Ergin and Brentari 2017; Ergin et al. 2018, 2020, 2021). There were also four deaf children who constituted a potential fourth cohort, though their linguistic behavior has not been documented yet.

2. Study 1

The goal of this study is to investigate object-based and action-based iconic strategies and their combinations across generations when the target objects are presented in isolation.

2.1. Materials and Methods

Participants. Ten deaf signers from 2 successive age cohorts (5 CTSL-1 signers: M_{age} = 51.8, age range = 43–55; 5 CTSL-2 signers: M_{age} = 41.4, age range = 35–44[4]) were tested. All of the participants used CTSL as their sole language, and the CTSL-2 signers were the younger siblings of the CTSL-1 signers.

Stimuli and Procedure. The deaf CTSL signers were tested in a *picture-naming task*. They viewed stimuli involving pictures of 26 everyday objects (Table 1) on a computer screen and labeled them for another deaf addressee or a hearing family member fluent in CTSL. A previous investigation of CTSL revealed systematic opposition across semantic categories such as tools and fruits and vegetables, which frequently elicit *handling* or *instrument* (cf. simultaneous *action* and *object* in the current coding scheme) and *object* strategies in CTSL, respectively (Hwang et al. 2017). In order not to create a bias for certain iconic strategies in the cumulative results, these semantic categories were not used in the current stimuli set. Instead, a variety of everyday objects that were not previously studied in CTSL for iconic representations were included in the stimuli set. All of the stimuli items were presented in isolation (i.e., non-agentive context) in a single randomized block (see Supplementary S2 for the pictures of the stimuli items). The data were collected in August 2013.

Table 1. List of objects used in study 1.

box	fork	motor vehicle	spoon
bread board	gas tank	pen	stove
broom	game cards	plate	string
car	glass	pot	telephone
cologne	glasses	sieve	teapot
cooking pot	iron	soap	video camera
copper vessel	matches		

Coding Procedure. The responses to the stimuli were transcribed using ELAN, a tool developed at the Max Planck Institute for Psycholinguistics in Nijmegen, for analysis of the spoken language, sign language, and gestures (Crasborn and Sloetjes 2008) and coded[5] based on the following the criteria defining the iconic representations of the target stimuli items.

Action: In this strategy, the signer's hand represents a hand performing an action (cf. "acting" by Müller 2013). For example, for CAR, the sign that represents holding the steering wheel with both hands and controlling it by moving the hands up and down in opposite directions is coded as an "action".

Object: The hand represents the object itself or represents an aspect of the target object, such as its dimensions, size, or shape (Ergin and Brentari 2017 and Padden et al. 2013). There is no motion representing an action. For instance, COOKING POT, a sign involving two C-static handshapes representing the **shape** of the pot, is coded as an "object" sign. A sign representing the **size** of an object, as well as the simultaneous depiction of shape and size, is also coded as an "object" sign[6]. Object signs depicting the size or shape of an object can be either one-handed or two-handed (e.g., GLASS, an L-handshape after DRINK to represent the size of the glass, or STICK, with two extended index fingers showing the length of the stick). Finally, signs involving the hand or hands in any configuration **tracing**[7] the outline of an object is also coded as an "object" sign (e.g., BREAD BOARD, with two flat hands moving horizontally outward to trace the surface of a bread board, or DRESS, with the flat dominant hand facing upward and tracing the length of the dress or the length of its sleeves on the signer's body).

Note that the goal was to understand whether it was the object-based or the action-based iconic representations that were more salient to be selected for iconic representations. That is why the object category was not divided into further subcategories (e.g., size, shape, and tracing), but all static forms depicting the physical property of the target object as a whole or an aspect of it (e.g., size) were evaluated under the "object" category.

Action and Object: In this strategy, action and object strategies are used simultaneously. If it is a one-handed sign, the dominant hand is used either as an instrument or an agent handling the object and simultaneously performing the action associated with that instrument (e.g., BROOM, with extended widespread fingers representing the object and simultaneously producing vertical right-to-left movement of the hand representing the sweeping action, or GLASS, where the C-handshape represents handling the object or its shape, and the motion represents bringing the glass to the mouth for drinking) (cf. "instrument" and "handling" by Padden et al. 2013 and "handling" by Ergin and Brentari 2017).

If it is a two-handed sign, both hands are simultaneously used to represent an object with the non-dominant hand and to depict an action performed on that object with the dominant hand (e.g., MATCH, where the dominant hand represents the action of swiping a matchstick, and the non-dominant hand represents the surface of a match box, where the action takes place).

Deictic: Gestures involving showing, pointing, or touching the objects in the immediate physical environment with or without the object present are coded as "deictic" signs (e.g., SCARF, by touching the scarf one is wearing). The pointing can be with an open hand or extended index finger (Kita 2003).

Unrecognizable signs that did not fit any of the categories listed above were coded as "other" (e.g., MATCH, where the signer produces a sign with the index finger and thumb touching each other, but it is not clear whether the signer refers to the size of the match or he or she is holding the match).

Repeated signs in a response were ignored. For example, in a sign string like "$action_1$—$deictic_1$—$action_1$—$deictic_1$", the action sign and the deictic with the same form and function were repeated and therefore ignored. This response was counted as a two-sign string. Likewise, a string involving "$object_1$—$action_1$—$action_2$—$object_1$" was considered a three-sign string, as the same object sign was repeated at the end.

2.2. Results

Signers across cohorts differed in the number of signs to refer to objects. The CTSL-1 signers produced a total of 122 sign strings involving a total of 204 signs in all strings (repetitions excluded). The CTSL-2 signers produced 123 sign strings involving a total 274 signs in all strings. The overall most frequent strings were single signs (38.7%, e.g., CAR, SPOON, MATCHES, or GAME CARDS), followed by two-sign (36.3%, e.g., BREAD BOARD, GLASS, VIDEO CAMERA, or POT), three-sign (13.9%, e.g., COLOGNE), and four-sign or more strings (11%, e.g., COOKING POT). Overall, the CTSL-1 signers used significantly shorter strings of signs ($M_{\text{CTSL-1}} = 1.78$, $SD_{\text{CTSL-1}} = 0.62$) than the CTSL-2 signers ($M_{\text{CTSL-2}} = 2.25$, $SD_{\text{CTSL-2}} = 0.79$) ($t(25) = 2.60$ $p = 0.019$). In addition, the CTSL-1 signers produced significantly more single-sign responses than the CTSL-2 signers ($\chi^2(1) = 7.83$, $p = 0.0051$). In other words, the CTSL-2 signers relied more on the combinatorial strategies over single signs (Figure 2).

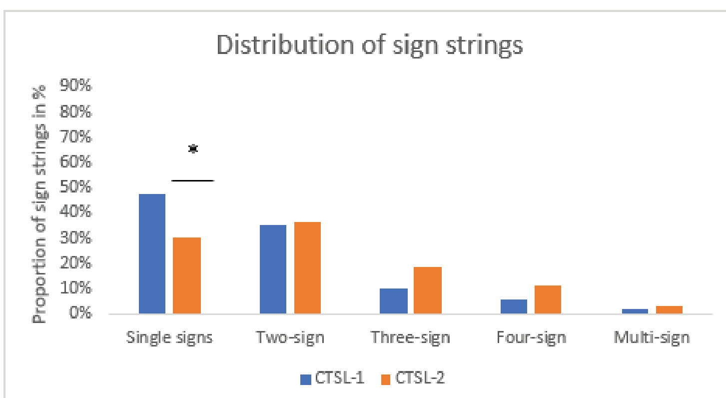


Figure 2. Distribution of sign strings. The *Y*-axis represents the proportional frequency of responses involving sign strings on the *X*-axis. The blue bars represent CTSL-1, and the orange bars represent CTSL-2 ($N_{total} = 245$, $N_{\text{CTSL-1}} = 122$, $N_{\text{CTSL-2}} = 123$).

While there was a difference in the number of signs and lengths of strings, there were no differences in the implementation of the iconic strategies across cohorts. In single-sign strings ($N_{\text{single-sign}} = 95$), the favored strategy was *action* (46.3% of instances), followed by the simultaneous production of *action* and *object* (35.8%) and *object* (17.9%) strategies. Among the remaining signs produced in the overall multi-sign strings ($N_{total} = 383$), a slightly different pattern was displayed: the favored strategy was *action* (37% of instances), closely followed by the *object* (34.6%), simultaneous production of *action* and *object* (17%), and *deictic* (7.8%) strategies. BOX, COLOGNE, CAR, CARDS, MOTOR VEHICLE, SIEVE, and SOAP frequently elicited components involving action-based iconic strategies, while COOKING POT, GLASSES, PLATE, and STOVE elicited components involving object-based strategies, and BROOM, CELLPHONE, FORK, GLASS, MATCHES, etc. frequently elicited components involving simultaneous use of the object- and action-based strategies (Figure 3).

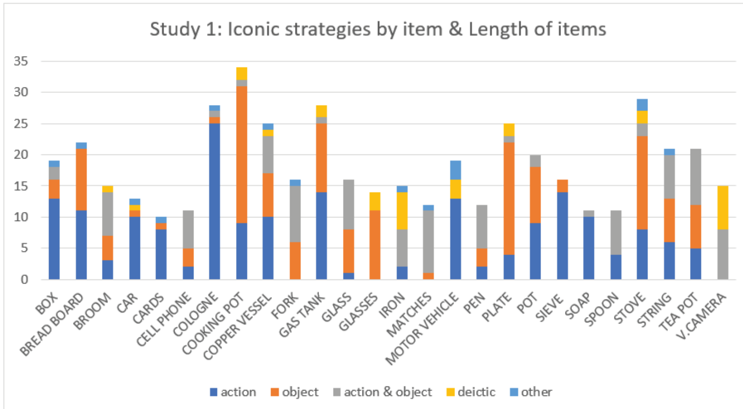


Figure 3. Distribution of iconic strategies by item. The *Y*-axis represents the number of occurrences of iconic strategies by items on the *X*-axis (N_{total} = 478, $N_{CTSL\text{-}1}$ = 204, $N_{CTSL\text{-}2}$ = 274). Shorter bars indicate shorter sign-strings, and taller bars indicate longer sign strings.

In two-sign strings ($n_{two\text{-}sign}$ = 89), *action* and *object* were equally favored (34.1% and 34.1% of instances, respectfully), followed by simultaneous *action* and *object* (19.9%) and *deictic* strategies (10.2%). The most common combination in two-sign strings involved an *object* strategy combined with an *action* strategy irrespective of their ordering (e.g., BREAD BOARD, GLASS, TEAPOT, or POT) or with a simultaneous *action* and *object* strategy to further disambiguate the target object (e.g., FORK or COPPER VESSEL). The other combinations involved strategies of $action_1$—$action_2$, $object_1$—$object_2$, action and object—deictic, etc., with no significant difference across cohorts in either the implementation of iconic strategies or ordering of the constituents in two-sign strings (Figure 4).

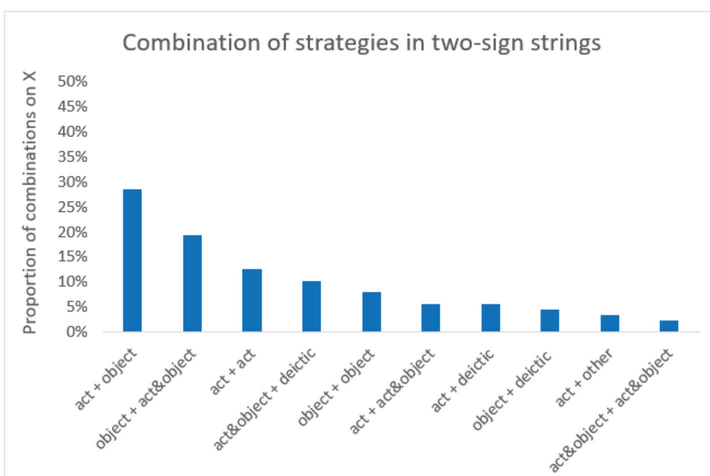


Figure 4. Combination of strategies used in two-sign strings. The *Y*-axis represents the proportional frequency of responses involving the combination of iconic representations on the *X*-axis (N_{total} = 88, 35.9% of all strings). The categories represent the constituents irrespective of their order (i.e., the bar for action + object also includes object + action combinations).

For instance, to refer to GLASS, the signers tended to reenact drinking (*action*) and then use an *object* sign denoting the dimensions of the target object (Figure 5). For CELLPHONE, they reenacted talking on the phone (*action*) simultaneously with an object sign representing the phone, and then they used an *object* sign representing the size of the object (Figure 6).

(**a**) (**b**) (**c**)

Figure 5. (**a**) Stimulus item used in the task. (**b**) Reenactment of drinking (*action*). (**c**) Size or dimensions of the target object (*object*). The *action* and *object* combination depicted in (**b**,**c**) refers to a GLASS.

(**a**) (**b**) (**c**)

Figure 6. (**a**) Stimulus item used in the task. (**b**) Cellphone (object) and depiction of the reenactment of talking on the phone (*action*). (**c**) Size of the cellphone (object). The *object—action* and *object* combination depicted in (**b**,**c**) refers to a CELLPHONE.

2.3. Summary and Conclusions

The goal of study 1 was to explore and investigate the developmental trajectory of an emerging lexicon in a language in its initial stages. The results show that the CTSL-1 signers produced significantly shorter responses and more single-sign strings for labeling everyday objects as opposed to the CTSL-2 signers, who produced more combinatorial responses, suggesting that the language became morphologically more complex over time. There were no significant differences across cohorts in implementing iconic strategies. The most common strategy produced by both cohorts in the entire task was *action*, followed by *object* and simultaneous implementation of *action* and *object* strategies. In two-sign strings, *action—object* was the most frequent combination, followed by the *object—action* and *object* combination, for both cohorts. These findings corroborate the previous studies suggesting that action simulations are the precursors of iconic forms in a manual lexicon (e.g., Cook and Tanenhaus 2009; Hostetter and Alibali 2008; and Ortega and Özyürek 2020).

The same types of iconic forms were present for CTSL-1, suggesting that they emerged quickly in the first generation of the language, whereas the combinatorial use of them waited until CTSL-2 to emerge. In line with the findings in other emerging sign languages (e.g., ABSL), more established sign languages (e.g., ASL), and also homesign systems, some lexical items were produced as compounds, whereas others elicited longer idiosyncratic sign strings (e.g., Tkachman and Sandler 2013; Klima and Bellugi 1979; Haviland 2013;

Morgan 2015; and Ergin et al. 2021). Going beyond the previous findings, this study shows that the lexical items becme more combinatorial and morphologically complex as of CTSL-2.

This study provideD us insight into the emerging lexicon of a newly developing language. However, it was limited in that the target objects were presented in isolation without context. This may have resulted in elicitation of longer descriptions for objects rather than shorter labels.

3. Study 2

Building upon the findings of study 1, study 2 investigated the emerging lexicon of CTSL in further detail with a new set of everyday objects presented in isolation and in context. The goal of this study was two-fold: (1) to replicate the findings in study 1 and (2) to investigate whether there were any similarities or differences between labeling everyday objects when they were presented in isolation vs. in context.

3.1. Materials and Methods

Participants. Eight deaf signers from 2 successive age cohorts (4 CTSL-1 signers: M_{age} = 48.7, age range = 44–54; Four CTSL-2 signers: M_{age} = 40.5, age range = 35–44) were tested. All signers used CTSL as their primary and only means of communication. The CTSL-1 signers were the older siblings of the CTSL-2 signers. The signers in studies 1 and 2 were the same individuals.

Stimuli and Procedure. Deaf CTSL signers were paired up with another deaf or hearing addressee fluent in CTSL. They were tested in two consecutive tasks. (1) As in study 1, the signers performed a *picture-naming task* for images of 16 everyday objects (Table 2) depicted in isolation (see Supplementary S3 for the images of the objects). Semantic categories such as tools and fruits and vegetables were intentionally avoided not to create a bias for *object* and simultaneous *object* and *action* strategies (see Hwang et al. 2017 and Ergin and Brentari 2017). The participants viewed the images on a computer screen and labeled them to an addressee. (2) The signers performed a *communicative task* in which they were asked to view short video clips involving the exact same objects (Table 2) and describe the event in the clips to an addressee, who then selected the corresponding picture from an array of three pictures (see Supplementary S4 for a sample trial in the task). All data were collected in August 2014.

Table 2. List of objects used in study 2.

ball	dress	glasses	washing basin
box	hat	plastic bag	suitcase
book	jacket	scarf	teapot
bottle	glass	stick	toy car

The stimuli items in task 2 involved a human agent performing a non-prototypical action on the target objects (Table 3). The rationale behind using non-prototypical actions was to minimize object incorporation into prototypical actions, which is a potential bias for the simultaneous use of object and action strategies (i.e., objects with actions like “reading a book”, “drinking from bottle”, “putting the jacket, hat, or dress on”, “pouring tea from a teapot”, etc. were intentionally avoided). Three stimuli items (i.e., a washing basin, plastic bag, and box) were used with their prototypical function as containers and not directly acted upon by an agent but rather as containers for objects acted upon by a human agent.

Table 3. List of contexts used in study 2.

Woman puts the **ball** inside the **plastic bag**	Woman puts the **glass** on the **table**
Man puts the onion in the **plastic bag**	Man puts the **glasses** on woman's face
Man puts the **teapot** into the **box**	The woman drops the **glasses**
Man throws the **hat**	Man is sewing the **jacket**
Man puts the **hat** on woman's head	Man takes off the **jacket**
Man picks up the small **book** on the table	Man takes the **bottle** from the woman
Toy car hits the **book**	**Bottle** falls on the woman
Man irons **dress**	Woman is trying to break the **stick**
Woman is washing the **dress** in the **washing basin**	Man is trying to open the **suitcase**
Woman is washing the **scarf** in the **washing basin**	

Coding Procedure. Coding procedure was the same as in study 2 (see Section 2.1).

3.2. Results

Picture-naming task. The CTSL-1 signers produced a total of 70 sign strings involving a total of 129 signs in all strings. The CTSL-2 signers produced 68 sign strings involving a total 163 signs in all strings (repetitions excluded). The overall most frequent strings were two-sign strings (41.3%, e.g., BOTTLE, WASHING BASIN, and GLASS), followed by single signs (31.1%, e.g., BOOK, BOX, and GLASSES) and three-sign (16.6%, e.g., TEAPOT and TOY CAR) and four-sign or more strings (10.9%, e.g., SUITCASE). This was a slightly different pattern from that in study 1, in which the frequency of single signs was higher than that for the two-sign strings. However, a similar pattern to the one in study 1 in the distribution of sign strings was observed: the CTSL-1 signers used significantly shorter strings of signs ($M_{CTSL\text{-}1}$ = 1.88, $SD_{CTSL\text{-}1}$ = 0.64) than the CTSL-2 signers ($M_{CTSL\text{-}2}$ = 2.37, $SD_{CTSL\text{-}2}$ = 0.59) ($t(15)$ = 2.131, p = 0.03). In addition, the CTSL-1 signers produced significantly more single-sign strings than the CTSL-2 signers ($\chi^2(1)$ = 6.93, p = 0.0085) (Figure 7).

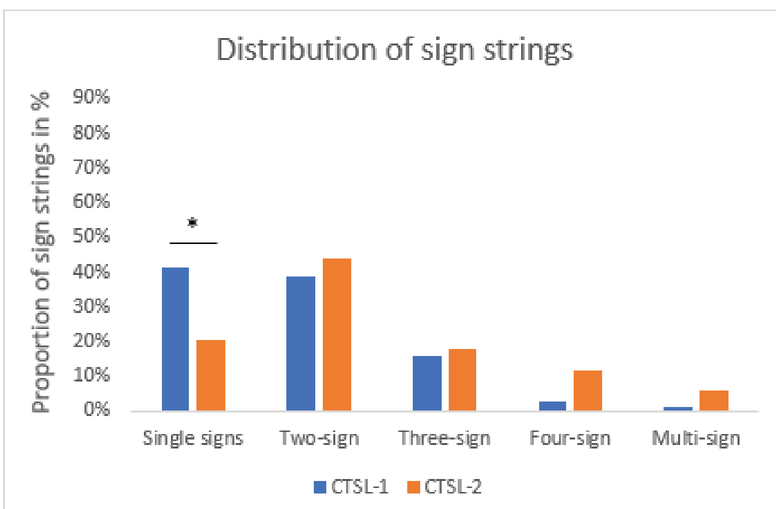


Figure 7. Distribution of sign strings. The Y-axis represents the proportional frequency of responses involving sign strings on the X-axis. The blue bars represent CTSL-1, and the orange bars represent CTSL-2 (N_{total} = 138, $N_{CTSL\text{-}1}$ = 70, $N_{CTSL\text{-}2}$ = 68). CTSL-1 produces significantly more single-sign strings than CTSL-2.

As in study 1, there were no significant differences in the implementation of the iconic strategies across cohorts. In the overall sign strings (N_{total} = 292), the primary strategy was *object* (42%, 8 of instances), followed by the *action* (26.7%), simultaneous production of *action* and *object* (20.9%), and *deictic* (6.8%) strategies. This was a slightly different pattern than the one in study 1, in which *action* was favored over *object* as the primary strategy. DRESS, GLASS, GLASSES, and HAT frequently elicited object-based strategies, while BOX, PLASTIC BAG, WASHING BASIN, and SUITCASE frequently elicited action-based strategies combined with object ones or simultaneous use of action and object strategies.

In two-sign strings, a pattern similar to that in Study 1 was observed. The most common combination was *action—object*, followed by *object—action* and *object*, and *action—action* combinations (see Figures 8 and 9). BALL, DRESS, PLASTIC BAG, WASHING BASIN, SCARF, WATER BOTTLE, and GLASS frequently elicited two-sign (or more) strings.

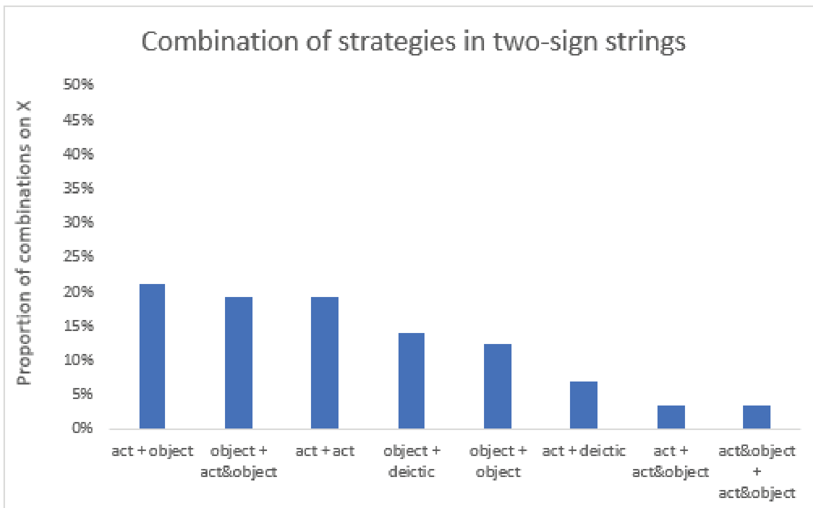


Figure 8. Combination of strategies used in two-sign strings. The *Y*-axis represents the proportional frequency of responses involving the combination of iconic representations on the *X*-axis ($N_{total} = 57$, 41.3% of all strings). The categories represent the constituents irrespective of their order (i.e., the bar for act + object also includes object + act combinations).

(**a**) (**b**) (**c**)

Figure 9. (**a**) Stimulus item used in the task. (**b**) Reenactment of washing (*action*). (**c**) Tracing of the circular shape (*object*). The *action-object* combination depicted in (**a**,**b**) refers to a WASHING BASIN.

Communicative task. The CTSL-1 signers produced a total of 84 sign strings involving a total of 101 signs in all strings. The CTSL-2 signers produced 111 sign strings involving a total 151 signs in all strings (repetitions excluded). The results show that an overwhelming majority of the overall productions in context were single signs (74.8%, e.g., GLASSES, HAT, JACKET, and BOOK), followed by two-sign strings (21%, e.g., PLASTIC BAG and WASHING BASIN) and three-sign strings (4.1%, e.g., SUITCASE and TOY CAR). Both the CTSL-1 and CTSL-2 signers used significantly shorter strings when the target objects (Tables 2 and 3) were presented in context as opposed to being presented in isolation (<u>CTSL-1</u>: $t(15) = 2.131$, $p = 0.001$; <u>CTSL-2</u>: $t(15) = 2.131$, $p < 0.001$). Figure 10 shows that single-sign responses were a lot more frequent in context ($\chi^2(1) = 62.71$, $p < 0.0001$). Furthermore, responses involving two or three signs were significantly less frequent when the objects were presented in context (two-sign strings in context vs. in isolation ($\chi^2(1) = 15.93$, $p = 0.0001$) and three-sign strings in context vs. in isolation ($\chi^2(1) = 15.08$, $p = 0.0001$)). Multi-sign strings involving four or more signs were not produced in context (i.e., the signers tended to produce short labels for objects when they were presented in context, rather than producing longer descriptions as they did when they were presented in isolation).

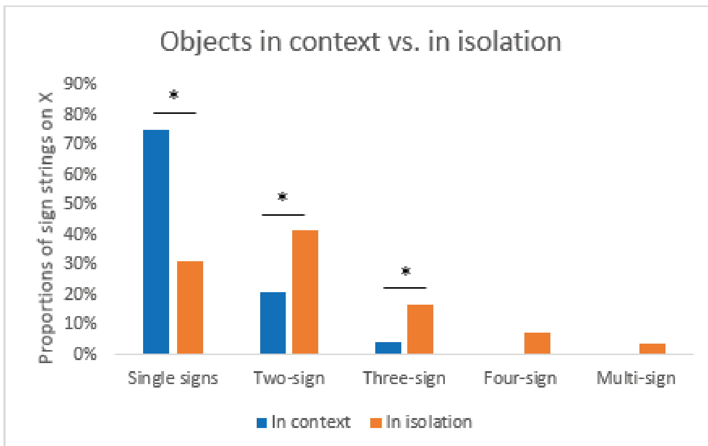


Figure 10. Sign strings produced for objects when they were presented in context vs. in isolation. The *Y*-axis represents the proportional frequency of sign strings on the *X*-axis. The blue bars represent responses produced for objects presented in context, and the orange bars represent responses produced for objects presented in isolation ($N_{context} = 195$, $N_{isolation} = 138$). CTSL-2 produces significantly longer sign strings than CTSL-1.

While there was a significant difference between the lengths of the responses for the CTSL-1 and CTSL-2 signers when objects were presented in isolation, there was no overall significant difference across cohorts when the same objects were presented in context ($M_{CTSL\text{-}1} = 1.23$, $SD_{CTSL\text{-}1} = 0.27$; $M_{CTSL\text{-}2} = 1.39$, $SD_{CTSL\text{-}2} = 0.32$; $t(15) = 2.131$, $p = 0.12$). Although the general tendency of both cohorts was to produce shorter responses in context with no overall significant difference in the lengths of the sign strings across cohorts, CTSL-1 still produced more single signs in context ($\chi^2(1) = 5.55$, $p = 0.018$), and CTSL-2 produced more two-sign strings ($\chi^2(1) = 5.63$, $p = 0.0176$), indicating more reliance on combinatorial responses to label objects not only in isolation but also in context (Figure 11). Items which were not always labeled with a single sign and still produced in combination with at least one more sign in context were PLASTIC BAG, TEAPOT, DRESS, BOTTLE, WASHING BASIN, TOY CAR, STICK, SUITCASE, and GLASS.

Overall, for the sign strings produced in context by both cohorts ($N_{total} = 252$), the primary strategy was *object* (53.1% of instances), followed by simultaneous production of *action* and *object* (30.1%), *action* (10.7%), and *deictic* (5.9%) strategies. As in the responses for the target items elicited in isolation, there was no significant difference across cohorts in the implementation of iconic strategies either. However, there were significant differences in the implementation of iconic strategies when the target objects were presented in isolation vs. context: action-based iconic representations were produced significantly less in context ($\chi^2(1) = 22.2$, $p < 0.0001$), and object-based and simultaneous action and object strategies were used significantly more ($\chi^2(1) = 5.73$, $p = 0.0167$ and $\chi^2(1) = 6.08$, $p = 0.0137$, respectively). Many objects involved an *action* component in response to objects presented in isolation (e.g., BALL, BOX, JACKET, PLASTIC BAG, WASHING BASIN, SCARF, SUITCASE, TEAPOT, TOY CAR, and WATER BOTTLE) (Figure 12), whereas fewer objects involved an *action* component in response to an object presented in context (e.g., BALL, JACKET, PLASTIC BAG, SUITCASE, and TOY CAR) (Figure 13).

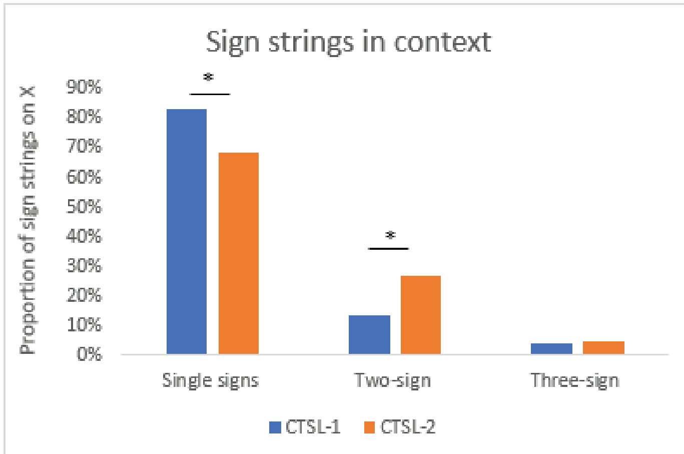


Figure 11. Sign strings produced by CTSL-1 and CTSL-2 for objects when they were presented in context. The *Y*-axis represents the proportional frequency of sign strings on the *X*-axis. The blue bars represent responses by CTSL-1, and the orange bars represent responses by CTSL-2 ($N_{CTSL\text{-}1t}$ = 84, $N_{CTSL\text{-}2}$ = 111). CTSL-2 produces significantly longer sign strings than CTSL-1.

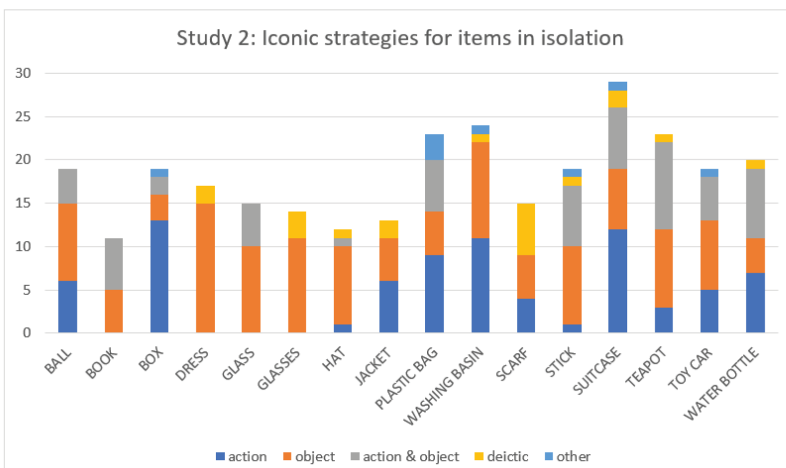


Figure 12. Iconic strategies by item when objects were presented in isolation. The *Y*-axis represents the number of occurrences of iconic strategies used in items on the *X*-axis ($N_{isolation}$ = 292).

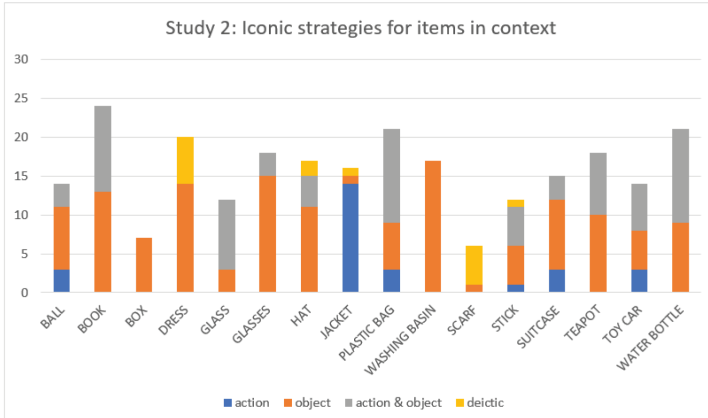


Figure 13. Iconic strategies by item when objects were presented in context. The *Y*-axis represents the number of ocurrences of iconic strategies used in items on the *X*-axis ($N_{context}$ = 252).

Some of the actual responses to the stimuli as they were produced by CTSL-1 signers in isolation vs. context were as follows:

(1) **STICK** [=FIRE ˆ CUT ˆ SIZE][8]

In (1), STICK, as produced in isolation by a CTSL-1 signer, was a three-sign string. The first sign had an action-based iconic form resembling blowing, which represents FIRE in CTSL (Figure 14b). This was followed by a simultaneous action and object sign for CUTTING, representing cutting wood. Both hands are flat in a cross-configuration, with the non-dominant hand standing still and the dominant hand making a repetitive downward and upward movement on the non-dominant hand (Figure 14c). The last component of the string was an object-based iconic sign depicting the size of the target object with both hands flat facing each other on a horizontal plane (Figure 14d). In sum, this is an object with a certain size that is cut and used for making fire.

(2) **STICK** [= FIRE ˆ CUT] BREAK WOMAN BREAK

Eng. "Woman breaks or is trying to break the stick."

In (2), the same participant dropped the last component denoting the size of the object and produced a two-sign string for STICK in context (Figure 14b,c).

(**a**) (**b**) (**c**) (**d**)

Figure 14. (**a**) STICK produced in isolation by a CTSL-1 signer. (**b**) FIRE. (**c**) Action of CUTTING. (**d**) Size of the target object. All three together refer to the target object. For STICK in context, the first two components were preserved (**b**,**c**), and the last component depicting the size of the object (**d**) was dropped.

(3) **BALL** [= CIRCULAR SHAPE ˆ BALL THROW]

In (3), another CTSL-1 signer produced BALL as a two-sign string in isolation. The first sign in the string denotes the circular shape of the object with both hands (Figure 15b).

The second sign is a simultaneous combination of the same iconic form with a repetitive forward and backward ball-throwing action in front of the body (Figure 15c).

(**a**) (**b**) (**c**)

Figure 15. (**a**) BALL produced in isolation by a CTSL-1 signer. (**b**) The circular shape of the object, and (**c**) depicts the simultaneous object and action of BALL THROWING. Together, they refer to the target object. For BALL in context, the first component (**b**) was preserved, and the second component (**c**) was dropped.

(4) **PLASTIC BAG** [= HOLD ˆ SPHERICAL SHAPE]

In (4), the same CTSL-1 signer produced PLASTIC-BAG in isolation as a compound involving the action of HOLDING with both hands on both sides of the target object (Figure 16b), followed by a two-handed sign depicting the size and spherical shape of the object (Figure 16c).

(5) PUT INSIDE WOMAN **BALL**[= CIRCULAR SHAPE] PUT INSIDE **PLASTIC BAG**[= HOLD] PUT INSIDE

Eng. "Woman puts the ball inside the plastic bag."

In (5), the CTSL-1 signer produced a reduced form for both BALL and PLASTIC BAG in context. The component containing the size and shape information of BALL was preserved, but the one containing an associated action was dropped. For PLASTIC BAG, the component denoting the action of HOLDING was preserved, and it was produced as a one-handed sign in context (Figure 16d), but the sign denoting the shape and size of the object was dropped (Figure 16c). In other words, there was no systematicity regarding which iconic form to preserve and which one to drop. In addition, further information regarding the physical form of BALL and PLASTIC BAG was incorporated into the main action: PUT INSIDE. The non-dominant hand represents a circular object with a container function (i.e., PLASTIC BAG), and the dominant hand represents another—the circular object (i.e., BALL)—and makes a movement toward the non-dominant hand to signal that the BALL goes into the PLASTIC BAG (Figure 16e).

(**a**) (**b**) (**c**) (**d**) (**e**)

Figure 16. (**a**) PLASTIC BAG produced in isolation by a CTSL-1 signer. (**b**) The action of HOLDING, and (**c**) depicts the spherical shape of the target object. Together, they refer to the target object. For PLASTIC BAG in context, (**d**) depicts the action of HOLDING, referring to the target object in a reduced form. (**e**) The action of PUTTING INSIDE, in which the reduced form of BALL and PLASTIC BAG are incorporated.

Some of the actual responses to the stimuli as they were produced by the CTSL-2 signers in isolation vs. context are as follows:

(6) **BALL** [= CIRCULAR SHAPE ˆ BOUNCE]

In (6), similar to the response of the CTSL-1 signer (Figure 15), the CTSL-2 signer produced a compound involving an object-based iconic form in response to the image of a BALL (Figure 17b). This was followed by a simultaneous object and action sign signaling the shape of the target object incorporated in a bouncing action (Figure 17c). However, the imagistic forms of the iconic strategies the CTSL-2 signer used differed from the ones the CTSL-1 signer used. The CTSL-2 signer produced a one-handed circular shape to represent a specific smaller bouncing BALL, as was displayed in the stimulus.

(**a**) (**b**) (**c**)

Figure 17. (**a**) BALL produced in isolation by a CTSL-2 signer. (**b**) Circular shape of the object. (**c**) Simultaneous object and action of BALL BOUNCING. Together, they refer to the target object. For BALL in context, the first component (**b**) was preserved, and the second component (**c**) was dropped.

(7) **PLASTIC BAG** [= HOLD ˆ PUT INSIDE ˆ SIZE]

In (7), the CTSL-2 signer produced a three-sign string to refer to PLASTIC BAG in isolation. The first sign refers to the action of HOLDING a bag (Figure 18b). The second sign is a simultaneous action and object of putting something inside a container, with the non-dominant hand representing the container and the dominant hand representing the agent performing the action (Figure 18c). The third sign refers to the spherical shape and size of the target object, with two C-shaped hands facing each other on the horizontal plane (Figure 18d).

(8) WOMAN **PLASTIC BAG** [= PUT INSIDE ˆ HOLD ˆ SIZE] **BALL**[= CIRCULAR SHAPE] PUT INSIDE

Eng. "Woman puts the ball inside the plastic bag."

In (8), just as the CTSL-1 signer did, the CTSL-2 signer also dropped the second sign for BALL in context and produced only the first sign denoting the size and shape of the object. For PLASTIC BAG, the CTSL-2 signer kept all three signs of the sign string and produced all of them consistently in the same imagistic form (Figure 18b–d), but HOLD and PUT INSIDE came in varying orders. It is important to note that the first sign (i.e., PUT INSIDE) in the sign string referring to a component of PLASTIC BAG was different from the main action of the sentence (i.e., PUT INSIDE) in that it was smaller in form and involved only a brief movement of putting inside (Figure 18c). In contrast, PUT INSIDE as the main action of the sentence was bigger in form, with the movement of the dominant hand more emphasized and the function of the non-dominant hand as a container more visible (Figure 18e).

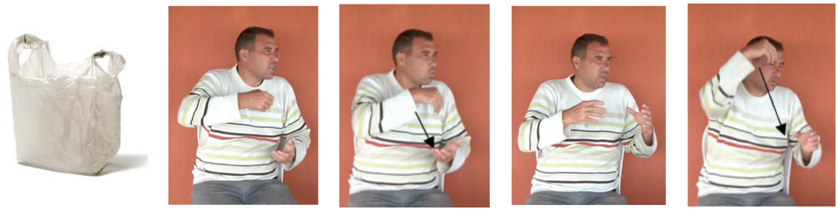


Figure 18. (**a**) PLASTIC BAG produced in isolation by a CTSL-2 signer. (**b**) Action of HOLDING. (**c**) The simultaneous action and object of PUT INSIDE. (**d**) Size and shape of the target object. All three together refer to the target object. For PLASTIC BAG in context, all three components were preservsed in context, but the first two components varied in order. (**e**) The main action for PUT INSIDE in the sentence, which is different in its form from the form of the PUT INSIDE sign in (**b**).

3.3. Summary and Conclusions

The goal of this study was to replicate the results from study 1 and investigate the lexical inventory of a newly emerging language when objects were presented in isolation vs. in context. In line with the findings from study 1, the CTSL-1 signers produced significantly shorter sign strings than the CTSL-2 signers when objects were presented in isolation. They also produced more single-sign strings than the CTSL-2 signers. There was no significant difference across cohorts in their implementation of iconic strategies in either study 1 or study 2. While the most frequent iconic strategy was *action* in the overall signs produced in study 1, it was the *object* strategy in study 2. In the two-sign strings, an *object* strategy was frequently combined with an *action* or a simultaneous *action* and *object* strategy. This pattern further corroborates the findings of the two-sign strings in study 1.

When objects were presented in context, the lengths of the strings overall were significantly shorter compared with the lengths of the strings elicited when objects were presented in isolation. This finding suggests that the signers gave longer descriptions for objects when they were presented in isolation rather than labeling them with a single sign, as they frequently did in context. In addition, no significant difference in the lengths of the sign strings across cohorts was found. Yet, the CTSL-1 signers still produced significantly more single-sign and significantly fewer combinatorial responses than the CTSL-2 signers. This shows that the CTSL-2 signers were not only more elaborate in giving descriptions for objects in isolation, but they were also more precise in disambiguating them with combinatorial structures in context. Finally, there was no difference either across cohorts in the implementation of iconic strategies or across the sign strings within both tasks. However, there were significant differences in the implementation of all iconic strategies across tasks. Fewer *action* strategies and more *object* and simultaneous *object* and *action* strategies were implemented when the target items were presented in context.

4. General Discussion

4.1. Object-Based or Action-Based Iconic Strategies: Which One Is More Salient?

One of the main goals in this study was to understand whether an imagistic *object* form, an *action* associated with the target object, or the simultaneous use of both is more salient to be selected for iconic representations of everyday objects. With this goal in mind, a set of everyday objects not previously studied for iconicity in CTSL was selected as the stimuli in study 1 and study 2. They were coded for iconic representations in five categories: *object*, *action*, simultaneous use of *object* and *action*, *deictic*, and *other*. Any iconic forms signaling the shape and size information either through a static phonological realization or tracing the shape of the target item were collapsed together under the object category, as they all referred to a physical feature of an object. In order to minimize a potential bias for certain iconic representations, semantic categories such as fruits and vegetables and tools were not used in the stimuli sets. In study 2, the target objects were presented with a non-prototypical action (e.g., "hat" with "throw" or "glasses" with "drop") in context in order to prevent a potential bias for the simultaneous use of action and object strategies through object incorporations into prototypical actions.

Previous investigations on CTSL have revealed cross-linguistic similarities of iconic patterning in that CTSL uses more action-based iconic forms for tools, whereas more object-based iconic forms for semantic categories such as vegetables and fruits are used. Similar findings have been reported in the gestural productions of non-signers and signers of ASL, ABSL, ISL, German Sign Language (DGS), Japanese Sign Language (JSL) (Hwang et al. 2017), as well as San Juan Quiahije Chatino Sign Language (Hou 2018). Moreover, in line with the findings in ASL, NSL, and Nicaraguan homesign systems (Goldin-Meadow et al. 2015), CTSL signers have been shown to favor object-based strategies in non-agentive contexts and action-based strategies in agentive contexts (Ergin and Brentari 2017). In summation, CTSL typologically fit with the way other sign languages favor their use of iconic strategies in certain semantic categories and event structures.

When potential biases are removed, the available data in this study suggest that there is not a strong preference in CTSL for either action-based or object-based iconic forms for referring to everyday objects, as study 1 presented evidence in favor of action-based strategies and study 2 presented evidence for object-based strategies. Action-based iconic representations have been claimed to be the building blocks of an emerging lexicon in the manual modality (e.g., Ortega et al. 2014 and Ortega and Özyürek 2020). In particular, Ortega and Özyürek (2020)[9] presented evidence for the overwhelming use of *acting* in gestures across a variety of concepts[10]. While study 1 presented evidence in line with this finding (i.e., action is the primary mode of iconic representation, closely followed by object-based strategies), study 2 portrayed another possibility where object representations dominate the cumulative results. In other words, there is no suggestive evidence from the present data for action-based iconic representations to be the main precursor of an emerging lexicon in the manual modality. Mental images capturing the physical form (i.e., size and shape) of the target items or the simultaneous selection of an image representing the physical form of an object and an action associated with that object seem to be equally likely to be selected for iconic representations.

4.2. Is There a Difference across Cohorts of Signers in the Use of Iconic Strategies?

Previous research on emerging sign languages presented evidence for developmental differences across cohorts of signers (e.g., Senghas et al. 2004 and Padden et al. 2013). For instance, Ergin and Brentari (2017) showed that CTSL in its first generation favored action-based iconic forms over object-based iconic forms and evolved into systems favoring the opposite patterns as of the second generation. NSL in its first generation favored object-based strategies and evolved into a system favoring action-based iconic forms over time (Goldin-Meadow et al. 2015). Along these lines, previous research on CTSL also presented evidence for generational differences in various linguistic domains, such as systematic opposition in word order preferences across event types, the use of distinct morphological devices in differentiating various verb classes, and in modification strategies (Ergin et al. 2018, 2020; and Ergin et al. 2021, respectively). For example, in response to transitive constructions, CTSL-1 frequently produces object-verb (OV) sequences without the subject (S) and irrespective of the semantic structure of the construed event, whereas CTSL-2 produces more complete responsenses involving all three arguments, with a systematic opposition of SOV and OSV word orders in those events involving an inanimate patient acted upon by a human agent and those involving a human patient acted upon by a human agent, respectively (Ergin et al. 2018). Similarly, CTSL-1 signers produce significantly shorter responses and make use of simple or complex modification structures significantly less often than CTSL-2 signers in reliably differentiating between the modifier and the modified (Ergin et al. 2021). This study reveals a similar developmental pattern across generations of signers: the CTSL-1 signers produced single-sign responses significantly more often than the CTSL-2 signers, and their responses in object descriptions were significantly shorter both in study 1 and study 2. In other words, the CTSL-2 signers relied on more combinatorial sequences of signs, probably to mark the target objects more precisely. Regarding the preference for compositionality between CTSL-1 and CTSL-2, the findings of the current study can be considered evidence of a systematization of the lexicon, being more precise semantically and more complex morphologically.

For the implementation of iconic strategies, these data show that there were no differences across generations of signers. Many of the iconic forms were already present as of CTSL-1, and they did not wait until CTSL-2 to emerge. Similarly, Ergin et al. (2020) reported that *mirroring*, an *iconically motivated morphological device* that makes use of both hands in a mirror configuration to express symmetry and plays a differentiating role between events involving symmetry and asymmetry, is present both in CTSL-1 and CTSL-2 with no significant difference. Other devices that do not iconically represent a mental image, such as *temporal sequencing* of events (e.g., WOMAN PUSH and GIRL FALL for "Woman pushes girl"), follow a developmental path that requires them to be invented over time, as they are almost completely absent in CTSL-1 and start to emerge in CTSL-2. Although many linguistic devices may require a developmental trajectory across generations, iconic representations may not be one of them. This may be a reason for not observing differences between CTSL-1 and CTSL-2 in the implementation of iconic strategies in the lexicon.

4.3. Is There a Difference in the Use of İconic Strategies and Their Combinations When the Target Objects Are Presented in İsolation vs. Context?

The available data in this study present evidence for significant differences in CTSL responses when objects are presented in isolation and in context. First, both cohorts produced significantly shorter responses in context. Second, there was no significant difference in the lengths of the responses between CTSL-1 and CTSL-2 in context. However, they significantly differed from each other in their responses when the objects were presented in isolation, and CTSL-2 still used more combinatorial forms in context, suggesting that CTSL-2 may be more reliably marking the target's real-world referents by narrowing the number of possibilities for the intended meaning.

Another key finding here is the differences in the implementation of iconic strategies in response to objects presented in isolation and in context. Both cohorts were inclined to use significantly fewer action-based iconic strategies in context and significantly more object-based or simultaneous object- and action-based strategies. When presented in isolation, in order to identify the target items more precisely, signers may tend to put them in context and produce iconic combinations involving actions associated with the target objects along with the object-based iconic forms. Alternatively, they may tend to incorporate the object-based forms into the associated actions and simultaneously produce both in order to reliably convey the intended message (e.g., see Section 3.2 for PLASTIC BAG and BALL being incorporated into the main action PUT INSIDE). However, when items are presented in context, this may not be considered a necessary condition, as there are already sufficient contextual clues contributing to the accurate interpretation of the event structure.

4.4. Final Remarks and Future Directions

In summation, this study adds to the body of research investigating how object-based and action-based iconic representations and their combinations are used for referring to everyday objects in the emerging lexicon of CTSL, which has emerged in the absence of a conventionalized linguistic system. It also expands the previous research on the similarities and differences across CTSL generations and items produced in isolation vs. in context. In order to talk about the CTSL lexicon as a whole and to generalize these results to natural discourse in CTSL, further evidence from the conversational data should be analyzed for future work.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/languages7020118/s1. Supplementary S1: the family tree. Supplementary S2: the pictures of the stimuli items. Supplementary S3: the images of the objects. Supplementary S4: a sample trial in the task.

Funding: This research received no external funding.

Institutional Review Board Statement: The study protocol was approved by the Institutional Review Board of Boğaziçi University Social Sciences Ethics Committee (SBINAREK) 2019-43.

Data Availability Statement: Not applicable.

Acknowledgments: The author thanks Carol Padden and Deniz İlkbaşaran for their help with data collection for Study 1 in August 2013, and Ray Jackendoff and Anastasia Smirnova for their useful comments on the stimuli set in Study 2. The documentation of Central Taurus Sign Language was funded by Center for Cognitive Studies at Tufts University in 2013–2014, by Tufts Collaborates in 2015–2016 and it is currently funded by the Scientific and Technological Research Council of Turkey (Project no: 118C358).

Conflicts of Interest: The author declare no conflict of interest.

Notes

1. Ergin and Brentari (2017) cautiously drew this conclusion as there was only one signer tested for handshape preferences in the first generation.
2. See also Kimmelman et al. (2018) for unsystematic variation of object vs. handling strategies across European sign languages.
3. Note that not every two-sign string is a systematic compound in CTSL (see Ergin et al. 2021).
4. The age range of the participants was reported as they were tested in 2013.
5. The data in Study 1 and Study 2 were collected in August 2013 and August 2014, respectively. All data were coded by the corresponding author.
6. These signs are typically referred to as size and shape classifiers in the literature (i.e., SASS; see Supalla 1982). In this study, they are referred to as object-based strategies, as they depict the physical form or an aspect of it, which is in line with the main research question of the current study, aiming to address whether it is the object-based or the action-based strategies that form the building blocks of an emerging lexicon.
7. Note that the movement involved in tracing forms is not in any way related to the manipulation of an object but describes the properties of size or shape.
8. The sign strings referring to the target objects are stated in square brackets. "^" is used for combining the signs in each string.
9. In their coding scheme, Ortega and Özyürek (2020) divided object-based iconic forms into further categories such as *representing* and *drawing*, which may have resulted in amplifying the count of action-based iconic forms.
10. Note that although sign languages are not improvised gestural systems, and there is ample evidence showing complex linguistic organization in sign languages, there is also growing evidence showing that gesturers and signers consistently draw from the same set of iconic strategies to mark the differences across semantic categories when they are asked to express entities in the manual modality (e.g., Hwang et al. 2017; and Ortega et al. 2017).

References

Brentari, Diane, Marie Coppola, Laura Mazzoni, and Susan Goldin-Meadow. 2012. When does a system become phonological? Handshape production in gesturers, signers, and homesigners. *Natural Language & Linguistic Theory* 30: 1–31.

Cook, Susan Wagner, and Michael K. Tanenhaus. 2009. Embodied communication: Speakers' gestures affect listeners' actions. *Cognition* 113: 98–104. [CrossRef] [PubMed]

Crasborn, Onno, and Han Sloetjes. 2008. Enhanced ELAN functionality for sign language corpora. Paper presented at the LREC 2008, Sixth International Conference on Language Resources and Evaluation, Marrakech, Morocco, May 28–30.

Emmorey, Karen. 2014. Iconicity as structure mapping. *Philosophical Transactions of the Royal Society B: Biological Sciences* 369: 20130301. [CrossRef] [PubMed]

Ergin, Rabia. 2017. Central Taurus Sign Language: A Unique Vantage Point into Language Emergence. Ph.D. dissertation, ProQuest Dissertations Publishing, Ann Arbor, MI, USA, p. 10277095.

Ergin, Rabia, Ann Senghas, Ray Jackendoff, and Lila Gleitman. 2020. Structural cues for symmetry, asymmetry, and non-symmetry in Central Taurus Sign Language. *Sign Language & Linguistics* 23: 171–207.

Ergin, Rabia, and Diane Brentari. 2017. Handshape preferences for objects and predicates in Central Taurus sign language. In *Proceedings of the 41st Annual Boston University Conference on Language Development*. Edited by Maria LaMendola and Jennifer Scott. Medford: Cascadilla Press, pp. 222–35.

Ergin, Rabia, Irit Meir, Deniz Ilkbaşaran, Carol Padden, and Ray Jackendoff. 2018. The development of argument structure in Central Taurus Sign Language. *Sign Language Studies* 18: 612–39. [CrossRef]

Ergin, Rabia, Leyla Kürşat, Ethan Hartzell, and Ray Jackendoff. 2021. Central Taurus Sign Language: On the Edge of Conventionalization. Available online: https://psyarxiv.com/x9emd/ (accessed on 20 March 2022).

Goldin-Meadow, Susan, Diane Brentari, Marie Coppola, Laura Horton, and Ann Senghas. 2015. Watching language grow in the manual modality: Nominals, predicates, and handshapes. *Cognition* 136: 381–95. [CrossRef]

Haviland, John B. 2013. The emerging grammar of nouns in a first generation sign language: Specification, iconicity, and syntax. *Gesture* 13: 309–53. [CrossRef]

Hostetter, Autumn B., and Martha W. Alibali. 2008. Visible embodiment: Gestures as simulated action. *Psychonomic Bulletin & Review* 15: 495–514.

Hou, Lynn. 2018. Iconic Patterns in San Juan Quiahije Chatino Sign Language. *Sign Language Studies* 18: 570–611. [CrossRef]

Hwang, So-One, Nozomi Tomita, Hope Morgan, Rabia Ergin, Deniz İlkbaşaran, Sharon Seegers, Ryan Lepic, and Carol Padden. 2017. Of the body and the hands: Patterned iconicity for semantic categories. *Language and Cognition* 9: 573–602. [CrossRef]

Kimmelman, Vadim I., Klezovich G. Anna, and Moroz George. 2018. IPSL: A database of iconicity patterns in sign languages. Creation and use. Paper presented at the Eleventh International Conference on Language Resources and Evaluation (LREC 2018), Miyazaki, Japan, May 7–12; Edited by Nicoletta Calzolari, Khalid Choukri, Christopher Cieri, Thierry Declerck, Sara Goggi, Koiti Hasida and Takenobu Tokunaga. Miyazaki: ELRA.

Kita, Sotaro. 2003. Pointing: A Foundational Building Block of Human Communication. In *Pointing: Where Language, Culture, and Cognition Meet*. Edited by Sotaro Kita. Mahwah: L. Erlbaum Associates, pp. vii, 339.

Klima, Edward, and Ursula Bellugi. 1979. *The Signs of Language*. Cambridge: Harvard University Press.

Lepic, Ryan, and Carol Padden. 2017. A-morphous iconicity. In *On Looking into Words (and Beyond)*. Berlin: Language Science Press, vol. 23, p. 489. [CrossRef]

Meir, Irit, Carol Padden, Mark Aronoff, and Wendy Sandler. 2013. Competing Iconicities in the Structure of Languages. *Cognitive Linguistics* 24. [CrossRef]

Meir, Irit, Mark Aronoff, Wendy Sandler, and Carol A. Padden. 2010. Sign Languages and compounding. In *Cross-Disciplinary Issues in Compounding*. Edited by Sergio Scalise and Irene Vogel. Amsterdam: John Benjamins Publishing, pp. 301–22.

Morgan, Hope E. 2015. When Does a Word Emerge? Lexical and Phonological Variation in a Young Sign Language. *San Diego Linguistic Papers* 5: 2–17.

Müller, Cornelia. 2013. Gestural modes of representation as techniques of depcition. In *Body–Language–Communication: An International Handbook on Multimodality in Human Interaction*. Edited by Cornelia Müller, Alan J. Cienki, Ellen Fricke, Silva H. Ladewig, David McNeill and Sedinha Tessendorf. Berlin: De Gruyter Mouton, pp. 1687–701.

Müller, Cornelia, Jana Bressem, and Silva H. Ladewig. 2013. Towards a Grammar of Gestures: A Form-Based View. In *Body–Language–Communication: An International Handbook on Multimodality in Human Interaction*. Berlin: De Gruyter Mouton, vol. 1, pp. 707–33.

Nyst, Victoria, Marta Morgado, Timothy Hadjah, Marco Nyarko, Mariana Martins, Lisa van der Mark, Evans Burichani, Tano Angoua, Moustapha Magassouba, Dieydi Sylla, and et al. 2021. Object and handling handshapes in 11 sign languages: Towards a typology of the iconic use of the hands. *Linguistic Typology*. [CrossRef]

Ortega, Gerardo, Annika Schiefner, and Asli Özyürek. 2017. Speakers' gestures predict the meaning and perception of iconicity in signs. Paper presented at the 39th Annual Conference of the Cognitive Science Society (CogSci 2017), London, UK, July 16–29. pp. 889–94.

Ortega, Gerardo, and Asli Özyürek. 2020. Systematic mappings between semantic categories and types of iconic representations in the manual modality: A normed database of silent gesture. *Behavior Research Methods* 52: 51–67. [CrossRef]

Ortega, Gerardo, Beyza Sumer, and Asli Ozyurek. 2014. Type of iconicity matters: Bias for action-based signs in sign language acquisition. Paper presented at the 36th Annual Meeting of the Cognitive Science Society (CogSci 2014), Quebec City, QC, Canada, July 23–26. pp. 1114–19.

Padden, Carol A. 2016. *Interaction of Morphology and Syntax in American Sign Language*. London: Routledge.

Padden, Carol, Irit Meir, So-One Hwang, Ryan Lepic, Sharon Seegers, and Tory Sampson. 2013. Patterned iconicity in sign language lexicons. *Gesture* 13: 287–305. [CrossRef]

Padden, Carol, So-One Hwang, Ryan Lepic, and Sharon Seegers. 2015. Tools for language: Patterned iconicity in sign language nouns and verbs. *Topics in Cognitive Science* 7: 81–94. [CrossRef]

Perniss, Pamela M. 2007. Space and Iconicity in German Sign Language (DGS). [Sl]: MPI Series in Psycholinguistics. Available online: http://www.pernipa.eu/papers/Perniss_MPI_dissertation.pdf (accessed on 20 March 2022).

Perniss, Pamela, Robin Thompson, and Gabriella Vigliocco. 2010. Iconicity as a general property of language: Evidence from spoken and signed languages. *Frontiers in Psychology* 1: 227. [CrossRef] [PubMed]

Pietrandrea, Paola. 2002. Iconicity and arbitrariness in Italian sign language. *Sign Language Studies* 2: 296–321. [CrossRef]

Pizzuto, Elena, and Virginia Volterra. 2000. Iconicity and transparency in Sign Languages: A cross-linguistic cross-cultural view. In *The Signs of Language Revisited: An Anthology to Honor Ursula Bellugi and Edward Klima*. Edited by Karen Emmorey and Harlan L. Lane. Mahwah: Lawrence Erlbaum Associates, pp. 229–250.

Sandler, Wendy, Mark Aronoff, Irit Meir, and Carol Padden. 2011. The gradual emergence of phonological form in a new language. *Natural Language & Linguistic Theory* 29: 503–43.

Schembri, Adam, Jones Caroline, and Burnham Denis. 2005. Comparing action gestures and classifier verbs of motion: Evidence from Australian Sign Language, Taiwan Sign Language, and nonsigners' gestures without speech. *Journal of Deaf Studies and Deaf Education* 10: 272–90. [CrossRef] [PubMed]

Senghas, Ann, Sotaro Kita, and Aali Özyürek. 2004. Children creating core properties of language: Evidence from an emerging sign language in Nicaragua. *Science* 305: 1779–82. [CrossRef]

Supalla, Ted R. 1982. Structure and Acquisition of Verbs of Motion and Location in American Sign Language. Ph.D. dissertation, University of California, San Diego, CA, USA.

Taub, Sarah. 2001. *Language from the Body: Iconicity and Metaphor in American Sign Language*. Cambridge: Cambridge University Press.

Tkachman, Oksana, and Wendy Sandler. 2013. The noun-verb distinction in two young sign languages. *Gesture* 13: 253–86. [CrossRef]

Vermeerbergen, Myriam. 2006. Past and current trends in sign language research. *Language & Communication* 26: 168–92.

Wilbur, Ronnie. 2003. Representations of telicity in ASL. Paper presented at the Proceedings from the Annual Meeting of the Chicago Linguistic Society, Atlanta, GA, USA, January 2–5. vol. 39, pp. 354–68.

languages MDPI

Article

How and When to Sign "Hey!" Socialization into Grammar in Z, a 1st Generation Family Sign Language from Mexico

John B. Haviland

Department of Anthropology, University of California San Diego, San Diego, CA 92093, USA; jhaviland@ucsd.edu

Abstract: "Z" is a young sign language developing in a family whose hearing members speak Tzotzil (Mayan). Three deaf siblings, together with an intervening hearing sister and a hearing niece, formed the original cohort of signing adults. A hearing son of the original signer became the first native signer of a second generation. Z provides evidence for a classic grammaticalization chain linking a sign requesting attention (HEY1) to a pragmatic turn-initiating particle (HEY2), which signals a new utterance or change of topic. Such an emergent grammatical particle linked to the pragmatic exigencies of communication is a primordial example of emergent grammar. The chapter presents the stages in the son's language socialization and acquisition of HEY1 and HEY2, starting at 11 months, through his subsequent bilingual development in both Z and Tzotzil, jointly deploying other communicative modalities such as gaze and touch. It proposes a series of stages leading, by 4 years of age, to his understanding of the complex sequential structure that using the sign involves. Acquiring pragmatic signs such as HEY in Z demonstrates how the grammar of a language, including an emergent sign language, is built upon the practices of a language community and the basic expected parameters of local social life.

Keywords: homesign; emerging grammar; grammaticalization; turn-taking; acquisition; socialization; Mexico; Tzotzil

Citation: Haviland, John B.. 2022. How and When to Sign "Hey!" Socialization into Grammar in Z, a 1st Generation Family Sign Language from Mexico. *Languages* 7: 80. https://doi.org/10.3390/languages7020080

Academic Editors: Mark Aronoff, Wendy Sandler and Carol Padden

Received: 14 October 2021
Accepted: 14 March 2022
Published: 29 March 2022

1. The Language(s)

"Z" is a new sign language, emerging in a single extended family of indigenous peasants in Mexico, whose hearing members speak Tzotzil (Mayan). The family sign language began after the birth in 1976 of Jane (Haviland 2020b), the fourth daughter and first deaf child of a hearing couple living in a small *paraje* 'hamlet' of then about two thousand people and part of a larger *municipio* 'township' composed of over a dozen such villages. For her first 6 years Jane was the only deaf person in the family—indeed, in the entire hamlet, as far as the family knows—and she developed a homesign system, apparently in a close, privileged (Fusellier-Souza 2006) relationship with her mother and her older sisters, who helped raise her. There followed two deaf brothers and an intervening hearing sister, and they were still later joined by a hearing niece to form the original cohort of five adults who communicate with each other primarily via the developing sign language. They have had direct contact with neither other deaf people nor sign languages. This group was subsequently augmented by Jane's hearing son, Vic, born in 2007, who thus became the first signing child of a deaf Z adult. Figure 1 shows a simplified genealogy of these original members of the miniature Z signing community.[1]

Although Z has existed for less than 50 years, the lifetime of its oldest deaf speaker, and although it necessarily started out as a homesign system developing around a deaf child in an otherwise speaking family, the language confounds most typologies of sign language (e.g., Le Guen et al. 2020; Hou and de Vos 2021). Extensive studies of fully-fledged sign languages have given us what Brentari and Goldin-Meadow (2017) call "a fairly clear picture of sign language as a point of arrival" for any theory of full-blown language emergence. In a variety of obvious ways, Z is far from full-blown. It is very hard to estimate, for example, the size of its conventionalized lexicon because of extensive variation both within and between individual signers and, perhaps more importantly, because the language is highly telegraphic and "inferential" (Lutzenberger et al. 2022, this volume), relying to an extent only possible for a family homesign on the massive, shared life experiences—the highly detailed "common ground" (Clark 1996)—of the signers. Such reliance reduces the utility of "portable" signs, that is, conventional signs which can easily be moved between signers, times, places, or social situations. The language is also multimodal in itself, making constant use of not only sight but also sound and touch as part of its sensorial ecology. The Z signers are well aware that others in the social surroundings can hear as well as see, taste, smell, and feel, and they freely build into Z utterances the multiple semiotic modalities such senses might afford (Hodge et al. 2019). On the other hand, Z serves as virtually the only vehicle of communication for at least the deaf members of the miniscule speech community of the Z family, as well as for the privileged set of hearing signers who interact with them routinely in Z. In that sense, it has "emerged" as a functioning linguistic system, which can be contrasted on a variety of dimensions with homesign systems for singleton deaf individuals. As each new child was born into the growing Z "speech community", the language changed by necessity, requiring a new triadic conventionality as the next youngest deaf signer was added, incorporating a bridge to the surrounding spoken language with a later hearing sibling, and adding to the mix a third deaf sibling for whom the evolving sign system was the natural and given background for learning to communicate, something that would in turn pass to a nascent 2nd generation. The additive systematicity from each new signer, and their conjoint reliance on it as the default vehicle of communication, brought to the language a character quite different from the original homesign and launched it on a potential road to becoming a conventional sign language (albeit a miniscule one).

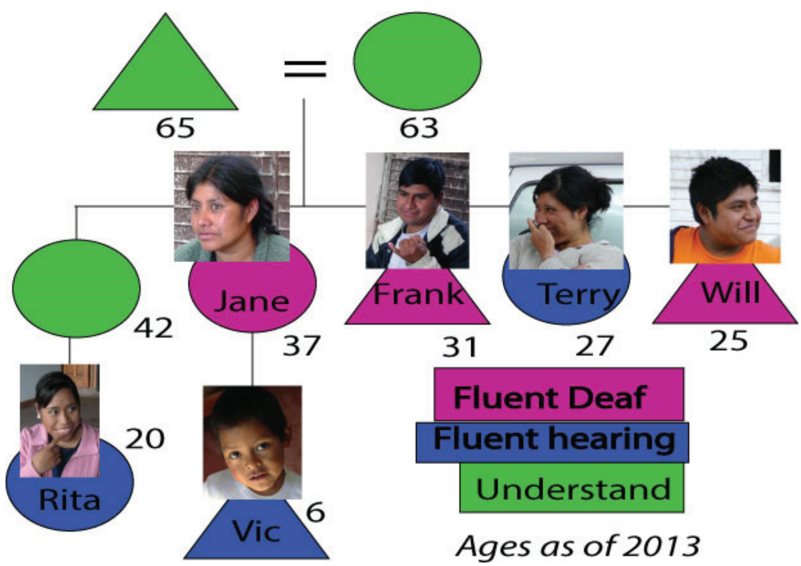


Figure 1. Genealogy of Z family (simplified).

The systematic study of Z began in 2008, when Jane's infant, Vic, was about 11 months old. At that point, he was already starting to sign, although not yet to speak. Through regular and frequent field visits over the following 10 years, and continuing more sporadically until the present, the author[2] has collaborated with members of the extended Z family on a project of extensive recording of naturally occurring and pseudo-experimental signed conversations. The research has focused on the conventionalized lexical signs and syntax, on the interactional structure, on the use of space, and on the sociolinguistics of this tiny speech/sign community (Haviland 2011, 2013a, 2013b, 2013c, 2014, 2020a, 2020b). Z is perhaps unique as an emerging family sign language to have been studied systematically, if not from its very birth, at least while still in active development during a first generation.[3] Importantly, the ongoing study of Z includes close observation of the young Vic, from the time he started signing but did not yet speak, through his bimodal language acquisition and bilingual socialization into both Z and Tzotzil.

2. Emergence, Complexity, and Bimodality

Language "emergence" involves (at least) two intertwined but distinct temporal scales and conceptual domains, one at the level of a language itself, and another at the level of the individual language users. When an entire language "emerges", the process (hypothetical, except in the privileged case of young sign languages) begins with an initial cohort of language users. "Emergence" encompasses changes over time in the resources users develop and employ for linguistic functions, as cohorts mature and reproduce themselves. Thus, in a case such as Z, we can imagine an early stage in which Jane, interacting with her mother and sisters, began to develop a system of visual and tactile 'signs' (in an abundant Peircean sense) to accomplish a range of interactive social tasks. As I speculate above, there must have followed several subsequent stages when each new sibling joined the cohort of users, both building on and transforming the semiotic inventory already available and expanding it and, at the same time, elaborating the interactive repertoire required for new tasks and social exigencies. It was, presumably, one matter for Jane first to invent a method to draw her mother's attention (or vice versa), say, to a particular hen by manual means and another for Jane and her brothers to work out how to refer to chickens in general or to distinguish them from, say, turkeys or chicks at a "later stage" of referential complexity in the developing sign language. The resulting systematicity ultimately would constitute a new language.

Emergence in a new language is not restricted to functions such as inventing conventional ways to name chickens or other entities and to predicate about them. Jane's needs for her language and the needs of her younger siblings presumably both diverged and converged over time, producing linguistic changes that mutually fed (and fed upon) the siblings' repertoires, aggregating systems of linguistic forms and adapting them to increasing sorts of communicative and interactive complexity. Haviland (2015) provides evidence for a single example of such emerging complexity in Z: a classic "grammaticalization chain" that links several different, but formally interrelated, linguistic forms to a cline of linguistic functions which, in this case, regiment conversational structure. On this account, a sign for doing one thing (seeking an interlocutor's attention) over time came to be used for something slightly different, both more abstract and more general: introducing a new conversational turn or topic, even when an interlocutor's attention was already secured. The need to manage conversational turns among a widening potential cast of competing interlocutors—that is, given increased interactive, demographic, and sociolinguistic complexity across the miniature signing community—motivated and multiplied linguistic elements (which fissioned formally and functionally) and also widened the scope of their potential uses. One makes such a grammaticalization argument using classic approaches of historical linguistics, starting with formal resemblances and arguing analogically from a theoretically driven grammaticalization model of simplification of form and generalization of function.[4]

As Goldin-Meadow and Brentari (2017, p. 364) point out, although language emergence is continuously visible at an individual level every time a prelinguistic child learns a language, the processes involve different scales of time and analytic delicacy from language emergence de novo, as language acquisition is "grounded in previously established languages". Acquiring language, in the linguistic tradition, is typically measured by milestones in the mastery of certain characteristic diagnostic forms and constructions recognizable from the preexisting adult language. Linguistic competence in the tradition of language socialization (e.g., Ochs and Schieffelin 1984; Duranti et al. 2012; Ochs and Schieffelin 2012) focusses instead on how a child comes to learn language(s) for particular culturally sanctioned ends and how one comes to (inter)act appropriately in a pre-structured social world.

This paper explores, in one specific case, whether an individual language-acquiring child will, over the gradual course of adding complexity to a linguistic repertoire, mirror or otherwise parallel the processes by which a whole language—taken as a system of expressive resources shared among members of a community—is assumed to accrue complexity over time. Vic is a hearing child who was socialized from birth into both a spoken and a sign language. Notably, the "established languages" that form the prototype which he targets have different statuses: one, a modern Mayan language in its current spoken incarnation in a large, multidialectal (and, indeed, multilingual) speech community; the other, a very young, visual homesign system still growing into its role as the communicative vehicle for a primary group of just five adults who are changing it as they go along, as are the still younger recruits to its use. The article presents longitudinal evidence about how Vic began over his first few years of life to distinguish the different forms linked in the hypothesized grammaticalization chain which regiment the interlocutors' attention, as detailed below. The conclusion is that, confronted from birth with the adult Z signs as a model, Vic acquired the distinct forms of the grammaticalization chain piecemeal and distinguished them fully over time in a sequence that recalls the hypothetical original grammaticalization processes that spawned them. It is as though he reinvented the linguistic innovation by himself, although the impetus was already present in the adults' performances. This is emerging grammar recapitulated in a single individual.

Note that this volume's emphasis on emerging complexity encourages sensitivity to two often disattended aspects of the ethnographic data on which research on emerging sign languages must be based. One is the inescapable polymodality of interaction. Although speech is frequently caricatured as oral/aural, and sign taken as a visual medium, the principled co-expressivity of natural language is inevitable and extreme. This is true even within a single sensory modality. The sound of speech, for example, involves multiple and theoretically separate oral channels (from phonemes, to intonation, to rhythm), just as the visible aspects of sign include discrete as well as continuous chunks (hand shapes vs. gaze, motion vs. rest, signing bodies and visible aspects of their surrounding spaces, and inventories of objects). Moreover, complementary modalities obligatorily combine with one another. Manual signs in Z are often accompanied by vocalizations, a recognition of the sensory ecology of the community that includes hearers among the signers and the audience. Sounds and vibrations are sent and recognized as signals. Signs are also routinely and multiply inflected, for example, by facial expressions and bodily postures, to convey interpersonal attitudes and affect—(dis)approval, (dis)agreement, (in)attention, as well as criticism and praise, among others. These visible expressions can also "spread" (Lutzenberger et al. 2022, this volume) syntagmatically across signed segments, just as multiple signing articulators characteristically operate simultaneously (Pfau 2015). Furthermore, although Tzotzil speakers in the surrounding community are characteristically reserved physically, Z signers are notably relaxed about tactile expression and free to touch each other in ways uncharacteristic of most speakers in this community, but thus incorporating touch systematically into their sign language as a further modality.

The other inescapable aspect of Z signing, linked to multimodality and central to the argument of this paper, is the organizational complexity of its characteristic context: natural conversation in joint interaction (Sacks et al. 1974). When people do things together, they must arrange their participation collaboratively. In conversation, signed or otherwise, this means, among other things, exchanging turns at talk (Levinson 2006; Holler et al. 2006) and regimenting one's conversational contributions in accordance with what the interlocutors are doing. Emphasizing complexity within a linguistic system may displace attention from the complexity of linguistic interaction itself—starting and stopping turns, the choreography of attention between interlocutors, and the impact on grammar of turn construction. In Z specifically, each conversational sequence involves a polymodal mix of gaze, face, and body (Haviland 2019), carefully monitored to calibrate mutual access between the participants. The phenomena of interest in what follows are mechanisms within the sign language itself, apparently designed to help regiment conversational interchanges.

3. A Grammaticalization Chain in Z

Z seems to have adopted a full-fledged conventionalized gestural emblem (Kendon 2004) familiar to all Tzotzil speakers and, indeed, to almost all Latin Americans (but, by contrast, frequently misunderstood by English speaking North Americans). It means "come here!" (sometimes "give it here!"). A common North American gestural equivalent starts with a loosely clenched supine hand with the index finger extended or a flat upturned palm extended in front of the body, followed by flipping the index finger (or all the fingers) upward toward the speaker. However, the Mexican version starts with the palm extended partly forward and flips the fingers downward instead, sometimes multiple times. Ordinarily, the hand gesture also accompanies mutual gaze between the interlocutors (see Figure 2).

Figure 2. A Tzotzil speaking man issues a COME gesture.

Adult Z signers use a formally identical hand movement to mean COME!, frequently also with mutual gaze and sometimes further inflected for speed, size, and repetition to modulate the force of the request. Figure 3 shows both a hearing (a) and a deaf (b) signer calling someone with a sign meaning "Come!" The sign is glossed into Tzotzil by hearing signers as *la?*—the suppletive 2nd person imperative for *tal* 'come'.

Figure 3. (**a**) Terry (hearing) and (**b**) Jane (deaf), summoning an interlocutor to come with a Z sign.

It is not surprising that a family sign language surrounded entirely by (and, indeed, including) Tzotzil speakers would readily adopt a conventional Tzotzil co-speech emblem as part of its repertoire of signs, as in the case of COME. Indeed, Mesh and Hou (2018) report comparable phenomena in the communicative repertoires of deaf people and their families among Chatino (Otomanguean) speakers. More linguistically interesting is a formally similar sign in Z (which is *not* used as a co-speech gesture in spoken Tzotzil), dubbed HEY1 in Haviland (2015), used for a notionally perhaps interrelated[5] but quite different purpose. It is used to call for an interlocutor's visual attention. This sign is glossed by the hearing signers with the Tzotzil phrase *k-al-tik av-aʔi*, literally "let us speak so that you will understand", i.e., "listen here!"[6] In terms of its formation, it involves the same hand shape and movement as COME, although with a couple of systematic differences. Although in Z the COME sign may be repeated, it typically involves a single sharp downward movement of the fingers from a slightly raised outward palm, often held briefly in the downward position after the fingers have been retracted toward the signer. By contrast, the Z sign HEY1 characteristically involves several rapid downward waves of the hand, with the hand more loosely held and moving in a smaller trajectory. Usually this manually signed HEY1 (by contrast with other more direct requests for attention, such as touching or poking a desired recipient) is also accompanied by the signer's gazing intently at her would-be interlocutor, as in both examples in Figure 3. The desired interlocutor does not always start out reciprocating the gaze.

This specifically Z sign HEY1 forms the starting point for a classic grammaticalization chain which leads to a more abstract and functionally specific, pragmatic turn-initiating particle (glossed HEY2), which signals that a signer is about to start a new signed utterance or to transition to a new conversational topic, when she has already secured her interlocutors' visual attention. Insofar as such an emergent grammatical category ("I want the floor", or "I'm about to start a new turn [or topic]") links to the pragmatic exigencies of all communication, incorporating a formal grammatical device for expressing it is a primordial example of emergent grammar—a grammar of turns. Securing an interlocutor's attention is a foundational link in any communicative chain. Refining such attention to a notion such as "new topic" and linking it specifically to presaging a forthcoming utterance is also a characteristic aspect of the functional linguistic specialization of grammaticalization. In Z, the HEY2 sign marking a new turn or topic is reduced in form from the more exuberant HEY1 sign. It is normally not repeated; its movement trajectory is smaller and more perfunctory; and it is not necessarily accompanied by a gaze at the intended recipient. A typical example of HEY2, can be seen in Figure 4, where Terry (on the right of the split screen image), already having started signing to her interlocutors (who are attending to her, on the left in the split screen image), performs the HEY2 sign to them while visually checking the stimulus details on a computer screen, only afterward engaging them with a mutual gaze (Figure 5).

Figure 4. Terry signs HEY2, already having her interlocutors' attention, and looking away from them at a computer screen.

Figure 5. Terry begins her signed turn, gazing at her interlocutors.

4. Victor's Acquisition of HEY

The Z sign language thus has three distinct, if morphologically similar, signs: COME, HEY1, and HEY2. These signs, that is, form part of the presumed adult target language that young Vic was socialized into as part of his overall linguistic repertoire. I examine the stages observed as young Vic learned to use these signs, jointly deployed with other communicative modalities, such as gaze and touch, starting with his early efforts to sign, filmed first when he was 11 months old, through his subsequent bi-lingual development in both Z and Tzotzil. Here is a brief summary of what the data show. At 11 months, Vic had neither HEY1 nor HEY2, although very shortly thereafter he had acquired COME. By 18 months, he had learned largely to funnel requests for interlocutors' attention into a manual modality (including HEY1), even as he experimented with other modalities, including speech and touch, to partition his world of potential communicative partners into those who signed or heard. Between the ages of 3 and 4 years, he had also begun to acquire HEY2, which implied both an awareness of the pragmatic requisites for linguistic interaction as well as an understanding of the complex sequential structure that using the sign involves, i.e., the kinds of "adjacency" (Sacks [1973] 1987) implied by a summons for attention at the beginning of an utterance.

Before looking at the longitudinal results, here is a brief account of the methods and data employed. In May 2008, I decided after years of reluctance to delve into the new sign language in a community I had long studied as an anthropologist and student of spoken Tzotzil. I approached the family to ask if they would teach me about their sign language. On the first day, I filmed a short interaction involving all the deaf siblings as well as the infant Vic, just a few weeks short of his first birthday. Encouraged by the first film, I returned a month later to begin to develop techniques for structured eliciting in Z. After an enforced five-month hiatus, to obtain funding and permissions,[7] there began a period of ten years of at least monthly stays in the village, concentrating on Vic's acquisition of both signed Z and spoken Tzotzil. I cajoled Rita, bilingual in Tzotzil and Z, into filming her infant cousin in uncontrived family circumstances every few days, starting when he was 19 months old until he turned four. By that point, Vic was fluent in both Z and spoken Tzotzil, and he participated in ever more involved ways with the sporadic, monthly sessions with the adult signers. The result is an enormous of corpus of signed and spoken interaction, including well over 70 h of video focused on Vic's interactions during the first half dozen years of his life.

4.1. The Corpus and the Annotations

For the "controlled eliciting" of Z signing, our roughly monthly sessions of 3 or 4 days at a time involved a wide variety of stimulus materials, designed to encourage fulsome signed descriptions of different kinds of phenomena, in an interactive setting that allowed careful filming (multiple cameras and partly controlled lighting, but little control over sun, rain, thunderstorms, passing vehicles, visitors, and passers-by). Equally important was the documenting of informal exchanges between the signers during breaks in the 'work' the adult signers were doing with the elicitation materials. Other recordings, usually with only a single handheld video camera, focused on the everyday interaction involving Vic. A principled difference between elicitation and "corpus" data is hard to maintain or justify in such a project, given the circumstances of the work with the family and the practical circumstances on the ground, and we have made no such distinctions in the longitudinal analysis.

The corpus, including the recordings of Vic and the more extensive elicitation filmed with multiple camera angles, is unevenly and only partially transcribed, although Vic's recorded signing up until he was around 4 is reasonably well annotated. Some sequences have been transcribed in detail and others more roughly annotated, in company with one or more of the Tzotzil speaking signers.[8]

Methods for transcribing interacting bodies range from nil or spartan (Yngve 1970; Schegloff 1998) to exuberant (Mondada 2018; Mondada et al. 2021). Because the focus is on the evolving details of Vic's production of specific sign tokens and the relevant attentional ecology, this survey opts for only skeletal representations of action sequences, accompanied by still frames, some labelled with letters that correspond to textual notes. Some of the still frames are split-screen images that combine simultaneous views from two different camera angles. Where a figure presents a static configuration—of handshapes, for example, or arrangement of participants—the still frames can stand by themselves. When the ballistics of movement or the precise timing of synchronous events in discrete articulators are potentially crucial to understanding a scene, the figures are complemented by a timeline (a vertical stroke (¦) divides seconds, and the timeline is graduated by default in frames, sometimes with greater or less granularity), accompanied by a miniature partiture with distinct synchronized tiers of action. Individual tiers use letters as abbreviations for the names of individual participants and rough and ready labels such as Gaze, Gest(ure), Sign, Act(ion)—i.e., non-sign specific actions. Thus, for example, a tier labelled "VGaze" traces the trajectory of Vic's gaze. For tiers with relevant ballistic trajectories, I use a sequence of full stops (. . .) to mark preparatory movements; a "target" (such as a person or thing gazed at)—indicated in words or by an exclamation point (!) for the stroke of a gesture, or in CAPs for an approximate sign label—a series of dashes (—) to mark holds; and a series of commas (,,,) to mark a retraction phase. A gloss of the form 'IX:y z' represents a putative indexical sign, where 'y' labels the indexing articulator (e.g., 'RH' for "right hand" or 'LF' for "left finger") and 'z' the putative referent, sometimes abbreviated to fit better on the timeline. Table 1 summarizes these abbreviations and conventions for the detailed transcripts. Other abbreviations in individual figures are annotated by specific footnotes and captions.

Table 1. Key to transcriptions/partitures.

Frame	Letters show the position of each labeled illustrative still frame with respect to the full timeline		
Time	Shows subdivided timeline in the form ∣. . . . .∣	Vertical bar (∣) marks each second	Individual dots (.) subdivide each second into equal subunits
Label for each tier	XY	X is a participant initial	Y is a type: Gaze, Gest(ure), Sign, Act(ion)
Ballistics	. . . ..	Preparatory excursion	
	!	Stroke of a gesture	
	—-	Hold	
	,,,,	Retraction	
Abbreviations in glosses	IX:y z	Indexical sign, with y as articulator	
		z = putative referent	
	RH	Right hand	
	LF, RF	Left, or right (index) finger	

4.2. Vic at about 1 Year of Age: Communicative Intentions, Pointing?

In Vic's first appearance in the corpus, his two deaf uncles were briefly at home having a quick meal before returning to their construction job. Jane brought in the infant, swaddled on her back. A slice of the ensuing interaction illustrates what Vic was learning at the age of 11 months, when he barely vocalized at all.[9] Vic appeared to point and gaze at Will, who was finishing his meal. Let us assume, for the sake of argument, that Vic's pointing gesture was an intentional communicative act. The detailed sequential development of the exchange is important (Figure 6).

Whatever one imagines Vic might have intended by his pointing gesture (looking at the film afterwards, the family thought that he wanted some of his uncle's soft drink), Jane's reaction was clearly to try to control his actions. If one interprets Vic's pointing gesture as an utterance, she was "shushing" him. The scene suggests, first, that Vic had understood that he needed to achieve attention before trying to communicate gesturally and, second, that his mother was already metapragmatically trying to regiment or suppress what could be interpreted as his communicative intentions. Vic was at least interpreted, after the fact, to be trying to communicate gesturally, although without formally attempting to achieve the attentional requisites for such communication.

```
Frame  |            a           b                        c                d           e
VGest  |                     ... IX:RH W           ..... IX:RH, Lean
WillG  |   .....V--------,,
JAct   |                                                                Pull V hand down
Time   |······¦···········¦············¦···········¦············¦···········¦··········¦··
```

Figure 6. Vic at 11 mos. pointed at Will and was restrained. (**a**) Will had glanced up to meet Vic's gaze, establishing apparent brief eye contact. (**b**) Vic's raised "pointing" hand appeared. (**c**) Vic repeated the pointing gesture insistently a second time. (**d**) Jane reached up quite deliberately, (**e**) to pull his hand down.

One month later, it is easier to parse Vic's attempts to participate interactively and to manage the interlocutors' attention. His pointing—with hands and eyes—was more clearly integrated into the miniature speech situation. The adult signers and I were discussing how we might work together. Vic was asleep, swaddled on his aunt's back. He awoke to find the adult signers seated around a table, pointing to sheets of paper and a computer screen. Vic seemed eager to join in (Figure 7). Except for my Tzotzil explanations to Terry, all the interaction was in Z.

```
Frame   |  a    b    c
Vgaze   |   ...T---------..
Tgaze   |           .V-----..
Time    ||¦·········¦·········¦
```

Figure 7. Vic at 12 mos. called for attention by sound, touch, and gaze. (**a**) Vic sought the visual attention of his aunt, although it never became clear what "content" he might want to convey other than getting her to attend to him. Vic moved from staring at his uncle Frank, (**b**) to turning his gaze to Terry and placing his hand on her shoulder, and then (**c**) engaging in a mutual gaze with Terry when she turned to look at him.

Figure 8 shows what happens next.

A few days later, Vic sat on his mother's lap as the four adult signers attempted an experimental eliciting task in which two signers described short videos projected on a video screen and described them to the others, who matched them to a picture. Several times Vic apparently tried to intervene. As before, his primary communicative tool was pointing—or sometimes reaching (Figure 9). He thus coordinated both an apparent referential gesture (accompanied by gaze) with an explicit subsequent gaze at his addressee. Even though it was far from clear what one-year-old Vic actually "meant" to "point at" or why—except perhaps to mimic his uncle's own admonition—his careful visual choreography of attention seemed already well-developed.

```
Frame      |       a  b       c     d
Vgaze      |       ..T---------------
Tgaze      |               .... V---------,,
Vhead      |                    nods
THead      |                          nods
Time       |·······¦·········¦·········¦···
```

Figure 8. Vic at 12 mos. waited for Terry to engage with his pointing gesture. When Vic attempted, apparently, to mimic a pointing gesture one of the adults made, (**a**) he articulated it with a well-formed pointing hand, (**b**,**c**) again waited to engage Terry's attention, then (**d**) nodded slightly at her (and received a nod in return) when she turned to meet his gaze.[10]

```
Frame   |                     a                  b                c
FAct    |         turns, pats_V's_face
Vgaze   |                          ..Screen?----,, ...T?- ..F---------,,
VGest   |                              IX:RH-comp ..X:RH-T------------,,
Time    |·¦·········¦·········¦·········¦·········¦·········¦·········¦··
```

Figure 9. Vic at 12 mos. interacted with his uncle Frank. (**a**) Frank cupped the baby's face and jokingly told him not to interfere with the work. (Frank signed WAIT to Vic, then pointed at the two signers watching the video and signed SHUSH.) In response, (**b**) Vic pointed at the two signers actively watching a video on the laptop, then (**c**) turned his gaze explicitly to Frank as if to direct his uncle's attention to where he was pointing.

Consider, additionally, the formal morphology of Vic's movements. He had already mastered a well-formed "pointing hand" of the style used by both Z signers and Tzotzil speakers.[11] Even at this early stage, Vic's performances also seemed to presage a miniature waving motion that often characterizes the adult HEY1. Vic appeared to try to draw his mother's attention to the laptop with an initial index finger pointing gesture, which then dissolved into a slight waving motion (Figure 10).

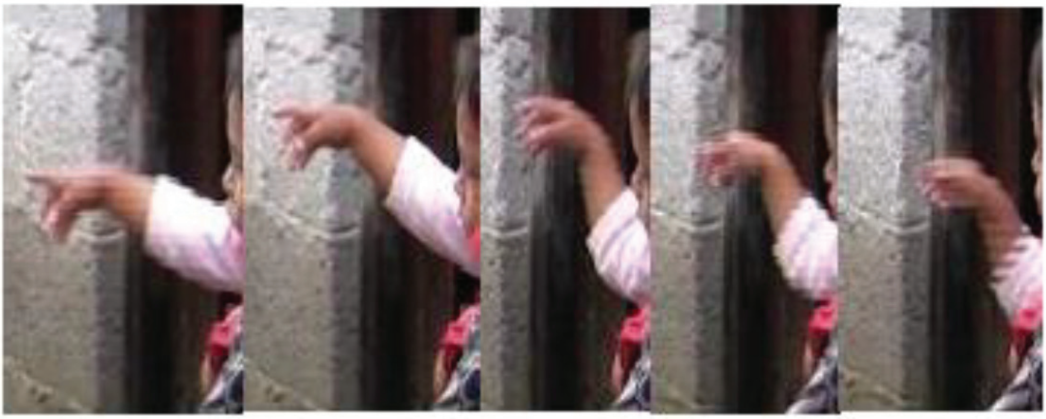


Figure 10. Vic's extended index figure seem to give way to a little wave.

Similarly, Figure 11 shows a pointing/waving motion that appears in a different interaction from the same day, where Victor apparently pointed and waved the hand nine times over the course of 5 s, while also looking around. Such a movement was perhaps a version, not yet properly well-formed or interactively integrated, of the Z HEY1 sign ubiquitous in the adult signing. At this age, Vic sometimes directed his own gaze at the object of attention itself (if not elsewhere), rather than at an interlocutor whose attention he sought. (Indeed, in this little sequence, it was not clear who, if anyone, was attending to him. As can be seen, his mother Jane was looking away). Vic's apparent attempt to direct attention thus seemed to be a transitional or derivative partial step towards Vic's acquisition of the adult HEY1 sign, to which we shortly turn.

Figure 11. Vic appears to point and then make an extended wave.

5. Vic's Apparent Conventional Z COME Sign at 16 Months

I was unfortunately not able to visit the Z signers from just after Vic's first birthday until just before he reached 17 months of age. By that time, he had clearly acquired considerable skill in Z signing, although he had not yet begun to speak Tzotzil. Indeed, his grandparents—who, as Tzotzil speakers, conflated the notion of deafness with the term *uma*?, literally 'mute'—were beginning to worry that, like his deaf mother and uncles, Vic would simply never learn to speak (see Petitto et al. 2001). His interactions at the time were largely with the adult signers, although the non-signing members of the household, as well as the two hearing signers Terry and Rita, who often served as his caregivers, addressed him constantly in Tzotzil and encouraged him to speak. He already had a significant repertoire of conventional Z signs by 16 months (although it was hard to distinguish on formal grounds some of his signs from the Tzotzil speakers' emblems, except that he did not accompany them with speech).

Most relevant here is that by this age Vic had begun to master the "COME" gesture/sign and to direct it at quite a range of different addressees. The first time I caught him on video using the sign, when he was 16 months old, he was interacting with his hearing aunt Terry at a stage when he did not yet speak to her in Tzotzil (Figure 12).

```
Frames |                        a          b      c  d e
VSign  |                                   .........COME,,
Vgaze  |   ..............to T--------.. ..front-------
VMov   |                                  ..........walks_to_yard
TMov   |                                      steps_up steps_out
Time   |·········¦············¦···········¦···········¦··········
```

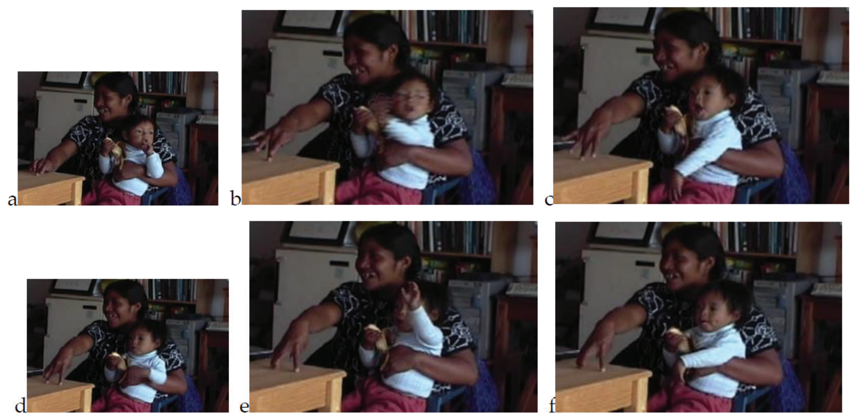
Figure 12. Vic at 16 mos. offered a somewhat diffident and rapid but clear "COME" command. Standing outside the house where Terry was, (**a**) Vic appeared to catch her eye. (**b**) He then moved off toward the nearby patio, (**c**,**d**) gesturing—without looking back—for her to follow him (**e**) as she herself stepped out the door.

Of course, because the Z "COME" sign and the similar Tzotzil gestural holophrase are part of both the Z and the Tzotzil linguistic repertoires, how (and whether) Vic distinguishes them in his own psycholinguistic universe is hard to know. At 19 months he used similar motions—wordlessly—to summon both his hearing cousin with a single, strongly articulated downward stroke (Figure 13), and also his own (deaf) mother with a less strongly articulated double "COME" sign, in both cases initiating the movement after first engaging his (signing) interlocutors' gazes.

Figure 13. Vic summons his hearing cousin with a single, strong "come here!" gesture (19 moss).

6. Vic's Development of HEY1 for Attentional Control

Starting about the same time that he began to use the COME sign, Vic also appeared to begin try out various nascent forms of HEY1 for attentional control. Recall that HEY1 involves a tiny interactive routine: the signer starts by gazing at the desired interlocutor, waving the hand downward to attract the interlocutor's visual attention, thereby generating an expectation that what will follow is a signed turn to which the HEY1 sign itself invited attention. Vic seemed to acquire the elements of this gestalt piecemeal, without recognizing that the initial HEY1, for Z signers, makes relevant the whole sequence (Schegloff 1970). For example, at 17 months, Vic, gazing out the window, turned to look (suddenly and intently) at his intended interlocutor (Figure 14). Notable in this sequence is Vic's failure to follow up with a further substantive turn. He summoned his (hearing) interlocutors' attention but then did nothing with it.[12]



```
Frame  |    a                                  b      c         d     e    f
VGaze  |    out_window                        .......T--------------------
VSign  |                                        HEY                  HEY
Time   |..........¦...........¦............¦...........¦...........¦.........
```

Figure 14. At 17 mos. Vic issued an empty summons. (**a**,**b**) Vic turns to look at his intended interlocutor, (**c**) immediately completing a sharp downward sweep of his arm very much like the COME gesture, and then (**d**–**f**) repeating it.

At the same age, Vic had a variety of different methods for gaining his mother's attention, in addition to a possible HEY1 sign. He frequently touched her or pulled on her clothes (Figure 15a, which contains split screen stills combining different synchronized camera angles). Sometimes, he would simply stare at her and make a demonstrative point or grab at something, as in (Figure 15b) where he asked his mother to help him with his sandal, which was about to fall off.

Figure 15. (**a**) Touching, pulling, and (**b**) grabbing for attention.

A striking illustration of Vic's explicit ability to engage and maintain interaction came when he was almost exactly 18 months old. His deaf uncles, about to be served a meal, were seated at a table near the cooking fire tended by his mother. Vic began to gesture, apparently at a gourd bowl which his mother wanted to fill with hot tortillas for his uncles (Figure 16). His performance showed how the unmediated gestural expression of his desires and directives was at least partially channeled through the signed conventions for managing interaction and turn-taking, even at this early age.

```
Frame  |     a            b                          c
VSign  |                                              HEY1?   →
VGaze  |to bowl------------------------------.. .W-----..→
VMove  |              raise both arms -------------------..→
Time   |··········¦············¦···········¦···········¦··

Frame  |                                     d       e       f
VSign  |HEY1?                                        IX:RF-bowl
VGaze  |--------..bowl----------------------------------..
VMove  |------------ ..wave wave -------,,,,,,,
Time   |··········¦············¦···········¦···········¦··
```

Figure 16. At 18 mos., Vic engages and tried to manipulate attention with deaf adults. (**a**) Vic launched a pointing gesture with his left hand, (**b**) then raised both hands with palms forward and (**c**) produced what resembled the start of a prolonged HEY1, with his hand in the air, as he gazed at his uncle Will seated at the table. Vic held this pose for more than 4 s, ending with (**d**) a slight wiggling of his fingers when finally the bowl was passed. Then, (**e**,**f**) Vic's proto-HEY1 sign dissolved into a point in the direction of where he apparently wanted the bowl to be.

By three months later, at 22 months, Vic was still not speaking Tzotzil, being almost exclusively socialized into the communicative practices of the small group of signers in his household. Some of his techniques for attracting attention were direct and physical. To get his deaf mom's attention, he would sometimes persistently grab her clothes or even her face (Figure 17).

Figure 17. Vic at 22 mos. grabbed his mom's face to comment on a broken table leg. (**a**,**b**) Vic touches his mother's face, (**c**) to secure her gaze before (**d**) signing a comment, here about a broken table leg.

In more elaborate interactions with the deaf adults, although he sometimes had recourse to direct tactile interventions, Vic preferred instead a conventional signed technique to initiate conversations (Figure 18).

Figure 18. Vic, 22 mos., signed and grabbed to ask his uncle to sit. (**a**) Vic tried first a HEY1 sign (extended palm and multiple downward flips with his fingers) to Frank, before (**b**) he resorted to pulling on Frank's trousers and (**c**) asking him to launch a wooden top onto the ground.

As Vic approached two years of age his conversational competence in Z became markedly more sophisticated. Vic had been listening to a procession that marched past his house compound, playing music that his mother could not hear (Figure 19).

When he turned two, Vic had become still more practiced at the norms of signed interaction, including the use of HEY1 to gain the conversational floor, although the hearing people in his social world also began to urge him to speak. When he was 25 months old, a school primer was being passed around the house, and Rita was repeating for Vic the Spanish names for some items pictured in the book. Vic's mother Jane was examining it, and Rita told him, "Say to your mother, 'What's that called?'"—i.e., ask her whether she recognized the item in question and had a way to sign it (Figure 20). Although it is unclear whether Jane ever bothered to look at Vic at all in the course of this little interchange, it illustrates the growing linkage between HEY and a following utterance, as the metalinguistic framing of Rita's directive ("Tell your mother, 'X'") appears to imply for Victor that the substance of his linguistic contribution be introduced by an initial HEY.

The uses of what I have characterized here as the attentional HEY1 are formally distinguished from the HEY2 turn marker, to which we shortly turn, by one central criterion: they all are issued at a point when a signer appears to want an interlocutor's visual attention but does not yet have it, or at least not in the desired way. When he was just short of 26 months old, Vic was sitting in his mother's arms facing his uncle Will, who in turn was looking down towards Vic's feet and playing with the little boy's sandals (Figure 21).

```
Frames |      a                  b      c     d                   e
VSign  |                       ...HEY---..  waves-----  .GO--------------
VGaze  |  down-------  ....X-----------------------
JSign  |                                (chin lift)---------------------
JGaze  |   camera--------------    ...  V----------------------------------
Time   |....................¦.................................¦..........
```

Figure 19. Victor at 23 months started to ask his mom if they could go to hear a band. As the band marched off, (**a**) Vic sat on a pile of cinderblocks holding his right hand on a clothesline. He then (**b**) turned to his mother, who was looking elsewhere, and raised his left hand (**c**) to make a quick HEY1 gesture, with (**d**) two tiny final downward flips of the hand which attracted Jane's gaze. Jane had raised her chin in an interrogative head tilt to acknowledge that she was paying attention. Vic then (**e**) began a substantive turn, signing "Let's go", and going on to tell her that he wanted to follow the band to continue to listen to it.

```
Frames |  a        b               c
VSign  |        HEY1                 IX:LF-picture
Vgaze  |   R   ..J----------------..book--------
JGaze  |  book------------------...R---,,      book------
Time   |............¦.........................¦.........
```

Figure 20. Vic at 24 mos. was told "ask your mom what it's called". (**a**) Vic looked away from his cousin as she spoke to him, turned to his mother, who was looking down at the book, raised his left hand so that it passed through her line of sight, and (**b**) did a quick HEY1 with downward flip of the fingers, before (**c**) touching the chosen picture on the page.

By this point in his life, based on his interactions with the adult signers, Vic seems to have fully mastered the HEY1 sign in Z as a request for attention, even if his interlocutors did not always honor such requests, much as they did not always respond to HEY1 requests from one another (Haviland 2013c).

In fact, in this period of his development, Vic's interactions illustrate a central sociopolitical feature of linguistic interaction, namely that formal means for initiating or managing communicative exchanges may be conventionalized in a language community—even one so young and so tiny as that of Z—but that their effectiveness relies less on linguistic convention than on power. Vic has clearly learned, by around the time he is two, *how* to request an interlocutor's attention in Z, but he still must rely on the interlocutor's uptake (and tailor his request to his candidate recipient) before he can usefully launch a turn. He is also clearly aware by this age which among his interlocutors hear, which do not, and who can use what linguistic modalities. Consider the sequence illustrated in Figure 22, with Vic, at 27 months, strapped on his mother's back preparing to go out on an excursion with the other women of the household. Vic was anxious not to be left behind, and he tried multiple times to hurry Jane along (Figure 22).

a b c d

```
Frames  |         a     b                                 c       d
VSign   |     HEY1*7--------------------------      IX:LF2-ref.   IX:LF2-ref.----..
VGaze   |  W-------------------------------------.. referent--..  W-----------..
JGaze   |  TV?-----------------------.. V-hand V----.. TV-- ..sandal  V---..
WGaze   |  Vfoot -----------------------------.. V-LH-----.. REF? V--------------..
Time    |···········¦···········¦············¦···········¦············¦···········
```

Figure 21. As Will played with his foot, Vic, at 25 mos., tried for 4 s to get his attention. (**a**) Vic began to make the HEY1 sign at Will repeatedly. It took four full seconds for Will to respond to his nephew's request for attention, during which time Vic continued to wave his hand making the HEY1 sign. It is hard to discern from the video stills, but during his delayed response, Will was pointedly gazing at Vic's feet and playing with his sandals, doggedly avoiding a response to Vic's HEY. Jane, in turn, appeared to be watching the TV screen in front of her. She first glanced down at Vic's signing hand just before Will also appeared to see it. Once his gaze moved to Vic's HEY1 sign, close attention to the dance of Will's eyes shows that (**b**) he attended first to Vic's waving hand and (**c**) then looked at Vic's face, realizing that the child wanted his attention. It was only at that point that (**d**) Vic began to form a pointing hand in the direction of the door—what he had apparently wanted to point out from the start. Vic's reference to the door in turn prompted both Will and Jane to glance in that direction.

a b c d

```
Frames  |        a          b                    c              d
VSign   |     HEY*2                                     GO!
VAct    |        hit        hit             grab_hair
VGaze   |   ......J-----.. ...J---.. --J hair. J face------
Time    |00:00:02.510······¦············¦···········¦·······
```

Figure 22. Vic at 27 mos. was as a bimodal interactive tyrant. First, (**a**) Vic tried a signed HEY1, augmented by forcefully dropping his hand onto his mother's shoulder. A second time, as she hiked him higher onto her back and strapped him in more tightly, (**b**) he tried again, putting more effort into both the blow and the hand sign. Finally, (**c**) he reached forward with his left hand and grabbed his mother's hair just behind her ear, forcefully pulled her head around where she could see him, and only then (**d**) signed that he was anxious to go, which was doubtless already obvious to Jane.

7. The Development of HEY2 and Emancipation from Attention

I conclude by tracing Vic's acquisition of the grammaticalized variant of the HEY sign, labelled HEY2: a morphologically reduced version of the sign, involving a single smaller downward movement of the hand, with a more restricted syntactic distribution (characteristically limited to circumstances in which the signer already has the visual attention of an interlocutor),[13] and a highly stylized pragmatic meaning to signal a forthcoming turn or topic change. Vic's use of the attenuated form and its coordination with attention checks on his interlocutors show how the grammaticalized sign began to take shape.

At 27 months, Vic was seated with his uncle Frank. Frank was watching a program on the TV, and both were chewing on slivers of sugarcane (Figure 23).

a b c d

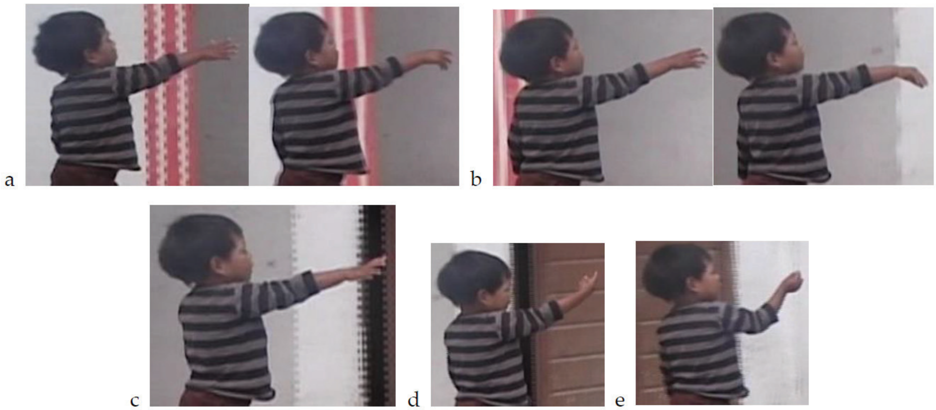
```
Frames |  a                    b    c          d
VSign  |                       HEY1 HEY2?
VAct   |                                     shows_cane
VGaze  |...F-------------------------------------------..
FSign  |                                       NOD
Time   |............¦...........¦............¦............
```

Figure 23. Vic, eating sugarcane with his uncle Frank, asked for more. (**a**) Vic was watching Frank's face intently, apparently waiting for his uncle to look up at him. Either because Frank had returned the boy's gaze or because Vic had (**b**) summoned his attention with a very quick HEY1 sign, Vic (**c**) went on to give a second extremely brief downward hand flick, apparently after Frank had already engaged his mutual gaze. The second very attenuated hand flick at Frank seems more like a precursor of HEY2 than a simple repetition of the preceding HEY1. Vic (**d**) went on to ask for another piece of cane (by holding up the remaining stub of the one he was already finishing), to which Frank assented with a nod. This explicit response from his interlocutor that suggests that Vic had employed the HEY2 sign successfully to frame his request.

Similarly ambiguous were several HEY-like signs that Vic used, at about the same age, in a protracted interaction with his mother (Figure 24). As Jane is not visible on screen, it is unknown at which point Vic gained her attention and thus whether the HEY sequences in Figure 24a–c included another precursor to HEY2, uttered by Vic even after he gained his mother's attention, or whether he simply abandoned a third HEY1 after he saw she was attending to him.

About a month later, in interaction with another young, hearing cousin, Vic interestingly distinguished between his two signing hands. Seated inside the house near the door, Vic heard his cousin exclaim in Tzotzil that it had started to rain hard (Figure 25).

Many of the videos in the corpus of Vic's signing as he neared 3 years of age were filmed by his cousin, using a single camera, in the course of quotidian interaction.[14] As a result, in many of the films his interlocutors are not visible; it is thus difficult to be sure when a HEY sign is primarily intended to achieve a mutual gaze. Nonetheless, sometimes a conversational sequence suggests how attention develops in the course of interaction, and other video sequences give direct evidence about changing gaze.




```
Frames |              a             b       c           d   e
VSign  |  KEY      HEY        HEY        HEY?,,,....ONE   KEY
VGaze  | J-------------------------------------------------------------------
VAct   |  walking                                                      ........ takes_key
Time   |...............¦.............................¦............................¦............
```

Figure 24. Vic at 27 mos. walked to his mother requesting a key. Vic started toward his mother signing KEY with an outstretched hand. (**a**,**b**) He then made two HEY signs 300ms. apart and then apparently (**c**) started to make a third HEY. Before completing the downward flip of his hand, (**d**) he formed the sign ONE—often used as a determiner-like element in Z—followed again (**e**) by the sign KEY. He finally took a proffered key from Jane.

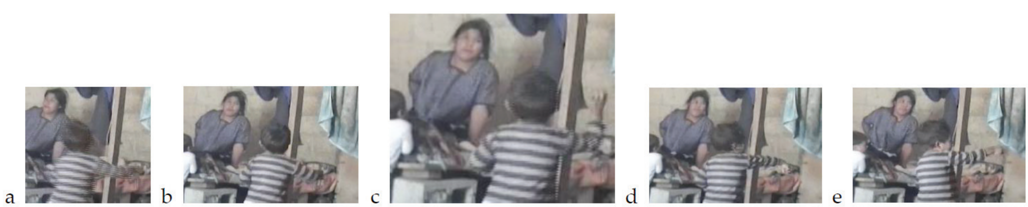
Sometimes, Vic clearly intended a HEY sign as more than simply a call for attention, because his interlocutor was already visibly gazing at him as he signed. A couple of months before Vic's third birthday, Vic walked past Jane seated on her bed after a nap (Figure 26). The HEY2 sign at Figure 26c—if that is what it was[15]—did not seem designed to request Jane's attention but rather to orient it to Vic's next move, which in this case was to point to his uncle Frank (from whom he was about to receive a coin to spend).

At 35 months, Vic was roughhousing with his uncle Will, who would pull him by the arm and try to make him do something. Vic, interacting the entire time, kept pulling away and pretending to try to escape (Figure 27). The HEY2 in Figure 27b can be understood as a feigned prelude to a similarly feigned indexical directive.

My last example to show Vic's developing use of the fully grammaticalized HEY2 sign comes from an extended interaction when he was 41 months old, as Jane was getting him dressed for an excursion. She was concentrated on one of his socks, when he apparently spied the clean shirt she had placed on the ground to put on him (Figure 28). The whole sequence can be glossed, "Hey, I have two of those [shirts]; go get me the other one that is outside."

```
Frames  |     a                          b     c                 d
VGaze   |     Cousin-------------------------------,, in back-----,,
VLHand  |                           HEY2---               IX:LF *2
VRHand  |                              RAIN *4---------
Time    |¦. . . . . . . . . . . ¦. . . . . . . . . . . . ¦. . . . . . . . . . . . ¦. . . . . . . . . . . . ¦. . . . . . . . . .
```

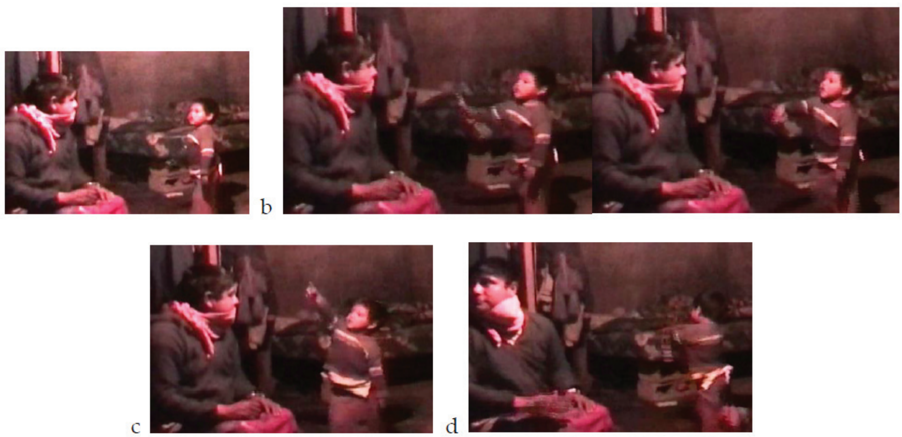
Figure 25. Vic at 28 mos. signed with both hands to comment on his cousin's remarks about the rain. (**a**) Vic turned quickly to look outside, and then (**b**) he launched a HEY sign at her with his left hand. From his quick smile, one gathers that he had his cousin's attention before he finished the quick hand flip, and even as he retracted his left hand to his shoulder, (**c**) he had begun signing HEAVY RAIN with his right hand. He repeated the sign several times, as he fully retracted his left hand, and then turned to point with his left hand at his mother on the other side of the room, (**d**) nodding as he signed for his cousin to tell her, too, that it was raining. Because of the limited camera view, it was again not possible to check when or whether Vic's cousin saw and responded to his HEY sign, but he had already begun to prepare the RAIN sign with his right hand before he had finished the first request for attention with his left.



```
Frames |                         a          b            c    d   e
VSign  |          ........... IX:RF            HEY2------ .....IX:RF-(to F?)---,,,
VGaze  |             .....J-----------------,,,,,, ........ right-- .....J----------
VAct   |    walking-------------------------- stops in place----------------------
JGaze  |    left----------------    ................V-- ....right---------,, ..down to bed
Time   |....................¦..............................¦........................
```

Figure 26. At 34 mos. Vic used HEY2 to direct Jane to look at something. At first, (**a**) Jane was looking away from Vic, but (**b**) she turned her attention to him as he passed with arm outstretched. The moment she gazed at him, (**c**) he raised his right arm in a demonstrative HEY2 sign, (**d**) dropping it immediately into a pointing hand, after which (**e**) Jane turned to look in the direction of his point.

As an epilogue to Vic's trajectory in acquiring this basic part of Z grammar, here is a clip from an elicitation session with the deaf adults. Vic started to participate in these sessions around age four. He had been shown a photograph, and his job was to describe the picture to his mother and uncles, who appear on the right side of the split screen images in Figure 29. The adults in turn were asked to pick the corresponding image from an array. Even at four, Vic had mastered typically adult attention management. Note that he ends his first signed utterance with an apparent visual check of his uncle Will's comprehension and that his mother (shown as J in the transcription) has been tracking both his face and his hands constantly throughout his turn. The adults had no difficulty matching his description.




```
Frames |  a        b       c                                             d
VSign  |         . HEY2... ..... IX.. -----------------------.. ,,..
VMov   |                                                        ((spins))
VGaze  |  W--- ......up-- W— up —W-- up-----------------
WGaze  |   V------------.. ------------------------------   ... behind---..
VMov   |                                                        ((spins))
Time   |...........................¦.................................
```

Figure 27. At 35 mos. Vic played with his uncle Will. From a safe distance, Vic (**a**) fixed his gaze on his uncle, (**b**) turned his body toward him, and issued a very rapid single downward right-hand flip, HEY2, immediately segueing into (**c**) a rapid right-handed point above and behind Will. (**d**) Will turned to gaze in that direction as young Vic did a playful pirouette (presumably because he was joking about the point in the first place, as his uncle had previously been doing with him).

```
Frames |  a              b                                  c
VRHand |        ...TWO--------     TWO*2                    HEY2      →
VGaze  |down   ...J-------------------------------------------        →
VAct   |step_back                  RH_in_J_face
JGaze  |@ hands-------------         ....... ...V--------------------→
JAct   |fix_V_socks
Time   |···························¦····························
```

```
Frames |      d     e          f                                g
VRHand |      ....IX:R-- IX-RF-out---, ..IX:RF-out    IX:RF-down
VLHand |  IX:LF-shirt
VAct   |  bends_forward up_look_right
VGaze  |down---------- out-------------------- down-------------
JGaze  |    ....... shirt.. ....V--------- out_door ......V_socks
JAct   |hold_V_socks                                     put_V_socks_on
Time   |·······················¦·······················¦···············
```

Figure 28. Vic asked for a different shirt, at 41 mons. (**a**) Vic formed a TWO sign right in front Jane's face and (**b**) moved it into her line of sight. (**c**) Gazing at her, he quickly turned his TWO hand to face palm down and delivered to Jane a very quick HEY2, now having her full attention and intending to utter his main message. (**d**) He pointed down with his left hand to the shirt bundled on the floor, (**e**) switched hands to point at it with his right hand, (**f**) and then pointed from the shirt out the door and (**g**) back.

```
Frames  |       a     b    c                  d
VSign   |           ......HEY----  .......HEY--,,,,..
VGaze   |screen ...W---- ..screen--------------------..→
JGaze   |  pap....V--------------------..VHands V-- VHands..→
WGaze   |  pap...V-----------------------------------..→
Time    |·····················¦·····················|······

Frames  |                 e                      f
VSign   |   ........KEY-----------------,,,THERE (PL.)-----------------,,,
VGaze   |..screen-----------------------------------------------.. ......W
JGaze   |VHands------------------------------ ..V-------------------------
WGaze   |..V--------------------------------------------------------------
Time    |········¦·······························¦·······················
```

Figure 29. Vic at 4 years and 4 months participated in an eliciting session. (**a**) Vic perused the image as (**b**) the adults began to wait expectantly for him to describe it. He started, however, by (**c**) signing HEY2, (**d**) repeating the sign briefly a second time. Only then did he begin to describe the picture itself by (**e**) mentioning a KEY depicted in it and (**f**) pointing at the computer screen.

8. Final Remarks

Vic's socialization into language is a single example of a process that has occurred countless times in the history of humanity as new signed communication systems have emerged around sometimes vanishingly small and usually evanescent deaf communities. This article has concentrated on Vic's acquisition of a limited set of Z signs which largely deal not with reference and predication (taken as both preeminent and unproblematic in some recent studies of language development [e.g., Carrigan and Coppola 2017]) but rather with managing interaction and attention, a central organizing aspect of conversation—the most characteristic of linguistic activities.

This study of the emergent quality of Z has been both formal and ethnographic. On the one hand, an austere "form first" principle—attending to the polymodal details of the signers' actions within the wider contexts of their interactions—avoids premature generalization and typological temptations and minimizes assumptions about what to expect or where to look in the creators' linguistic inventions. On the other hand, without the expert eyes, ears, and bodies of the signers (and their distinct techniques for training or guiding those of the rest of us) there are no a priori hints about how to discover meaning or even where to look for it in the specific circumstances of social life. In particular, as the transcripts included here suggest, gaze among Z signers seems to be preeminent in everything from reference (e.g., indexing referents) to turn transitions, even as such functions are also regimented by conventional manual signs and other bodily actions.

Let me end with a (highly speculative) tabular summary (Table 2) of Vic's longitudinal progression into the Z signs under consideration.[16] It is arranged chronologically, with a rough set of candidate "stages" suggested by his performance to hypothesize about how he moved from conceptually simple and perhaps even iconically motivated signaling devices and cognitive requisites to increasing systematicity in the formal elements of interactive communication. There is a natural sort of logic to such development, given Vic's growing perceptual, cognitive, and interactive capacities, and—especially in the earliest stages—a gradually increasing dependence on his socialization into the local communicative environment.

Table 2. Hypothesized stages in Vic's acquisition of HEY1 and HEY2.

Putative "Stages"	Months	Figures	Developing Stages
I. Pointing, gaze, touch without signs	11	Figure 6	Vic is aware of the gaze of others (and it may prompt him to try to initiate interaction). He also uses pointing as a proto directive and expects a reaction. However, he has no "control" over his expressive use of either gaze or gesture and almost no formal mechanisms for achieving attention (except, perhaps, reaching/pointing). His mother already communicates a kind of metapragmatic "suppression" of some of his actions.
Ia. Limited gestural attention management.	12	Figures 7–11	Explicit devices for achieving attention: (mutual) gaze, touch, and voice, synchronized with gaze. In Figure 8, Vic adjusts to and acknowledges mutual attention, coordinating gaze with head movements and touch, as well as more pointing (Figure 9). There is also the first hint of developing gestural morphology: an index finger point leads to a tiny proto-wave (Figures 10 and 11), although Vic's attention remains focused on referents and only laterally moves to potential interlocutors. Nonetheless, Vic seems to start to recruit manual signals for managing attention.
II. Conventional signs, directives	16	Figure 12	Vic has acquired a robust set of conventional Z signs, including COME, which stands as a silent Z directive, appropriately addressed via prior gaze but with no attentional device other than the sign itself.
IIb. HEY as unmoored request for attention	17	Figure 14	Vic appears to try to use a sign similar to COME to request a (hearing) interlocutor's attention. It is not yet clear whether he intends the sign to be a preamble to some specific follow-up action. He still resorts to tactile and indexical gestures to request attention from deaf interlocutors (Figure 15).
IIc. HEY in combination with other modalities	18	Figure 16	In interaction with the deaf adults, Vic uses a variety of manual devices to try to control attention, including versions of what looks clearly like HEY, sometimes coalescing with indexical pointing directives, and beginning to coordinate his gaze with the candidate interlocutors.
	22	Figure 17	Vic was even more actively trying to manage the interlocutors' attention, but perhaps because he lacked status to do so by a HEY sign, he resorted to other means to coerce the others' gaze—grabbing people's faces or clothes (Figure 18).

Table 2. *Cont.*

Putative "Stages"	Months	Figures	Developing Stages
IId. Interactive and sequential links between HEY and following utterance	24	Figure 20	Vic's turn to his mother suggests a growing metalinguistic connection between the HEY1 sign and an immediately following utterance.
	25–27	Figure 21	Vic's contributions to conversational exchanges begin to be closely coordinated with his achieving prior visual attention from the target of HEY1 signs. This is plainly true in conversation with his uncles, who often disattend his attempts to sign, but also true on occasion with his normally doting mother (Figure 22).
III. HEY2 as probable separable sign	27	Figures 23 and 24	Although filmed evidence often fails to demonstrate that Vic has already secured his interlocutor's gaze, aspects of the conversational structure suggests that Vic has begun to distinguish HEY2 by using the latter to highlight and introduce a specific signed utterance.
IIIa. Articulatory and functional emancipation of HEY2 from attention request.	28	Figure 25	By using one hand to sign what appears to be HEY2 and the other hand almost simultaneously to sign a substantive utterance, Vic demonstrates a close synchronic link between the pragmatic sign HEY2 and the forthcoming conversational turn which it pre-visages.
	34	Figure 26	Vic makes no request for attention, but when he gets it, he issues HEY2 before making a substantive turn.
	35	Figure 27	Vic is engaged in intensive interaction with a single interlocutor, but when he achieves a mutual gaze, he uses HEY2 to start to introduce a new topic.
IIIb. Adult-like use of HEY2	41+	Figures 28 and 29	Vic's use of HEY2 seems to be fully adult, introducing a new turn or an explicit topic change.

Research on Z has been predicated on a leading assumption: both the manual and the non-manual visible elements from the surrounding Tzotzil speech and gesture community are potentially available to the novel, emerging sign-language. The Z forms whose development in Vic's signing have been traced here are, indeed, partly shared across his spoken linguistic repertoires as well. A special virtue of studying bimodal acquisition, in trying to tease out the processes underlying emerging language, is the insight it gives in distinguishing clearly between spoken and signed grammars, their cognitive representations, and their distribution across linguistic performances. This article has considered how Vic acquires a form—HEY2—that is ONLY part of Z and not part of the shared bimodal repertoire of Z and Tzotzil. Truly emergent grammar can be directly observed in the early socialization of a bimodal child such as Vic as he allocates linguistic resources and separates out elements that may be functionally similar (whether referentially or pragmatically) but operate in parallel modalities.

More generally, this single longitudinal case, arrayed against speculative claims about diachronic changes in even a first-generation emerging language, illustrates how principles of formal simplicity, syntactic or pragmatic specialization, and semantic "bleaching" in the development of emerging grammar have parallels in the progression from simpler (perhaps more iconic) to more complex or linguistically integrated elements or mechanisms in a child's language socialization. Vic's gradual acquisition of HEY2 seems to follow, both in chronology and in growing linguistic sophistication, the hypothetical pathways that resulted in the inventory of adult forms. That inventory, then, was not acquired whole cloth by the child signer simply because the adults made it available to him. Instead, it accrued to his repertoire in a logical sequence motivated by phases in his growing competence in the use of the new sign language, as both a communicative and an interactive medium.

Acquiring pragmatic signs such as HEY in Z also demonstrates how the grammar of a language, including an emergent sign language, itself is built upon the practices of a language community—even one as miniscule as that of the Z family to which Vic belongs. The basic parameters of social life that set the conditions for communication also raise a more general question about what kinds of "sharing" there are in linguistic communities and the very nature of what are called "shared sign languages." This always centrally involves both ethics (Green 2021) and mini-politics (Haviland 2013a, 2016): Who's the boss? Who decides? Who leads changes or innovations? As new forms of grammar emerge, some are adopted and others lost or suppressed. Studies of longitudinal language socialization may help understand the mechanisms by which language "emergence" at one point may, perhaps all too frequently, also lead to loss: the ultimate language "submergence."

Funding: This research was funded by the National Science Foundation under grants BCS-0935407 and BCS-1053089, administered by the Center for Research on Language [CRL] at UCSD.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the University of California, San Diego, Human Research Protections Program, Project #081071 initially approved 7/2/2008, and Project #110862SX, initially approved 4 December 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Interested readers are invited to contact the author to access video clips of illustrative material used in this publication.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

1 Other younger children were later born into the signing household, but their developing language repertoires are not considered in this article. The notion of "generation" is vexed in such a genealogy. The terminological distinction between "generation" and "cohort" applied (for example, in Coppola 2020b) to the evolution of Nicaraguan Sign Language is complicated in Z by Rita, the hearing daughter of one of Jane's hearing older sisters, who is thus genealogically the start of a 2nd generation, but who nonetheless grew up as (by five years) the youngest of a small cohort of household children, including all the deaf siblings, who were already signing when she was born.

2 The author has been a fictive kinsman and close friend of the deaf children's parents since they were first married in the late 1960s. He was probably the first to realize that Jane was deaf, although sadly—out of ignorance—insufficiently perspicacious at the time to help her parents facilitate a different sort of linguistic development for her, for example, via appropriate deaf schooling, something not readily available in rural Mexico and of no interest then, or now, to the parents themselves. The author's work on Z was in turn directly inspired by the research of Carol Padden and her co-authors on ABSL (e.g., Sandler et al. 2005; Aronoff et al. 2008), a village sign language of the Negev with somewhat similar origins, having also begun with a cohort of deaf siblings.

3 See the sketchy but fascinating early reference to a family homesign in Frishberg (1975, p. 713 fn. 13). Aside from classic studies of individual homesigners—deaf children born to hearing parents who receive little or no early exposure to sign languages—most famously by Susan Goldin-Meadow and her colleagues (e.g., Goldin-Meadow and Feldman 1977; Feldman et al. 1978; Goldin-Meadow et al. 1994; Goldin-Meadow 2003, 2012), there is comparative material on adult Brazilian homesigners in the work of Ivani Fusellier-Souza (e.g., Fusellier-Souza 2004, 2006; Martinod et al. 2020), as well as extensive work on Nicaraguan homesigners (e.g., Hunsicker and Goldin-Meadow 2012, 2013; Coppola 2020a; Flaherty et al. 2021).

4 For grammaticalization in general, see Heine (1997); Hopper and Traugott (1993). Overviews of grammaticalization processes in sign languages are in Pfau and Steinbach (2006, 2011), and Janzen (2012). For proposed grammaticalization paths in emerging sign languages linking speakers' gestures to signed lexemes, see, for example, Perniss and Zeshan (2008), De Vos (2012b), and, for a village sign language in another Mayan context, Le Guen (2012).

5 Kata Kolok, a Balinese village sign language, is reported by De Vos (2012a, p. 186) to have "[a] form of COME that is produced with repeated movement and directed at a person to summon an addressee. This function is linked to Balinese co-speech gesture, in which an identical gesture has been observed". There is no evidence that the Z HEY1 sign has a relationship to "come" either as a gesture or as Z sign itself (Haviland 2015), and as Austin German (p.c.) points out to me, other sign languages have very similar signs in both form and function.

6 In connection with the reduced pragmatic or semantic function of the Z sign HEY2, introduced below, note that the spoken Tzotzil *k-al-tik av-aʔi* expression also has a heavily abbreviated and similarly grammaticalized form *vaʔi* 'listen' or "pay attention (to what I'm about to say or do)", which often introduces new topics in discourse or even such a non-verbal act as passing over a coin to pay for something. The initial *v-* in this form is a reduction of the second person ergative proclitic, and the underlying Tzotzil root *aʔi*, sometimes glossed as 'hear', is more accurately translated as 'perceive', regardless of sensory modality.

7 This material is based upon work supported by the National Science Foundation under grants BCS-0935407 and BCS-1053089, administered by the Center for Research on Language [CRL] at UCSD. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation

8 Initial annotation of the corpus was conducted by the author or by Austin German (see German 2018). We have not tried to control systematically for the differences in Vic's linguistic practices across different categories of interlocutors, hearing and deaf.

9 See Haviland (2020a, pp. 47–51) for a more detailed treatment of this small interaction.

10 This short scene is treated in more detail in Haviland (2020a, pp. 51–54).

11 A reviewer asks whether Tzotzil-speaking infants in families without deaf members use visual and tactile gestures for getting attention, and not surprisingly, they do, abundantly (see Haviland 2000; De León Pasquel 2005). They also grab or manipulate clothing, hair, and bodyparts—even faces—to attract caregivers.

12 To be fair to Vic, in that context he was unable to summon *anyone's* attention with his gesture, as his mother was busy describing an eliciting stimulus to Rita and Terry, and they ignored him. Vic had been eating a banana and had been trying to get them to notice it. In any case, he did not follow up, returning to his banana and soon being distracted elsewhere. However, it seems clear that Vic can acquire some aspects of a Z sign without mastering the entire gestalt of appropriate usage (see De Vos 2012b).

13 Because previously secured attention is the criterion for glossing a sign such as HEY2 in my transcriptions, there can sometimes be doubt about individual instances when the video record leaves unclear or ambiguous where an interlocutor is gazing, as is the case in Figure 23.

14 During this period, because of his grandparents' fears, the little boy was sent to live with his hearing aunt who ran a small vegetable shop in the nearby Mexican town, for days at a time rarely interacting with his deaf mother and uncles and exposed continuously to spoken Tzotzil and some Spanish. The grandparents only relented after several months before Vic was allowed to alternate between living in the village with his mother and spending time with his aunt in town.

15 Viewing this scene eleven years after it was filmed, Rita and Terry were unsure whether to read this sign as HEY2 or to interpret it as COME, which here would be a directive for Jane to get out of bed. If that was what it was, it failed, because what Jane did instead was flop back down on the bed and ignore Vic entirely.

16 I thank Austin German for suggesting that a summary table be included, although I doubt he will thank me for the lengthiness of the result.

References

Aronoff, Mark, Irit Meir, Carol A. Padden, and Wendy Sandler. 2008. The roots of linguistic organization in a new language. *Interaction Studies* 9: 133–53. [CrossRef] [PubMed]

Brentari, Diane, and Susan Goldin-Meadow. 2017. Language emergence. *Annual Review of Linguistics* 3: 363–88. [CrossRef] [PubMed]

Carrigan, Emily M., and Marie Coppola. 2017. Successful communication does not drive language development: Evidence from adult homesign. *Cognition* 158: 10–27.

Clark, Herbert H. 1996. *Using Language*. Cambridge: Cambridge University Press.

Coppola, Marie. 2020a. Gestures, homesign, sign language: Cultural and social factors driving lexical conventionalization. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 349–90. [CrossRef]

Coppola, Marie. 2020b. Sociolinguistic sketch: Nicaraguan Sign Language and homesign systems in Nicaragua. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 438–50.

De León Pasquel, Lourdes. 2005. *La Llegada del Alma: Lenguaje, Infancia y Socialización Entre los Mayas de Zinacantán*. Mexico City: CIESAS.

De Vos, Connie. 2012a. Sign-Spatiality in Kata Kolok. Ph.D. dissertation, Radboud University, Nijmegen, The Netherlands.

De Vos, Connie. 2012b. The Kata Kolok perfective in child signing: Coordination of manual and non-manual components. In *Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Ulrike Zeshan and Connie De Vos. Berlin and New York: Mouton de Gruyter, pp. 127–52.

Duranti, Alessandro, Elinor Ochs, and Bambi Schieffelin, eds. 2012. *The Handbook of Language Socialization*. Malden: Wiley Blackwell.

Feldman, Heidi, Susan Goldin-Meadow, and Lila Gleitman. 1978. Beyond Herodotus: The creation of language by linguistically deprived deaf children. In *Action, Symbol, and Gesture: The Emergence of Language*. Edited by Andrew Lock. New York: Academic Press, pp. 351–414.

Flaherty, Molly, Dea Hunsicker, and Susan Goldin-Meadow. 2021. Structural biases that children bring to language learning: A cross-cultural look at gestural input to homesign. *Cognition* 211: 104608. [CrossRef]

Frishberg, Nancy. 1975. Arbitrariness and iconicity: Historical change in American Sign Language. *Language* 51: 696–719. [CrossRef]

Fusellier-Souza, Ivani. 2004. Sémiogenèse des Langues des Signes, Étude de Langues des Signes Emergentes (LS ÉMG) Pratiquées par des Sourds Brésiliens. Doctoral thesis, Sciences du Langage, Université Paris 8, Paris, France.

Fusellier-Souza, Ivani. 2006. Emergence and development of sign languages: From a semiogenetic point of view. *Sign Language Studies* 7: 30–56. [CrossRef]

German, Austin. 2018. Constructing Space in Zinacantec Family Homesign. BA Honors thesis, Department of Linguistics, University of California San Diego, San Diego, CA, USA.

Goldin-Meadow, Susan, and Dianne Brentari. 2017. Gesture, sign, and language: The coming of age of sign language and gesture studies. *Behavioral and Brain Sciences* 40: E46. [CrossRef]

Goldin-Meadow, Susan, and Heidi Feldman. 1977. The development of language-like communication without a language model. *Science* 197: 401–3. [CrossRef]

Goldin-Meadow, Susan, Cynthia Butcher, Carolyn Mylander, and Mark Dodge. 1994. Nouns and Verbs in A Self-Styled Gesture System: What's in A Name? *Cognitive Psychology* 27: 259–319. [CrossRef]

Goldin-Meadow, Susan. 2003. *The Resilience of Language: What Gesture Creation in Deaf Children Can Tell Us about How All Children Learn Language*. New York: Psychology Press.

Goldin-Meadow, Susan. 2012. Homesign: Gesture to language. In *Sign Language. An International Handbook*. Edited by Roland Pfau, Marcus Steinbach and Bencie Woll. Berlin: Mouton de Gruyter, pp. 601–25.

Green, E. Mara. 2021. The eye and the other: Language and ethics in deaf Nepal. *American Anthropologist* 124: 21–38. [CrossRef]

Haviland, John B. 2000. Early pointing gestures in Zinacantán. *Journal of Linguistic Anthropology* 8: 162–96. [CrossRef]

Haviland, John B. 2011. Nouns, verbs, and constituents in an emerging 'Tzotzil' sign language. In *Representing Language: Essays in Honor of Judith Aissen*. Edited by Sandra Chung, William Ladusaw, James McCloskey, Rodrígo Gutiérrez-Bravo, Line Mikkelsen and Eric Potsdam. Santa Cruz: California Digital Library eScholarship Repository, Linguistic Research Center, University of California, Santa Cruz, pp. 151–71.

Haviland, John B. 2013a. (Mis)understanding and obtuseness: Ethnolinguistic borders in a miniscule speech community. *Journal of Linguistic Anthropology* 23: 160–91. [CrossRef]

Haviland, John B. 2013b. The emerging grammar of nouns in a first generation sign language: Specification, iconicity, and syntax. *Gesture* 13: 309–53. [CrossRef]

Haviland, John B. 2013c. Xi to vi: Over that way, look! (Meta)spatial representation in an emerging (Mayan?) sign language. In *Space in Language and Linguistics*. Edited by Peter Auer, Martin Hilpert, Anja Stukenbrock and Benedikt Szmerecsanyi. Berlin and Boston: Walter De Gruyter, pp. 334–400.

Haviland, John B. 2014. Different strokes: Gesture phrases and gesture units in a family homesign from Chiapas, Mexico. In *From Gesture in Conversation to Visible Action as Utterance*. Edited by Mandana Seyfeddinipur and Marianne Gulberg. Berlin: Mouton de Gruyter, pp. 245–88.

Haviland, John B. 2015. Hey! *Topics in Cognitive Science* 7: 124–49. [CrossRef]

Haviland, John B. 2016. But you said 'four sheep'.!: (sign) language, ideology, and self (esteem) across generations in a Mayan family. *Language and Communication* 46: 62–94. [CrossRef]

Haviland, John B. 2019. Grammaticalizing the face (as well as the hands) in a first generation sign language: The case of Zinacantec Family Homesign. In *Papers from the ICHL22*. Edited by Michela Cennamo and Claudia Fabrizio. Amsterdam: John Benjamins, pp. 521–62.

Haviland, John B. 2020a. Signs, interaction, coordination, and gaze: Interactive foundations of Z—an emerging (sign) language from Chiapas, Mexico. In *Emerging Sign Languages of the Americas*. Edited by Olivier LeGuen, Josefina Safar and Marie Coppola. Berlin: DeGruyter, Ishara Press, pp. 35–96.

Haviland, John B. 2020b. Zinacantec Family homesign (or Z). In *Emerging Sign Languages of the Americas*. Edited by Olivier LeGuen, Josefina Safar and Marie Coppola. Berlin: DeGruyter, Ishara Press, pp. 293–400.

Heine, Berndt. 1997. *Possession: Cognitive Sources, Forces, and Grammaticalization*. Cambridge: Cambridge University Press.

Hodge, Gabrielle, Lindsay N. Ferrara, and Benjamin D. Anible. 2019. The semiotic diversity of doing reference in a deaf signed language. *Journal of Pragmatics* 143: 33–53. [CrossRef]

Holler, Judith, Kobin H. Kendrick, Marisa Casillas, and Stephen C. Levinson. 2006. *Turn-Taking in Human Communicative Interaction*. Lausanne: Frontiers Media SA.

Hopper, Paul J., and Elizabeth C. Traugott. 1993. *Grammaticalization*. Cambridge: Cambridge University Press.

Hou, Lynn, and Connie de Vos. 2021. Classifications and typologies: Labeling sign languages and signing communties. *Journal of Sociolinguistics* 26: 118–25. [CrossRef]

Hunsicker, Dea, and Susan Goldin-Meadow. 2012. Hierarchical structure in a self-created communication system: Building nominal constituents in homesign. *Language* 88: 732–63. [CrossRef]

Hunsicker, Dea, and Susan Goldin-Meadow. 2013. How handshape type can distinguish between nouns and verbs in homesign. *Gesture* 13: 354–76. [CrossRef]

Janzen, Terry. 2012. Lexicalization and grammaticalization. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: Mouton de Gruyter, pp. 816–41.

Kendon, Adam. 2004. *Gesture, Visible Action as Utterance*. Cambridge: Cambridge University Press.

Le Guen, Olivier. 2012. An exploration in the domain of time: From Yucatec Maya time gestures to Yucatec Maya Sign Language time signs. In *Endangered Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Ulrike Zeshan and Connie de Vos. Berlin: Mouton de Gruyter and Ishara Press, pp. 209–50.

Le Guen, Olivier, Marie Coppola, and Josefina Safar. 2020. Introduction: How Emerging Sign Languages in the Americas contributes to the study of linguistics and (emerging) sign languages. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin: De Gruyter Mouton, pp. 1–32.

Levinson, Stephen C. 2006. On the human interaction engine. In *Roots of Human Sociality*. Edited by Nicholas J. Enfield and Stephen C. Levinson. New York: Routledge, pp. 39–69.

Lutzenberger, Hannah, Roland Pfau, and Connie de Vos. 2022. Emergence or Grammaticalization? The Case of Negation in Kata Kolok. *Languages* 7: 23.

Martinod, Emmanuella, Brigitte Garcia, and Ivani Fusellier. 2020. A typological perspective on the meaningful handshapes in the emerging sign languages on Marajó Island (Brazil). In *Emerging Sign Languages of the Americas*. Edited by Olivier LeGuen, Josefina Safar and Marie Coppola. Berlin: De Gruyter Mouton, pp. 203–50.

Mesh, Kate, and Lynn Hou. 2018. Negation in San Juan Quiahije Chatino Sign Language. Gesture. *John Benjamins Publishing Company* 17: 330–74. [CrossRef]

Mondada, Lorenza. 2018. Multiple temporalities of language and body in interaction: Challenges for transcribing multimodality. *Research on Language and Social Interaction* 51: 85–106. [CrossRef]

Mondada, Lorenza, Sofian Bouaouina, Laurent Camus, Guillaume Gauthier, Hanna Svensson, and Burak Tekin. 2021. The local and filmed accountability of sensorial practices. The intersubjectivity of touch as an interactional achievement. *Social Interaction. Video-Based Studies of Human Sociality* 4: 3. [CrossRef]

Ochs, Elinor, and Bambi Schieffelin. 1984. Language acquisition and socialization: Three developmental stories. In *Culture Theory: Mind, Self, and Emotion*. Edited by Richard Shweder and Robert LeVine. Cambridge: Cambridge University Press.

Ochs, Elinor, and Bambi Schieffelin. 2012. The theory of language socialization. In *The Handbook of Language Socialization*. Edited by Alessandro Duranti, Elinor Ochs and Bambi B. Schieffelin. New York: John Wiley & Sons, pp. 1–21.

Perniss, Pamela, and Ulrike Zeshan. 2008. Possessive and existential constructions in Kata Kolok (Bali). In *Possessive and Existential Constructions in Sign Languages*. Edited by Ulrike Zeshan and Pamela Perniss. Nijmegen: Ishara Press, pp. 125–50.

Petitto, Laura Ann, Marina Katerelos, Bronna G. Levy, Kristine Gauna, Karine Tétreault, and Vittoria Ferraro. 2001. Bilingual signed and spoken language acquisition from birth: Implications for the mechanisms underlying early bilingual language acquisition. *Journal of Child Language* 28: 453–96. [CrossRef] [PubMed]

Pfau, Roland, and Marcus Steinbach. 2006. Modality-independent and modality-specific aspects of grammaticalization in sign Languages. *Linguistics in Potsdam* 24: 5–98.

Pfau, Roland, and Marcus Steinbach. 2011. Grammaticalization in sign languages. In *The Oxford Handbook of Grammaticalization*. Edited by Heiko Narrog and Bernd Heine. Oxford: Oxford University Press, pp. 683–89.

Pfau, Roland. 2015. The grammaticalization of headshakes: From head movement to negative head. In *New Directions in Grammaticalization Research*. Edited by Andrew D. M. Smith, Graeme Trousdale and Richard Waltereit. Amsterdam: John Benjamins, pp. 9–50.

Sacks, Harvey, Emmanuel Schegloff, and Gail Jefferson. 1974. A simplest systematics for the organization of turn-taking for conversation. *Language* 50: 696–735. [CrossRef]

Sacks, Harvey. 1987. On the Preferences for Agreement and Contiguity in Sequences in Conversation. In *Talk and Social Organization*. Edited by Graham Button and John R. E. Lee. Clevedon: Multilingual Matters, pp. 54–69. First published 1973.

Sandler, Wendy, Irit Meir, Carol Padden, and Mark Aronoff. 2005. The emergence of a grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences* 102: 2661–65. [CrossRef]

Schegloff, Emmanuel A. 1970. Sequencing in conversational openings. *American Anthropologist* 70: 1075–95. [CrossRef]

Schegloff, Emmanuel A. 1998. Body torque. *Social Research* 65: 535–96.

Yngve, Victor H. 1970. On getting a word in edgewise. In *Chicago Linguistics Society, 6th Meeting*. Edited by M. A. Campbell. Chicago: University of Chicago, pp. 567–78.

languages

Article

Early Emergence of Agreement in Yucatec Maya Sign Language

Olivier Le Guen

Posgrado en Lingüística Indoamericana, CIESAS, Mexico City 14000, Mexico; ompleguen@gmail.com

Abstract: In many sign languages, space is used to express grammatical features. However, verb agreement in space is noticeably slow to appear in emerging sign languages. Many reasons have been proposed to explain this delay or even absence: the reduced size of the community, the recent creation of the sign language and the lack of exposure to a fully formed language. To examine the way space is used to express agreement in Yucatec Maya Sign Language (YMSL), a new signed language from the peninsula of Yucatán (Mexico), a task was conducted using video stimuli created to elicit ditransitive constructions showing transfer events, such as events of giving or taking. Results show that agreement is present early in YMSL, even from the first generation of deaf signers. While many signers used single agreement constructions, the second generation of deaf children systematically employed double agreement constructions, placing them on the high end of the evolutionary path proposed for verb agreement in sign languages. I argue that cultural habits of the surrounding community, namely the preference for a geocentric frame of reference among Yucatec Maya speakers, is what facilitates the early emergence of the use of space to express agreement in YMSL.

Keywords: sign language evolution; signing space; verb agreement; pronouns; Yucatec Maya Sign Language

Citation: Le Guen, Olivier. 2022. Early Emergence of Agreement in Yucatec Maya Sign Language. *Languages* 7: 233. https://doi.org/10.3390/languages7030233

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 12 May 2022
Accepted: 31 August 2022
Published: 7 September 2022

1. Introduction

Sign languages are visual languages and their grammar relies heavily on the use of space. However, several authors have pointed out that the use of space to encode verb agreement takes time to develop (if it develops at all) in emerging sign languages (Senghas and Coppola 2001; Senghas 2003; Padden et al. 2009; Rathmann and Mathur 2008). Previous studies have looked at how signers from various types of sign languages use space for grammatical purposes. In sign languages generally, there is no agreement for indirect objects. However, it is typically verbs of transfer—verbs with subjects, direct objects, and concrete or abstract indirect objects—that form the category of agreeing verbs (Meir 2002), and agreement marks direct objects, and sometimes, subjects as well. Tasks based on eliciting verbs of transfer have been conducted in many settings around the world. Overall results point to the existence of an evolutionary path that initially lacks the expression of verb agreement in space (especially for early generations of emerging sign languages) which appears only later in the life of the sign language (de Vos and Pfau 2015; Meir et al. 2010).

This paper aims to explain how signers of the Yucatec Maya Sign Language (YMSL) have managed to develop a new class of verbs that use space to express agreement, despite the very recent age of the linguistic community and its reduced size. Critical sociolinguistic factors that have been considered to make this development possible are reviewed, among them: the size of the community, the age of the sign language, exposure to the language from previous generations and the gestural habits of the surrounding culture as well as its preferred spatial frame of reference. I argue that the use of a geocentric frame of reference is what influences the emergence of certain grammatical structures and allows YMSL signers to use double verb agreement constructions much earlier than what has been previously described and claimed for emerging sign languages.

1.1. The Grammatical Use of Space in Sign Languages

Of special interest in sign languages is how signers realize agreement, that is, how they express on verbs which participant in the discourse is doing what to whom (e.g., roles such as subject vs. recipient). In sign languages, a specific class of verbs, called agreeing verbs, typically use movement in space to mark an action and the starting and ending points of the trajectory usually express syntactic relations among referents (agent, patient, recipient, direct or indirect object, location, etc.)

The main aim of this paper is to describe how a verb's movement in the signing space is used by YMSL signers to interpret semantic roles (i.e., subject vs. recipient). In order to do that, I follow the methodology and theoretical issues raised in previous studies on emerging sign languages, specifically Senghas (2003) on Nicaraguan Sign Language (NSL) and Padden et al. (2009) on Al-Sayyid Bedouin Sign Language (ABSL). Both studies show that the use of verbs inflected for agreement does not appear until later generations have been using the language. Crucially, in sign languages, not every verb makes use of space for grammar or expresses agreement. Padden (1983) considers three verb types: (a) *Plain verbs* that can generally be inflected for aspect but not for argument (for instance, in ASL verbs such as EAT, KNOW, LOVE, REMEMBER, UNDERSTAND). Usually, such verbs are performed on the body and have a semantics oriented to the subject being the experiencer. (b) *Spatial verbs* usually imply some directionality that describes a motion and an end point (for instance, in ASL, verbs such as MOVE, PUT, etc.). Crucially, these verbs do not consider the action of an agent on a patient or an object but most commonly a movement from one point in space to another location. Finally, (c) *agreeing verbs* use directionality to make the verb agree with the arguments of the utterance. Agreeing verbs make a relevant use of space and the location of the entities that are involved in the action described. When the entities treated as arguments are present, such as the agent and the patient, the verb will be oriented towards them. For instance, in ASL, the sentence "I TEACH YOU" starts from the body of the signer (her head in this case), and the end point is in the direction of the interlocutor. However, things become more complicated when the referents are not present. In this case, empty locations in the signing space are arbitrarily and contextually linked to these referents at the discourse level. Such points in space have been labeled R-locus (short for Referential locus, or R-loci in plural) (Lillo-Martin and Klima 1990; Lillo-Martin and Meier 2011). Consider for instance the sentence "Bill gives Maria a rose". If neither Bill nor Maria are present, the signer can assign an empty location to his/her right for Bill and another to his/her left for Maria and perform the verb GIVE between these two locations (from right to left in this case), hence making the verb agree with the arguments (Klima and Bellugi 1979). However, for such a grammatical system to work, noun phrases (in this case "Bill" and "Maria") should first be explicitly located in the signing space as pronouns and later referred to anaphorically in the discourse by moving the verb from and to these locations.

1.2. Establishing Pronominal Reference in Space

A common way that sign languages mark pronouns is through pointing. Many researchers consider that pointing to oneself refers to first person singular and pointing to the body of the addressee indicates second person (Mathur and Rathmann 2012; Meir and Sandler 2008). Third person can also be established by pointing if the referent is present. However, pointing to referents that are not present or unknown can be problematic. For known but non-present referents, in many sign languages, and especially emerging rural sign languages, one strategy is to use metonymic pointing (Le Guen 2011a), that is, to point to an intermediate referent in lieu of the primary referent: for instance, pointing to the house of Albert to refer to Albert (independently of whether he is there or not). Such a strategy is commonly used, even in some cases for directional verbs (Hou 2016). A second strategy is to use R-loci that allow signers to assign referents to arbitrary points in the signing space. Different referents are allocated to different points in space so that most cases of ambiguity are avoided (Meir and Sandler 2008, p. 65). As we shall see below, assigning referents in space is a crucial prelude to verb agreement.

1.3. Evolution of Space as a Means to Express Verb Agreement

While looking at verb agreement in sign languages, a cross-linguistic comparison reveals that not all languages rely on similar strategies. For some researchers (Mathur and Rathmann 2012; Rathmann and Mathur 2008), the process of verb agreement in sign languages has been interpreted as a linguistic innovation that occurs through a specific use of the signing space and the authors consider that "the cross-linguistic variation across sign languages with respect to certain properties of verb agreement can be explained by positing that the sign languages are at different points along the path of grammaticalization" (2012, p. 146). Indeed, the body of research currently available on emerging sign languages around the world points to three stages of evolution.

In the first stage, some languages do not have a class of agreeing verbs. So, in order to resolve the issue of explaining who is giving what to whom, they rely on a consistent word order using plain verbs. This is the case for ABSL, an emerging sign language used by a Bedouin community in Israel (Meir et al. 2007; Sandler et al. 2005; Padden et al. 2009). Signers do not use the signing space to express the subject and object of a transitive verb, but rather rely on a fixed word order to disambiguate the utterance, as in WOMAN GIVE MAN TAKE (Sandler et al. 2005, p. 2664). The authors conclude that "once languages have had time to accrue such mechanisms as verb agreement, marking properties of subject or object (. . .) the roles of participants can be made clear, even without consistent word order. In the absence of such mechanisms, word order is the only way to disambiguate a message linguistically" (Sandler et al. 2005, p. 2665). In such cases, a signer performs a plain verb in the signing space that can involve movement (such as TRANSFER) typically along the sagittal axis but that does not connect any argument in the signing space. Crucially, the direction of the verb's movement is not relevant grammatically. In a sense, the verb is performed in a neutral space since it is not inflected for arguments.

The second stage is what has been called single verb agreement. In this case, the signer will mark one argument and uses his/her body as the default second argument for transitive constructions. One argument can be located outside the body as an R-locus ascribed in the signing space, making directionality relevant. Morford and Kegl (2000) compared data from homesigners and signers who are exposed to more full-fledged forms of Nicaraguan Sign Language, and they found that homesigners have a tendency to express human action from a first person perspective (Morford and Kegl 2000, p. 376). Such findings support the idea that, in the early stages of the evolution of a language, signers seem to rely more heavily on representing actions from an agent's perspective, thus making extensive use of their own bodies. Meir et al. (2007) and Padden et al. (2010) present similar findings for two young sign languages: ABSL and Israeli Sign Language. However, despite the fact that Kata Kolok, an emerging sign language from Bali, has been used by six generations already, it does not yet have a class of true agreeing verbs (Marsaja 2008; de Vos 2012).

The final stage is the creation of double agreement verb types that rely on the use of the R-loci. As explained earlier, the R-locus strategy implies that locations around the body of the signer are arbitrarily linked to non-present referents. Such a use of the gestural space is actually common among speakers of most Western educated societies (McNeill 2003; McNeill et al. 1993), and it is thus not surprising to find it used for grammatical purposes in sign languages that arose and developed in these cultures. However, the use of abstract pointing is not a given in other societies, as people in these communities tend rather to make person reference by pointing to people's houses or usual place of residence, and only point to existing places in accordance with their real-world locations (Le Guen 2011a; de Vos 2012; Blythe et al. 2016).

In sum, studies suggest that using space symbolically and arbitrarily with R-loci comes later in the evolution of sign languages, and single agreement verbs that use the body as the subject seem to appear prior to the appearance of double agreement verbs. Several explanations have been put forward to explain this evolution and the appearance of agreeing verbs, especially in emerging sign languages. The first is the size of the community of signers; the more people use the sign language, the more complex and grammatically refined will it become. The second argument relates to the age of the sign language and the number of generations. In the case of emerging sign languages, evolution in the grammar is strongly linked to the number of cohorts that have been in contact, the first cohorts providing the shared symbolic environment that the subsequent generations can exploit. Linked to the previous argument, early exposure has also been considered crucial in the development of grammar, as certain periods of language exposure are essential in order to develop a more complex grammatical system. Finally, the use of space, and specifically of the frames of references, has been considered to help or to potentially restrain the emergence of certain grammatical structures. Frames of Reference (FoR) are systems of coordinates that allow to localize a referent (a figure) with respect to a ground. Three basic FoR are usually considered: (a) the intrinsic FoR in which the figure's location is represented in relation to the ground's intrinsic properties (front, back, sides). (b) The egocentric FoR in which relations between objects are calculated in relation to the speaker's (projected) point of view, that is, in relation to his left, right, front, or back. (c) the geocentric FoR (or sometimes more broadly considered within the "allocentric FoRs") in which coordinates between entities are defined by external features of the environment (i.e., neither by the internal orientation of a ground object nor the point of view of the speaker), often with the use of cardinal directions (See Levinson (2003) for a more detailed discussion and Haviland (1996, 2003), Le Guen (2011a, 2011b) for examples on how there are used with gestures in Mayan communities). The cultural or local preference for the geocentric FoR and its implication on gestures (as well as its correlated impact on pointing) has been suggested to go against an abstract use of the signing space and therefore the emergence of agreeing verbs in emerging sign languages (Le Guen 2011a; de Vos 2012).

The present study aims to determine where YMSL is placed on the evolutionary continuum: Does it behave like many other emerging sign languages, only using a sagittal axis with no agreement or does it use space to express verb agreement? I will show that despite YMSL's young age, YMSL signers already are able to use the signing space productively with agreeing verbs. I will discuss all the hypotheses previously considered and explain how the geocentric FoR actually favors the emergence of agreeing verbs in YMSL.

2. The Yucatec Maya Sign Language

Yucatec Maya Sign Language (YMSL) is an indigenous sign language used by deaf and hearing signers in Yucatec Mayan communities with a high incidence of deafness in the peninsula of Yucatán, Mexico. The sign language used in these communities is unrelated to Mexican Sign Language (*Lengua de Señas Mexicana*, LSM) and developed outside of institutional settings, out of the necessity for deaf and hearing community members to communicate with each other. Data for this paper were collected in three communities: Chicán, Nohkop and Trascorral. The communities of study are all located within the state of Yucatán but at one to several hours drive from each other. Members of the three communities have not been in contact in the past, their sign languages emerged within recent decades and are historically unrelated. In-depth interviews with community members, including the oldest deaf signers and their families, failed to provide any evidence for historical contact between the communities. In Nohkop and Trascorral, the oldest signers are still alive and in Chicán, the oldest signer passed away in early 2020. None of them remember the presence of any other deaf people or an already existing sign language in their environment during their childhood. Despite the lack of a historical link, the varieties of YMSL from different communities exhibit an important degree of overlap in their lexicon and can be considered a similar language, a proposition that has been argued in previous work, at least for Chicán and Nohkop (Le Guen 2012; Le Guen et al. 2020; Safar 2017, 2019; Safar et al. 2018). This can partly be explained by the shared sociolinguistic background and the common gestural precursors (precisely, the extensive use of multimodal communication among speakers of Yucatec Maya). The villages differ from each other in their overall population size as well as the number and distribution of deaf people.

Chicán is a village of 720 inhabitants, including 16 deaf people who are between 19 and 69 years old. The oldest signer was in his early eighties when he passed away in 2020. In Nohkop, signers are all from a family of five siblings between the ages of 20 and 28 who grew up together and among whom four are deaf. Trascorral is home to a family of 13 siblings, six of whom are deaf and are between 11 and 33 years old. Demographic data of the three communities are summarized in Table 1 (adapted from Safar 2017).

Table 1. Overview of the communities' population.

	Chicán	Nohkop *	Trascorral
Number of inhabitants	720 (Escobedo Delgado 2012)	No exact figure (around 30)	~300
Number of deaf people	16	4	6
Percentage of deaf people	~2.4% (Escobedo Delgado 2012)	No exact figure	~2%
Age of deaf people in 2021	18–69	20–28	11–33
Gender distribution of deaf people	8 female, 9 male	3 female, 1 male	2 female, 4 male
Family distribution of deaf people	Multiple families	Siblings of one family (family of 5 siblings)	Siblings of one family (family of 13 siblings)

* Nohkop is a pseudonym for a small neighborhood of the town Chemax, chosen according to the family's wish to remain anonymous. Signers now currently live in two separate villages: Chemax and Tixhualactun.

Only in Chicán do we encounter a maximum generational depth of three generations. However, the oldest signer in Chicán, now deceased, only had hearing children and was the only deaf person of his age group. Only the subsequent generation—today between 23 and 69 years old—included a critical mass of deaf signers. Le Guen (2012, p. 216), following Kisch (2012), divides deaf signers in Chicán into seven "interactional groups", some of which include several hearing and deaf members. There are two young deaf signers (19 and 23 years old in 2021) who were born to deaf parents and grew up in a house surrounded only by deaf people.

The deaf population of Nohkop and Trascorral is comprised of siblings within one family each, who constitute the first generation of users of their sign language. Over the past few years, the signing community in Nohkop has dissolved as deaf women have gone to live with their husbands, either in the same village but in a different household or in the husband's village. As of 2022, the oldest deaf signer had two hearing children (ten and seven years old). The second deaf girl of the family had three hearing children (twelve, eight and three years old). The youngest deaf girl had a two-year-old child. All the children are acquiring YMSL as their first language and Maya and Spanish as their second languages. It should be noted that, as of now, they are not very proficient in the sign language, at least compared to the Bilingual-Bimodal cousins of their parents. Additionally, and despite the fact that their hearing parents are native Yucatec Maya speakers, the socialization process is currently conducted almost exclusively in Spanish, based on the belief that Spanish will give them better education and job opportunities. The deaf women are married to hearing men who learned the sign language through living with their respective wives and are fluent in YMSL. In Trascorral, the women stay in the village as housewives while all deaf men go to work on the coast only coming back on the weekends.

In these communities, most people know each other and many are kin-related, thus the specific dynamics of interaction of YMSL signers conform to general cultural interaction patterns. As customary among the Yucatec Maya, people interact primarily with members of their own extended families. Deaf people do not socialize with each other based only on their shared experience of being deaf and a separate Deaf community, as in the context of national/urban sign languages, does not exist (Johnson 1991; Escobedo Delgado 2012; Macdougall 2012; Safar and Le Guen 2020; Safar 2017). This results in a situation where deaf signers from different interactional groups in Chicán have sometimes little contact with each other and exhibit some differences in their signing (Safar et al. 2018; Safar and Chan 2020).

3. Materials and Methods

3.1. Materials

The stimuli used were a set of 12 videos compiled by the Max Planck Institute for Psycholinguistics created in order to elicit ditransitive constructions with actions such as GIVE and TAKE. All the videos include three people (two women and one man or two men and one woman) who are transferring an object to one another. In most videos, only two of the three persons are conducting the action, the last one remaining still. The arrangement of the three persons varies in each video. Various types of objects are being passed around: a bulb, a flower, a book, etc., see Figure 1.

Figure 1. Stills of some of the video stimuli used in the task.

Verbs such as GIVE and TAKE were especially relevant as they can be used in ditransitive constructions, that is, with three arguments: an agent, a patient and an object being transferred. These stimuli are particularly relevant to examine whether signers are able to use the signing space to express verb agreement. In fact, these specific stimuli, or similar versions of them, have been employed in studies run in many sign languages all over the world in order to address the same question (see among others Meir et al. (2007) and Padden et al. (2009) for ABSL, Senghas (2003) and Gagne (2017) for NSL) and allow for a cross-cultural comparison of how agreement is expressed in these different languages.

3.2. Participants

A total of 23 participants volunteered to join the task (see Table 2), all from three communities studied by the author since 2009: Chicán, Nohkop and Trascorral. All experiments were video recorded with the permission of the participants.

In Chicán, 14 people participated (7 women) between 11 and 61 years old at the time of the interview. The average age was 37.7 years old. Thirteen of the participants from Chicán are deaf and one is a CODA (hearing Children Of Deaf Adults). Two siblings born from deaf parents, aged between 11 and 16 (average age is 13), constitute the second generation. In Nohkop, 6 people participated, five women and one man between 2011 and 2021. The average age of the participants was 23.4 years old. Four of the 6 participants are siblings, all deaf. Of the two hearing signers, one is a Bilingual-Bimodal cousin who grew up with the deaf siblings and played an integral part in the construction of the sign language. The second is a CODA, daughter of the oldest deaf sibling and her hearing husband, also fluent in YMSL. Finally, in Trascorral, only three participants were interviewed since they were the only ones present or willing to engage in the task. Two of the participants are deaf, while the daughter of the oldest sister is a hearing CODA. All CODAs are Bilingual-Bimodal signers of YMSL, and they are also fluent in Yucatec Maya and/or Spanish.

Table 2. Participants data (including interactional groups).

Community	Participant	Age in 2021	Gender	Generation	Deaf/Hearing	Data Collection Year
Chicán	JCC	69	M	1st	Deaf	2011
	NCT	51	F	1st	Deaf	2013
	MlCC	23	F	2nd	Deaf	2011
	CaCC	19	M	2nd	Deaf	2011
	StCC	59	M	1st	Deaf	2013
	GUC	34	M	1st	Deaf	2013
	MCH	18	F	2nd	Hearing CODA (BB)	2013
	MCC	66	F	1st	Deaf	2013
	LTP	31	F	1st	Deaf	2011
	BTP	29	F	1st	Deaf	2013
	RTP	23	M	1st	Deaf	2013
	ACC	50	M	1st	Deaf	2011
	ECC	48	F	1st	Deaf	2011
	LCC	40	F	1st	Deaf	2011
Nohkop	YKP	29	F	1st	Deaf	2011
	WKP	16	M	1st	Deaf	2011
	NKP	27	F	1st	Deaf	2012
	MKP	22	F	1st	Deaf	2021
	RKP	23	F	1st	Hearing (BB)	2014
	JSK	6	F	2nd	Hearing CODA (BB)	2021
Trascorral	CMM	33	F	1st	Deaf	2021
	MM	14	F	1st	Deaf	2021
	LMM	14	F	2nd	Hearing CODA (BB)	2021

The task was conducted with the researcher showing each video on a laptop or tablet. The computer was then closed and the participant was asked to retell the video to the camera. The video stimuli varied for movement, people involved in the actions performed, number of men and women, and the object being passed around. Each video triggered the need to provide information about agents and objects, either to the experimenter, or to another interlocutor who did not watch the clip. Indeed, the majority of signers provided such information, even when the researcher was the only interlocutor.

3.3. Transcription and Coding

All data were transcribed using the program ELAN (Brugman and Russel 2004). Coding involved transcription and translation of each complete utterance produced by signers, and special attention was paid to the coding of pronouns and the use of space or the body to express verbal inflection. In order to code how participants retold the video stimuli using the space around them, the people in the video were coded as "Persona" using a number for each one: 1 (the one on the right of the screen), 2 (the one in the middle) and 3 (the one on the left of the screen), as shown in Figure 2. Such coding allows us to understand how signers placed each Persona from the video stimulus in the signing space or if/when they used their own body instead. In total, the total possible number of items participants could indicate was 36.

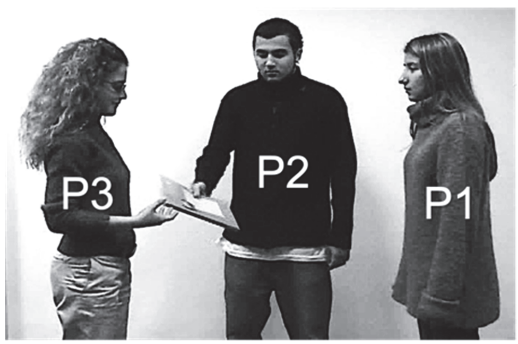


Figure 2. Coding of the "Persona" (people on the screen).

4. Results

4.1. Pronoun Marking and the Use of the Signing Space

As we saw earlier, in order to use space to express verb agreement in a sign language, one requisite is to be able to place referents as pronouns in the signing space. Such placement is essential for agreement, as the movement of an agreeing verb (such as GIVE or TAKE) will distinguish the agent from the recipient (Klima and Bellugi 1979; Meier 2002).

In the data, several strategies have been used to mark pronouns in R-loci. I will not dive into too much detail as to which handshapes were used but only mention that signers used entity classifier (see Safar (2019) for a detailed description of YMSL, and Meir and Sandler (2008)) and, in the case of one signer, buoys (see Figure 5a,b and Liddell (2003, p. 223-ff)) but the most common were pointing (see Figure 6b,d,f) and placing (see Figure 6j). The coding used in the analysis contrasts the marking of *R-locus* versus *no marking*, that is, whether the signer did or did not use the space around his/her body to indicate a pronoun.[1] Results are presented in Figure 3.

Results indicate that many signers from Chicán and Nohkop make a productive use of the signing space to indicate pronouns in R-loci: 54% of the responses in Chicán and 76% of the responses in Nohkop. In Chicán, the three second generation participants (two deaf children born from deaf parents and a CODA) all systematically used R-loci (i.e., 36 times in the task). In Nohkop, both first and second generation signers predominantly used R-loci for pronoun reference. However, none of the signers form Trascorral indicated pronouns in R-loci.

These results predict that signers from Chicán, especially second generation ones, and most of the signers from Nohkop can potentially use agreeing verbs, while none should be expected to do so in Trascorral.

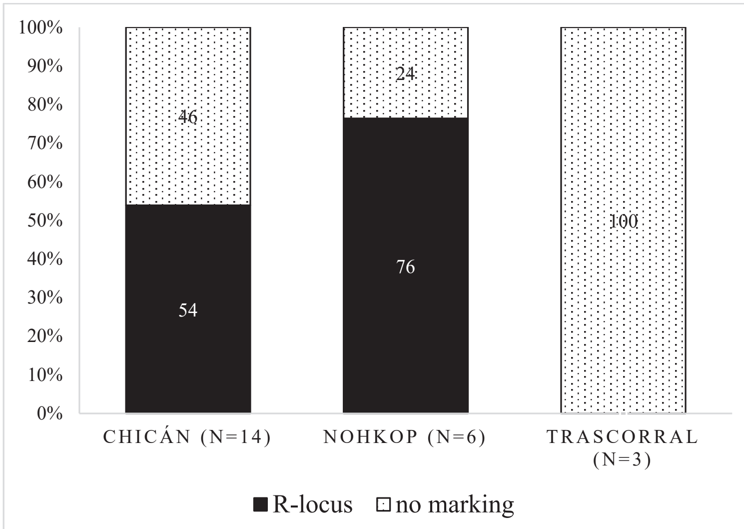


Figure 3. Total number of responses in percentages compared by communities for R-locus vs. no-marking.

4.2. The Use of Space and the Verb Classes

In many sign languages, verb classes have been described based on their lexical, morphological and sometimes semantic features, as in ASL for instance (Padden 1983). However, in emerging sign languages, established categories are not always applicable as signers may use different strategies and, more often than not, in-between verb classes. This is the reason why some authors have come up with ad-hoc categorizations, such as Padden et al. (2009) for ABSL.

In the task proposed here, participants had to retell, from video clips, actions involving an object being transferred from one Persona to another. If participants marked agreement, the verb should be performed between previously established R-loci (see above) and directionality was relevant. However, not all responses were uniform and results are better analyzed considering two types of verbs: uninflected and inflected verbs. In the latter case, two options are possible, either with a single argument or with two. Thus, three cases are observed: (a) uninflected verbs, which were only performing with an in/out center movement from the body and do not agree with the pronouns given that directionality is not relevant to indicate semantic roles; (b) single-agreement verbs, which only explicitly mark the patient or direct object argument while the participant enacts the default agent/subject, and; (c) double-agreement verbs, where the verb's movement explicitly indicates the relation between agent/subject and patient/direct object in the signing space (i.e., between two R-loci). A schematic representation is provided in Figure 4. The terminology is explained in the text below and in Section 5.1.

4.2.1. Uninflected Verbs

Padden et al. (2009) who conducted a similar task in ABSL considered that these verbs (that the authors refer to in their paper as "plain verbs") "lack the fine locational distinctions seen in verb forms used to mark motion and location and they lack person marking as well" (Padden et al. 2009, p. 388). As pointed out by Montemurro et al. "agreement is with the subject and/or object of the verb and is dependent on the previous establishment of the referent or referents" (Montemurro et al. 2019, p. 421). In the case of uninflected verbs (see examples in Figure 5) the path movement of the verb is not determined by any R-loci previously established in the signing space and consists simply of an in/out movement that does not indicate any specific argument in space. In fact, most of the participants who used uninflected verbs did not mark pronouns in R-loci prior to producing the verb and only mentioned the subject or the object lexically (Figure 5d,g, respectively).

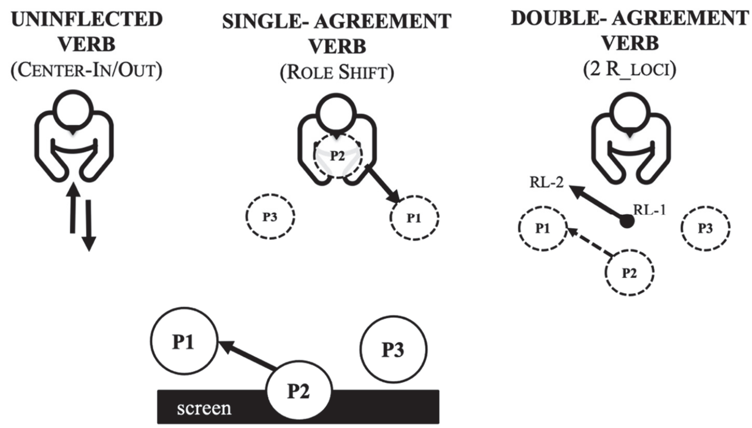


Figure 4. Representation of the three verb types used by participants in the task. The diagrams represent the signers and the signing area as viewed from above. The circles with P1, P2 and P3 indicate where the signers created R-Loci (RL) and the arrows represent the movement of the sign performed in the signing space. This representation is based on the action presented in a video clip on the screen (represented by a black line in the bottom of the image).

Figure 5. Examples of uninflected verbs ((**a**–**f**) signers of 1st generation from Chicán; (**f**,**g**) signer of 1st generation from Trascorral) (**a**–**c**) "there is a woman, she is on this end, she takes"; (**d**,**e**) "man gives"; (**f**,**g**) "someone gives a book". (Note that here TAKE is a 'backwards verb', moving from the direct object to the subject, see Meir (1998) for a discussion).

4.2.2. Single Agreement Verbs

Single agreement verbs involve a movement of the verb that depicts the displacement of an entity in space, and one end of the path is always associated with a single argument of the verb (labeled source or goal in Meir (Meir et al. 2007; Meir 2002).[2] In the case of GIVE and TAKE, the path always starts or ends at the body of the signer and the directionality of the verb reflects the path of the object being transferred. Crucially, and in contrast with uninflected verbs, in the case of single agreement verbs, the movement is usually performed in accordance with where a pronoun was placed in space in an R-Locus, i.e., either from center to the left or right or from left to right. Signers who used single agreement verbs always embodied the Persona from the video clips, that is, they used constructed action (also called role-shift or character perspective) to enact the action they are retelling. In constructed action, the signer takes the perspective or viewpoint of the giver or the recipient. This is the strategy that Meir et al. (2007) consider as "body as subject", in which the body is the subject agreement marker but is omitted while the marked argument is the object.

Examples of this strategy are presented in Figure 6. While the verb used by the signer is TAKE, a backwards verb, that is, the movement starts from the locus associated with the object and moves toward the locus associated with the subject (which is the goal of the transfer). In single verb agreement, the subject is only implied in the construction, making it distinct from double agreement verb constructions where both arguments are explicit and located in the signing space. In Figure 6a–i, the signer embodies the woman (P2) from the video stimuli. The action is that she takes a book from P3, the man to her right. When inflecting the verb, the signer acts as if he was the woman from the video clip, and takes the book from his right. The signer from Figure 6j,k first places the Persona in the signing space in R-loci, and then uses constructed action, enacting Persona (P2) taking an object from the Persona (P3) to her left. The perspective taking is particularly clear in Figure 6k, where she exaggerates on purpose and mimics the Persona from the video (based on her own interpretation).

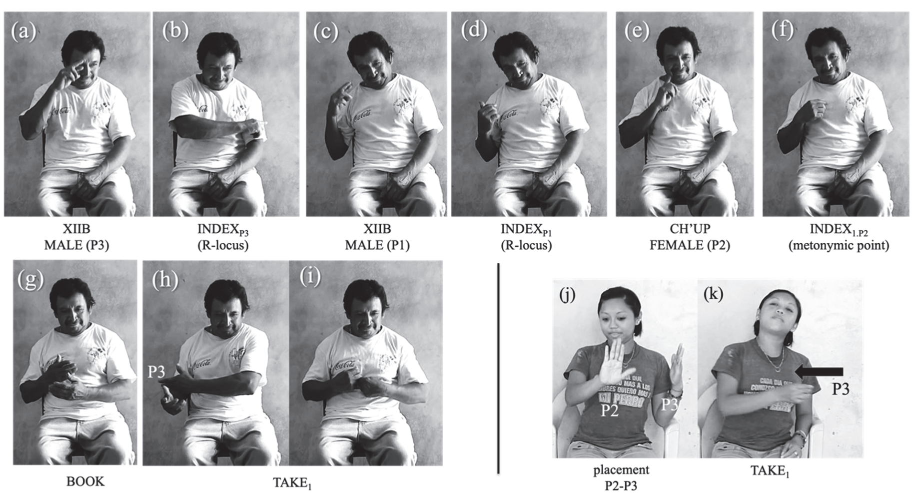


Figure 6. Responses using single agreement verbs ((**a**–**i**) signer of 1st generation from Chicán; (**j**,**k**) signer of 1st generation from Nohkop) (**a**–**i**) "there is a man here, a man here (and) a woman where I am, from P3 I take the book"; (**j**,**k**) "P2 and P3 are thusly placed, from P3 I take the book".

4.2.3. Double Agreement Verbs

Double agreement verbs agree with two arguments, their source argument and their goal argument. In sign languages, this process usually implies the creation of two R-loci in the signing space and agreement is performed with a movement of the verb from one R-locus to the other (i.e., between arguments). Although double agreement verbs are common in most Deaf Community sign languages that are adopted by schools and interpreters, they are noticeably absent in emerging sign languages, as pointed out for instance for ABSL (Padden et al. 2009) or Kata Kolok (de Vos 2012). In the data presented here, verb agreement constructions with two arguments independent of the signer's body were used by the YMSL participants from first and second generations.

Figure 7 presents an example of such a construction performed by a second generation signer from Chicán. The signer first creates R-loci that arbitrarily assigns the NPs ("the man" and "the woman") to empty locations in the signing space (glossed P1, P2 and P3). She then mentions the object being transferred, in this case a book (BOOK-SASS). Finally, she moves the verb in the space between two R-loci previously assigned to P2, the woman and P3, the man, semantically assigning the role of giver to P2 and of receiver to P3. In contrast with single argument constructions, her body is not involved and the movement of the verb marks the agreement with the two arguments located in the signing space.

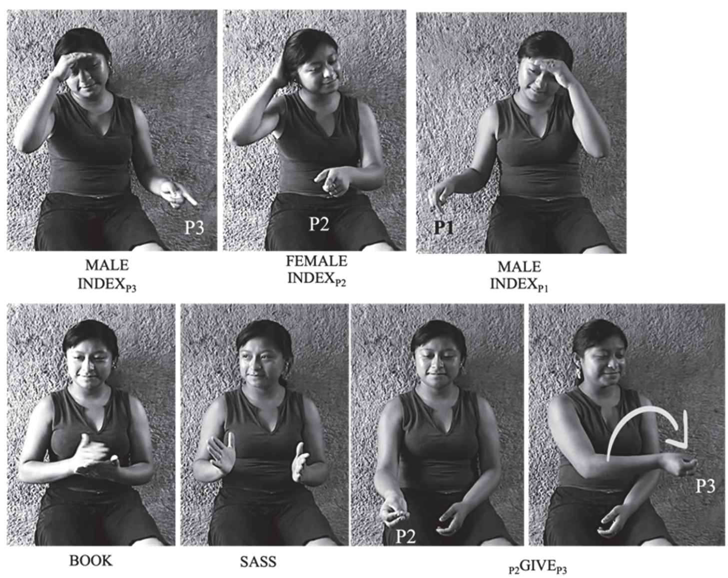


Figure 7. Second generation signer from Chicán using double agreement "There is a man here, a woman here, (and) a man here, the woman (P2) gives the book to the man (P3)".

4.2.4. Comparison between Communities

Results of the comparison between the types of verbs used in signers from different communities are presented in percentages in Figure 8. Interestingly, we observe that YMSL signers used double agreement verb constructions much earlier and more extensively than what would be predicted from previous research on emerging sign languages (Padden et al. 2009).

In Trascorral, as predicted by the analysis of the pronouns (or lack thereof in this case), signers relied on an uninflected verb strategy. Their response is comparable to what the majority of ABSL signers did in a similar task (Padden et al. 2009). In the case of Nohkop, all signers used verb agreement. Most of the constructions used (almost 80%) were single agreement verbs, but a fourth of the responses were double agreement verbs. A closer analysis reveals that three of the signers from Nohkop used exclusively single agreement construction, while the other three alternate between single and double agreement constructions.

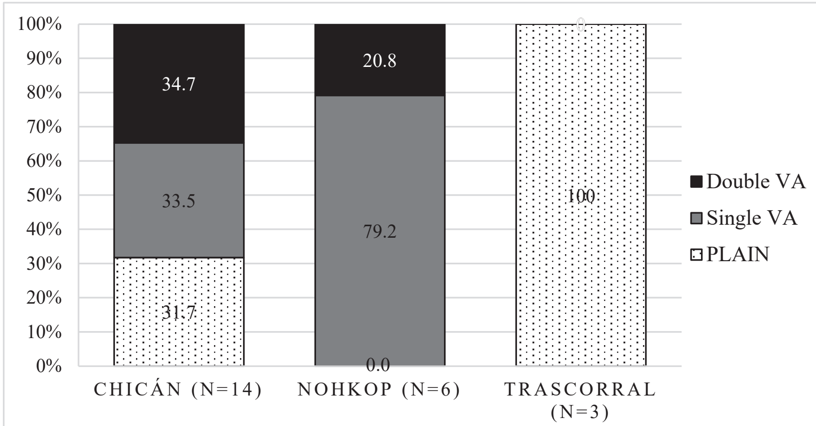


Figure 8. Results of the strategies used by the participants in the task separated by community (in percentages).

In the case of Chicán, conflated total responses do not show if some signers were more consistent in the verb construction types used than others. For this reason, Table 3 presents the results of Chicán signers considering consistency in individual responses. Three groups emerged based on their preference. Group 1, composed of four signers from first generation, chose to a great majority (95.8%) uninflected verb constructions. Group 2, composed of six adults from the first generation, chose predominantly singe agreement verb constructions, but did alternate during the task with other strategies. Finally, group 3 composed of 4 signers, 2 deaf signers form the second generation, a deaf adult from the first generation and his daughter, a hearing Bilingual-Bimodal signer from the second generation, exclusively used the double agreement strategy.

Table 3. Results of individuals from Chicán grouped according to the main strategy used in the task.

	GR.1 (*N* = 4)		GR.2 (*N* = 6)		GR.3 (*N* = 4)	
	#	%	#	%	#	%
Uninflected	46	**95.8**	7	9.9	0	0
Single VA	1	2.1	55	**77.5**	0	0
Double VA	1	2.1	9	12.7	48	**100**

Comparison of the results from the three communities presents an unexpected picture. Some YMSL signers only used uninflected verbs, behaving as signers from first generations of other emerging sign languages. This is the case for signers from Trascorral and Group 1 from Chicán. However, many signers also from first generations used single verb agreement strategies. This is the case for many signers from Nohkop and Group 2 from Chicán. Finally, and even more surprisingly, in Nohkop and Chicán, some signers from first and second generations (although systematically in Chicán in the latter case) were able to employ double agreement verb constructions, making grammatical use of the signing space.

5. Discussion

Results show that YMSL signers, even from first generations, are able to use single and, crucially, double agreement verbs, challenging the prediction of the evolutionary path hypothesis. How can we explain such early use of space to express grammatical categories such as verb inflection in YMSL? I will review previous arguments put forward to explain the evolutionary path towards the emergence of agreeing verbs, and I will propose that, in the case of YMSL, the use of the preferred frame of reference in the surrounding culture is what seems to motivate a specific use of space among signers.

5.1. Limitations of the Studies

While results indicate clear tendencies, it is important to consider some of the limitations of this study. First, the small number of participants is problematic in order to make overarching generalizations. However, this is not an obstacle that can be overcome as the number of deaf signers is limited in each community and in some cases (such as Trascorral for instance) there was a noted unwillingness of some participants to take part in the experiment.

A second limitation is that this task is not an everyday activity for signers. However, it is noteworthy that clear patterns arose from the signers' responses and that very fact is a confirmation that the task was not completely misunderstood, hence validating the results.

A third limitation is the low number of bilingual-bimodal signers. The inclusion of just a few of them was due to the exploratory character of the task, but a more systematic study should be run in the future to explore this population in more detail.

Finally, the task conducted was not a comprehension task as in Senghas (2003), so the results only show the tendency for production and not comprehension. This will also be the object of a follow-up study.

5.2. An Evolutionary Path

Studies conducted on emerging sign languages have been particularly helpful to determine an evolutionary path that seems to begin without the existence of verb agreement expressed in space and how it appears late in the life of the sign language (de Vos and Pfau 2015; Meir et al. 2010). Among the emerging sign languages documented to date, the most relevant studies for our issue at hand were conducted on the following languages: Nicaraguan Sign Language, Al-Sayyid Bedouin Sign Language, Kata Kolok and Inuit sign language. Seminal work on ASL and Auslan as well as Danish and Israeli sign languages describe the use of space for agreement, which motivated later studies in village communities. Table 4 provides some background information that will be used for comparison in the next subsections.

Table 4. Characteristics of various sign languages for cross-cultural comparison; based on de Vos (2012, p. 424), (Meir et al. 2007; Sandler et al. 2005; Aronoff et al. 2005), (Senghas 2003, 2005; Coppola 2020), (Schuit 2012, 2014; Schuit et al. 2011), Engberg-Pedersen (1993), de Beuzeville et al. (2009) and Liddell (2003).

	Total Number of Signers	Number of Generations	Age of the Sign Language (Aprox.)	Preferred FoR	Use of the Signing Space for Agreement
Kata Kolok	46	6	120?	Geocentric	NO
Al Sayyid SL	125	3	70	Geocentric?	NO
Nicaragua SL	800	3	25	?	NO-YES
Inuit SL	>40	1	60	Geocentric	YES
YMSL	16/4	2	80/20	Geocentric	YES
Israeli SL	10,000	3	90	Egocentric?	YES
Danish SL	5000	2	200	Egocentric?	YES
ASL	250,000–500,000	more than 8	200	Egocentric	YES

The use of space to express grammatic categories, specifically agreement, has been explored in these languages but, more importantly, very similar tasks have been conducted with signers, making a cross-cultural comparison possible. Such an attempt based on published materials is proposed in Table 5.

Table 5. Cross-linguistic comparison of verb agreement, based on de Vos (2012, p. 424), (Meir et al. 2007; Sandler et al. 2005; Aronoff et al. 2005), (Senghas 2003; Senghas et al. 2004), (Schuit 2012, 2014; Schuit et al. 2011), Engberg-Pedersen (1993), de Beuzeville et al. (2009) and Liddell (2003).

		Plain Verb (In/Out Movement)	Agreement (Use of the Signing Space)	
			Single Agreement Verbs	**Double Agreement Verbs**
Kata Kolok		■		
Al Sayyid SL		■	■	
Israeli SL	1st Gen.	■		
	2nd Gen.	■	■	
	3rd Gen.	■	■	■
YMSL	1st Gen.	■	■	◢
	2nd Gen. Deaf & BB	■	■	■
Inuit SL		■	■	■
Nicaragua SL	1st cohort	■		
	2nd cohort	■	■	
Danish SL	Older signers	■	■	
	Younger signers	■	■	■
ASL, Auslan		■	■	■

Table 5 indicates that recently created sign languages in small communities tend not to display agreement and even less double agreement marking, as is the case for ABSL (Meir et al. 2007; Padden et al. 2009, 2010), Kata Kolok (de Vos 2012, p. 129), the first two cohorts of NSL (Senghas 2003; Senghas et al. 2004) and the first two cohorts of ISL (Padden et al. 2010). Interestingly, the development of Danish sign language also follows a similar pattern (Engberg-Pedersen 1993). On the other end of the spectrum, later generations of signers and older sign languages, such as ASL or Auslan, for instance, make use of all three verb types. However, de Beuzeville et al. (2009) remind us that the use of double agreement verbs, although available, remains quite rare in everyday use (around 20% of all verb occurrences; see also Bauer (2014) for similar findings in Yolngu sign language in Australia).

A review of the literature indicates that the evolutionary path seems to be a robust tendency cross-linguistically. YMSL already has signers from the first generation who are able to use all three verb types, albeit not systematically, in the task. At first glance, YMSL seems to be an exception, but Schuit (2014) documented the use of verb agreement in Inuit sign language (IUR) also from first generation signers. What factors might contribute or restrain the early use of the signing space for agreement in emerging sign languages? Several explanations have been put forward: the size of the community, the age of the sign language, the early exposure to language.

5.2.1. Size of the Community and the Critical Mass of Deaf Signers

The appearance of agreeing verbs has been suggested to be connected with the size of the community of signers, especially the deaf individuals: the more (deaf) signers a community has, the more complex and refined linguistic messages ought to be. Senghas, in her review of the cases of ABSL and NSL, considers that "a language would develop more slowly within a small community" (Senghas et al. 2005, p. 464).

Table 4 shows that languages with up to 125 deaf signers still might not have developed a double agreement verb type. Israeli, Danish or American sign languages with signers in the thousands are more likely candidates. However, Chicán has 16 deaf signers (the maximum number of signers was 19) and Nohkop only 4 and yet, both communities display some use of double agreement verbs. Size of the community and the number of deaf signers alone cannot explain the emergence of agreement in space, at least not in the case of YMSL.

5.2.2. The Age of the Sign Language and the Number of Generations

When considering the age of the language, the number of years of existence of the language per se is not what counts but instead the number of generations. Senghas et al. (2005) point out that in a stage of NSL where signers already have regular contact with each other, perspective-taking (single agreement construction) tends to become more differentiated and is extended to the patient in addition to the agent role. The authors conclude that the kind of input deaf children receive has an influence on the complexity of expressing grammatical relations and marking perspective. One reason proposed is that children or new cohorts of signers build on the linguistic structures constructed by the previous generations. The authors are careful to point out that "no single age cohort can progress through the developmental stages in the order necessary to create a language in a single pass. Consequently, language genesis requires at least two cohorts of the community in sequence, the first providing the shared symbolic environment that the second can exploit" (Senghas et al. 2005, p. 304).

This proposal has more explanatory power and seems to support the data from YMSL. Although signers of first generations do use single and sometimes double agreement constructions, it is notable that Chicán deaf signers from the second generation used double agreement constructions systematically in the task. Still, the generational hypothesis fails to explain why YMSL signers were able to develop double agreement verbs since the first generation. It appears that just having successive generations of signers might not be enough either, as demonstrated by ABSL with three generations or Kata Kolok with six.

5.2.3. Early Exposure to the Language

Early exposure implies that certain periods of language exposure are crucial in order to develop a more complex grammatical system. Various studies have shown that native learners display superior performance to early and late learners in their knowledge and use of agreement (Emmorey and Reilly 1995; Newport 1990). However, Meier suggests that some linguistic structure might be harder to acquire: for instance, Turkish children master verb agreement around the age of 2.0 while ASL deaf children only around 3.0 (Meier 2002, p. 126).

Early exposure definitely contributes to the successful development of new sign languages and the refinement of their grammatical structures, but cannot be the main explanatory criteria in the case of YMSL as signers did not learn from previous sign languages. However, exposure to gestural habits from the speakers of the surrounding community might have an effect on how to use space, as I will argue below.

5.3. The Impact of the Geocentric Frame of Reference and the Semiotic Jump towards an Abstract Use of Space

I will argue that the preference for the geocentric frame of reference, especially through its use in gestures among speakers of Yucatec Maya in the surrounding culture, facilitates a cognitive and semiotic jump for signers towards a more abstract use of the signing space under certain conditions. Such analysis also put emphasis on the idea that some linguistic habits of the surrounding community can be a seed for the emergence of the sign language (e.g., Kocab et al. 2022), namely the gestural habits of the speakers of Yucatec Maya.

5.3.1. Looking at Signing Space in Terms of Frames of Reference (FoR)

A study conducted by Senghas (2003) with various cohorts of Nicaraguan Sign Language signers compared the production and comprehension data of spatially modulated verbs of first and second cohort signers. The author concentrated her analysis on whether signers used a rotated or an unrotated representation of events (see also Gagne 2017). That is, if presented with a video stimulus where a woman is giving a cup to a man to her right, will the signer produce the movement of the verb to his/her own right or to the left side of his/her body? A movement to the left would correspond to an unrotated representation and a movement to the right to a rotated one (Senghas 2003, p. 518). Senghas finds that while first cohort signers accept both a rotated or an unrotated layout for expressing spatially modulated verbs, second cohort signers all consistently apply a rotated representation which also limited their acceptance of the event depictions accordingly. Such innovation restrains the way signs can be produced and, in doing so, also limits what the signs can mean, and hence makes grammatical references more specific.

However, a different reading is possible taking into account spatial Frames of Reference (FoRs). In this interpretation, the rotated perspective would correspond to the egocentric FoR while the unrotated perspective to the geocentric. A schematic representation is proposed in Figure 9.

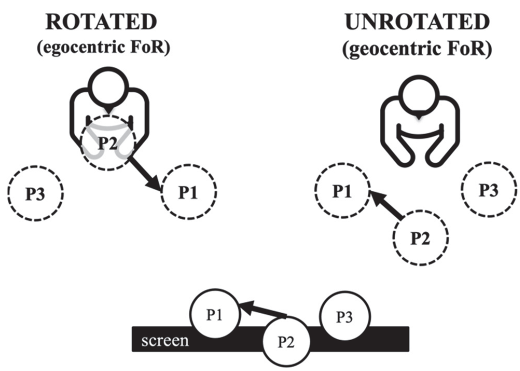


Figure 9. A new reading of Senghas (2003, p. 518)'s proposal in terms of spatial Frames of Reference. The diagrams represent the signers and the signing area as viewed from above. The circles with P1, P2 and P3 indicate where the signers created R-Loci (RL) and the arrows represent the movement of the sign performed in the signing space. This representation is based on the action presented in a video clip on the screen (represented by a black line in the bottom of the image).

In the case of the rotated perspective strategy, the point of reference to locate entities is the signer's point of view in considering the stimulus in video. Basically, this means that the signer takes the perspective of one of the characters in this video and reproduces the movement from his/her perspective. Such a strategy implies a mental rotation from the stimulus and means that if the person in the video clip gives an object to the person on her right, the signer will produce a sign oriented to his/her own right. This use of space relies on the use of an egocentric Frame of Reference. For the unrotated perspective, one explanation is that the signer reads the same spatial arrangement but based on a geocentric frame of reference, meaning that the movement is not taken as being to the "right to the person in the stimulus" but, say, "north of the person" or "towards the door (in the real world)". Although it might be highly counterintuitive for speakers of languages that heavily rely on egocentric FoRs (such as English or Spanish), this is actually the most common way to use space in locating objects in space in rural and non-Western communities around the world (de Vos 2012; Bauer 2014; Levinson 2003).

5.3.2. The Condition of Truth in the Use of Space

Schegloff (1984) notes that sometimes, in daily conversation, U.S. English speakers from the West Coast point to places in the real world but indicate these entities in a somewhat random manner, since the orientation of their pointing does not correspond to the actual location of the places they are mentioning. McNeill (2003) looking at the same issue among English speakers in Chicago, considers that what is at stake is the morality of pointing and how much intersubjectivity is involved as well as the speakers' willingness to negotiate meaning. If English speakers from urban settings are able to point randomly to real places in the world without consequences, this is not the case in other cultures. Among speakers of Yucatec Maya (but also in many other settings, see Bauer (2014) de Vos (2012) or Haviland (1993), inter alia), one is entitled to point towards real entities and places in retaining their actual orientation (Le Guen 2011a). Doing otherwise is considered lying, hence, the significance of the "condition of truth".

Among geocentric coders (i.e., language users that prefer to use geocentric FoRs in locating objects in space), the cultural tendency to maintain real orientation is prevalent and has even been described in spontaneous narratives by Haviland (1993) among Tsotsil speakers from Mexico and in stories from deaf signers of Kata Kolok by De Vos (de Vos 2012, p. 268-ff). In these cases, it is noteworthy that direction and orientation are important and foregrounded. For instance, in the story of a shipwreck reported by Haviland, the orientation towards the sea is a crucial element and, in a narrative reported in De Vos' work, the path taken inside a tunnel cannot be modified as it implies going one way and not the other. In both cases, when the speaker changes location and orientation, (s)he will always locate the elements of the story according to their actual orientation and not based on his/her point of view at the place and time of the narration.

While culturally prevalent, speakers and signers do not always stick to these principles, specifically when they judge that the spatial location or orientation of the entities is not that crucial (or that it can be backgrounded) and the story can be told in a more abstract spatial setting, usually relying on an intrinsic frame of refence (in which both cardinal directions and the signer's point of view are irrelevant). In such narrative contexts, both entities are located with respect to one another and not according to their real-world orientation (a fact also acknowledged in De Vos' data). Such differentiation in the use of space is crucial and understanding how truth conditions can be cancelled by the signers provides one key to explain why they are able to make a semiotic jump towards placing entities in the signing space in an abstract manner.

In the task used in his study, the setting, the people involved and the actions performed are not familiar, habitual and, crucially, not localizable in real space. As a result, it is not surprising to see signers treating it as the kind of narrative that can be freed from the spatial condition of truth. I argue that this condition is one significant argument to understand why the use of the signing space in an abstract way is possible and can give rise to an agreeing verb class. However, this criterion is not the only thing that can trigger an abstract use of space, since signers have built upon the use of allocentric localizations habitually used by Yucatec Maya speakers when talking and gesturing about spatial arrangements.

5.3.3. A Cultural Habit of Allocentric Localization

Most readers might be familiar with locating two entities in the real world using their projected point of view on a scene, locating them to the left and right (e.g., "Leaving the faculty building, I parked my car at the right end of the parking lot"). Such a conception of space relies on an egocentric FoR from which relations between external entities are made based on the speaker/signer's transposed point of view. However, in many cultures, speakers or signers prefer to use a geocentric FoR and explain that "the well is to the south-side of the palm tree". In more extreme cases, such as among the Yucatec Mayas, an indication can be reduced to a verbal cue, such as a manner deictic, and it is a gesture oriented according to the real-world orientation that provides the relevant spatial information, as in the following statement *le áasulero máa bey yanika'?* (accompanied by a waving gesture towards the north) "isn't the Azulero (a shop) located like this (=on the north side)?".[3]

Yucatec Maya speakers have a habit of using an allocentric perspective when locating two entities with respect to one another. To do so, they place both entities in the gesturing/signing space but, instead of using their point of view, they rely on external anchors, such as cardinal directions or salient elements in the world. In such types of locative constructions, the body is not considered, not even the projected point of view, so the use of the left and right becomes irrelevant. What is central however, is the positioning of the entities according to their real-world orientation. Consequently, speakers make use of the symbolic space all around their body, locating the entities either in front of them, on each side of the body or even behind them (see Le Guen (2011b) for examples).

In order to illustrate this strategy, consider the following example in Figure 10 where a deaf signer from the second generation in Chicán was asked to perform a task similar to the one used in Le Le Guen (2011b). In Figure 10, the signer is facing East and the array she has to describe is located on the other side of the village. The signer was asked to locate the water tank with respect to the *comisaria* (the local administrative office). From where she is sitting, the arrangement stands to her back. She first mentions both entities using NPs and then places them in the signing space. However, her placement is not random, nor does it rely on her projected point of view (using an egocentric FoR), and she correctly locates the water tank south of the soccer field (where the *comisaria* is situated). Such a strategy uses the signing space symbolically but also respects the requirement of the truth condition exposed above and is performed with a geocentric FoR.

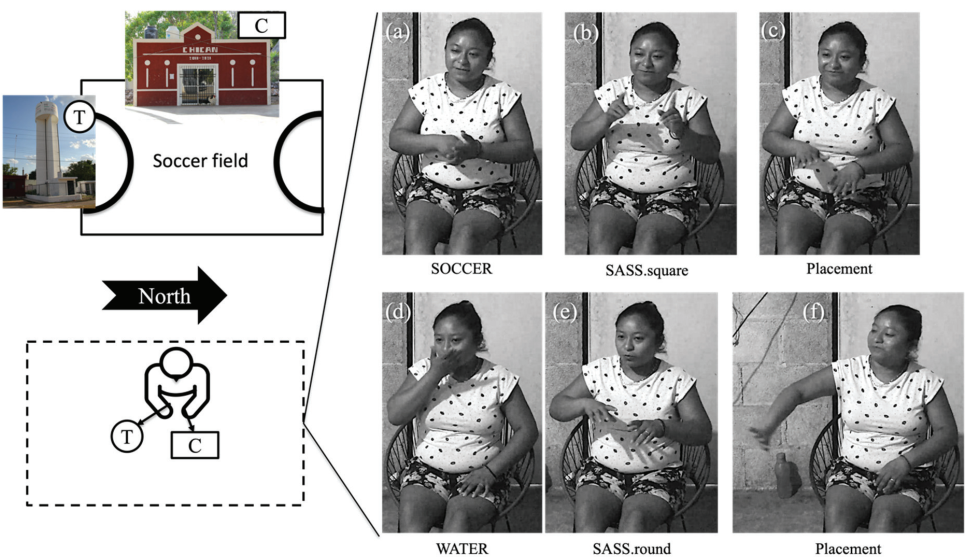


Figure 10. Spatial localization using the geocentric FoR, in placing the entities in the signing space according to their real-world orientation (on the left are diagrams that represent the array of objects and the signers and the signing area as viewed from above). "The soccer field (=*comisaria*) (**a**,**b**) is here (**c**), and the water tank (**d**,**e**) is there (=south of the *comisaria*) (**f**)" (Deaf signer form second generation of Chicán).

This same task was conducted with all the deaf signers in Chicán and results show that signers use the space around their body quite like Yucatec Maya speakers. When asked to locate two entities distant from their current location (but within their village), the great majority of signers placed them in the signing space according to a geocentric FoR, that is, according to their real-world orientation (see Tuz Baas forthcoming for more detail).

5.3.4. Towards an Arbitrary Use of the Signing Space

The explanation I propose is that signers behave like Yucatec Maya speakers in their use of space for spatial localizations. Signers also locate spatial arrangements based on their real-world orientation, using the signing space symbolically. However, when it comes to agreement, speakers have an oral language to express these relations. Because YMSL is a visual medium, signers can recruit the spatial localization strategy and, putting on hold the truth conditions, they can now assign arbitrary points in the signing space to unknown entities (i.e., creating pronouns) and establish relations between them (i.e., marking agreement with the verb's movement). Such recruitment of local norms for the use of space in the surrounding culture seems to be a better explanatory factor as for why signers were able to use the signing space symbolically even since the first generation of deaf signers.

6. Conclusions

Results from this study support the three stages of evolution from the use of uninflected verbs towards the emergence of a more grammatical use of space with single agreement and then double agreement verbs. However, the striking element in the present study is the early appearance of agreement in space in YMSL as compared to other emerging sign languages that have been documented to date. The proposed explanation is that the use of a geocentric Frame of Reference and the habits of Yucatec Maya speakers to use the gesturing space symbolically is what steers deaf signers towards a more arbitrary use of the signing space. Deaf YMSL signers from the first generation also habitually locate entities in the space around their body respecting real-world orientation. The hypothesis is that they rely on this habit and extend it to the creation of R-loci and verb agreement constructions in the signing space. As pointed out by Meier (2002) and Senghas et al. (2005), second and subsequent generations of signers usually improve on and systematize the language, and this is clearly what second generation YMSL deaf signers are doing in employing double agreement constructions systematically in the task. While this explanation holds for the early emergence of agreement in YMSL, it might not directly apply to ABSL or Kata Kolok, for instance, and each group follows its own specific pace, with various local constraints on the language.

Documenting and taking into account the surrounding culture proves fundamental to understand emerging sign languages' linguistic structures, although it is too often overlooked. The YMSL data shed light on an issue sometimes ignored, that is, the potential richness of first generation signers and homesign systems, as well as the importance of the cultural setting and gestural habits of the surrounding culture in which a new sign language emerges.

Funding: Part of this research was supported by the MPI-Language and Cognition Group and the CONACyT project FC-2016-2893.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: I wish to sincerely thank the people of Chicán, Nohkop and Trascorral for their patience and will to share their language and culture with me. I would also like to thank Josefina Safar who helped with a first version of this study, Lorena Pool Balam for helping with some of the data collection, and the participants of the 2012 EuroBABEL workshop. I am indebted to the anonymous reviewers and Wendy Sandler for their useful comments and relevant critics as well as Carolyn O'Meara for her generous assistance with the manuscript.

Conflicts of Interest: The author declares no conflict of interest.

Notes

1. Results for the use of buoys were collapsed with the no-marking strategy as it only accounts for one participant.
2. Different authors refer to syntactic roles such as subject and direct or indirect object, and others prefer semantic roles like agent and patient or source and goal. For our purposes here, these terms are used interchangeably.
3. For a more detailed discussion, see Le Le Guen (2011b) who describes in detail the integration of spatial gestures in speech based on the geocentric FoR among the Yucatec Maya.

References

Aronoff, Mark, Irit Meir, Carol Padden, and Wendy Sandler. 2005. Morphological Universals and the Sign Language Type. In *Yearbook of Morphology*. Edited by G. Booij and J. van Marle. Dordrecht: Springer, pp. 19–39. [CrossRef]

Bauer, Anastasia. 2014. *The Use of Signing Space in a Shared Sign Language of Australia*. Boston and Lancaster: De Gruyter Mouton.

Blythe, Joe, Kinngirri Carmelita Mardigan, Mawurt Ernest Perdjert, and Stoakes Hywel. 2016. Pointing out Directions in Murrinhpatha. *Open Linguistics* 2: 132–59.

Brugman, Hennie, and Albert Russel. 2004. Annotating Multi-Media/Multi-Modal Resources with ELAN. Paper presented at Fourth International Conference on Language Resources and Evaluation (LREC'04), Marseille, France, June 20–25; Lisbon: European Language Resources Association (ELRA).

Coppola, Marie. 2020. Sociolinguistic Sketch: Nicaraguan Sign Language and Homesign Systems in Nicaragua. In *Emerging Sign Languages of the America*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Sign Language Typology [SLT]. Berlin and Boston: De Gruyter Mouton, pp. 439–50.

de Beuzeville, L., Trevor Johnston, and Adam Schembri. 2009. The Use of Space with Indicating Verbs in Australian Sign Language: A Corpus-Based Investigation. *Sign Language and Linguistics* 12: 52–83. [CrossRef]

de Vos, Connie. 2012. Sign-Spatiality in Kata Kolok: How a Village Sign Language of Bali Inscribes Its Signing Space. Ph.D. thesis, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands.

de Vos, Connie, and Roland Pfau. 2015. Sign Language Typology: The Contribution of Rural Sign Languages. *Annual Review of Linguistics* 1: 265–88. [CrossRef]

Emmorey, Karen, and Judy S. Reilly. 1995. Theoretical Issues Relating Language, Gesture, and Space: An Overview. In *Language, Gesture, and Space*. Edited by Karen Emmorey and Judy S. Reilly. Hillsdale: Lawrence Erlbaum Associates, pp. 1–16.

Engberg-Pedersen, Elisabeth. 1993. *Space in Danish Sign Language*. Hamburg: Signum-Verlag.

Escobedo Delgado, Cesar Ernesto. 2012. Chican Sign Language: A Sociolinguistic Sketch. In *Endangered Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Ulrike Zeshan and Connie de Vos. Berlin: Mouton de Gruyter & Ishara Press, pp. 377–80.

Gagne, Deanna. 2017. With a Little Help from My Friends: The Contributions of a Peer Language Network on the Conventionalization of Space in an Emerging Language. Doctoral dissertation, University of Connecticut, Storrs, CT, USA.

Haviland, John B. 1993. Anchoring, Iconicity, and Orientation in Guugu Yimithirr Pointing Gestures. *Journal of Linguistic Anthropology* 3: 3–45. [CrossRef]

Haviland, John B. 1996. Projections, Transpositions, and Relativity. In *Rethinking Linguistic Relativity*. Edited by John Gumperz and Stephen C. Levinson. Cambridge: Cambridge University Press, pp. 271–323.

Haviland, John B. 2003. How to Point in Zinacantán. In *Pointing: Where Language, Culture, and Cognition Meet*. Edited by Sotaro Kita. Mahwah: Lawrence Erlbaum, pp. 139–69.

Hou, Lynn Yong-Shi. 2016. 'Making Hands': Family Sign Languages in the San Juan Quiahije Community. Ph.D. thesis, The University of Texas at Austin, Austin, TX, USA.

Johnson, Robert E. 1991. Sign Language, Culture and Community in a Traditional Yucatec Maya Village. *Sign Language Studies* 73: 461–74. [CrossRef]

Kisch, Shifra. 2012. Demarcating Generations of Signers in the Dynamic Sociolinguistic Landscape of a Shared Sign-Language: The Case of the Al-Sayyid Bedouin. In *Endangered Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Ulrike Zeshan and Connie de Vos. Berlin: Mouton de Gruyter & Ishara Press, pp. 87–125.

Klima, Edward, and Ursula Bellugi. 1979. *The Signs of Language*. Cambridge: Harvard University Press.

Kocab, Annemarie, Ann Senghas, and Jennie Pyers. 2022. From Seed to System: The Emergence of Non-Manual Markers for Wh-Questions in Nicaraguan Sign Language. *Languages* 7: 137. [CrossRef]

Le Guen, Olivier. 2011a. Modes of Pointing to Existing Spaces and the Use of Frames of Reference. *Gesture* 11: 271–307. [CrossRef]

Le Guen, Olivier. 2011b. Speech and Gesture in Spatial Language and Cognition Among the Yucatec Mayas. *Cognitive Science* 35: 905–38. [CrossRef]

Le Guen, Olivier. 2012. An Exploration in the Domain of Time: From Yucatec Maya Time Gestures to Yucatec Maya Sign Language Time Signs. In *Endangered Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Ulrike Zeshan and Connie de Vos. Berlin: Mouton de Gruyter & Ishara Press, pp. 209–50.

Le Guen, Olivier, Rebeca Petatillo Balam, and Rita (Rossy) Kinil Canché. 2020. Yucatec Maya Multimodal Interaction as Basis for Yucatec Maya Sign Language. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Sign Language Typology [SLT]. Berlin and Boston: De Gruyter Mouton, pp. 287–348.

Levinson, Stephen C. 2003. *Space in Language and Cognition: Explorations in Cognitive Diversity*. Language, Culture and Cognition; 5. Cambridge: Cambridge University Press.

Liddell, Scott K. 2003. *Grammar, Gesture, and Meaning in American Sign Language*. Cambridge: Cambridge University Press.

Lillo-Martin, Diane, and Edward Klima. 1990. Pointing out Differences: ASL Pronouns in Syntactic Theory. In *Theoretical Issues in Sign Language Research, Vol. 1: Linguistics*. Edited by Susan Fischer and Patricia Siple. Chicago: Chicago University Press, pp. 191–210.

Lillo-Martin, Diane, and Richard P. Meier. 2011. On the Linguistic Status of 'Agreement' in Sign Languages. *Theoretical Linguistics* 37: 95–142. [CrossRef]

Macdougall, J. Paige. 2012. Being Deaf in a Yucatec Maya Community: Communication and Identity Negotiation. Ph.D. thesis, McGill University, Montreal, QC, USA.

Marsaja, I. Gede. 2008. *Desa Kolok: A Deaf Village and Its Sign Language in Bali, Indonesia*. Nijmegen: Ishara Press.

Mathur, Gaurav, and Christian Rathmann. 2012. Verb Agreement. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Amsterdam: De Gruyter Mouton, pp. 136–57. [CrossRef]

McNeill, David. 2003. Pointing and Morality in Chicago. In *Pointing: Where Language, Culture and Cognition Meet*. Edited by Sotaro Kita. Mahwah: Erlbaum, pp. 293–306.

McNeill, David, Justine Cassell, and Elena T. Levy. 1993. Abstract Deixis. *Semiotica* 95: 5–20. [CrossRef]

Meier, Richard P. 2002. The Acquisition of Verb Agreement: Pointing out Arguments for the Linguistic Status of Agreement in Signed Languages. *Directions in Sign Language Acquisition* 7: 115–41.

Meir, Irit. 1998. Syntactic-Semantic Interaction in Israeli Sign Language Verbs: The Case of Backwards Verbs. *Sign Language & Linguistics* 1: 3–37. [CrossRef]

Meir, Irit. 2002. A Cross-Modality Perspective On Verb Agreement. *Natural Language & Linguistic Theory* 20: 413–50. [CrossRef]

Meir, Irit, and Wendy Sandler. 2008. *A Language in Space: The Story of Israeli Sign Language*. New York: Lawrence Erlbaum Associates.

Meir, Irit, Carol A. Padden, Mark Aronoff, and Wendy Sandler. 2007. Body as Subject. *Journal of Linguistics* 43: 531–63. [CrossRef] [PubMed]

Meir, Irit, Wendy Sandler, Carol A. Padden, and Mark Aronoff. 2010. Emerging Sign Languages. In *The Oxford Handbook of Deaf Studies, Language, and Education, Volume 2*. Edited by Marc Marschark, Patricia Elizabeth Spencer and Peter E. Nathan. Oxford: Oxford University Press, pp. 267–80.

Montemurro, Kathryn, Molly Flaherty, Marie Coppola, Susan Goldin-Meadow, and Diane Brentari. 2019. Grammaticalization of the Body and Space in Nicaraguan Sign Language. In *Proceedings of the 43rd Boston University Conference on Language Development*. Edited by Megan M. Brown and Brady Dailey. Somerville: Cascadilla Press, pp. 415–26.

Morford, Jill P., and Judy Kegl. 2000. Gestural Precursors of Linguistic Constructs: How Input Shapes the Form of Language. In *Language and Gesture*. Edited by David McNeill. Cambridge: Cambridge University Press, pp. 358–87.

Newport, Elissa L. 1990. Maturational Constraints on Language Learning. *Cognitive Science* 14: 11–28. [CrossRef]

Padden, Carol A. 1983. Interaction of Morphology and Syntax in American Sign Language. Ph.D. dissertation, University of California, San Diego, CA, USA.

Padden, Carol A., Irit Meir, Wendy Sandler, and Mark Aronoff. 2009. Against All Expectations: Encoding Subjects and Objects in a New Language. In *Hypothesis A/Hypothesis B: Linguistic Explorations in Honor of David M. Perlmutter*. Edited by D. Gerdts, J. Moore and M. Polinsky. Cambridge: MIT Press, pp. 383–400.

Padden, Carol A., Irit Meir, Mark Aronoff, and Wendy Sandler. 2010. The Grammar of Space in Two New Sign Languages. In *Sign Languages: A Cambridge Language Survey*. Edited by D. Brentari. Cambridge: Cambridge University Press, pp. 570–92.

Rathmann, Christian, and Gaurav Mathur. 2008. Verb Agreement as a Linguistic Innovation in Signed Languages. In *Signs of the Time: Selected Papers from TISLR 2004*. Edited by Josep Quer. Hamburg: Signum Press, pp. 191–216.

Safar, Josefina. 2017. Translanguaging in Yucatec Maya Signing Communities. *Applied Linguistics Review* 10: 31–53. [CrossRef]

Safar, Josefina. 2019. 'When You Were That Little . . . ': From Yucatec Maya Height-Specifier Gestures to Yucatec Maya Sign Language Person-Classifier Signs. *Gesture* 18: 1–40. [CrossRef]

Safar, Josefina, and Olivier Le Guen. 2020. Yucatec Maya Sign Language: A Sociolinguistic Overview. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Sign Language Typology [SLT]. Berlin and Boston: De Gruyter Mouton.

Safar, Josefina, and Rodrigo Petatillo Chan. 2020. Strategies of Noun-Verb Distinction in Yucatec Maya Sign Languages. In *Emerging Sign Language of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Sign Language Typology [SLT]. Berlin and Boston: De Gruyter Mouton.

Safar, Josefina, Olivier Le Guen, Geli Collí Collí, and Merli Collí Hau. 2018. Numeral Variation in Yucatec Maya Sign Languages. *Sign Language Studies* 18: 488–516. [CrossRef]

Sandler, Wendy, Irit Meir, Carol A. Padden, and Mark Aronoff. 2005. The Emergence of Grammar: Systematic Structure in a New Language. *Proceedings of the National Academy of Sciences of the United States of America* 102: 2661–65. [CrossRef]

Schegloff, Emanuel A. 1984. On Some Gestures' Relation to Speech. In *Structures of Social Action: Studies in Conversation Analysis*. Edited by J. Atkinson and John Heritage. Cambridge: Cambridge University Press, pp. 266–96.

Schuit, Joke. 2012. Signing in the Arctic: External Influences on Inuit Sign Language. In *Endangered Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Ulrike Zeshan and Connie de Vos. Berlin: Mouton de Gruyter & Ishara Press, pp. 181–208.

Schuit, Joke. 2014. Signs of the Arctic: Typological Aspects of Inuit Sign Language. *Sign Language & Linguistics* 17: 276–84.

Schuit, Joke, Anne Baker, and Roland Pfau. 2011. Inuit Sign Language: A Contribution to Sign Language Typology. *Linguistics in Amsterdam* 4: 1–31.

Senghas, Ann. 2003. Intergenerational Influence and Ontogenetic Development in the Emergence of Spatial Grammar in Nicaraguan Sign Language. *Cognitive Development* 18: 511–31. [CrossRef]

Senghas, Ann. 2005. Language Emergence: Clues from a New Bedouin Sign Language. *Current Biology: CB* 15: R463–R65. [CrossRef]

Senghas, Ann, and Marie Coppola. 2001. Children Creating Language: How Nicaraguan Sign Language Acquired a Spatial Grammar. *Psychological Science* 12: 323–28. [CrossRef] [PubMed]

Senghas, Ann, Sotaro Kita, and Asli Özyürek. 2004. Children Creating Core Properties of Language: Evidence from an Emerging Sign Language in Nicaragua. *Science* 305: 1779–82. [CrossRef] [PubMed]

Senghas, Richard J., Ann Senghas, and Jennie E. Pyers. 2005. The Emergence of Nicaraguan Sign Language: Questions of Development, Acquisition, and Evolution. In *Biology and Knowledge Revisited: From Neurogcnesis to Psychogenesis*. Edited by J. Langer, S. T. Parker and C. Milbrath. Mahwah: Erlbaum, pp. 287–306.

Tuz Baas, José Alfredo. forthcoming. *Preferencias En El Uso de Marcos de Referencia Espaciales Entre Los Usuarios Sordos y Bilingües de La Lengua de Señas Maya Yucateca. B.A., Valladolid, YUc*. Mexico: Universidad de Oriente.

languages

MDPI

Article

From Seed to System: The Emergence of Non-Manual Markers for Wh-Questions in Nicaraguan Sign Language

Annemarie Kocab [1,*], Ann Senghas [2] and Jennie Pyers [3]

[1] Departments of Psychology and Linguistics, Harvard University, Cambridge, MA 02138, USA
[2] Department of Psychology, Barnard College, Columbia University, New York, NY 10027, USA; asenghas@barnard.edu
[3] Department of Psychology, Wellesley College, Wellesley, MA 02481, USA; jpyers@wellesley.edu
* Correspondence: kocab@fas.harvard.edu

Abstract: At a language's inception, what determines which elements are taken up to build a grammar? How is the initial raw material reshaped through intergenerational language learning? We approached this question by focusing on the emergence of non-manual wh-question markers in Nicaraguan Sign Language (LSN), a young sign language. We asked whether the seeds of non-manual markers originate in the facial gestures of the hearing Nicaraguan community, and we explored the iterated process by which a form becomes selected and then systematized through generational transmission. We identified six non-manual facial and body movements produced with questions by 34 deaf LSN signers, representing three sequential age cohorts of learners, and compared them to those produced by 16 non-signing Spanish speakers. We examined the frequency and duration of each non-manual, and its temporal overlap with a question word. One non-manual, the brow furrow, was overwhelmingly represented among LSN signers, despite appearing rarely among non-signers and not being initially favored in duration or temporal overlap. With the second and third cohorts, the brow furrow emerges as a frequent and systematic marker. With each cycle of child learners, variable input was transformed into a more constrained set of grammatical forms.

Keywords: language emergence; Nicaraguan Sign Language; non-manual markers; wh-questions

Citation: Kocab, Annemarie, Ann Senghas, and Jennie Pyers. 2022. From Seed to System: The Emergence of Non-Manual Markers for Wh-Questions in Nicaraguan Sign Language. *Languages* 7: 137. https://doi.org/10.3390/languages7020137

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 29 October 2021
Accepted: 28 April 2022
Published: 30 May 2022

1. Introduction

What are the origins of the complex symbolic systems that we find in modern human languages? Languages arise out of an interaction between the human mind that represents and organizes information, the body that manifests that information in a physical form, and the social function of transmitting the information from one individual to another. By looking at a language at its inception we can explore the nature of this interaction in order to learn about the specific contributions of these three resources. For example, what communicative expressions are pulled from the environment and how are they reshaped and reallocated as a system develops? Are initially dominant forms adopted from the outset, increasing in use as an emerging system is passed from one generation to the next? Or are alternative forms favored according to their suitability for particular functions? How is a dynamically changing linguistic system shaped according to its learnability by younger learners? In the current study we track the development of non-manual grammatical markers of wh-questions in Nicaraguan Sign Language (LSN[1]), over the course of the language's emergence over the past 45 years. We ask whether these markers originate from co-speech facial gestures, and we test three possible determinants of their selection and systematization.

Non-manual markers in sign languages are facial and body movements, often coarticulated with manual signs, that serve linguistic functions across all levels of language, from phonology to discourse (see Sandler and Lillo-Martin 2006, for a review). Although the appearance of non-manual features in conjunction with manual signs may seem holistic to a naive eye, these non-manual elements are indeed combinatorial (Herrmann 2015; Sandler 2010). Children natively learning a sign language can readily separate non-manual features from manual features, as evidenced by their early sequential, instead of simultaneous, articulation of non-manual and manual elements (Anderson and Reilly 1997; Reilly 2006; Reilly et al. 1990).

Several researchers have speculated that the non-manuals observed in sign languages have their source in the facial gestures produced by non-signers while speaking (Benitez-Quiroz et al. 2016; Janzen and Shaffer 2002; McClave 2001; Pfau and Steinbach 2006, 2011). In at least one isolated village sign language, Kata Kolok, researchers have observed the adoption of a gestural negative headshake as a marker of negation that increases across generations of signers (Lutzenberger et al. 2022). If facial gestures are indeed a source of non-manual markers, what is the process that integrates such gestures into the grammatical system of a sign language? In examinations of other morphosyntactic structures, we have documented the emergence of simultaneous manual morphology in LSN (Senghas and Coppola 2001; Kocab et al. 2016), so we expected we might observe a similar trajectory of emergence with non-manual markers. Some evidence points to the integration of the systematic use of non-manuals over generational transmission in another recently emerging sign language, Al Sayyid Bedouin Sign Language (ABSL); only second-generation signers showed a consistent use of head and body movements that were aligned with clause boundaries (Sandler 2010; Sandler et al. 2011).

In this study, we empirically test the proposal that the facial gestures of non-signers are the source of non-manual markers in sign languages by examining the emergence of non-manual markers in LSN. We specifically focus on those non-manual markers that indicate wh-questions; that is, questions that query specific information, such as who, what, when, how many, and where. Across many different sign languages, wh-questions are accompanied by a non-manual facial gesture, most commonly either a brow furrow or a brow raise (Zeshan 2004). We extend the previous linguistic work on the emergence and grammaticalization of non-manual markers by adopting a quantitative approach to our study of the emergence of non-manuals and by explicitly looking at the rates and characteristics of the production of a variety of possible non-manuals in non-signers and in learners of an emerging sign language in Nicaragua.

The case of LSN offers a unique opportunity to test the robustness of co-speech facial gestures as a source for non-manual markers and to observe the process by which such forms are taken up and integrated into a rapidly changing linguistic system. LSN was created by deaf children and adolescents, starting with an initial cohort of 50 individuals who arrived in a new special education school in Managua in the 1970s. Although they were instructed entirely in Spanish, they communicated with each other primarily using gestures and homesigns (Kegl et al. 1999; Polich 2005; Senghas et al. 2005). Through peer interaction and intergenerational transmission, these gestures and homesigns transformed into a new, natural sign language, currently the primary, daily language of over 1500 deaf people. Because the language developed so recently, its originators are still alive today and are able to offer us a view into its origins.

Transmission from the original cohort to the learners that followed was a critical moment in the emergence of this new linguistic system. Research on artificial language emergence in the laboratory suggests that combinatoriality and systematicity can arise over repeated transmission of a system, through multiple iterations of learning (Kirby et al. 2008). In the case of LSN, the language was taken up by each cohort predominantly while they were children, who later, as adolescents, transmitted the language to a subsequent cohort of child learners. In many cases, the new arrivals introduced systematic changes to the language that the (by that time) adolescent and adult members of the community did not acquire (Senghas and Coppola 2001). We capture this change empirically, by dividing today's LSN signers into three roughly decade-long age cohorts, with each cohort having served as a language model for the next. We can then apply an "apparent time" approach, measuring diachronic change over LSN's first three decades with a cross-sectional comparison of these cohorts today (Bailey et al. 1991; Labov 1963; Sankoff 2006). This approach critically rests on the observation that beyond adolescence individuals do not significantly change their language, and their current language use reflects the language of their childhood (Labov 1963). In this way, we can read a layered, living record of LSN, with the first cohort's language revealing aspects of the initial form of LSN, and the later cohorts' representing more recent developments and changes to the system.

If the markers for wh-questions in a sign language originate in co-speech facial gestures, we should be able to find, in that seed, corresponding forms for any LSN non-manual markers we identify. Furthermore, if observable characteristics of the seed determine which forms will ultimately be taken up by the language, we should be able to capture those characteristics empirically from the outset and measure their cascading effects. We selected three candidate characteristics that might influence the adoption of a form. First, we determined how frequently the different forms are used. Previous research on older languages has shown that the frequency of a construction in learners' input and in language-users' production predicts language acquisition and change (Bybee 2007, 2010; Diessel 2007). Accordingly, a non-manual that appears more frequently in the facial gestures that accompany spoken questions of non-signers might be more likely to be selected as a grammatical marker of questions in LSN. Second, we considered the duration of the forms, as a measure of their fitness for acquisition and a measure of their suitability to the function of marking questions. A feature or form that is produced for a longer period has greater salience than a shorter one, making it easier to perceive and acquire (e.g., Fridland et al. 2004). Additionally, a form that can be sustained has more potential to be leveraged for its grammatical affordances such as spreading over longer phrases (Sandler 1999) as a way to mark the scope of a query. Third, we examined the timing of the non-manual, specifically whether it was produced at the same time as the question word. Wh-question non-manuals in older sign languages are consistently produced simultaneously with the manual signs for a question (Benitez-Quiroz et al. 2014). The coarticulation of the non-manual with a wh-question word might strengthen the association between the non-manual and the function of asking a question, making the mapping between form and function more salient to learners. If these characteristics drive form selection, then the facial gestures and body movements of non-signers that are most frequent, are held the longest, and overlap the most frequently with a wh-question word should be the ones taken up as non-manual markers of wh-questions in LSN.

These factors should be relevant at each moment of transmission, with each cohort seeding the next, from the hearing Spanish speakers, to the first cohort, to the second, to the third. We don't expect the same outcome at every stage; rather, we expect the same mechanisms to apply to a dynamically changing system. As the input for each subsequent group changes, the application of these same mechanisms will yield a different, corresponding output. So, for example, we might see a tipping point where one or very few forms come to dominate. The pattern of change in the community today will give us clues to its origins. Changes that are due to adults and children using the language repeatedly, over time, should be evident in all of the groups today, since all of the members were adults at the time the recordings were made, with many years of experience using the language together. Changes that are the result of how language is learned initially by children will leave a different pattern, one of the differences between cohorts that persist in adulthood.

We might expect certain aspects of the nature of children's learning to leave a particular kind of imprint on their language. Of course, children are not exposed directly to the grammar that produces the language they observe; instead, they observe only the patterned output that is generated by their interlocutor's grammar. Even so, children are quite skilled at mastering the intricacies of their language. They are particularly sensitive to word-internal patterns, and detect them with very little exposure (Saffran et al. 1996). Evidence from both signed and spoken languages has shown that child learners are better than adult learners at extracting the regularities of languages (Mayberry and Fischer 1989; Saffran et al.

1996). How might we expect child learners to respond to a system that lacks such intricate regularities? One case study followed a deaf child acquiring his language from deaf parents who had learned ASL only as older adolescents, and therefore did not have the fluency of native signers. The child's command of ASL eventually surpassed his parents'; he applied the morphology of the language, particularly the spatial morphology, more consistently than they did (Singleton and Newport 2004). In artificial language-learning experiments, when children are presented with miniature languages that are unsystematic and variable, they deviate from that input in predictable ways, increasing its regularity. Adults in the same experiments generally do not impose that kind of reorganization (Hudson Kam and Newport 2005). Given this kind of creative power in each individual learner, we were interested in discovering how repeated acquisition of LSN in its earliest years, over 1500 instances of learners, might build up the system of the language, in this case, the grammar for generating questions.

In the current study, we documented the array of facial expressions and body movements produced by Nicaraguan Spanish-speaking non-signers and computed their frequency, duration, and co-articulation with a wh-question word. We then compared non-signers' use of these co-speech facial gestures with that of the first, second, and third cohorts of LSN signers. We hypothesized that the most frequently produced facial gestures produced by non-signers would be taken up as the preferred non-manual marker for wh-questions. We also hypothesized that facial gestures that were produced for a longer time and that were co-articulated with a wh-question word would also be more likely to be selected as a grammatical marker.

2. Methods

2.1. Participants

This study included 50 participants (23 female; 27 male) from Managua, Nicaragua. These consisted of 16 Spanish speakers who had typical hearing and no sign language experience (hearing cohort; M_{age} = 29.49, range = 17.0–55.3) and 34 deaf signers of LSN: 10 from the first cohort (M_{age} = 35.51, range = 30.5–50.0), 13 from the second cohort (M_{age} = 25.45, range = 21.5–34.1), and 11 from the third cohort (M_{age} = 20.29, range = 15.9–28.8). All LSN signers had joined the deaf community by the age of six, most upon entering school, and used LSN as their primary daily language since that time. First-cohort signers entered the community between 1974 and 1983; second-cohort signers between 1984 and 1990; third-cohort signers between 1993 and 1999. Ten additional hearing non-signers were tested but were excluded from coding due to errors in video recording. Two additional deaf signers were tested, but their data were excluded due to their history of contact with sign languages other than LSN. One first-cohort signer and four third-cohort signers were unintentionally tested at two different time points. In these cases, we selected the recording that had the best quality video for coding.

All adult participants provided verbal and written consent for participation. Participants under the age of 18 provided verbal and written assent, and their parents provided written consent for their participation. Participants were compensated for their time. Most hearing participants participated in this study only. For all deaf participants and some hearing participants, this study was conducted alongside other studies.

2.2. Procedure

Data collection took place between 2008 and 2017 in the city of Managua, Nicaragua and its outlying areas. Participants were seated facing a camera across from a confederate. They were instructed to ask the confederate a series of questions in order to learn specific personal information about him or her. For hearing participants, the confederate was a fluent Spanish speaker, and for deaf participants, the confederate was a fluent signer of LSN. The experimenter stood adjacent to the camera, holding up $8\frac{1}{2}'' \times 11''$ cards with brief words and phrases written in Spanish to cue the participant with the information to be elicited (Table 1). Each item was presented on a separate card. If a deaf participant did not understand the written Spanish word, the experimenter provided the LSN sign translation. Participants were never cued with the targeted question word or sign.

Table 1. Items of information that participants were asked to elicit from the confederate, and their respective targeted wh-question words.

Cued Information to Be Elicited	Target Wh-Question Word (English Translation)	Target Wh-Question Word (Spanish Translation)
Name	what	qué
Age	how many	cuanto
Birthday	when	cuándo
Number of siblings	how many	cuanto
Job [1]	what	qué
Supermarket [1]	where	donde
Favorite food [1]	what	qué
Home address	where	donde
Friend [1]	who, which	quién, cual
Transportation to work/school [2]	what	qué
Mother's birthday [2]	when	cuándo
Waking time [2]	when	cuándo
Dinner time [2]	when	cuándo
Name of your teacher/boss [2]	what	qué
Bus route nearest your home [2]	where	donde

[1] These items were included in the 2008 protocol only. [2] These items were added to the protocol after 2008.

The initial stimulus deck used in 2008 included nine items. However, some items were not always effective at eliciting the target questions, so these items were replaced, and three items were added, for a total of twelve items for data collected in 2009 and later (Table 1). Seven first-cohort signers and eight second-cohort signers were tested using the initial 2008 stimulus deck. Sessions lasted approximately five minutes per participant and were recorded on video for later coding and analyses.

2.3. Coding

The video recordings from each session were tagged and coded using ELAN version 6.2 (ELAN 2021). Spanish data were tagged by a fluent Spanish speaker trained by the third author; LSN data were tagged by the first and third author, both fluent signers with several years' experience coding Nicaraguan signing. Each target question was transcribed, and question words were tagged and categorized on a separate tier. Targeted question words are listed in Table 1, though all question words were tagged and coded, even if they differed from the target. Sample LSN question words are shown in Figure 1. Because we know little about the nature of the syntactic structure of questions in NSL, and even less about how this structure has changed over time, we tagged all interrogatives whether or not they included a wh-question word. Some participants asked a question more than once in response to a single prompt. Each elicited question was tagged. Once the questions were tagged, other trained coders, blind to cohort status, coded each of 6 non-manual facial expressions and body movements that had been observed with questions. Only non-manuals that overlapped with the question utterance were tagged and coded. In some cases, non-manuals began before and/or ended after the manual utterance. In rare cases, the non-manual was held through the interlocutor's response to the question. In these cases, we computed the non-manual offset as the onset of the interlocutor's response. Each of these non-manuals was coded on a dedicated tier in ELAN, indicating its onset and offset for every item in which it appeared. This enabled us to extract, for each non-manual, the number of times it was used, its duration, the question in which it occurred, and its temporal overlap with a targeted question word or sign. Examples of the six non-manuals can be seen in Table 2.

Figure 1. Examples of the LSN wh-question words that were elicited.

Table 2. Descriptions and examples of the six non-manuals coded.

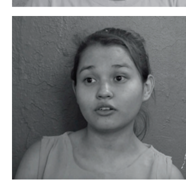
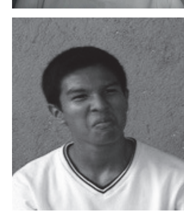
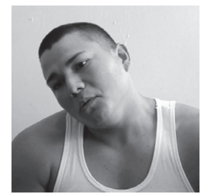
Non-Manual	Description	Example
Brow Furrow	Corresponds to Ekman's facial action unit 4 (AU4). Comprises a pulling together of the eyebrows that often is evidenced as vertical wrinkles between the eyebrows.	
Brow Raise	Corresponds to a combination of Ekman's facial action units 1 and 2 (AU1 + AU2) where both the inner and outer brow are raised, often resulting in lines on the forehead	
Nose Wrinkle	Corresponds with Eckman's facial action unit 9 (AU9) which involves a pulling up of the nose and a deepening of the creases on either side of the nostrils, often with a horizontal wrinkle across the bridge of the nose	

Table 2. *Cont.*

Non-Manual	Description	Example
Chin lift	Operationalized as a tilting of the head backwards to raise the chin. (This movement *does not* correspond with Eckman's facial action unit 17 "chin raiser.")	
Head tilt	Any tilt of the head to the left or right of a neutral head position, also referred to as a "head cant" (e.g., Goffman 1979)	
Shoulder raise	Any movement of the shoulder upwards from a neutral position; often looks like a shoulder shrug.	

2.4. Statistics

2.4.1. Dependent Variables

Frequency of type of non-manual use. For each participant we computed the number of each of the coded non-manuals produced with each elicited question. This computation allows us to see the change in frequency of non-manual use across cohorts.

Duration of non-manual production. For every non-manual that co-occurred with an interrogative, we measured the time from non-manual onset to offset.

Coarticulation of non-manuals with question words. For the subset of questions produced with a wh-question word and with a non-manual, we categorized whether the non-manual overlapped with an overtly articulated (spoken or signed) wh-question word.

2.4.2. Model Specification

For all analyses we ran mixed effect regression models using R version 4.0.3 (R Core Team 2021) and the lme4 package (Bates et al. 2015). For all models we included participants and items as random intercepts. We operationalized the change in the language by cohort. Cohort was dummy coded as hearing, first, second, and third, with hearing as the reference level. Non-manual type was dummy coded with chin lift as the reference level, because we had no theoretical motivation to preset any specific non-manual as the reference level, and that was the default reference level selected by the program. For each central question, we specify the models used.

To test the role of frequency in non-manual adoption, we ran a mixed effects linear regression predicting the total number of non-manuals produced alongside every question produced (N = 676) with participants and items as random intercepts, and cohort and non-manual type, and the interaction between cohort and non-manual type, as fixed factors. In addition, we ran six separate mixed effects linear regressions predicting the total number of each of the six non-manuals and cohort as a fixed factor. These analyses should allow us (a) to identify if the facial gestures of Nicaraguan Spanish speakers are the seed for the non-manual markers of wh-questions in LSN, and (b) to isolate the candidate grammatical markers of wh-questions in LSN–those that appear most frequently.

To test the role of *duration* in non-manual adoption, we ran a mixed effects linear regression predicting the duration of every non-manual produced (N = 1050), with participants and items as random intercepts and cohort and non-manual type, as well as the interaction between cohort and non-manual type, as fixed factors.

Finally, to capture any tendency to coordinate the timing of the non-manual with the production of a question word, we ran a mixed effects logistic regression using the glmr() function, predicting non-manual *coarticulation* with the question word, with participants and items as random intercepts and cohort and non-manual type, as well as the interaction between cohort and non-manual type, as fixed factors. For this analysis we considered only the subset of non-manuals that were produced during interrogatives where a wh-question word was also produced (N = 711).

When any models failed to converge, we removed participants as a random effect and changed the optimizer.

3. Results

Table 3 presents the total number of questions and non-manuals elicited from each cohort.

Table 3. Sum of questions, wh-question words, and non-manuals elicited by cohort.

Cohort	Questions	Wh-Question Words	Shoulder Raise	Nose Wrinkle	Brow Raise	Chin Lift	Head Tilt	Brow Furrow
Hearing (N = 16)	266	200	42	2	49	73	85	28
First (N = 10)	119	67	3	30	28	27	24	31
Second (N = 13)	165	229	12	50	39	73	73	99
Third (N = 11)	126	215	22	33	31	35	65	107

3.1. Frequency of Non-Manual Occurrence

To answer the question of how the available facial gestures in the hearing community have been taken up and repurposed as wh-question markers by Nicaraguan signers, we ran a mixed effects linear regression predicting total non-manual use with all questions, and then predicting the use of each of the six non-manuals (Table 4; see Statistics for model specification).

Table 4. Table of fixed and random effects predicting total non-manual production. Table generated using the tab_model function from the SJPlot package version 2.6.2 for the R programming environment (Lüdecke 2021).

	Total Non-Manuals		
Predictors	**Estimates**	**CI**	***p***
(Intercept)	1.03	0.64–1.41	**<0.001**
First cohort	0.28	−0.33–0.88	0.370
Second cohort	1.08	0.53–1.64	**<0.001**
Third cohort	1.22	0.64–1.81	**<0.001**
Random Effects			
σ^2	1.14		
$\tau_{00\ ID}$	0.49		
$\tau_{00\ item}$	0.05		
ICC	0.32		
N_{item}	17		
N_{ID}	50		
Observations	676		
Marginal R^2/Conditional R^2	0.146/0.419		

Note: lmer(total_nonmanual ~ cohort + (1 | item) + (1 | ID), data = df).

While first-cohort signers were statistically similar to the hearing non-signers in their total non-manual production, second- and third-cohort signers produced more non-manuals than the non-signer participants (Table 4). Turning to the patterns of the individual non-manuals, we see a tendency for them to increase or stabilize across the four groups, with the nose wrinkle and the brow furrow increasing to a significant degree (Table 5). Though it ultimately stabilizes at a relatively low level, the initial increase in the nose wrinkle is intriguing, given that it was virtually nonexistent among the hearing non-signers. The most dramatic change was in the use of the brow furrow, which was rare among the hearing non-signers, but came to dominate in its use by second- and third-cohort signers (Figure 2).

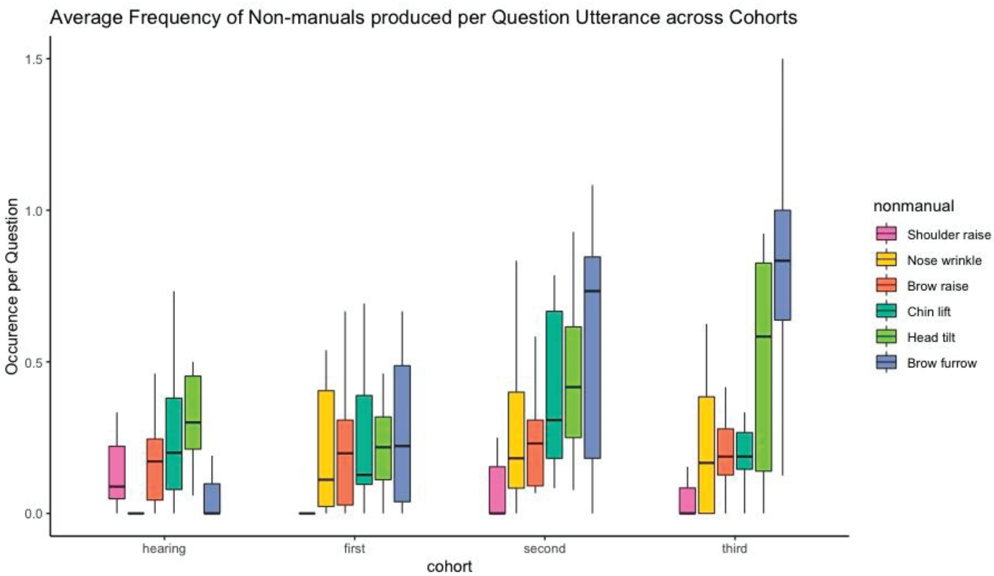


Figure 2. Average frequency each non-manual per question across cohorts. The black line indicates the median value for each non-manual type. Whiskers indicate the maximum and minimum values, excluding extreme outliers. Non-manuals are ordered according to mean frequency over all groups combined, with the more frequent to the right. Figure created using the ggplot2 package (Wickham 2016) in the R programming environment.

Visualization of the data allows us to better understand which facial gestures from the hearing community are taken up by the sign language, and how the distribution of non-manual use changes over time (Figure 2). Intriguingly, the brow furrow is the most dominant non-manual across all cohorts of signers, with a dramatic increase in its use from the first to second cohort. However, this non-manual was one of the least prevalent among the hearing participants. The non-manual most highly preferred by the hearing non-signers is the head tilt, followed by the chin lift and the brow raise. Among the signers, the head tilt emerges as the second most frequently used non-manual, but the chin lift and the brow raise remain relatively constant across groups. Thus, the primary markers of wh-questions for the later users of LSN are the brow furrow and the head tilt, even though only the head tilt, and not the brow furrow, is heavily represented among the facial gestures produced by non-signers.

Table 5. Fixed and random effects predicting each nonmanual's production. Table generated using the tab_model function from the SJPlot package version 2.6.2 for the R programming environment (Lüdecke 2021).

	Shoulder Raise			Nose Wrinkle			Brow Raise			Chin Lift			Head Tilt			Brow Furrow		
Predictors	**Estimates**	**CI**	***p***	**Estimates**	**CI**	***p***	**Estimates**	**CI**	***p***	**Estimates**	**CI**	***p***	**Estimates**	**CI**	***p***	**Estimates**	**CI**	***p***
(Intercept)	0.16	0.06–0.26	**0.001**	0	−0.11–0.12	0.941	0.19	0.10–0.28	**<0.001**	0.26	0.13–0.39	**<0.001**	0.32	0.20–0.44	**<0.001**	0.1	−0.04–0.24	0.172
First cohort	−0.14	−0.30–0.02	0.096	0.28	0.09–0.47	**0.004**	0.05	−0.10–0.20	0.494	−0.01	−0.22–0.19	0.891	−0.11	−0.31–0.09	0.271	0.18	−0.05–0.41	0.128
Second cohort	−0.09	−0.24–0.06	0.248	0.29	0.12–0.47	**0.001**	0.05	−0.08–0.18	0.459	0.18	−0.00–0.37	0.056	0.13	−0.06–0.31	0.180	0.5	0.29–0.71	**<0.001**
Third Cohort	−0.02	−0.18–0.13	0.762	0.24	0.06–0.42	**0.011**	0.07	−0.08–0.21	0.371	0.03	−0.17–0.22	0.804	0.19	−0.00–0.38	0.055	0.72	0.50–0.94	**<0.001**
Random Effects																		
σ^2	0.08			0.16			0.2			0.23			0.22			0.19		
τ_{00}	0.04 $_{ID}$			0.04 $_{ID}$			0.02 $_{ID}$			0.05 $_{ID}$			0.05 $_{ID}$			0.07 $_{ID}$		
	0.00 $_{item}$			0.00 $_{item}$			0.00 $_{item}$			0.01 $_{item}$			0.00 $_{item}$			0.00 $_{item}$		
ICC	0.33			0.22			0.09			0.18			0.18					
N	17 $_{item}$			17 $_{item}$			17 $_{item}$			17 $_{item}$			17 $_{item}$			17 $_{item}$		
	50 $_{ID}$			50 $_{ID}$			50 $_{ID}$			50 $_{ID}$			50 $_{ID}$			50 $_{ID}$		
Observations	676			676			676			676			676			676		
Marginal R^2 / Conditional R^2	0.025/0.344			0.081/0.282			0.003/0.096			0.021/0.201			0.037/0.208			0.293/NA		

Note: lmer(shoulder_raise ~ cohort + (1 | item) + (1 | ID), data = qc2); we ran this code for each non-manual type.

3.2. Duration of Non-Manual

We asked whether non-manuals with the longest duration among the hearing non-signers might be especially salient, or better able to serve grammatical functions, and therefore be favored for selection. We did not observe any simple effects of group or non-manual type on duration (See Table S1 in Supplementary Materials), indicating that duration is highly unlikely to be driving the effect of cohort on frequency observed in the analyses above. What is crucial is whether we see interactive effects between cohort and non-manual type, specifically for the non-manuals that we saw most frequently among the later cohorts of signers, the brow furrow and the head tilt. Indeed, we did see an interactive effect for cohort and brow furrow, such that first and second cohort signers produced the brow furrow for a longer duration than hearing signers and relative to the chin lift (first cohort x furrowed brow: $\beta = 0.63$, 95% CI [0.12–1.15], $p = 0.016$; second cohort x furrowed brow: $\beta = 0.65$, 95%CI [0.24–1.07], $p = 0.002$). We also observed a similar interactive effect for the second-cohort signers and their production of the head tilt; they held the head tilt for longer, relative to the chin lift, than hearing signers (second cohort x head tilt: $\beta = 0.39$, 95% CI [0.05–0.73], $p = 0.023$).

Visual inspection of the data (Figure 3) shows that among later cohorts of signers, the head tilt and brow furrow are indeed held the longest, with the brow furrow showing the greatest variability in duration. Thus, for the two non-manuals that emerge as likely candidates for grammatical markers, we observe that they are produced for a longer duration by LSN signers. The upper bounds of the whiskers in Figure 3 indicate that the brow furrow, in particular, has the potential to be held for much longer among the LSN signers, compared to the other non-manuals, and compared to the non-signers. The later emergence of a longer duration for the brow furrow suggests that duration is not driving the selection of the form; rather, it may be an indicator of increasing systematization that follows along with its increase in frequency.

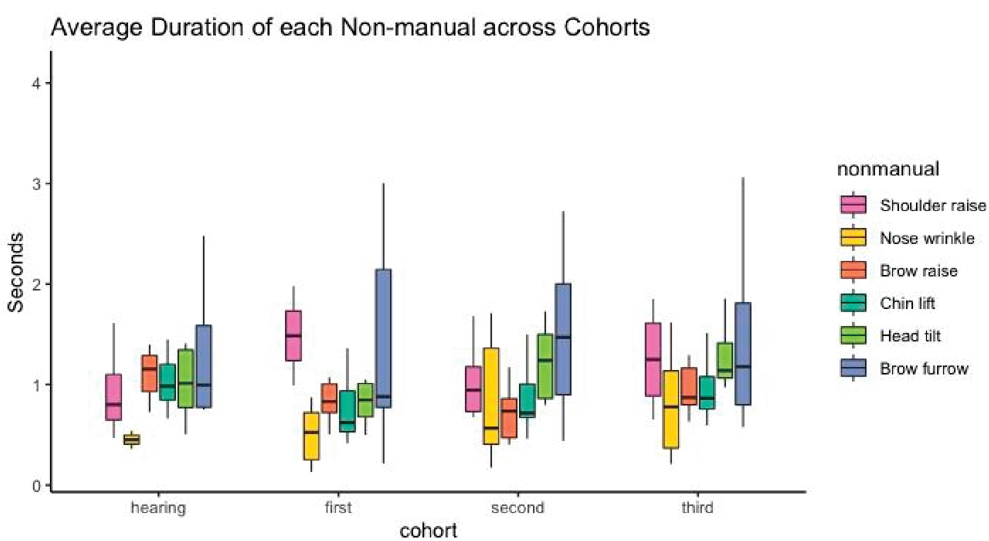


Figure 3. Average duration of each non-manual produced across cohorts. The black line shows median duration for each non-manual. Whiskers represent maximum and minimum scores, excluding extreme outliers. Non-manual categories are ordered according to frequency, as represented in Figure 2, with the more frequent to the right. Figure created using the ggplot2 package (Wickham 2016) in the R programming environment.

3.3. Coarticulation of Non-Manual with Wh-Question Word

Our third test examined whether the coarticulation of a non-manual with the wh-question word made it more likely to be taken up as a marker of wh-questions. The position of the wh-word in the elicited questions varied within and across cohorts, with the wh-word appearing in sentence-initial, sentence-medial, and sentence-final positions.

We ran a mixed-effects logistic regression (see Statistics section for model specification) on the subset of the data that included the questions that had both a manually articulated question word (Figure 1) and a non-manual. The model showed that the three cohorts did not significantly differ from non-signers in their coordination of the non-manual with the wh-question word (see Table S2 in the Supplementary Materials). Regardless of cohort, head tilt was significantly more likely than the chin lift to be coarticulated with the wh-question word (*OR* = 0.39, 95%CI [0.18–0.83], *p* = 0.015). The most frequently produced non-manual, the brow furrow, was not significantly more likely than the chin-lift to be produced at the same time as the wh-question word.

Visual inspection of the data (Figure 4) reveals that, while on average the number of questions where the brow furrow is coarticulated with the wh-question word is relatively constant across the groups, with the later cohorts we observe more cases above the median, suggesting that within these later cohorts, more signers are articulating the question words and brow furrow simultaneously, although this effect is not significant.

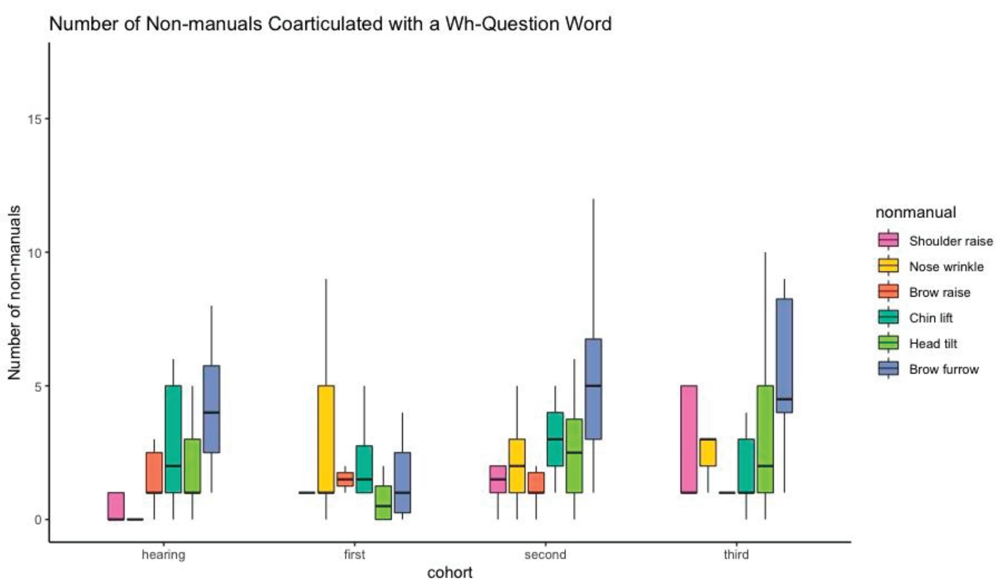


Figure 4. Number of each non-manuals type coarticulated with the wh-question word. The black line shows the median number of questions for which the non-manual was coarticulated with the wh-question word. Whiskers represent maximum and minimum scores, excluding extreme outliers. Non-manual categories are ordered according to mean frequency as represented in Figure 2, with the more frequent to the right. (The unusually skewed bar for the shoulder raise in the third cohort results from a single participant who repeated questions multiple times per item, raising the shoulders multiple times per question.) Figure created using the ggplot2 package (Wickham 2016) in the R programming environment.

4. Discussion

We began our inquiry into the emergence of the grammar of LSN by seeking the origins of the forms used to mark wh-questions. We looked for the seed of non-manual markers in the facial gestures of members of the hearing community as they asked questions in Spanish and followed the use of these non-manual expressions in the signing of three age cohorts of LSN, representing the first three decades of the language's birth and growth. Our cross-sectional comparison of the frequency and duration of several non-manuals captured the progressive adoption of two of these forms: the brow furrow and the head tilt. Intriguingly, these two non-manual forms were not the ones most frequently produced by the Spanish speakers; nor were they initially sustained for the longest duration; nor were they the forms most apt to overlap in timing with the spoken wh-word. Thus, while the seed of non-manual markers can be found in the diversity of candidate facial gestures produced by the surrounding Nicaraguan hearing community, the adoption of the dominant forms into LSN is not driven by their frequency, duration, or overlap among non-signers. Rather these metrics appear to be indicators, not drivers, of language evolution.

The changes that we documented over the early years of LSN suggest a path of grammaticalization of selected non-manual forms. However, none of our three measures of the initial seed effectively determined which non-manuals would ultimately be selected for grammaticalization. We consider three possible alternative mechanisms that merit further exploration.

First, there may be other visual-perceptual or articulatory affordances, not measured in our current study, that favored these particular non-manuals for selection. For example, coarticulation with other facial gestures could work in multiple ways. The appearance of a facial gesture in isolation may make it more salient to a learner; alternatively, selection may favor facial gestures that can be easily co-articulated with other facial gestures. In addition, there are other characteristics of facial gestures, such as the intensity of the articulated form (e.g., Domaneschi et al. 2017), that may increase its salience. The affordances of particular non-manual expressions, such as the brow furrow, may allow them to be maintained over stretches of discourse. These characteristics may favor certain non-manuals in the service of prosodic functions, such as marking the boundaries of clauses and sentences, and pragmatic functions such as turn taking and back-channeling (Brentari et al. 2018; Mesch 2016; Sandler 2010; Wilbur 2013). Exploration of these other aspects of articulation would be especially informative.

Second, the selection of the brow furrow and the head tilt may have more to do with communicative salience. The brow furrow and, to a lesser extent, the head tilt, may be capitalizing on human universals in non-verbal communication. Eyebrow movements, including the brow furrow, have been observed to signal that a speaker feels uncertain or perplexed (Campbell et al. 1999; Domaneschi et al. 2017; Ekman 1979; Swerts and Krahmer 2005), two mental states that underpin requests for information. The articulatory affordance and/or communicative function of the brow furrow might explain its consistent association with wh-questions across a variety of sign languages around the world (Zeshan 2004). However, our data did not reveal a preference for hearing non-signers to produce the brow furrow with questions. Why we don't empirically find an overwhelming preference to produce this nonmanual is unclear. The previous work showing an association between uncertainty and the brow furrow among non-signers did not measure the frequency of the production of the brow furrow with questions but rather the intensity of facial expression production (Domaneschi et al. 2017) or the interlocutor's interpretation of these facial expressions (Campbell et al. 1999; Swerts and Krahmer 2005). The one study that quantified the number of brow furrows accompanying wh-questions produced by hearing non-signers in the U.S. also showed very low rates of production (~5% of the time; Pyers and Emmorey 2008). Thus, it may be the case that while hearing non-signers produce the brow furrow, they generally do so less often than previously estimated. Instead of the brow furrow, non-signers in the present study preferred the lateral head tilt, which also carries communicative significance. While the use of the lateral head tilt in wh-questions is less documented in sign languages, research on spoken communication has proposed that a lateral head tilt functions to make a speaker appear more friendly by offsetting direct eye contact with the listener (Costa and Bitti 2000), perhaps making a question more likely to be answered. Thus, communicative salience may account for the facial expressions that are produced by hearing non-signers when asking questions. Once a facial expression is taken up into a language, additional considerations, such as articulatory affordance, may then come into play.

Third, the gestures that hearing people produce when they speak to each other are just one of several possible seeds of LSN. It is unclear the degree to which deaf children would be able to access the ambient spoken conversations in their environment. There are likely other gestural behaviors in the communication between hearing family members and deaf children, such as enactments, pointing, and other gestures unaccompanied by speech, in the communication between hearing family members and deaf children that are taken up in the creation of the homesign systems that arise in families with a deaf child (Coppola 2020; Goldin-Meadow 2005). Indeed, parents of Nicaraguan homesigners overwhelmingly prefer to communicate with their children using manual gestures without any accompanying speech (Coppola et al. 2006). The nature of facial gestures produced without speech is an open question. However, such voice-off homesign systems were probably a more direct precursor to first-cohort signing.

Given that the brow furrow is observed in many other sign languages around the world, one might wonder about direct influence from other sign languages on LSN. Over the years, there have been several lexical signs adopted from other sign languages, some from direct contact and some via dictionaries, which we have been documenting in other studies. However, the history of language contact and the pattern of emergence of non-manuals suggest that international contact is a less likely source than local gestures. In the 1970s and 1980s in Nicaragua, and even into the 1990s, international contact was limited to a few individual signers, all members of the first cohort, for limited periods. Yet the dominance of the brow furrow is not evident in their signing. Its dominance begins with the second cohort, whose primary exposure was to that first cohort, and their own peer community. This signature suggests that it arose locally as the language was taken up by younger signers.

Whatever their pattern of initial use, the non-manuals were deployed differently by signers from different cohorts. The brow furrow appears to have shifted early from disfavor into favor. The first-cohort signers used it more frequently than non-signers, and occasionally sustained it longer (though this is not a statistically detected difference). However, the first cohort dropped any tendency to coarticulate the brow furrow with the wh-question sign. Indeed, they showed little coarticulation of any non-manual with a wh-question sign. As they took up the language, the second and then third cohorts began coarticulating the brow furrow, in particular, with wh-question signs. At the same time, they increasingly differentiated their two favored forms, the brow furrow and the head tilt, from the others in frequency. These changes over cohorts in the coarticulation of non-manual and manual signs are likely to have interacted with other changes in the use of lexical signs for questions. Consider the data in Table 3 that reveal a striking shift from first-cohort signers who rarely produced manual wh-question signs, to second- and third-cohort signers who often produced more than one manual wh-question sign in a single question. It would be a useful pursuit in future inquiry to carry out an analysis of the changing syntactic structure of wh-questions in LSN, in coordination with the changing use of non-manuals.

What does this pattern across cohorts today reveal about the nature and history of the emergence of LSN? Recall that a synchronous, cross-sectional "apparent time" analysis can be taken to reflect a diachronic history of the language, with older age cohorts reflecting language of longer ago, and younger age cohorts reflecting a more recent variant. While this pattern indicates the changes that took place, it does not fully explain why new developments in the language do not spread to all members of the community, and why an earlier variant of the language persists among older members. The three cohorts in this study roughly and categorically represent a constant, continuous influx of new members into the LSN signing community across three decades. While new arrivals learn from older members, all members continue to interact within and across age groups, and any communication between younger and older individuals would logically have an equal potential of influence in either direction. We would expect an emerging language to undergo reorganization and signal compression, in response to articulatory and perceptual pressures that favor communicative and processing efficiency (Kirby et al. 2008; Kanwal et al. 2017). However, everyone, regardless of age, is subject to these pressures. Accommodations that result during peer interaction and transmission, that are generated by or learnable by adults, should be evident in longitudinal, real-time snapshots of the language over the years, but not show up in "apparent time" cross-sectional analyses today. In contrast, differences between age cohorts that are still evident decades later point to the effect of the changing nature of learning across the life span. In such cases, their different natures will lead children and adults to arrive at different accommodations to these pressures. The measurable differences between age cohorts that we have documented, in both the selection of brow furrow by the first cohort, and the coarticulation of non-manuals by the second and third cohorts, thus reveal the nature of children's learning in particular. Early childhood appears to be a time when key language-learning mechanisms are available, and each age cohort, in sequence, took their turn in this childhood stage, passing on a changed system.

In following these changes, we appear to have captured two tipping points in the emergence of LSN. The first, with the first cohort, entailed the selection of a small number of potential non-manual markers from the variety of facial gestures that accompanied spoken questions in the local non-signing community. As the nonmanuals were adopted into LSN, their relative frequency and use did not correspond to their use as facial gestures by the non-signers. They were less differentiated, not reflecting the variability of their source. At the same time, the non-manuals became more separate, rather than co-articulated with the wh-word in the sentence.

The second tipping point occurred when the second cohort took up LSN, and a subset of the non-manuals started to dominate. This change is particularly interesting in light of differences between adult and child learners when presented with certain kinds of variability in their input. Research using artificially created languages in the laboratory has found that when the input includes several alternative forms whose use is undifferentiated, child learners will acquire a smaller set of forms, and apply them more systematically (Hudson Kam and Newport 2005). Adult learners are not as quick to reorganize a language under the same conditions (Hudson Kam and Newport 2009). This particular solution of narrowing and systematizing appears to be an imprint of typical child learning on LSN.

As a few forms started to dominate, LSN signers of the second and third cohort increased the co-articulation of the non-manual wh-markers with the signed wh-word. The timing of this change is notable given the ecology of the language at that time. The systematization of the grammar of wh-questions in LSN happens concurrently with the establishment of a lexicon, the organization of argument structure, and the coordination of discourse, among other linguistic features. Previous work has documented that the transition from the first to the second cohort was characterized by the appearance of grammatical features that depend on simultaneous, rather than sequential, production (Senghas et al. 1997; Senghas and Coppola 2001; Senghas 2003; Kocab et al. 2015, 2016). The grammar of LSN non-manuals apparently emerged in coordination with other simultaneous aspects of the grammar.

A fuller consideration might explore these and other aspects of the changing ecology of LSN, and how the brow furrow and other non-manuals fit in as the full repertoire of signs and their syntax is being created. For example, at the transition from the first to the second cohort of LSN signers, the system for marking syntactic objects was changing (Senghas et al. 1997; Senghas 2003). Research on ASL has shown that wh-question words can be absent from the surface structure of a signed question, leaving the non-manual with a greater role in indicating the syntax of the sentence (Petronio and Lillo-Martin 1997). It would be useful to examine non-manuals' temporal overlap with other arguments in question sentences, aside from wh-question words. We informally observed that non-manuals were sometimes co-articulated with the sign for the queried item or object. There are many such possible ways, as LSN was transmitted from one generation to the next, that the syntax of non-manual question markers may have been changing dynamically with the rest of the language.

By closely examining subtle movements of the face during a simple communication task, we have captured key aspects of the earliest stages of the evolution of markers for wh-questions in LSN. Though it represents only a sliver of the grammar, this small piece can reveal mechanisms responsible for the birth and growth of a grammar. The seeds of language are borne of countless acts of communication, in which individuals leverage the expressive power of the body to represent and transmit information. Once initial forms are available, they evolve through transmission from one person to the next. This is how a language is created. Even an element as small as the furrowing of the eyebrows, once produced, is available to be shaped into language. The changes that we have captured here reveal the progressive effects of language acquisition processes, applied by hundreds of children over several decades, with the language of the youngest LSN signers today reflecting their combined, cumulative impact.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/languages7020137/s1, Table S1: Fixed and Random effects predicting non-manual duration. Table S2: Fixed and random effects predicting the coordination of the non-manual with the wh-question word.

Author Contributions: Conceptualization, A.K., J.P. and A.S.; Methodology, A.K., J.P. and A.S.; Investigation, A.K. and J.P.; Data Curation, J.P.; Writing—Original Draft Preparation, A.K., J.P. and A.S.; Writing—Review & Editing, A.K., J.P. and A.S.; Visualization, J.P.; Supervision, A.K. and J.P.; Funding Acquisition, A.K., J.P. and A.S. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by grants from NSF GRFP (A.K.), NIH/NIDCD grant R01 DC005407 (A.S.), the James S. McDonnell Foundation (J.P.) and the Wellesley College Provost Office (J.P.).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of Barnard College on 29 April 2008 (and annually henceforth).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Deidentified data presented in this study are available on request from the corresponding author.

Acknowledgments: We are grateful for the Nicaraguan Deaf community for their ongoing support. We thank Kristie Casanova-Artl, Sofia Fioretti, Sara Maria Hasbun, Shannon Howard, Catherine Jaramillo, Audrey Lin, Kathryn Marton, Kristianny Ruelas-Vargas, Andrea Takahesu-Tabori, Rafael Treviño, and Caroline Zola for research assistance on this project.

Conflicts of Interest: The authors declare no conflict of interest.

Note

[1] Following Gagne (2017) and Kocab et al. (2022), we use LSN as the initialism for Nicaraguan Sign Language, reflecting our best information about the community's current preference for representing the name of the language: Lenguaje de Señas Nicaragüense. Previous initialisms include NSL and ISN.

References

Anderson, Diane E., and Judy S. Reilly. 1997. The puzzle of negation: How children move from communicative to grammatical negation in ASL. *Applied Psycholinguistics* 18: 411–29. [CrossRef]

Bailey, Guy, Tom Wikle, Jan Tillery, and Lori Sand. 1991. The apparent time construct. *Language Variation and Change* 3: 241–64. [CrossRef]

Bates, Douglas, Martin Maechler, Benjamin Bolker, and Steve Walker. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67: 1–48. [CrossRef]

Benitez-Quiroz, C. Fabian, Kadir Gökgöz, Ronnie B. Wilbur, and Aleix M. Martinez. 2014. Discriminant features and temporal structure of non-manuals in American Sign Language. *PLoS ONE* 9: e86268. [CrossRef] [PubMed]

Benitez-Quiroz, C. Fabian, Ronnie B. Wilbur, and Aleix M. Martinez. 2016. The not face: A grammaticalization of facial expressions of emotion. *Cognition* 150: 77–84. [CrossRef]

Brentari, Diane, Joshua Falk, Anastasia Giannakidou, Annika Herrmann, Elisabeth Volk, and Markus Steinbach. 2018. Production and comprehension of prosodic markers in sign language imperatives. *Frontiers in Psychology* 9: 770. [CrossRef]

Bybee, Joan. 2007. *Frequency of Use and the Organization of Language*. Oxford: Oxford University Press on Demand.

Bybee, Joan. 2010. *Language, Usage and Cognition*. Cambridge: Cambridge University Press.

Campbell, Ruth, Bencie Woll, Philip J. Benson, and Simon B. Wallace. 1999. Categorical perception of face actions: Their role in sign language and in communicative facial displays. *The Quarterly Journal of Experimental Psychology Section A* 52: 67–95. [CrossRef]

Coppola, Marie. 2020. Gestures, homesign, sign language: Cultural and social factors driving lexical conventionalization. In *Emerging Sign Languages of the Americas*. Berlin: De Gruyter Mouton, pp. 349–90.

Coppola, Marie, Susan Goldin-Meadow, and Carolyn Mylander. 2006. How do hearing parents communicate with deaf children? Comparing parents' speech and gesture across five cultures. Presented at the Meeting of Society for Research on Child Language Disorders, Madison, WI, USA, June.

Costa, Marco, and Pio Enrico Ricci Bitti. 2000. Face-ism effect and head canting in one's own and others' photographs. *European Psychologist* 5: 293. [CrossRef]

Diessel, Holger. 2007. Frequency effects in language acquisition, language use, and diachronic change. *New Ideas in Psychology* 25: 108–27. [CrossRef]

Domaneschi, Filippo, Marcello Passarelli, and Carlo Chiorri. 2017. Facial expressions and speech acts: Experimental evidences on the role of the upper face as an illocutionary force indicating device in language comprehension. *Cognitive Processing* 18: 285–306. [CrossRef]

Ekman, Paul. 1979. About brows: Emotional and conversational signals. In *Human Ethology*. Edited by Mario von Cranach, Klaus Foppa, Wolf Lepenies and Detlev Ploog. Cambridge: Cambridge University Press.

ELAN. 2021. Nijmegen: Max Planck Institute for Psycholinguistics, The Language Archive. (Version 6.2) [Computer Software]. Available online: https://archive.mpi.nl/tla/elan (accessed on 1 July 2021).

Fridland, Valerie, Kathryn Bartlett, and Roger Kreuz. 2004. Do you hear what I hear? Experimental measurement of the perceptual salience of acoustically manipulated vowel variants by Southern speakers in Memphis, TN. *Language Variation and Change* 16: 1–16. [CrossRef]

Gagne, D.L. 2017. With a Little Help from My Friends: The Contributions of a Peer Language Network on the Conventionalization of Space in an Emerging Language. Doctoral Dissertations. 1493. Available online: https://opencommons.uconn.edu/dissertations/1493 (accessed on 1 July 2021).

Goffman, Erving. 1979. *Gender Advertisements*. New York: Harper and Row.

Goldin-Meadow, Susan. 2005. *The Resilience of Language: What Gesture Creation in Deaf Children Can Tell Us about How All Children Learn Language*. London: Psychology Press.

Herrmann, Annika. 2015. The marking of information structure in German Sign Language. *Lingua* 165: 277–97. [CrossRef]

Hudson Kam, Carla L., and Elissa L. Newport. 2005. Regularizing unpredictable variation: The roles of adult and child learners in language formation and change. *Language Learning and Development* 1: 151–95. [CrossRef]

Hudson Kam, Carla L., and Elissa L. Newport. 2009. Getting it right by getting it wrong: When learners change languages. *Cognitive Psychology* 59: 30–66. [CrossRef] [PubMed]

Janzen, Terry, and Barbara Shaffer. 2002. Gesture as the substrate in the process of ASL grammaticization. In *Modality and Structure in Signed and Spoken Languages*. Edited by Richard P. Meier, Kearsy Cormier and David Quinto-Pozos. Cambridge: Cambridge University Press, pp. 199–223.

Kanwal, Jasmeen, Kenny Smith, Jennifer Culbertson, and Simon Kirby. 2017. Zipf's law of abbreviation and the principle of least effort: Language users optimise a miniature lexicon for efficient communication. *Cognition* 165: 45–52. [CrossRef]

Kegl, Judy, Ann Senghas, and Marie Coppola. 1999. Creation through contact: Sign language emergence and sign language change in Nicaragua. In *Language Creation and Language Change: Creolization, Diachrony, and Development*. Cambridge: The MIT Press, pp. 179–237.

Kirby, Simon, Hannah Cornish, and Kenny Smith. 2008. Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences USA* 105: 10681–86. [CrossRef]

Kocab, Annemarie, Ann Senghas, and Jesse Snedeker. 2016. The emergence of temporal language in Nicaraguan Sign Language. *Cognition* 156: 147–63. [CrossRef]

Kocab, Annemarie, Jennie Pyers, and Ann Senghas. 2015. Referential shift in Nicaraguan Sign Language: A transition from lexical to spatial devices. *Frontiers in Psychology* 5: 1540. [CrossRef]

Kocab, Annemarie, Kathryn Davidson, and Jesse Snedeker. 2022. The Emergence of Natural Language Quantification. *Cognitive Science* 46: e13097. [CrossRef]

Labov, William. 1963. The social motivation of a sound change. *Word* 19: 273–309. [CrossRef]

Lüdecke, Daniel. 2021. sjPlot: Data Visualization for Statistics in Social Science. R package version 2.8.9. Available online: https://CRAN.R-project.org/package=sjPlot (accessed on 1 October 2021).

Lutzenberger, Hannah, Roland Pfau, and Connie de Vos. 2022. Emergence or Grammaticalization? The Case of Negation in Kata Kolok. *Languages* 7: 23. [CrossRef]

Mayberry, Rachel I., and Susan D. Fischer. 1989. Looking through phonological shape to lexical meaning: The bottleneck of non-native sign language processing. *Memory and Cognition* 17: 740–54. [CrossRef] [PubMed]

McClave, Evelyn. 2001. The relationship between spontaneous gestures of the hearing and American Sign Language. *Gesture* 1: 51–72. [CrossRef]

Mesch, Johanna. 2016. Manual backchannel responses in signers' conversations in Swedish Sign Language. *Language and Communication* 50: 22–41. [CrossRef]

Petronio, Karen, and Diane Lillo-Martin. 1997. WH-movement and the position of Spec-CP: Evidence from American Sign Language. *Language* 73: 18–57. [CrossRef]

Pfau, Roland, and Markus Steinbach. 2006. Modality-independent and modality-specific aspects of grammaticalization in sign languages. *Linguistics in Potsdam* 24: 3–98.

Pfau, Roland, and Markus Steinbach. 2011. Grammaticalization in sign languages. In *The Oxford Handbook of Grammaticalization*. Edited by Bernd Heine and Heiko Narrog. Oxford: Oxford University Press, pp. 681–93. [CrossRef]

Polich, Laura. 2005. *The Emergence of the Deaf Community in Nicaragua: "With Sign Language You Can Learn So Much"*. Washington, DC: Gallaudet University Press.

Pyers, Jennie, and Karen Emmorey. 2008. The face of bimodal bilingualism: Grammatical markers in American Sign Language are produced when bilinguals speak to English monolinguals. *Psychological Science* 19: 531–35. [CrossRef]

R Core Team. 2021. *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing. Available online: https://www.R-project.org/ (accessed on 1 October 2021).

Reilly, Judy. 2006. How faces come to serve grammar: The development of non-manual morphology in American Sign Language. In *Advances in the Sign Language Development of Deaf Children*. Edited by Marc Marschark Brenda Schick and Patricia Elizabeth Spencer. Oxford: Oxford University Press, pp. 262–90.

Reilly, Judy Snitzer, MarinaMcIntire, and Ursula Bellugi. 1990. The acquisition of conditionals in American Sign Language: Grammaticized facial expressions. *Applied Psycholinguistics* 11: 369–92. [CrossRef]

Saffran, Jenny R., Richard N. Aslin, and Elissa L. Newport. 1996. Statistical learning by 8-month-old infants. *Science* 274: 1926–28. [CrossRef]

Sandler, Wendy. 1999. The medium and the message: Prosodic interpretation of linguistic content in Israeli Sign Language. *Sign Language & Linguistics* 2: 187–215.

Sandler, Wendy. 2010. Prosody and syntax in sign languages. *Transactions of the Philological Society* 108: 298–328. [CrossRef]

Sandler, Wendy, and Diane Lillo-Martin. 2006. *Sign Language and Linguistic Universals*. Cambridge: Cambridge University Press.

Sandler, Wendy, Irit Meir, Svetlana Dachkovsky, Carol Padden, and Mark Aronoff. 2011. The emergence of complexity in prosody and syntax. *Lingua* 121: 2014–33. [CrossRef]

Sankoff, Gillian. 2006. Age: Apparent time and real time. In *Encyclopedia of Language and Linguistics*. Amsterdam: Elsevier, pp. 110–15.

Senghas, Ann. 2003. Intergenerational influence and ontogenetic development in the emergence of spatial grammar in Nicaraguan Sign Language. *Cognitive Development* 18: 511–31. [CrossRef]

Senghas, Ann, and Marie Coppola. 2001. Children creating language: How Nicaraguan Sign Language acquired a spatial grammar. *Psychological Science* 12: 323–28. [CrossRef] [PubMed]

Senghas, Ann, Marie Coppola, Elissa L. Newport, and Ted Supalla. 1997. Argument structure in Nicaraguan Sign Language: The emergence of grammatical devices. In *BUCLD 21: Proceedings of the 21st Annual Boston University Conference on Language Development*. Edited by Elizabeth Hughes, Mary Hughes and Annabel Greenhill. Boston: Cascadilla Press, pp. 550–61.

Senghas, Richard, Ann Senghas, and Jennie Pyers. 2005. The emergence of Nicaraguan Sign Language: Questions of development, acquisition, and evolution. In *Biology and Knowledge Revisited*. London: Routledge, pp. 305–24.

Singleton, Jenny L., and Elissa L. Newport. 2004. When learners surpass their models: The acquisition of American Sign Language from inconsistent input. *Cognitive Psychology* 49: 370–407. [CrossRef]

Swerts, Marc, and Emiel Krahmer. 2005. Audiovisual prosody and feeling of knowing. *Journal of Memory and Language* 53: 81–94. [CrossRef]

Wickham, Hadley. 2016. *ggplot2: Elegant Graphics for Data Analysis*. New York: Springer.

Wilbur, Ronnie B. 2013. Phonological and prosodic layering of nonmanuals in American Sign Language. In *The Signs of Language Revisited*. London: Psychology Press, pp. 196–220.

Zeshan, Ulrike. 2004. Interrogative constructions in signed languages: Crosslinguistic perspectives. *Language* 80: 7–39. [CrossRef]

languages

MDPI

Article

Emergence or Grammaticalization? The Case of Negation in Kata Kolok

Hannah Lutzenberger [1,2,*], Roland Pfau [3] and Connie de Vos [4]

1 Department of English Language and Literature, University of Birmingham, Birmingham B15 2SQ, UK
2 Center for Language Studies, Radboud University, 6525 HT Nijmegen, The Netherlands
3 Department of Linguistics, University of Amsterdam, 1012 VB Amsterdam, The Netherlands; r.pfau@uva.nl
4 Tilburg Center for Cognition and Communication, Tilburg University, 5037 AB Tilburg, The Netherlands; c.l.g.devos@tilburguniversity.edu
* Correspondence: h.lutzenberger@bham.ac.uk

Abstract: Typological comparisons have revealed that signers can use manual elements and/or a non-manual marker to express standard negation, but little is known about how such systematic marking emerges from its gestural counterparts as a new sign language arises. We analyzed 1.73 h of spontaneous language data, featuring six deaf native signers from generations III-V of the sign language isolate Kata Kolok (Bali). These data show that Kata Kolok cannot be classified as a manual dominant or non-manual dominant sign language since both the manual negative sign and a side-to-side headshake are used extensively. Moreover, the intergenerational comparisons indicate a considerable increase in the use of headshake spreading for generation V which is unlikely to have resulted from contact with Indonesian Sign Language varieties. We also attest a specialized negative existential marker, namely, tongue protrusion, which does not appear in co-speech gesture in the surrounding community. We conclude that Kata Kolok is uniquely placed in the typological landscape of sign language negation, and that grammaticalization theory is essential to a deeper understanding of the emergence of grammatical structure from gesture.

Keywords: Kata Kolok; negation; grammaticalization; language emergence; language change; non-manuals; gesture

Citation: Lutzenberger, Hannah, Roland Pfau, and Connie de Vos. 2022. Emergence or Grammaticalization? The Case of Negation in Kata Kolok. *Languages* 7: 23. https://doi.org/10.3390/languages7010023

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 17 September 2021
Accepted: 20 December 2021
Published: 28 January 2022

1. Introduction

Studies on sign languages from all around the world have demonstrated that signed languages—just like spoken languages—vary from each other, and that, for the most part, the attested variation aligns well with typological patterns identified for spoken languages. A fairly recent addition to the typological study of signed languages are rural isolates, which typically arise in areas of the Global South with high incidences of hereditary deafness (Zeshan et al. 2013; de Vos and Pfau 2015). The expression of negation in signed languages has received considerable attention in recent years. In fact, standard negation is one of the domains of linguistic inquiry that gave the impetus to the field of sign language typology (Pfau 2016; Zeshan 2004). In the present study, we add to the picture data from Kata Kolok (KK), a rural, isolate sign language from Bali. Our goal is twofold: First, we aim to situate Kata Kolok typologically with respect to other sign languages, thus contributing to our understanding of variation in this grammatical domain. Second, the use of corpus data from different generations of Kata Kolok signers also allows us to address age-related variation that may be indicative of ongoing language change, in particular the emergence of non-manual negation strategies.

We start in Section 2 by providing some background on the emergence of structure in visual communication systems, addressing also documented instances of grammaticalization. In Section 3, we present a typological sketch of negation in spoken and signed languages, and in Section 4, we briefly introduce sociolinguistic characteristics of Kata

Kolok and its users. The methodology of the present study is laid out in Section 5. Our findings are then presented in Section 6, separately for the specific manual and non-manual markers of negation that we identified. In the discussion in Section 7, we address synchronic and diachronic aspects pertinent to the study of Kata Kolok negation: First, we evaluate the theoretical and practical implications of the observed patterns from a typological perspective; second, we sketch potential pathways of diachronic language change. We close with some remarks on the limitations of the present study and suggestions for future research in Section 8.

2. On the Emergence of Structure in Visual Communication Systems

2.1. Emergence

As languages emerge, structure emerges (Kocab and Senghas 2021). Given the time depth of spoken languages, it is notoriously difficult to make claims about the emergence of structure at their early stages, but various types of experimental data have been taken to provide evidence, e.g., iterated learning experiments involving non-linguistic structures (Kirby et al. 2008) and gestural descriptions produced by hearing non-signers (Goldin-Meadow 2014; Meir et al. 2017; Motamedi et al. 2019). The sign languages which are still in use are assumed to be much younger, with the oldest ones being approximately 250–300 years old (McBurney 2012). This time depth is reminiscent of some creole languages, with which sign languages have been argued to share certain (socio)linguistic properties (see Adone 2012 for an overview). Still, with respect to availability of data, the situation for sign languages is not much different from spoken languages. As sign languages do not have a written form, the oldest informative documents available date back only 100 years (Supalla 2001) and extensive corpus data are much more recent.

While the opportunities to study the emergence of new sign languages remain few and far between (cf. Meir et al. 2010; de Vos and Nyst 2018), linguists have been able to study this phenomenon by comparing sign language use by older and younger signers in a handful of cases. For example, they were able to capture, among other things, the emergence of word order and spatial grammar (for Nicaraguan Sign Language, see Kegl et al. 1999; Senghas and Coppola 2001; for Al-Sayyid Bedouin Sign Language, see Sandler et al. 2005; Meir and Sandler 2020), the gradual development of phonology (Sandler et al. 2011), and the use of reference tracking devices (Stamp and Sandler 2021). While it is impossible to present a comprehensive overview within the context of this paper, it is important to note that these studies have shown mixed results across grammatical domains and across language communities. For example, while Dachkovsky et al. (2018) report a reduction in the simultaneous use of manual and non-manual markers in personal life stories in Israeli Sign Language, Stamp and Sandler (2021) report an increase in simultaneity in the use of referential shift devices. Moreover, while Al-Sayyid Bedouin Sign Language did not develop spatial verb morphology over the course of three generations, Israeli Sign Language—about the same age as ABSL—did develop spatial verbal morphology in the same three-generation time period (Padden et al. 2010). In Nicaraguan Sign Language, spatial morphology emerged even more rapidly (Senghas 2005). All in all, these comparisons suggest that who learns the sign language and how signers interact may well lead to very different patterns of grammaticalization. In order to arrive at a unified understanding of the earliest stages of language formation, we therefore require more intergenerational analyses focused on particular grammatical domains.

As for negation—the focus of the present chapter—we are not aware of any other work on emerging sign languages, perhaps with the exception of a case study reported by Franklin et al. (2011). Franklin and colleagues report that David, the American homesigner whose productions they analyzed, systematically employed non-manual and/or manual markers of negation, namely a side-to-side-headshake and a ‘flip’ gesture, the former being the most frequent marker (84% of the negative sentences). Furthermore, they observed that 79% of the headshakes appeared sentence-initially. The authors conclude “that side-to-side headshakes crystallize early as the expression of logical (i.e., sentential) negation in David’s homesign system, and that the form for this meaning has a fixed position at the beginning of the sentence" (Franklin et al. 2011, p. 404).

2.2. Grammaticalization: A Special Case of Language Change in Sign Languages

Sign languages, just like spoken languages, are subject to synchronic and diachronic variation. As for the former type of variation, it has been demonstrated that sociolinguistic variables like region, age, gender, ethnicity, and family background (deaf relatives) may be responsible for variation at all levels of linguistic structure (see Lucas et al. 2001; Schembri and Johnston 2012; Bayley et al. 2015 for overviews). As for the latter type of variation, it can be due to language-external and language-internal factors. In the following, we will only be concerned with age-related variation and its relation to language change, focusing, for the most part, on the role of language-internal factors, because variation across generations allows us to investigate the unfolding process of grammaticalization.[1] That is to say, by comparing signers from different age groups, we are able to see how learning biases may shape language structure from one generation to the next.

Age-related changes have already been reported for American Sign Language (ASL) by Frishberg (1975), who documents systematic changes in the place of articulation and handshape of signs (Frishberg 1975; for BSL, see Woll 1987). While these changes were not explicitly linked to sociolinguistic factors, but were taken to be triggered by ease of production and/or perception, Schembri et al. (2009) demonstrate that phonological variation, with respect to place of articulation in Australian Sign Language (Auslan), is driven by age; lowering (of a particular class) of signs occurs as a result of age, among other (socio)linguistic factors, such that younger signers drive the change towards lowered locations. As with the other sociolinguistic factors, reports on (morpho)syntactic variation related to age are scarce in the literature.

Finally, an important language-internal process leading to changes in the lexicon is grammaticalization, whereby lexical elements take on a grammatical function. It has been shown that grammaticalization works pretty much the same way in sign languages as it does in spoken languages. For instance, in both modalities, auxiliaries (e.g., future tense markers) commonly develop from verbs and complementizers from nouns (Pfau and Steinbach 2011). Yet, there is also an interesting modality-specific side to grammaticalization, as in sign languages, manual and non-manual gestures may grammaticalize, such as pointing gestures (see Coppola and Senghas 2010 for Nicaraguan Sign Language; de Vos 2015 for Kata Kolok; Dachkovsky 2020 for Israeli Sign Language), the 'palm up' gesture (which belongs to the same gesture family as the before-mentioned 'flip' gesture; cf. Cooperrider et al. 2018; Mesh and Hou 2018), and headshakes (cf. Pfau 2015). In a sense, grammaticalization of a gesture displays properties of language-external and language-internal change. In a first step, the gesture enters the language system, and this, of course, involves contact with the community in which the gesture is used. Subsequently, the gesture may take on further, increasingly grammatical functions, as has been argued, for instance, for pointing (Pfau 2011; Kwok et al. 2020) and 'palm up' (van Loon et al. 2014)—and this is fully in line with traditional conceptions of grammaticalization for spoken languages. This modality-specific potential to grammaticalize gestures will turn out to be relevant in the context of our study.

3. Negation: A Typological Overview

Our study is concerned exclusively with the encoding of standard negation. Standard negation describes the most basic strategy to convert a sentence (S1) into a semantically opposite sentence (S2) so that S1 is true whenever S2 is false and vice versa, or, put differently, the most neutral strategy for changing the polarity of a sentence from affirmative to negative. Standard negation is by definition sentential (e.g., English *He is not happy*). Consequently, constituent negation (e.g., by means of affixation: *He is unhappy*) and other specialized forms of negation, such as negative adverbials (*He is never happy*), neg-words (*Nobody is happy*), negative existentials (*There is no happiness*), and negative imperatives (*Don't be happy!*) go beyond the scope of the present study. Deviating from some of the definitions offered in the literature (e.g., Miestamo 2005; Dahl 2011), but in line with the procedure applied by Oomen and Pfau (2017) in their study on standard negation in Sign Language of The Netherlands (NGT), we will include in our data set sentences with (apparent) nominal and adjectival predicates, for the simple reason that determining word class is notoriously difficult in Kata Kolok (Schwager and Zeshan 2008).

Some variation in the theoretical approach notwithstanding, classifications of negation are often based on the nature of the basic clause negator (Payne 1985; Dahl 2011)—and this is the strategy we adopt in the next subsection on spoken languages. We then turn to sign languages and show how sign language negation has been classified, and how this compares to spoken languages.

3.1. Spoken Languages

Typological studies on a large number of typologically diverse spoken languages have revealed that by far the most common strategies for expressing negation are negative particles and negative affixes (Dahl 2011, 1979; Payne 1985; Dryer 2005; Miestamo 2005).[2] The use of a negative particle, i.e., an uninflected and free-standing (in this case, pre-verbal) morpheme, is illustrated in the Indonesian example in (1), while example (2) shows that Turkish employs a morphological strategy, viz. the negative suffix *-mV*, which attaches to the verbal root and is subject to vowel harmony.

(1)	a.	*Saya*	*tidur*	
		I	asleep	
		'I am asleep.'		
	b.	*Saya*	*tidak*	*tidur*
	a.	I	NEG	asleep
		'I am not asleep.'		[Indonesian; Dahl (2011, p. 19)]

(2)	a.	*Oku-*	*yor-*	*um*	
		read-	PROG-	1SG	
		'I am reading.'			
	b.	*Oku-*	***mu-***	*yor-*	*um*
		read-	**NEG-**	PROG	1SG
		'I am not reading.'			[Turkish; Dahl (2011, p. 14)]

Beyond these two very common options, we wish to introduce two further strategies, as they will become relevant in our discussion of sign language negation in the next subsection. First, some languages require the combination of two (or more) elements for the expression of standard negation; this is commonly referred to as split negation or Negative Concord. French is probably the most famous example, but in (3), we provide an example from Cuiba, a Guahiban language of Venezuela. In this language, a pre-verbal particle combines with a verbal suffix, thus, in a sense, combining the Indonesian and the Turkish strategy.

(3)	*wajjan-*	*be*	***jopa***	*apänchi-*	***yo-***	*be*
	1.INCL-	DU	**NEG**	drink.1.INCL-	**NEG-**	DU
	'We two do not drink.'					

[Cuiba; Mosonyi et al. 2000, in Miestamo (2005, p. 156)]

Second, in a few tone languages, the morphological change that realizes negation may be suprasegmental in nature. In Mbembe, a Niger-Congo language from Nigeria, for instance, it is only the tone change (from high to low) on the tense prefix that signals negation, as is shown in (4).

(4)	a.	*mɔ́-*	*tá*	
		3.FUT-	go	
		'He will go.'		
	b.	*mɔ̀-*	*tá*	
		3.**NEG-**	go	
		'He won't go.'		[Mbembe; Dahl (2011, p. 17)]

3.2. Sign Languages

For sign languages, too, efforts have been made to classify their negation systems. However, the most common typological classification is different from that suggested for spoken languages in that it focuses on the use and combination of manual and non-manual negative markers.

All sign languages studied to date employ manual negative signs and specific non-manual markers—mostly a headshake[3]—for the expression of standard negation. The way in which these two types of markers combine, however, may differ from one sign language to the next. Consider the two examples in (5) from Catalan Sign Language (LSC) and Italian Sign Language (LIS), respectively.[4] At first sight, the two negated clauses look very similar: both sign languages have SOV order, and the negative particle (NOT/NON) follows the verb. In fact, even the form of the negative particle is similar: a handshape with extended index finger (fingertip pointing upward) performing a repeated side-to-side movement in front of the signer's body. Additionally, in both examples, a headshake (hs) accompanies the manual negator. However, in LSC, the headshake is not confined to co-occurring with the negative particle; it may optionally spread onto the verb or the verb phrase, as indicated by the broken line in (5a). In contrast, in LIS, the headshake cannot spread beyond the negative particle.

(5) a.
```
        _ _ _ _   _ _ _   __hs
SANTI   MEAT      EAT     NOT
```
'Santi doesn't eat meat.' [LSC; Quer (2012, p. 318)]

b.
```
                           _hs
PAOLO  CONTRACT  SIGN     NON
```
'Paolo didn't sign the contract.' [LIS; Geraci (2005, p. 221)]

The possibility of spreading already suggests that in LSC, the headshake is less tightly associated with the manual negator than in LIS. That this is indeed the case is further evidenced by the observation that using the manual particle is optional in LSC, that is, sentences are commonly negated by a headshake only in this language. In this case, the headshake minimally accompanies the verb, but it may optionally spread onto the object (6a). As opposed to LSC, headshake-only negation is impossible in LIS, irrespective of the scope of the headshake, as indicated by the brackets in (6b).

(6) a.
```
        _ _ _ _   __hs
SANTI   MEAT      EAT
```
'Santi doesn't eat meat.' [LSC; Quer (2012, p. 318)]

b.
```
(______ (__________  (____   (__hs)
PAOLO   CONTRACT     SIGN
```
'Paolo didn't sign the contract.' [LIS; Geraci (2005, p. 221)]

Despite syntactic commonalities, LSC and LIS thus belong to different typological groups: LSC is a so-called non-manual dominant sign language, while LIS is a manual dominant sign language (Zeshan 2004, 2006). In the former type, the use of a manual negative sign is optional, and the headshake is capable of spreading. In contrast, in the latter type, the use of a manual negator is obligatory, and the headshake is (generally) confined to accompanying the manual negator. Beyond this broad distinction, it is worth noting that within-group variation with respect to certain grammatical characteristics is also attested, for instance, when it comes to the availability of Negative Concord involving two manual negative signs (van Boven et al. Forthcoming). Additionally, research has claimed that within the group of non-manual dominant sign languages, there are differences in spreading options for the headshake (see Pfau and Quer 2002 for a comparison of LSC, ASL, and German Sign Language, three non-manual dominant sign languages; also see our discussion in Section 7). If confirmed by the analysis of naturalistic corpus data, these combinatorial restrictions would strongly suggest that the headshake is not just a co-speech gesture (cf. Kendon 2002), but rather a grammatical marker, the use of which is language-specific and tightly linked to the syntactic structure of the respective sign language. In other words, and as already alluded to above, the non-manual gesture has grammaticalized (van Loon et al. 2014; Pfau 2015).

Some recent studies, however, suggest that not all sign languages fit neatly into this two-way classification, that is, the classification may be too simplistic. First of all, it has been argued that in Russian Sign Language, a manual dominant sign language, the headshake is capable of spreading, thus presenting us with a hybrid system (Rudnev and Kuznetsova 2021). Secondly, Kuder (2020) observes for Polish Sign Language that headshake-only negation is attested, but that the headshake almost never spreads beyond a single sign. Finally, a corpus-based study on Auslan (Johnston 2018) suggests that this sign language employs a headshake in negative contexts, but that the headshake is not (yet) grammaticalized. In particular, (i) a headshake is only observed in half of the negative clauses extracted from the corpus; (ii) the headshake hardly ever negates a clause by itself; and (iii) the position and spreading behavior of headshakes, when present, do not appear to be linguistically constrained in this sign language. Johnston (2018) further draws attention to non-manuals surfacing in negative contexts in addition to or instead of headshaking (nodding and negative facial expressions, incl. mouth gestures) and points out the impact these may have on the interpretation of headshaking and other non-manuals as formal markers of negation.

With this in mind, we return to the typological classification of negation in spoken languages (i.e., use of negative particles vs. negative affixes). Pfau (2015) and Oomen and Pfau (2017) argue that the spoken language classification can be applied to at least some sign languages. As for prototypical manual dominant sign languages, they suggest that these sign languages employ a negative particle that is lexically specified for a headshake, that is, the headshake is part of the lexical entry of the manual negator. In contrast, in non-manual dominant sign languages, the negative particle and the headshake are independent negative elements, which implies that these sign languages involve split negation, whereby the manual negator is optional. Pfau and Oomen further argue, adopting a proposal made in Pfau (2008), that the headshake is a suprasegmental affix that attaches to the verb, comparable to tonal affixes in spoken languages. Given this line of reasoning, negation in LSC (and, for instance, German Sign Language) combines characteristics of Cuiba and Mbembe: just as in Cuiba (3), split negation involves a free particle and a verbal affix; just as in Mbembe (4b), the verbal affix is suprasegmental in nature (and just as in, e.g., Colloquial French, one of the two elements is optional).

4. Kata Kolok

4.1. Community Characteristics

Kata Kolok (KK) is a sign language isolate that emerged in a rural Balinese village community (Marsaja 2008; de Vos 2012; Lutzenberger, forthcoming). It thus belongs to the group of so-called rural (or village/shared) sign languages (Nyst 2012; Zeshan and de Vos 2012). Rural signing varieties represent a special sociolinguistic case, as they emerge rapidly in mostly isolated, rural enclaves, often as a result of an exceptionally high incidence of hereditary deafness. Sign languages arising in such contexts are relatively young. As for Kata Kolok, genetic and genealogical evidence indicates the first instance of a deaf cohort approximately six generations ago, and Kata Kolok has been used and acquired by deaf children ever since (Winata et al. 1995; Friedman et al. 1995). Moreover, Kata Kolok, just like other rural sign languages, represents a communicative tool that is shared by the deaf and a large proportion of the hearing community members. Deafness is not stigmatized, and the community has adapted culturally and linguistically to deafness in various ways (Marsaja 2008). Kata Kolok thus serves as means of communication in social, political, and religious contexts. Deaf children receive language input in Kata Kolok from birth, and Kata Kolok has been used at a local primary school as a medium of instruction since 2007 (Marsaja 2008; de Vos 2012).

There is a growing body of research investigating the diversity, as well as the similarities, among rural signing varieties, comparing them with sign languages used in urban settings (de Vos and Pfau 2015; Meir and Sandler 2020). Until recently, Kata Kolok has developed under virtually no influence from any other sign languages. Yet, nowadays, deaf youngsters may pursue further education in other parts of Bali where Indonesian signing varieties are used, and contact with and influence from other sign languages will thus likely increase (Moriarty 2020; Lutzenberger, forthcoming).

4.2. Typological Sketch

According to Marsaja (2008), the basic word order in Kata Kolok is SVO; yet de Vos (2012) shows that Kata Kolok signers do not primarily rely on word order to mark argument structure, as subject and object are frequently omitted in spontaneous interaction. de Vos (2012) has studied the use of space in Kata Kolok, and reports that the use of an enlarged signing space and an absolute frame of reference are common. Another typologically unusual pattern is the absence of mouthings, i.e., silent articulations of spoken words accompanying signs (Marsaja 2008; de Vos 2012).

4.3. Previous Work on Negation in Kata Kolok

Compared to other signed languages, the range of manual signs considered to be negative in Kata Kolok is rather small. Marsaja (2008) discusses the basic clause negator NEG (glossed as SING in his study) and the negative completive marker NOT.YET (which he glosses as KONDEN), and Perniss and Zeshan (2008) add the sign FINISH, which expresses a negative existential meaning and can be used interchangeably with NEG in most contexts of negative existence and possession. These negative signs occur predominantly in post-predicative or clause-final position, with the exception of NOT.YET, which occurs clause-initially (Marsaja 2008; de Vos 2012). Since the focus of the present study is on standard negation, we will concentrate on the basic clause negator NEG, which is articulated with a 5-handshape performing a side-to-side handwave (Figure 1).

Figure 1. Basic manual clause negator in Kata Kolok including a negative facial expression with furrowed brows and pulled-down corners of the mouth, as described by Marsaja (2008). Adapted with permission from de Vos (2012); copyright 2012 Max Planck Institute for Psycholinguistics.

Marsaja (2008, p. 194) claims that NEG is mandatory in all negative utterances, and provides one example involving doubling of NEG within a clause (but does not further discuss this phenomenon). He further suggests that the use of a headshake is optional in standard negation. In those instances in which a headshake does occur, “it is generally small and quick; it never exceeds the scope of SING’s manual component, and never extends to previous or subsequent signs in a sentence” (Marsaja 2008, p. 197). As all sign languages described to date make use of both kinds of markers, this pattern would be typologically highly marked (Zeshan 2006, 2004). In the present study, we add to the picture another non-manual marker—a protruded tongue—addressing also its potential role as a negative existential marker in Section 6.2.2.

4.4. Focus of the Present Study

The current study offers a revised and more thorough account of negation in Kata Kolok. Using naturalistic corpus data, we address the following questions: (i) Is NEG indeed the main negator in Kata Kolok, while the headshake plays a minor role? (ii) What is the role of non-manual markers in Kata Kolok negation? (iii) Is there evidence for language change in the expression of standard negation across generations of Kata Kolok signers? Based on examples previously elicited by Marsaja (2008), we expect to find few instances where NEG co-occurs with a negative headshake. Based on observations from fieldwork and corpus data, however, there is reason to expect that NEG frequently co-occurs with (a) non-manual element(s), specifically a headshake and/or tongue protrusion, and that negation is occasionally expressed without the use of the manual negator. We hypothesize that non-manual negators may still be grammaticalizing within the three generations of Kata Kolok signers studied in this paper. For this reason, we opted for an intergenerational sample of naturalistic corpus data for the current study of standard negation in Kata Kolok.

5. Methodology

5.1. Data

The current study is based on the Kata Kolok Corpus, a naturalistic data set of deaf Kata Kolok signers of generations II through VI (de Vos 2016). The corpus is stored and archived in *The Language Archive* at the Max Planck Institute for Psycholinguistics, The Netherlands (König 2011). For the purpose of this study, three dialogues between close friends with a relatively high level of transcription detail were selected. The most important selection criterion was to cover signers from different generations. Given that there are very few recordings of a single generation II-signer available and that generation VI consists of infants and small children, the final data set comprised generations III through V. Details of the sample, including their length in minutes, are provided in Table 1. The variance in the length of recordings will be taken into account by reporting values of negation per minute rather than absolute frequency.

Table 1. Detailed information on the sample used in the present study.

Generation	**III**		**IV**		**V**	
Participant	**Signer 1**	**Signer 2**	**Signer 3**	**Signer 4**	**Signer 5**	**Signer 6**
Gender	male	male	female	female	male	male
Length of Recording	61 min		18 min		25 min	
Dyad	**Dyad I**		**Dyad II**		**Dyad III**	

With the exception of Palfreyman (2019), who reports a correlation between gender and syntactic position of the negator in two urban signing varieties of Indonesia, gender has never been reported to affect the grammatical realization of negation. For Kata Kolok, there is some indication that gender may affect lexical variation, and we therefore account for individual variation in the statistical analyses by adding signer ID as a random intercept (cf. Mudd et al. 2020).

5.2. Coding and Procedure

Although the selected data included detailed transcriptions, all files were enriched by manual coding, using the annotation software ELAN (Wittenburg et al. 2006; *ELAN [Computer Software]* (version 5.9) 2020).[5] Moreover, while negative forms such as negative interjections, negative existentials, etc. were included in the initial coding, our report here focuses on standard negation. In addition to coding the manual and non-manual activity, separate tiers were dedicated to selected functional and analytic information (for the coding scheme, see Appendix A). All coding was done by the first author and proceeded in three rounds, initially targeting all instances of negation, then completing the information in the remaining tiers, before reviewing the coding in a final round. Data were systematically checked for missed tokens by searching for NEG, headshakes, and tongue protrusion in the prior transcriptions. Some instances had to be excluded due to reasons such as (i) absence of a felicitous translation of the utterance, (ii) the camera being out of focus temporarily during the recording, and/or (iii) bad lighting conditions in the video. Coding presented several challenges, of which the most frequent ones are addressed briefly.

First, just as in Spanish and other spoken languages, the means of negative interjection and the clause negator are formally identical in Kata Kolok. Second, Kata Kolok relies heavily on shared knowledge and context, which makes the omission of sentential constituents a very common pragmatic strategy; as a result, elliptic standard negation and negative interjections are not always distinguishable. We coded conservatively by excluding instances with subtle articulatory breaks or changes within the accompanying non-manuals, as these features indicate separate prosodic domains as would be expected in the case of a negative interjection (Sandler 1999). Third, together with the frequent omission of constituents in spontaneous discourse, it was not always straightforward whether the negative element operated on a declarative clause or a negative existential. Fourth, every instance that did not clearly involve a negative existential meaning was coded as standard negation. Fifth, and finally, instances of negator doubling are noted as such in the comment tier, but counted as a single negative sentence. Similarly, immediate repetitions of the same negative utterance were counted as a single instance of negation.

We double-coded 10% of the data (11 min) to provide an intra-coder reliability measure, ensuring the validity of the findings of the present study. Cohen's Kappa was calculated using the irr package (Gamer et al. 2012) in R (R Core Team 2019) and yielded substantial intra-coder agreement between both rounds of coding ($\kappa = 0.951$; $z = 15.6$; $p < 0.05$) (Fleiss et al. 2003).

6. Results

With a total of 162 instances in the final data set, standard negation occurred on average 1.6 times per minute (1.1/min in generation III, 2.7/min in generation IV, 1.8/min in generation V).[6] Table 2 provides an overview of the negation strategies employed by the six signers. Use of the manual negator NEG is most frequent: it is attested in 86% (139/162) of the examples—also note that NEG mostly appears in clause-final position (75%; 104/139). Yet, non-manual markers are also frequently observed: a headshake occurs in 80% (130/162) and tongue protrusion in 19% (30/162) of the data. Hence, the headshake is almost as frequent as the manual negator, while tongue protrusion is used notably less often. Below we will suggest that tongue protrusion functions as a specialized negation marker for non-existence and negative evaluation. Video clips of all our examples can be viewed as Supplementary Materials on the Open Science Framework.

Table 2. Absolute and relative frequency of manual and non-manual markers used in standard negation.[7].

	Manual Particle NEG	Non-Manual Element		Total
		Headshake	Tongue Protrusion	
Generation III	56 (81.2%)	61 (88.4%)	5 (7.2%)	69
Generation IV	41 (85.4%)	35 (72.9%)	10 20.8%)	48
Generation V	42 (93.3%)	34 (75.6%)	15 (33.3%)	45
Total	139 (85.8%)	130 (80.2%)	30 (18.5%)	162

6.1. Manual Marking

In line with Marsaja's (2008) observation, NEG is the only manual negator attested for negating a clause in Kata Kolok; this suggests that NEG is used for various kinds of negative meanings, including ‘not’, ‘never’, ‘nobody’, etc. The distribution of how manual and non-manual markers combine in our dataset is illustrated in Figure 2 for each generation separately, i.e., combinations of NEG with a negative headshake and/or tongue protrusion. Note that the figure also contains the cases in which negation is only expressed non-manually.

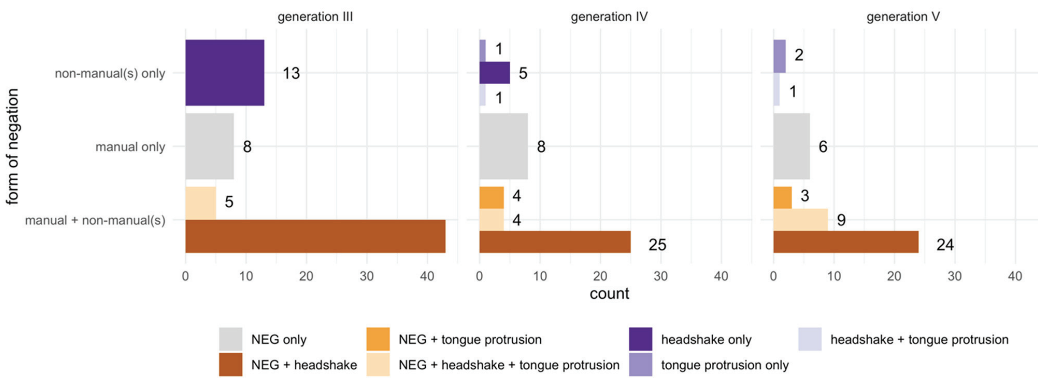
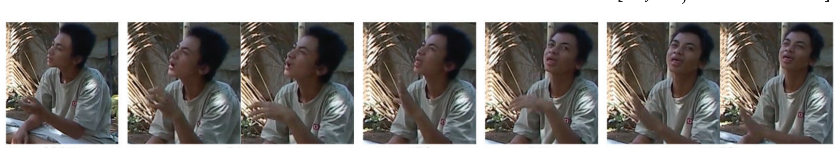


Figure 2. Combinatorial patterns of relevant manual and non-manual markers shown per generation.

As for the examples featuring NEG (139 instances), the pattern in example (7a) is the most common one: the (clause-final) manual negator is accompanied by a headshake in 57% (92/162) of all tokens, which amounts to half of the data from generations III and IV and almost two thirds of the data from generation V. Considerably less frequently, the manual negator combines with tongue protrusion (4%; 7/162), illustrated in (7b), or with both non-manual markers (11%; 18/162). Note that example (7b) contains two negative particles as a result of full repetition; that is, this is not a case of negator doubling, as the verb is also repeated, and the prosody suggests that we are dealing with two separate clauses. In 14% of cases (22/162), and at similar rates across generations, the manual negator is not accompanied by any negative non-manual markers (7c). Remember that this is the pattern which Marsaja (2008) claimed to be the most common.

(7) a. BI$_1$ IX‘locative’ IX‘locative’ COFFEE NEG (hs over NEG)
‘I don’t take my coffee over here.’[8] [GD3jan7 00:27:55.880]

b. SPRAY RAIN NEG RAIN NEG (tp over each NEG)
‘No rain came after the pesticides had been sprayed.’
[SuJu16jan7 00:16:21.209]



c. DRINK SWEET NEG
'She does not drink tea.' [PiKe4jan7 00:16:14.000]

Although examples (7a) and (7c) are semantically and syntactically similar, only (7a) contains a headshake. Based on the variety of topics covered, the topic of conversation does not appear to have an impact on the use of headshake.

As for the different types of negation systems, Pfau (2015) refers to Jespersen's Cycle and hypothesizes that sign languages start out as purely manual systems, go through a stage with a combined pattern, before developing into a non-manual dominant system (see Section 7.2). If this hypothesis is true, we would expect intergenerational differences with older generations using the manual negator more often than the non-manual one. However, Figure 2 paints a more complex picture. First, we note a slight decrease in the use of negation with NEG only in younger generations. Second, more diverse combinations are observed in the two younger generations as compared to the older generation. Third, this, in turn, is paired with less instances of non-manual only negation. This suggests that, if anything, there might be a slight trend towards using the manual negator more frequently in younger generations (see Figure 2). However, these numerical differences across generations remain rather small.[9]

6.2. Non-Manual Marking

6.2.1. Scope of the Headshake

In 67.9% of cases (110/162), both the manual negator and a headshake are involved. The high frequency of headshakes identifies it as the canonical non-manual negation marker. Note that whenever the manual negator and the headshake co-occur in a negated clause, the headshake can either accompany only NEG (8a) or extend over NEG and one or more adjacent signs (headshake spreading)—the latter pattern contradicting claims made by Marsaja (2008). Although headshake spreading is clearly an option, it is attested in only 26% (28/110) of the examples. Nevertheless, in six examples, the spreading can be considered a harmony phenomenon as a result of negator doubling or repetition of the entire negative clause; in two cases, a manual sign cliticizes to NEG, which makes it impossible to distinguish true headshake spreading from a lexical headshake bound to NEG; and three cases include co-articulatory, thus phonetic, headshake spreading, e.g., a locative point includes a sidewards head movement that fuses with the headshake. This leaves us with 17 instances (15.5%; 17/110) of the data that include clear spreading of the negative headshake across adjacent sign(s), (8b) and (8c) being examples. Example (8b) shows the most common form of headshake spreading; the headshake precedes the manual negator NEG and is co-articulated with (part of) the preceding sign. Example (8c) shows an example in which spreading occurs over multiple signs, a pattern which is only rarely attested.

$$\text{(8) a. THINK IX}_2 \text{ MONEY GIVE } \overline{\text{NEG}}^{\text{hs}}$$
'You know, he does not give me money.' [SuJu16jan7 00:04:06.600]

hs (over NINE NEG)

b. TIME NINE NEG TIME EIGHT BI_1 TALK

'I was told to come at eight o'clock in the morning, not at nine.'

[PiKe4jan7 00:04:20.000]

hs (over ANGRY BI_1 NEG)

c. ANGRY BI_1 NEG

'Me, I am not angry.' [GD3jan7 00:12:39.360]

At this point, it is unclear whether headshake spreading is indeed highly restricted to the preceding constituent, or whether the fact that we observed only minimal spreading can be attributed to the fact that Kata Kolok utterances prototypically are short, often consisting of a single sign. From an articulatory point of view, the headshake can precede the manual negator because the hands produce signs in sequence—one after the other.

Figure 3 exemplifies how headshake spreading is distributed across the different generations, and more specifically across the different signers. Clearly, headshake spreading very rarely occurs among signers from generation III and generation IV and is considerably more frequent in generation V signers. The observation of an inter-generational difference in the occurrence of headshake spreading is enhanced by the fact that individual variation among the signers from each generation is generally low. For signer 1 from generation III, no instances of headshake spreading are attested at all, and it occurs few times in signer 2 from generation III (12.5%; 4/32). Among both signers of generation IV, headshake spreading is extremely uncommon, in 6% (1/17) in signer 3 of generation IV and in 10% (1/10) signer 4 of generation IV. Headshake spreading is much more common in both signers of generation V; it is attested in 57% (4/7) in signer 5 of generation V and in in 35% (7/20) of signer 6 of generation V. In sum, while headshake spreading occurs at 6–12% among signers from generation III and generation IV, it is at least three times as common among signers of generation V.[10] While those numbers suggest inter-generational differences—with generation III and IV displaying more similar patterns and generation V showing a strikingly different pattern—it needs to be noted that the phenomenon remains relatively low overall. Crucially, however, the pattern observed does not seem to be driven by individual variation: Although there are, of course, small differences as to how frequent spreading is across different signers, the overall pattern is similar across signers from the same generation.

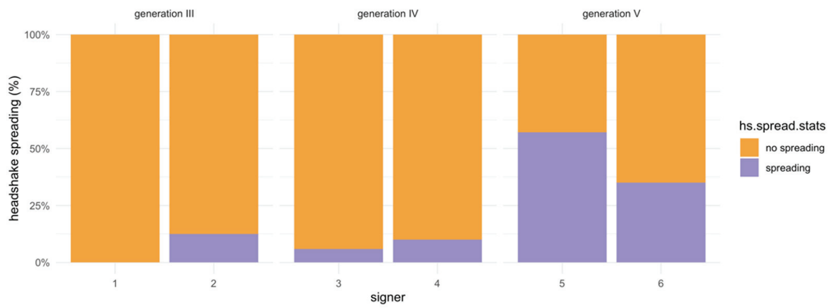


Figure 3. Distribution of headshake spreading across the three generations.

6.2.2. Tongue Protrusion

Tongue protrusion is observed in a total of 30/162 instances of negation (18.5%). Four different patterns are attested: tongue protrusion may combine with NEG, as in example (7b), repeated here as (9a) (N = 7); it may be co-articulated with NEG and headshake (N = 18), as shown in (9b); it may be the sole negator (N = 3), illustrated in (9c); and it may be co-articulated with a headshake (N = 2) in the absence of the manual negator (9d).

(9) a. SPRAY RAIN $\overline{\text{NEG}}^{\text{tp}}$ RAIN $\overline{\text{NEG}}^{\text{tp}}$
'No rain came after the pesticides had been sprayed.'
[SuJu16jan7 00:16:21.209]

b. SIGN-NAME$_A$ SIGN-NAME$_B$ $\overline{\text{NEG}}^{\text{hs+tp}}$
'*A* and *B* are not coming to the event.' [GD3jan7 00:08:54.100]

c. SIGN-NAME$_A$ $\overline{\text{FISHING GOOD}}^{\text{tp}}$
'*A* did not catch anything.' [SuJu16jan7 00:13:03.780]

hs+tp
d. BI$_1$ DRUNK IX'locative'
'I hadn't been drinking over there.' [PiKe4jan7 14:31.500]

As the examples in (9) illustrate, tongue protrusion is commonly observed in examples which may be interpreted as negative existentials—in fact, this is true for 83% of the 30 examples including tongue protrusion. The non-existential meaning in (9a) is obvious: the absence of rainfall. Example (9b) deals with the fact that two villagers are not coming, which entails that they will not be present during a specific social event. The villager in (9c) returns home with empty hands—FISHING is negated with a protruded tongue to express that villager *A* did not catch any fish when going on a fishing trip with other villagers. Similarly, tongue protrusion is co-produced with a negative headshake in (9d) in order to express that a particular signer did not gather with peers to consume alcohol. Besides non-existence, it is also possible that tongue protrusion relates to another, previously identified function: negative evaluation. This interpretation is compatible with all examples provided above. The lack of rain after the spreading of pesticides, as described in example (9a), prevents the chemicals from diffusing in the soil, and thus minimizes its effects. In (9b), villagers may be expected to attend this particular meeting due to ceremonial responsibilities. The negative evaluation of (9c) is straightforward: the lack of prey means that the family will not have food to eat. Lastly, the negative judgment in example (9d) may arise from the events that occurred as a consequence of drinking, since drinking itself is not necessarily always regarded negatively.

Testing whether tongue protrusion expresses negative evaluation reveals the following pattern: although 60% of all instances of tongue protrusion are compatible with an interpretation of negative evaluation, all of them are also examples of negated phrases. Essentially, both negative evaluation and non-existence are inferential and therefore more implicit than explicit, i.e., they require contextual knowledge that allows the interlocutor to judge that something is considered negatively. Nevertheless, the use of tongue protrusion as a pragmatic marker for negative evaluation and as a specified negative element may have co-evolved alongside the general negation markers, now co-existing in Kata Kolok. This idea is further supported by the examples that do not contain any non-manual elements (*manual-only*). The *manual-only* examples in our dataset do not allow (inferential) negative evaluation as a reading, i.e., they do not require contextual knowledge to evaluate whether something is good or bad but simply (and exclusively) negate phrases. Similarly, a maximum of five instances of *manual-only* negation may be compatible with (inferential) non-existence. This suggests that tongue protrusion may be treated as a pragmatic marker of negative evaluation and potentially as a negation marker that is used for a specific type of negation, namely, non-existence.

This interpretation is corroborated by the fact that the examples provided above are strikingly different from examples that feature tongue protrusion but no negation. While tongue protrusion may feature in lexical signs such as DIE or SALT, tongue protrusion in Kata Kolok has also been observed in contexts that are clearly evaluated negatively, such as examples (10a) and (10b). In example (10a), the signer expresses his despair over the fact that everything is expensive, marked by the protruded tongue accompanying the sign HIGH-PRICE. In example (10b), the signer's (and possibly the community's) attitude towards appropriate behavior is evident; it is expected that one cleans their hand after consuming food (which is commonly done with the right hand). Clearly, both examples express a negative judgment towards a state or event rather than negating it.

(10) a. tp: HIGH-PRICE MONEY ALL
‘Everything is expensive.’ [SuJu16jan7 00:17:14]

b. tp: RUB-CLEAN FINISH GOOD
‘It is good when your hands are completely clean (from the leftover food).’
[GD3jan7 00:15:22]

These examples, combined with the examples provided before, corroborate the interpretation that tongue protrusion is linked to negative evaluation. This is in line with a general property of tongue protrusion being associated with a negative stance; tongue protrusion serves as a gestural reflex expressing mood, specifically disgust, among all humans (Fridlund 1994; Rozin and Fallon 1987; Givens 2002), and has been observed to cover a range of semantic meanings, including disgust and rejection, in some sign languages (e.g., Johnston et al. 2016 for Auslan). As such, the use of tongue protrusion in Kata Kolok appears to be another instance of grammaticalization, not from a gesture from the ambient culture but of a more basic human trait.

6.2.3. Choice of Non-Manual Marker

The non-manual elements that we focus on in this study are headshake and tongue protrusion. Both these markers are most commonly co-articulated with NEG (72.2%; 117/162). Yet, in a substantial number of examples (14%; 23/162), non-manual elements occur independently, i.e., without the accompanying manual negator—be it in combination or on their own; thirteen examples occur in generation III, seven are attested in generation IV, and three in generation V (see Figure 2). Among these examples of non-manual elements occurring in the absence of NEG, the headshake occurs more frequently (86.9%; 20/23) than tongue protrusion (21.7%; 5/23)—see also examples (9c) and (9d). Generally, what we observe in these cases is that the headshake is co-articulated with the clause-final constituent (11a). Nevertheless, in some cases, the headshake and the non-negative sign it is co-articulated with are not fully synchronized, i.e., articulation of the manual sign precedes the onset of the headshake or vice versa. As a result, in (11b) the headshake starts only while the manual sign RICE is already being articulated. This example highlights the challenge of analyzing maximally reduced instances of negation, as is common in Kata Kolok. In addition, four cases are attested in generation III-signers in which the headshake is produced completely independently of manual signs, i.e., it is articulated by itself following a manual sign (11c). This pattern has also been reported for a few other sign languages (e.g., Hendriks 2008 for Jordanian Sign Language; Johnston 2018 for Auslan).

(11) a. hs (over TWICE-MARRIED)
BI$_1$ TWICE-MARRIED
'I won't get married a second time.' [GD3jan7 00:30:31.119]

b. hs (over RICE)
RICE
'I don't bring any rice.' [PiKe4jan7 00:13:41.000]

c. hs (over MOTORBIKE)
MOTORBIKE
'He does not like driving the motorbike.' [GD3jan7 00:49:02.470]

7. Discussion

In an effort to elucidate standard negation in Kata Kolok, we conducted a study of 1.73 h of intergenerational data drawn from the Kata Kolok Corpus. In line with what Marsaja (2008) described previously, we found examples that are negated by using only the manual negator NEG (13.6% of the dataset). Most commonly, however, the manual negator is combined with a clearly articulated headshake, a pattern which does not align with Marsaja's observations. Importantly, we identified an additional non-manual marker, namely, tongue protrusion, which functions as a specialized marker for negative evaluation and non-existence. Furthermore, and again contradicting Marsaja, the data reveal that a clause can be negated only by a non-manual marker (14.2% of the dataset), and this is more likely to happen in generation III—the oldest generation in our sample. Finally, while it is true that the headshake does not usually spread onto adjacent signs, headshake spreading seems to emerge in generation V. In short, the Kata Kolok pattern does not neatly fit into the existing classifications of manual dominant and non-manual dominant sign languages. This does not necessarily mean that this classification is wrong—there may well be sign languages that fit neatly into the proposed dichotomy. However, as already pointed out in Section 3.2, the classification may well be insufficient, as a sign language may display characteristics of both systems, or may employ a non-manual marker in a more gesture-like, i.e., less grammaticalized fashion.

It is likely that Kata Kolok and other recently studied sign languages challenge the proposed dichotomy because this dichotomy has been mostly based on elicited data, and corpus data may not always fully support such a clear-cut distinction. Alternatively, the patterns attested here could be the result of diachronic language change across three generations of signers. In the following, we first review the general pattern and tendencies identified in this study from a typological perspective. Then, we contextualize the results from the perspective of diachronic language change by drawing comparisons between generations.

7.1. Kata Kolok Negation in Typological Perspective

As described in the introduction, sign language negation systems are differentiated by (i) the presence of an obligatory manual marker and (ii) the scope of the headshake (Zeshan 2004, 2006). Systems in which the manual negator functions as the main negator require this negative sign at all times, and the headshake does not usually spread beyond this sign. In contrast, in systems where the headshake is the main negator, the manual negator is optional and the headshake may have scope over adjacent signs. In Table 3, we reproduce, with some adaptations, a comparative chart from Oomen and Pfau (2017), which details selected characteristics of negation systems in seven sign languages; these characteristics relate to the presence of NEG and the scope of the headshake. We added Kata Kolok, the only rural sign language in the table.

Table 3. Typological comparison of negation patterns across seven sign languages (adapted from Oomen and Pfau 2017; Kata Kolok added).

	DGS	LSC	ASL	NGT	LIS	TİD	KK
Country of Usage	**Germany**	**Catalonia**	**USA**	**The Netherlands**	**Italy**	**Turkey**	**Bali**
manual dominant?	−	−	−	−	+	+	(+)
NEG clause-final?	+	+	+/−	+/−	+	+	+
hs only on NEG?	−	+	+	?	+	+	+
hs only on predicate (if NEG is absent)	+	+	−	+	−	−	+
hs spread onto object?	+	+	+	+	−	−	+/−
hs spread onto subject?	−	−	+/−	−	−	−	+/−

The patterns reported in this study reveal that (i) as in the other sign languages included in Table 3, negative particles occur predominantly in clause-final position in Kata Kolok;[11] (ii) Kata Kolok negation is incompatible with either system, that is to say neither the manual nor the non-manual element appears obligatory; and (iii) Kata Kolok exhibits a language-specific pattern when it comes to the use of the headshake—headshake spreading is uncommon, and when present, it is very restricted in scope.

Interestingly, Kata Kolok is the only attested sign language where the headshake can accompany the negative particle, spread onto the subject or the object when the manual negator is present, *and* over the (verbal or non-verbal) predicate when the manual negator is absent. This observation may be related to the fact that many utterances comprise very few signs, irrespective of the type of constituent. Thus, it is possible that headshake spreading is associated with the clause-final position regardless of a specific word class. In line with Marsaja (2008), the manual negator represents the most frequent marker, which might suggest it as the main negator. This is supported by the rare and highly restricted nature of headshake spreading in Kata Kolok, which is typical for this pattern. Nevertheless, one must not forget that, despite the optionality of the manual negator in systems in which the headshake is the main negator, it still is commonly used; it was attested in 86% of cases in this sample (cf. Oomen and Pfau 2017 for NGT). Crucially, the manual negator is absent in 14% of all instances. The present results are thus also compatible with a system where the headshake functions as the main negator. In both classificatory scenarios, 14% of the data is negated by the use of the manual negator or the headshake only. In other words, it is impossible to categorize Kata Kolok as either a manual dominant or a non-manual dominant system. Growing evidence from studies investigating negation based on corpus data, much like the present study, shows that such naturalistic data may present us with characteristics from both extremes (Oomen and Pfau 2017; Johnston 2018; Kuder 2020).

Hence, they present a challenge to the established dichotomy, suggesting that the balance between manual and non-manual elements involved in sign language negation entails a continuum rather than binary categories. The present study contributes to sign language typology by adding a sign language of the lesser-studied type to the picture. Our results also suggest that prior classifications based on elicited data may have to be re-evaluated.

7.2. Emergence of Structure in the Domain of Negation

It is possible that Kata Kolok negation is currently in a transitional stage where different systems co-exist. The sampling method used in this study provides us with intergenerational data, which enables us to adopt the perspective of diachronic language change across three generations of signers. Five key observations can be made:

1. The combination of NEG and headshake is the most common strategy across all three generations.
2. There is a trend towards an increased engagement of the manual particle over the three generations.
3. Signers from the youngest generation make use of a greater range of combinatorial variants of NEG, headshake, or/and tongue protrusion.
4. The use of independent non-manual markers slowly decreases over time.
5. The frequency of headshake spreading increases considerably in generation V.

Although the effect appears small, we note a tendency towards more combined forms and greater presence of the manual negator in generation V compared to generations III and IV. In contrast, the difference in the use of headshake spreading in younger (generation V) versus older signers (III–IV) is striking, and we interpret this difference as evidence of language change. Nonetheless, there are at least four alternative explanations for this development. First, headshake spreading might be characteristic of a sociolinguistic youth-variant. Potentially, this feature is used only at a certain age, while it is abandoned again when growing older (Labov 1965, 1994; Sankoff 2006). Second, headshake spreading in generation V may be caused by a single lexical item: the verb GIVE precedes the manual negator in six out of eleven instances of headshake spreading in generation V, while GIVE accompanied by headshake is not attested in any other generation. Nevertheless, possible interactions of signer and predicate would have to be studied in detail in a separate study. Third, in spite of the striking pattern across generations (the significant result in the linear mixed effects model), the possible influence of idiosyncratic inter-signer variation cannot be excluded. Increasing the sample size could ameliorate the effect. Fourth, one may hypothesize that the emerging headshake spreading in generation V represents a language contact phenomenon. This is, however, unlikely, since the headshake plays a minor role in negation in signing varieties across Indonesia (Palfreyman 2019), including the variety used in Singaraja, a nearby city (p.c. with Nick Palfreyman).

We now offer some hypotheses on possible diachronic scenarios in the expression of negation. Pfau (2015) proposes that sign language negation conforms to the key principles of Jespersen's Cycle (Jespersen 1917). According to this theory, negative elements are reinforced through the use of a second negative particle and then weakened again by losing one of the two, as has been observed, for instance, in the history of French negation (van der Auwera 2011). Pfau (2015) hypothesizes that sign languages may have emerged as systems where the manual negator (derived from a manual gesture) dominates, and a headshake is only associated with the manual negator in a second step. In a subsequent step, the headshake may become more flexible and may eventually become an independent marker of negation, i.e., it may increasingly detach from the manual element and may then take over the status of the obligatory element. In this scenario, headshake spreading can only occur in the second step, where both markers are used, and the ability of spreading necessarily can only occur with the disassociation of the headshake and the manual particle. Ultimately, this can result in a system in which the headshake assumes the role of the main negator. Due to the shared modality of gesture and sign, the grammaticalization of manual gestures is common in sign languages (Wilcox 2004; Pfau and Steinbach 2011; van Loon et al.

2014), and especially prominent in negation (Zeshan 2004). For Kata Kolok, it is likely that the manual negator originates in a manual gesture used by (hearing) members within the community (Marsaja 2008). Notwithstanding these findings, non-manual elements function as fundamental elements in sign languages (Sandler and Lillo-Martin 2006; Pfau and Quer 2010). Thus, the visuo-gestural modality also favors the integration of non-manual gestures into sign language grammar (Pfau and Steinbach 2011). However, what motivates the assumption that manual gestures precede non-manual ones? Pfau (2015) argues with the aid of linguistic typology: cross-linguistically, the existence of particles is universal. Given that manual negators are used as particles, it seems likely that they arise before non-manual markers do. It is plausible that manual (handwave) and non-manual (headshake and protruded tongue) gestures entered the linguistic system of Kata Kolok around the same time after the language's emergence. What is unclear, however, is what the distribution of these forms may have looked like at these early stages. One way of gaining more insight into this issue would be a study of homesign data from the region to bridge the empirical gap between the data of generation III–V signers analyzed in this study and the very initial stages of the language. Such a study would allow us to extrapolate whether Kata Kolok is indeed likely to have started out as a manual dominant/only system, as suggested in the scenario created by Pfau (2015).

In this scenario, Kata Kolok initially made use of a range of diverse variants based on manual (NEG) and non-manual (headshake, tongue protrusion) elements, all of which originated in culture-specific gestures (Spitz 1957; Meltzoff and Moore 1989, 1977; Rozin and Fallon 1987; Fridlund 1994; Kendon 2002; Marsaja 2008; Kettner and Carpendale 2013; Pfau 2015). Later, signers start to converge on different, yet functionally redundant markers. Sign languages strive for simultaneity where possible in order to increase language efficiency (Pfau 2015). The Kata Kolok data set endorses this: the use of independent non-manuals decreases alongside an increase in combinations. In favor of enhancing language efficiency, and to reduce redundancy, individual markers begin to specialize, as in the case of tongue protrusion, for which a negative existential meaning is crystallizing.[12] It is possible that Kata Kolok negation has reached the stage of a manual dominant system: the use of only non-manual markers to negate decreases whilst the proportions of the manual negator remain stable. Although the increase in headshake spreading in generation V may even delineate a first step towards freeing the negative particle from its non-manual counterpart, a reduction in the use of the *manual-only* pattern would be expected if Kata Kolok were to move towards a *non-manual dominant* system.

One can envisage at least three scenarios for future generations: (i) Headshake spreading occurs as an artefact of a system in transition towards a system where the manual negator dominates. As the manual negator becomes dominant, the headshake will stabilize in its dedicated position, and headshake spreading may eventually decrease or fully disappear. Thus, the scope of the headshake is reduced to a single sign, namely, the manual negator, which functions as the obligatory marker. (ii) Headshake spreading remains, and becomes more systematic and productive. At the same time, instances that are negated exclusively by non-manuals steadily decrease until they have disappeared completely, and the manual negator stabilizes as an obligatory element. (iii) The systematicity of headshake spreading increases, and manual negators are progressively dropped. As a result, the headshake becomes obligatory. The different scenarios are visualized in Figure 4.

If the grammaticalization patterns attested here were to represent the initial stages of the emergence of negative structures in the language, one may have expected either gradual differences between each generation, or, alternatively, larger differences between generations III and IV, than between IV and V. Although the findings from this study do not necessarily suggest that Kata Kolok negation primarily used the manual negator in its initial stages, it is possible that this pattern precedes the analyzed data. Thus, such a system may have been characteristic of the language use of signers from generations I and II. In that case, however, it remains unclear what motivated the use of independent non-manual markers and why this is considerably more frequent in generation III than in younger signers. While the earlier generations of Kata Kolok signers are no longer alive, our proposed way forward is to study the distribution and functional diversification of negative gestures alongside speech (cf. Mesh and Hou 2018), in addition to various homesign languages that have been identified in the region.

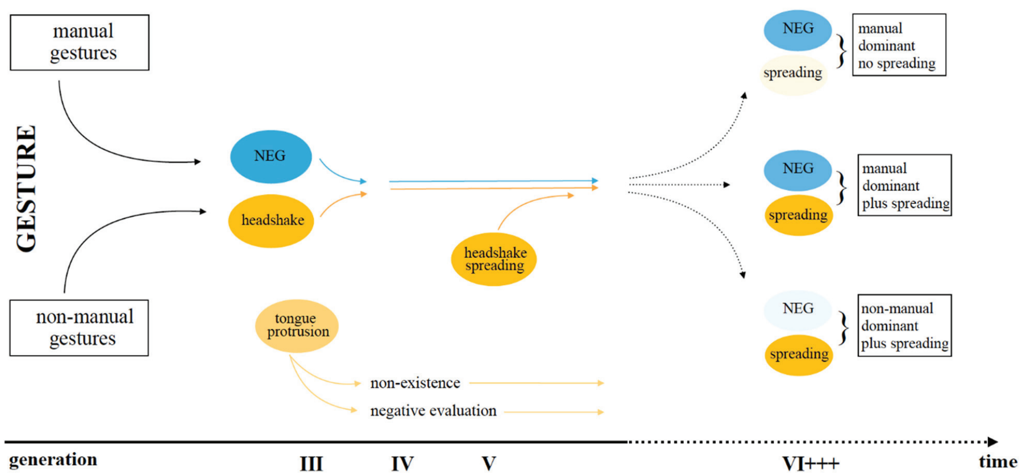


Figure 4. Sketch of possible grammaticalization scenarios of the main two negation markers in Kata Kolok. Note that the pathway for tongue protrusion is not integrated into the main pathway of negation given the low numbers attested in this study. Instead, tongue protrusion is kept as a somewhat separate pathway with more specialized, i.e., restricted, negative meanings.

8. Conclusions

To conclude, Kata Kolok is uniquely placed in the typological landscape of sign language negation, as it can neither be classified as a manual dominant system nor as a non-manual dominant system. Adopting a grammaticalization theory approach, we furthermore suggest multiple trajectories regarding how this distinct pattern may have arisen from its gestural precursors. It is hoped that future comparisons to home sign languages in the broader area of Bali will allow us to evaluate these possible grammaticalization scenarios. The study of the relationship between standard negation and other negative forms, e.g., negative interjections, imperatives, existentials, incompletives, and completives, entails a promising contribution to the study of diachronic language change. While the hands are often the focus of studies on sign language grammar (Puupponen 2019), the use of specific non-manual elements is of equal interest; the data provided in this article may indicate a grammaticalization continuum for all negative non-manual markers used in negative contexts. This highlights the need to consider the full repertoire of different signals that signers have at their disposal. At any rate, our study contributes to a better understanding of how grammaticalization may unfold throughout a sign language's lifespan with specific reference to negation. As such, this paper contributes to the contrastive analyses that are needed to pinpoint the factors that shape sign language grammars.

Supplementary Materials: Videos of all examples included in this article are available at https://osf.io/3ncfq/. (DOI 10.17605/OSF.IO/3NCFQ); accessed on 19 December 2021.

Author Contributions: Conceptualization, H.L., R.P. and C.d.V.; methodology, H.L., R.P. and C.d.V.; formal analysis, H.L., R.P. and C.d.V.; resources, C.d.V.; data curation, H.L.; writing—original draft preparation H.L.; writing—review and editing, H.L., R.P. and C.d.V.; visualization, H.L.; supervision, R.P. and C.d.V.; funding acquisition, C.d.V. All authors have read and agreed to the published version of the manuscript.

Funding: FWO-NWO under grant [NWO 326-70-002] "The emergence of phonology within six generations" awarded to Bart de Boer, Paula Fikkert, and Connie de Vos, by NWO under the VENI grant [VENI 275-89-028] "The face in sign language interaction" awarded to Connie de Vos, and by ERC under the ERC Starting Grant [ELISA—852352] "Emergence of Language in Social Interaction".

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki. Data used for this project was originally collected by de Vos (2012, 2016), and reuse was approved by the Ethics Assessment Committee of the Faculty of Arts and the Faculty of Philosophy, Theology, and Religious Studies (EAC) of Radboud University as part of the research project The emergence of phonology in six generations (application #2013, approved 17 March 2017).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: All data presented in this paper stem from the Kata Kolok Corpus, curated by The Language Archive (TLA) at the Max Planck Institute for Psycholinguistics, The Netherlands. Metadata are available at https://hdl.handle.net/1839/7ea873da-5ad4-474a-8cc7-7dfc51bbb552 (accessed on 19 December 2021) and access can be requested through the TLA website.

Acknowledgments: We thank all the Kata Kolok signers that have contributed to the Kata Kolok Corpus and have worked with us in documenting and describing the language through the years, in particular Ni Made Dadi Astini, Ni Made Sumarni, and I Ketut Kanta. Moreover, we are indebted to our three reviewers, who provided valuable feedback, which helped us improve the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Coding Scheme

Tier Name	Function	Code
manual (dom./non-dom)	glosses	
non-manual	tongue protrusion	
non-manual_head	headshake	
translation	translation into English	
negation	marks instance of negation indicates the signer	
negation category	specifies the negation category	refusal, non-existence, denial
constituent order	position of the negator in relation to predicate, subject and object	
combined form	manual negator co-articulated with non-manual elements	0 (absent) 1 (present)
pt function	function of tongue protrusion	0 (absent), gestural, lexical, death marker, negative evaluation, negation
negation type	specifies the type of negation	standard negation negative imperative negative completive negative modal negative interjection negative existential negative contrast
NEG presence	presence of manual negator	0 (absent) 1 (present)
hs presence	presence of headshake	0 (absent) 1 (present)
pt presence	presence of tongue protrusion	0 (absent) 1 (present)
hs spreading	presence of headshake spreading	0 (absent) 1 (present)
Comment	additional comment	

Notes

1 Language-external factors include processes like standardization (e.g., Schermer 2003) and borrowing—be it from another sign language or the surrounding spoken language, e.g., in the form of mouthings or fingerspelling (Brentari 2001). Fischer (1975) describes how due to external factors, i.e., contact with English, word order in American Sign Language has changed from SOV to SVO.

2 Other, far less common, strategies are higher negative verbs and negative auxiliaries (Payne 1985), but these will not be considered here.

3 In some sign languages of the Eastern Mediterranean region, besides a headshake, a backward head tilt is also used as a non-manual marker of negation (e.g., Gökgöz 2011 for Turkish Sign Language; Hendriks 2008 for Jordanian Sign Language); this is clearly an areal feature, as a backward head tilt is also used as a negative co-speech gesture in that region. Moreover, for Chinese Sign Language, it has been claimed that a negative facial expression functions as the main non-manual device for negating a clause while a headshake alone cannot yield a negative interpretation (Yang and Fischer 2002). Except for a brief note when discussing Auslan below, we will not further address these non-manual markers (see also Zeshan 2004), but in Section 6.2.2, we add to the typological picture another non-manual marker, viz. tongue protrusion.

4 Following the convention in sign language linguistics, signs are represented as glosses in small caps (GLOSS). Examples are accompanied by video stills where available. Written examples of signed sentences are represented in three lines, one including the non-manual markers, one including the glosses, and a free translation. Non-manual markers are represented in common letters with an underscore line indicating the scope of the respective marker and brackets to indicate where the spreading of the non-manual is optional. Glosses are provided in English throughout.

5 The software is accessible from http://tla.mpi.nl/tools/tla-tools/elan/, (accessed on 19 December 2021).

6 As pointed out in the section on the typology of negation, our study focuses on standard negation. Still, for the sake of completeness, we want to point out that the corpus search also yielded numerous examples of other negation strategies, namely negative existentials (89 instances), negative imperatives (78 instances), and negative interjections (69 instances).

7 Values do not add up to 100% since the manual particle may combine with one or even both of the non-manual markers listed here.

8 BI_1 represents the gloss for a first-person-pointing with a flat-B-handshape. IX is generally used for a pointing sign, specifying IX'locative' for locative reference and IX_2 for a second-person point. Note that non-manuals may be more clearly visible in the video clips provided on the OSF page than in the stills.

9 In addition to the descriptive statistics provided in the main text, we also used a linear mixed effect model in R (R Core Team 2019), using the lme4 package (Bates et al. 2015), to determine whether generation (fixed effect) is a significant predictor for the use of the manual negator, taking into account individual variation (random intercept by participant). The significance value was determined at 0.05. Contrasts were defined manually to compare the youngest generation (V) against generation III and generation IV, as well as the two older generations against each other. The model did not provide any evidence that older and younger generations differ significantly in the use of the manual negator. Note, however, that any statistical analysis should be interpreted with caution, given the size of our sample.

10 In addition to the descriptive statistics provided here above, we also used a linear mixed effect model in R (R Core Team 2019), using the lme4 package (Bates et al. 2015), to determine whether generation (fixed effect) is a significant predictor for headshake spreading when taking individual variation (random intercept by participant) into account. The significance value was determined at 0.05. Contrasts were defined manually to compare the youngest generation (V) against generation III and generation IV, as well as the two older generations against each other. This model revealed a significant effect for generation V when compared to generations III and IV ($z < 0.05$). Thus, the headshake spreads significantly more often in productions of the youngest signers than in those of the older signers (Figure 3). Given that signer ID was defined as random intercepts, the observed differences between signers from different generations are unlikely to be caused by idiosyncratic variation. This is corroborated by the relative frequency of scope that is considerably higher for both generation V-signers than for older signers. In addition, we checked for potential effects of gender in both models by defining gender as fixed effect. In both cases, gender does not seem to influence the use of the manual negator and headshake spreading. Note, however, that any statistical analysis should be interpreted with caution, given the size of our sample.

11 Similarly, Zeshan (2004, p. 39) reports for her sample of 38 sign languages, that "independent of word order typology, there is a striking preference for post-predicate or clause-final position of negatives across sign languages. [. . .] In some cases, this is the only acceptable position." Interestingly, Zeshan's sample includes Auslan, but Johnston's corpus-based study reveals that the negative particle predominantly precedes the predicate. We thank one of our reviewers for drawing our attention to this fact.

12 See also Mesh and Hou (2018) on the use of TWIST as a negative existential marker in San Juan Quiahije Chatino Sign Language.

References

Adone, Dany. 2012. Language Emergence and Creolisation. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter Mouton, pp. 862–89.

Bates, Douglas, Martin Mächler, Ben Bolker, and Steve Walker. 2015. Fitting Linear Mixed-Effects Models Using Lme4. *Journal of Statistical Software* 67. [CrossRef]

Bayley, Robert, Adam Schembri, and Ceil Lucas. 2015. Variation and Change in Sign Languages. In *Sociolinguistics and Deaf Communities*. Edited by Adam Schembri and Ceil Lucas. Cambridge: Cambridge University Press, pp. 61–94. [CrossRef]

Brentari, Diane. 2001. *Foreign Vocabulary in Sign Languages. A Cross-Linguistic Investigation of Word Formation*. Mahwah: Erlbaum.

Cooperrider, Kensy, Natasha Abner, and Susan Goldin-Meadow. 2018. The Palm-up Puzzle: Meanings and Origins of a Widespread Form in Gesture and Sign. *Frontiers in Communication* 3: 23. [CrossRef]

Coppola, Marie, and Ann Senghas. 2010. Deixis in an Emerging Sign Language. In *Sign Languages*, 1st ed. Edited by Diane Brentari. Cambridge: Cambridge University Press, pp. 543–69. [CrossRef]

Dachkovsky, Svetlana. 2020. From a Demonstrative to a Relative Clause Marker: Grammaticalization of Pointing Signs in Israeli Sign Language. *Sign Language & Linguistics* 23: 142–70. [CrossRef]

Dachkovsky, Svetlana, Rose Stamp, and Wendy Sandler. 2018. Constructing Complexity in a Young Sign Language. *Frontiers in Psychology* 9: 2202. [CrossRef]

Dahl, Östen. 1979. Typology of Sentence Negation. *Linguistics* 17: 79–106. [CrossRef]

Dahl, Östen. 2011. Typology of Negation. In *The Expression of Negation*. Edited by Laurence R. Horn. Berlin: De Gruyter Mouton, pp. 9–38.

de Vos, Connie. 2012. Sign-Spatiality in Kata Kolok: How a Village Sign Language of Bali Inscribes Its Signing Space. Ph.D. thesis, Radboud University, Nijmegen, The Netherlands. [CrossRef]

de Vos, Connie. 2015. The Kata Kolok Pointing System: Morphemization and Syntactic Integration. *Top Cogn. Sci.* 7: 150–68. [CrossRef]

de Vos, Connie. 2016. Sampling Shared Sign Languages. *Sign Language Studies* 16: 204–26. [CrossRef]

de Vos, Connie, and Roland Pfau. 2015. Sign Language Typology: The Contribution of Rural Sign Languages. *Annual Review of Linguistics* 1: 265–88. [CrossRef]

de Vos, Connie, and Victoria Nyst. 2018. The Time Depth and Typology of Rural Sign Languages. *Sign Language Studies* 18: 477–87. [CrossRef]

Dryer, Matthew. 2005. Negative Morphemes. In *World Atlas of Language Structures*. Edited by Martin Haspelmath, Matthew Dryer, David Gil and Bernard Comrie. Oxford: Oxford University Press, pp. 454–57.

ELAN [Computer Software] (version 5.9). 2020. Nijmegen: Max Planck Institute for Psycholinguistics, The Language Archive. Available online: https://archive.mpi.nl/tla/elan (accessed on 19 December 2021).

Fischer, Susan. 1975. Influences on Word Order Change in American SIgn Language. In *Word Order and Word Order Change*. Edited by Charles Li. Austin: University of Texas Press, pp. 1–25.

Fleiss, Joseph L., Bruce Levin, and Myunghee Cho Paik. 2003. *Statistical Methods for Rates and Proportions*, 3rd ed. Wiley Series in Probability and Statistics; Hoboken: J. Wiley.

Franklin, Amy, Anastasia Giannakidou, and Susan Goldin-Meadow. 2011. Negation, Questions, and Structure Building in a Homesign System. *Cognition* 118: 398–416. [CrossRef] [PubMed]

Fridlund, Alan. 1994. *Human Facial Expression. An Evolutionary View*. London: Academic Press.

Friedman, Thomas B., Yong Liang, James L. Weber, John T. Hinnant, Thomas D. Barber, Sunaryana Winata, I. Nyoman Arhya, and James H. Asher. 1995. A Gene for Congenital, Recessive Deafness DFNB3 Maps to the Pericentromeric Region of Chromosome 17. *Nature Genetics* 9: 86–91. [CrossRef] [PubMed]

Frishberg, Nancy. 1975. Arbitrariness and Iconicity: Historical Change in American Sign Language. *Language* 51: 696–719. [CrossRef]

Gamer, Matthias, Jim Lemon, Ian Fellows, and Puspendra Singh. 2012. Various Coefficients of Inter-Rater Reliability and Agreement. 818 R Package Version 0.84. Available online: https://CRAN.R-project.org/package=irr (accessed on 19 December 2021).

Geraci, Carlo. 2005. Negation in LIS (Italian Sign Language). In *Proceedings of the North East Linguistic Society (NELS 35)*. Edited by Leah Bateman and Cherlon Ussery. Amherst, MA: GLSA, pp. 217–29.

Givens, David B. 2002. *The Nonverbal Dictionary of Gestures, Signs & Body Language Cues*. Washington, DC: Center for Nonverbal Studies Press.

Gökgöz, Kadir. 2011. Negation in Turkish Sign Language: The Syntax of Nonmanual Markers. *Sign Language & Linguistics* 14: 49–75. [CrossRef]

Goldin-Meadow, Susan. 2014. The Impact of Time on Predicate Forms in the Manual Modality: Signers, Homesigners, and Silent Gesturers. *Topics in Cognitive Science* 7: 169–84. [CrossRef]

Hendriks, Bernadet. 2008. *Jordanian Sign Language: Aspects of Grammar from a Cross-Linguistic Perspective*. LOT 193. Utrecht: LOT.

Jespersen, Otto. 1917. *Negation in English and Other Languages*. Copenhagen: Høst.

Johnston, Trevor, Jane van Roekel, and Adam Schembri. 2016. On the Conventionalization of Mouth Actions in Australian Sign Language. *Language and Speech* 59: 3–42. [CrossRef]

Johnston, Trevor. 2018. A Corpus-Based Study of the Role of Headshaking in Negation in Auslan (Australian Sign Language): Implications for Signed Language Typology. *Linguistic Typology* 22: 185–231. [CrossRef]

Kegl, Judy A., Ann Senghas, and Marie Coppola. 1999. Creation through Contact: Sign Language Emergence and Sign Language Change in Nicaragua. In *Language Creation and Language Change: Creolization, Diachrony, and Development*. Edited by Michel DeGraff. Cambridge: MIT Press, pp. 179–237.

Kendon, Adam. 2002. Some Uses of the Head Shake. *Gesture* 2: 147–82. [CrossRef]

Kettner, Viktoria A., and Jeremy I. M. Carpendale. 2013. Developing Gestures for No and Yes: Head Shaking and Nodding in Infancy. *Gesture* 13: 193–209. [CrossRef]

Kirby, Simon, Hannah Cornish, and Kenny Smith. 2008. Cumulative Cultural Evolution in the Laboratory: An Experimental Approach to the Origins of Structure in Human Language. *Proceedings of the National Academy of Sciences* 105: 10681–86. [CrossRef]

Kocab, Annemarie, and Ann Senghas. 2021. Language Emergence: Theoretical and Empirical Perspectives. In *The Routledge Handbook of Theoretical and Experimental Sign Language Research*. Edited by Josep Quer, Roland Pfau and Annika Herrmann. London: Routledge, pp. 636–63.

König, Alexander. 2011. The Language Archive. Available online: https://archive.mpi.nl/tla/ (accessed on 19 December 2021).

Kuder, Anna. 2020. Negation Markers in Polish Sign Language. Ph.D. thesis, University of Warsaw, Warsaw, Poland. (In Polish)

Kwok, Lily, Stephanie Berk, and Diane Lillo-Martin. 2020. Person vs. Locative Agreement: Evidence from Late Learners and Language Emergence. *Sign Language & Linguistics* 23: 17–37. [CrossRef]

Labov, William. 1965. On the Mechanism of Linguistic Change. In *Report of the Sixteenth Annual Round Table Meeting on Linguistics and 841 Language Studies*. Edited by Charles Kreidler. Washington, DC: Georgetown University Press, pp. 91–114.

Labov, William. 1994. *Principles of Linguistic Change*. Language in Society 20. Cambridge: Blackwell.

Lucas, Ceil, Robert Bayley, and Clayton Valli. 2001. *Sociolinguistic Variation in American Sign Language*. The Sociolinguistics of Deaf Communities 7. Washington, DC: Gallaudet University Press.

Lutzenberger, Hannah. Forthcoming. Threat or Natural Fluctuation? Revisiting Language Vitality of Kata Kolok, the Sign Language of a Village in Bali. In *State of the Art of Indigenous Languages in Research: A Collection of Selected Research Papers*. Paris: UNESCO, *in press*.

Marsaja, I. Gede. 2008. *Desa Kolok: A Deaf Village and Its Sign Language in Bali, Indonesia*. Nijmegen: Ishara Press.

McBurney, Susan. 2012. History of Sign Languages and Sign Language Linguistics. In *Sign Language—An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter Mouton, pp. 909–48. [CrossRef]

Meir, Irit, and Wendy Sandler. 2020. Variation and Conventionalization in Young Sign Languages. In *Linguistic Contact, Continuity and Change in the Genesis of Modern Hebrew*. Edited by Edit Doron, Malka Rappaport Hovav, Yael Reshef and Moshe Taube. Amsterdam: John Benjamins, pp. 337–63.

Meir, Irit, Mark Aronoff, Carl Börstell, So-One Hwang, Deniz Ilkbasaran, Itamar Kastner, Ryan Lepic, Adi Lifshitz Ben-Basat, Carol Padden, and Wendy Sandler. 2017. The Effect of Being Human and the Basis of Grammatical Word Order: Insights from Novel Communication Systems and Young Sign Languages. *Cognition* 158: 189–207. [CrossRef] [PubMed]

Meir, Irit, Wendy Sandler, Carol Padden, and Mark Aronoff. 2010. Emerging Sign Languages. In *The Oxford Handbook of Deaf Studies, Language, and Education*. Edited by Marc Marschark and Patricia Elizabeth Spencer. Oxford: Oxford University Press, vol. 2, pp. 267–80. [CrossRef]

Meltzoff, Andrew N., and M. Keith Moore. 1977. Imitation of Facial and Manual Gestures by Human Neonates. *Science* 198: 75–78. [CrossRef] [PubMed]

Meltzoff, Andrew N., and M. Keith Moore. 1989. Imitation in Newborn Infants: Exploring the Range of Gestures Imitated and the Underlying Mechanisms. *Developmental Psychology* 25: 954–62. [CrossRef]

Mesh, Kate, and Lynn Hou. 2018. Negation in San Juan Quiahije Chatino Sign Language: The Integration and Adaptation of Conventional Gestures. *Gesture* 17: 330–74. [CrossRef]

Miestamo, Matti. 2005. *Standard Negation: The Negation of Declarative Verbal Main Clauses in a Typological Perspective*. Empirical Approaches to Language Typology. Berlin: De Gruyter, vol. 31.

Moriarty, Erin. 2020. 'Sign to Me, Not the Children': Ideologies of Language Contamination at a Deaf Tourist Site in Bali. *Language & Communication* 74: 195–203. [CrossRef]

Motamedi, Yasamin, Marieke Schouwstra, Kenny Smith, Jennifer Culbertson, and Simon Kirby. 2019. Evolving Artificial Sign Languages in the Lab: From Improvised Gesture to Systematic Sign. *Cognition* 192: 103964. [CrossRef]

Mudd, Katie, Hannah Lutzenberger, Connie de Vos, Paula Fikkert, Onno Crasborn, and Bart de Boer. 2020. The Effect of Sociolinguistic Factors on Variation in the Kata Kolok Lexicon. *Asia-Pacific Language Variation* 6: 53–88. [CrossRef]

Nyst, Victoria. 2012. Shared Sign Languages. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter Mouton, pp. 552–74.

Oomen, Marloes, and Roland Pfau. 2017. Signing NOT (or Not): A Typological Perspective on Standard Negation in Sign Language of The Netherlands. *Linguistic Typology* 21: 1–51. [CrossRef]

Padden, Carol, Irit Meir, Mark Aronoff, and Wendy Sandler. 2010. The Grammar of Space in Two New Sign Languages. In *Sign Languages (Cambridge Language Surveys)*. Edited by Diane Brentari. New York: Cambridge University Press, pp. 573–95.

Palfreyman, Nick. 2019. *Variation in Indonesian Sign Language: A Typological and Sociolinguistic Analysis*. Berlin: De Gruyter Mouton. [CrossRef]

Payne, John. 1985. Negation. In *Language Typology and Syntactic Description, Vol. 1: Clause Structure*. Edited by Timothy Shopen. Cambridge: Cambridge University Press, pp. 197–242.

Perniss, Pamela, and Ulrike Zeshan. 2008. Possessive and Existential Constructions in Kata Kolok. In *Possessive and Existential Constructions in Sign Languages*. Edited by Pamela Perniss and Ulrike Zeshan. Sign Language Typology Series, No. 2. Nijmegen: Ishara Press, pp. 125–50.

Pfau, Roland. 2008. The Grammar of Headshake: A Typological Perspective on German Sign Language Negation. *Linguistics in Amsterdam* 1: 37–74.

Pfau, Roland. 2011. A Point Well Taken. On the Typology and Diachrony of Pointing. In *Deaf around the World. The Impact of Language*. Edited by Gaurav Mathur and Donna Jo Napoli. Oxford: Oxford University Press, pp. 144–63.

Pfau, Roland. 2015. The Grammaticalization of Headshakes: From Head Movement to Negative Head. In *New Directions in Grammaticalization Research*. Edited by Andrew D. M. Smith, Graeme Trousdale and Richard Waltereit. Amsterdam: John Benjamins, pp. 9–50. [CrossRef]

Pfau, Roland. 2016. A Featural Approach to Sign Language Negation. In *Negation and Polarity: Experimental Perspectives*. Edited by Pierre Larrivée and Chungmin Lee. Dordrecht: Springer, pp. 45–74. Available online: http://link.springer.com/chapter/10.1007/978-3-319-17464-8_3 (accessed on 19 December 2021).

Pfau, Roland, and Josep Quer. 2002. V-to-Neg Raising and Negative Concord in Three Sign Languages. *Rivista di Grammatica Generativa* 27: 73–86.

Pfau, Roland, and Josep Quer. 2010. Nonmanuals: Their Prosodic and Grammatical Roles. In *Sign Languages (Cambridge Language Surveys)*. Edited by Diane Brentari. Cambridge: Cambridge University Press, pp. 381–402.

Pfau, Roland, and Markus Steinbach. 2011. Grammaticalization in Sign Languages. In *The Oxford Handbook of Grammaticalization*. Edited by Bernd Heine and Heiko Narrog. Oxford: Oxford University Press, pp. 1–15. [CrossRef]

Puupponen, Anna. 2019. Towards Understanding Nonmanuality: A Semiotic Treatment of Signers' Head Movements. *Glossa: A Journal of General Linguistics* 4: 39. [CrossRef]

Quer, Josep. 2012. Negation. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter Mouton, pp. 316–39.

R Core Team. 2019. *R: A Language and Environment for Statistical Computing*. Version 1.0.143. Vienna: R Foundation for Statistical Computing. Available online: https://www.R-project.org/ (accessed on 19 December 2021).

Rozin, Paul, and April E. Fallon. 1987. A Perspective on Disgust. *Psychological Review* 94: 23–41. [CrossRef] [PubMed]

Rudnev, Pavel, and Anna Kuznetsova. 2021. Linearization Constraints on Sentential Negation in Russian Sign Language Are Prosodic. *Sign Language & Linguistics* 24: 259–73.

Sandler, Wendy, and Diane Lillo-Martin. 2006. *Sign Language and Linguistic Universals*. Cambridge: Cambridge University Press.

Sandler, Wendy, Irit Meir, Carol Padden, and Mark Aronoff. 2005. The Emergence of Grammar: Systematic Structure in a New Language. *Proceedings of the National Academy of Sciences of the United States of America* 102: 2661–65. [CrossRef] [PubMed]

Sandler, Wendy, Mark Aronoff, Irit Meir, and Carol Padden. 2011. The Gradual Emergence of Phonological Form in a New Language. *Natural Language & Linguistic Theory* 29: 503–43. [CrossRef]

Sandler, Wendy. 1999. The Medium and the Message: The Prosodic Interpretation of Linguistic Content in Israeli Sign Language. *Sign Language & Linguistics* 2: 187–215.

Sankoff, Gillian. 2006. Age: Apparent Time and Real Time. In *Encyclopedia of Language & Linguistics*. Amsterdam: Elsevier, pp. 110–16. [CrossRef]

Schembri, Adam, and Trevor Johnston. 2012. Sociolinguistic Aspects of Variation and Change. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter Mouton, pp. 788–816.

Schembri, Adam, David McKee, Rachel McKee, Sara Pivac, Trevor Johnston, and Della Goswell. 2009. Phonological Variation and Change in Australian and New Zealand Sign Languages: The Location Variable. *Language Variation and Change* 21: 193–231. [CrossRef]

Schermer, Trude. 2003. From Variant to Standard: An Overview of the Standardization Process of the Lexicon of Sign Language of The Netherlands over Two Decades. *Sign Language Studies* 3: 469–86. [CrossRef]

Schwager, Waldemar, and Ulrike Zeshan. 2008. Word Classes in Sign Languages: Criteria and Classifications. *Studies in Language* 32: 509–45. [CrossRef]

Senghas, Ann. 2005. Language Emergence: Clues from a New Bedouin Sign. *Current Biology* 15: R463–65. [CrossRef] [PubMed]

Senghas, Ann, and Marie Coppola. 2001. Children Creating Language: How Nicaraguan Sign Language Acquired a Spatial Grammar. *Psychological Science* 12: 323–28. [CrossRef]

Spitz, Rene A. 1957. *No and Yes: On the Genesis of Human Communication*. New York: International Universities Press.

Stamp, Rose, and Wendy Sandler. 2021. The Emergence of Referential Shift Devices in Three Young Sign Languages. *Lingua* 257: 103070. [CrossRef]

Supalla, Ted. 2001. Making Historical Sign Language Materials Accessible: A Prototype Database of Early ASL. *Sign Language & Linguistics* 4: 285–97. [CrossRef]

van Boven, Cindy, Marloes Oomen, and Roland Pfau. Forthcoming. Negative Concord in Sign Language of The Netherlands: Journey through a Corpus. In *Advances in Sign Language Corpus Linguistics*. Edited by Ella Wehrmeyer. Amsterdam: John Benjamins, *submitted*.

van der Auwera, Johan. 2011. On the Diachrony of Negation. In *The Expression of Negation*. Edited by Laurence R. Horn. Berlin: De Gruyter Mouton, pp. 73–109.

van Loon, Esther, Roland Pfau, and Markus Steinbach. 2014. The Grammaticalization of Gestures in Sign Languages. In *Body—Language—Communication: An International Handbook on Multimodality in Human Interaction*. Edited by Cornelia Müller, Alan Cienki, Ellen Fricke, Silva Ladewig, David McNeill and Sedinha Tessendorf. Berlin: De Gruyter Mouton, pp. 2133–49. [CrossRef]

Wilcox, Sherman. 2004. Gesture and Language. Cross-linguistic and Historical Data from Signed Languages. *Gesture* 4: 43–73. [CrossRef]

Winata, Sunaryana, I Nyoman Arhya, Sukarti Moeljopawiro, John T. Hinnant, Yong Liang, Thomas B. Friedman, and James H. Asher. 1995. Congenital Non-Syndromal Autosomal Recessive Deafness in Bengkala, an Isolated Balinese Village. *Journal of Medical Genetics* 32: 336–43. [CrossRef] [PubMed]

Wittenburg, Peter, Hennie Brugman, Albert Russel, Alex Klassmann, and Han Sloetjes. 2006. ELAN: A Professional Framework for Multimodality Research. Paper presented at the 5th International Conference on Language Resources and Evaluation (LREC 2006), Genoa, Italy, May 22–28, pp. 1556–59.

Woll, Bencie. 1987. Historical and Comparative Aspects of BSL. In *Sign and School: Using Signs in Deaf Children's Development*. Edited by Jim Kyle. Clevedon: Multilingual Matters, pp. 12–34.

Yang, Jun Hui, and Susan D. Fischer. 2002. Expressing Negation in Chinese Sign Language. *Sign Language & Linguistics* 5: 167–202.

Zeshan, Ulrike. 2004. Hand, Head, and Face: Negative Constructions in Sign Languages. *Linguistic Typology* 8: 1–58. [CrossRef]

Zeshan, Ulrike, ed. 2006. *Interrogative and Negative Constructions in Sign Languages*. Sign Language Typology Series No. 1. Nijmegen: Ishara Press.

Zeshan, Ulrike, and Connie de Vos, eds. 2012. *Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Sign Language Typology 4. Berlin: De Gruyter Mouton, Nijmegen: Ishara Press.

Zeshan, Ulrike, Ernesto Delgado, Hasan Dikyuva, Sibaji Panda, and Connie de Vos. 2013. Cardinal Numerals in Rural Sign Languages: Approaching Cross-Modal Typology. *Linguistic Typology* 17: 357–96. [CrossRef]

languages

MDPI

Article

Conventionalization of Iconic Handshape Preferences in Family Homesign Systems

Madeline Quam [1,2,*], Diane Brentari [3] and Marie Coppola [1,2,4]

[1] Department of Psychological Sciences, University of Connecticut, Storrs, CT 06268, USA; marie.coppola@uconn.edu
[2] The Connecticut Institute for the Brain and Cognitive Sciences, Storrs, CT 06268, USA
[3] Department of Linguistics, University of Chicago, Chicago, IL 60637, USA; dbrentari@uchicago.edu
[4] Department Linguistics, University of Connecticut, Storrs, CT 06268, USA
* Correspondence: madeline.quam@uconn.edu

Abstract: Variation in the linguistic use of handshapes exists across sign languages, but it is unclear how these iconic handshape preferences arise and become conventionalized. In order to understand the factors that shape such handshape preferences in the earliest stages of language emergence, we examined communication within family homesign systems. Homesigners are deaf individuals who have not acquired a signed or spoken language and who innovate unique gesture systems to communicate with hearing friends and family ("communication partners"). We analyzed how characteristics of participants and stimulus items influence handshape preferences and conventionalization. Participants included 11 deaf homesigners, 24 hearing communication partners (CPs), and 8 hearing non-signing adults from Nicaragua. Participants were asked to label items using gestures or signs. The handshape type (Handling, Object, or combined Handling+Object) was then coded. The participants and groups showed variability in iconic handshape preferences. Adult homesigners' families demonstrated more conventionalization than did child homesigners' families. Adult homesigners also used a combined Handling + Object form more than other participants. Younger CPs and those with fewer years of experience using a homesign system showed greater conventionalization. Items that elicited a reliable handshape preference were more likely to elicit Handling rather than Object handshapes. These findings suggest that similarity in terms of handshape type varies even within families, including hearing gesturers in the same culture. Although adult homesigners' families were more conventionalized than child homesigners' families, full conventionalization of these handshape preferences do not seem to appear reliably within two to three decades of use in a family when only one deaf homesigner uses it as a primary system.

Keywords: homesign; sign language emergence; conventionalization; handshape; iconicity

Citation: Quam, Madeline, Diane Brentari, and Marie Coppola. 2022. Conventionalization of Iconic Handshape Preferences in Family Homesign Systems. *Languages* 7: 156. https://doi.org/10.3390/languages7030156

Academic Editors: Wendy Sandler, Mark Aronoff, Carol Padden, Juana M. Liceras and Raquel Fernández Fuertes

Received: 12 October 2021
Accepted: 15 June 2022
Published: 21 June 2022

1. Introduction

Since Plato's dialogue *Cratylus*, researchers have been intrigued by the process of naming in spoken and, more recently, in signed languages. Decades of work on sign languages demonstrate that social conventionalization and natural iconic affordances both play important roles, as does the arbitrary nature of linguistic form. Research on "patterned iconicity", a term created by Padden and her colleagues, which refers to the repeated use of iconic strategies for signs within a certain category (Padden et al. 2013, 2015; Hwang et al. 2017), has demonstrated shared preferences for different types of iconicity when naming objects in both sign languages and in the gestures made by hearing people.

Typological variation in handshapes exists across sign languages (Brentari et al. 2015; Eccarius 2008), but it is unclear how iconic handshape preferences arise and become conventionalized. In this paper, we analyze several factors that may be important in tool naming, particularly related to handshape, revisiting this issue in an important population that naturally engages in the creation of names in their daily lives. The current study investigates the development of iconic handshape preferences by turning to the case of homesigners and their communication partners. Specifically, we examine handshape type preferences for tools within and across individuals and in families with and without a deaf homesigning family member to determine if there is an underlying universal handshape type preference and whether family members who communicate with each other frequently converge on a preference.

1.1. Iconic Handshape Preferences in Sign Languages

One way to classify handshape is by iconic class, as either Handling (i.e., the hand represents a hand manipulating an item) or Object (i.e., the hand resembles the item). The Handling/Object distinction is robust and systematically used in a variety of ways, and previous work has shown that handshape preference in sign languages is used both lexically and grammatically. Padden et al. (2015) analyzed the productions of ASL signers and gesturers in the United States and found that both groups used Handling handshapes more frequently to describe actions and Object handshapes more frequently to describe static objects. Hunsicker and Goldin-Meadow (2013) found a child homesigner used handshape class (handling/object) to distinguish nouns and verbs at an early stage of development. The Handling/Object distinction is therefore used to mark a distinction between lexical classes (noun/verb), even in homesign gesture systems in which structured linguistic input is not available.

Within verbs, handshape class (i.e., Handling vs. Object) is used grammatically to mark agent versus no-agent contexts in Nicaraguan Sign Language, American Sign Language, Hong Kong Sign Language, British Sign Language, and Italian Sign Language (Benedicto and Brentari 2004; Goldin-Meadow et al. 2015; Brentari et al. 2015, 2020).

For nouns, the focus of the current study, handshape type is often more uniform within a given language. For example, for lexical items referring to tools, Object handshapes are preferred in American Sign Language (ASL), while Handling handshapes are preferred in New Zealand Sign Language (NZSL) (Padden et al. 2013). San Juan Quiahije Chatino Sign Language (CSL), an emerging sign language, has also demonstrated a Handling preference for tools (Hou 2018). Note that when we use the term emerging sign languages, we are referring to languages that are relatively new (i.e., have existed for decades, rather than centuries or millennia), have a small number of initial users, and may exhibit more variety or higher rates of change (see Le Guen et al. 2020 for a more detailed definition of emerging sign languages). By describing a language as emerging, we are by no means implying any sort of hierarchy amongst languages and want to be clear that we are not suggesting that emerging languages are in any way less than established languages (see Braithwaite 2020 for further discussion). Rather, we are making a distinction between emerging languages and languages with much longer histories, which as a result have different characteristics. Because we take a developmental perspective on language creation and language genesis, we use the term "emerging" in the same spirit as one characterizes the developing language of a child. That is, the language is in flux and, therefore, can reveal the capacities and processes that allow it to emerge, which we propose are the same as those that allow children to acquire the languages around them so effortlessly (Senghas and Coppola 2001; Senghas 2019).

Since we can observe differences across languages for Handling or Object preferences, then presumably, during the emergence of a system, initial users of the system have the opportunity to somehow choose a handshape preference type. As this is likely not a conscious decision, we would like to understand the factors that go into settling on an iconic handshape preference. However, not every sign language uses patterned iconicity as a strategy, for example, the Yucatec Mayan Sign Languages, a group of relatively young village sign languages (Safar and Chan 2020). Since this systematic use of Handling/Object can be used in a variety of morphological and syntactic contrasts, and yet does not seem to be present in every sign language, patterned iconicity may not be a universal phenomenon early in language emergence, but instead may only become evident later. If there is indeed a universal cognitive bias towards Handling or Object, or if there are inherent properties of the items themselves, we might observe this when a system is emerging (Brentari et al. 2012). In other words, if this type of iconic handshape preference is available early, we may observe it in homesign systems as well, but if it emerges later, we would only see it in established sign languages and not in homesign systems. In order to understand how iconic handshape preferences develop for labeling objects, we must examine cases other than signers of established sign languages, such as homesigners and hearing gesturers.

Differences in handshape preferences between signers and non-signers are also observed; in general, hearing silent gesturers (i.e., hearing individuals with no exposure to a sign language who are asked to label an item or describe an event without speaking) tend to use Handling handshapes (Padden et al. 2015). Additionally, hearing people silently gesturing do not always show the same preferences and patterns as signers from the same community. Even in childhood, signers become attuned to the contrast between Object and Handling Handshapes and in turn use strategies to make those distinctions, something that hearing gesturers do not do (Brentari et al. 2015). There are also differences in the complexity of handshapes between signers and gesturers. In Nicaragua, Italy, and the United States, signers of Italian Sign Language (LIS) and ASL show higher finger complexity in Object Handshapes and higher joint complexity for Handling Handshapes, while hearing Italian and American gesturers show the reverse pattern (Brentari et al. 2012, 2017). Clearly signers and non-signers use iconic handshape preferences differently; specifically, only signers use this handshape preference grammatically. In order to understand how handshape preferences for tool naming develop, we turn to the case of homesigners. Homesigners are an important place to look because they, like signers of community signed languages with longer histories, use the manual modality as their primary means of communication. However, homesigners have little to no exposure to an existing sign language and communicate almost exclusively with hearing gesturers in their daily lives.

1.2. How Do Homesigners Compare to Communication Partners and Signers?

Homesigners are deaf individuals who have not acquired a signed or spoken language and who innovate gesture systems to communicate with hearing friends and family members. The homesigners in the current study have not had regular contact with each other or with signers of Lengua de Señas Nicaragüense (NSL); each individual has created their own unique system to use with hearing friends and family members (referred to here as "communication partners") (Coppola and Newport 2005; Coppola 2002). Homesign systems more closely resemble sign languages than gestures produced by non-signers (Brentari et al. 2012; Horton et al. 2015). However, since homesigners do not form a linguistic or social group, there is not a large overlap for shared handshape forms even on the individual level, and many homesigners do not have a stable handshape form that they routinely use (Goldin-Meadow et al. 2015). Some trends can be found, such as homesigners using handshape type systematically to distinguish agentive and non-agentive events and additionally homesigners showing a slight preference for Handling Handshape for nominals (Goldin-Meadow et al. 2015). Hearing gesturers in general do not use Object and Handling Handshapes systematically like adult and child homesigners do, but both hearing gesturers and homesigners show a lot of between-subject variability (Brentari et al. 2015).

1.3. Why Look at Homesign to Understand Sign Language Emergence?

Studying homesign can help elucidate the emergence of certain structures found in sign languages, such as iconic handshape preference. Some sign languages form when a group of deaf individuals (e.g., homesigners) come together. NSL, for example, came to be after a school was founded allowing deaf homesigners to come together and start converging on a signing system (Senghas et al. 2005; Coppola 2020a). As time went on and more individuals started using the same system, it became more conventionalized, that is, members of the community started sharing similar forms and patterns. The emergence of

NSL as an established language in a matter of decades supports the idea that language can be created, given some time and a receptive community of users (Brentari and Coppola 2013). The people that make up the community matter; in most cases like NSL, they must use the system as their primary form of communication in order for it to conventionalize. This is one major difference between sign languages and homesign; sign languages have been used as primary languages for many people over a long period of time, whereas homesign systems are used predominantly by one individual, which their communication partners use only with them. Even though communication partners use the homesigner's system to communicate with them, they do not use the system in the same way the homesigner uses it, so it may not become conventionalized (this is addressed in more detail in the next section; see also Coppola et al. 2013). Individual homesign family groups have the potential to conventionalize, but, if they do, it is much slower than NSL because of how centralized a homesign system is, given that all interactions involve the homesigner (Richie et al. 2014).

1.4. Is Conventionalization Possible in Homesign Systems?

Even though communication partners can use the homesigner's system, there is evidence that they do not always use the same patterns or the same degree of complexity, raising the question of whether homesign systems can become conventionalized. While Nicaraguan hearing gesturers produce gestures similar to some NSL signs, there is evidence of changes in form and meaning, likely mediated by homesigners; however, even over the course of 25 years, NSL still stabilized a lexicon much faster than homesign systems (Coppola 2020b). Homesigning children in Taiwan and the United States typically use similar gesture order, an ergative syntactic pattern in which patients and intransitive actors come before action gestures, while their parents do not follow their children's order and will sometimes put a transitive actor before action gestures, but this is not done consistently (Zheng and Goldin-Meadow 2002). In another group of American child homesigners, the mothers' gestures did not show the same structural regularities compared to their children's gestures; differences in each child's system is related more to the gestural input that the children provide for themselves and less due to any input their mothers may provide (Goldin-Meadow et al. 1984). It seems that communication partners are not enough; in order for conventionalization to happen more rapidly, homesigners must interact with other deaf people using a signing system. For example, in Nebaj, Guatemala, individual homesigners (i.e., those with no interaction with another deaf person) showed weak evidence for the use of patterned iconicity or a preferred handshape type when labeling items, while homesigners who used a shared system with either other deaf family members or deaf peers showed strong evidence for the use of patterned iconicity (Horton 2020).

Not only do communication partners not use the homesigner's system very well, they also do not appear to completely understand it sans context. Homesigners' mothers were significantly worse at comprehending homesign descriptions of vignettes from their deaf adult children than Spanish descriptions from their hearing adult children (Carrigan and Coppola 2017). This study also found that the younger a family member was when they first interacted with their deaf relative, the better their comprehension was; however, Deaf native ASL signers, who were not familiar with the homesign systems but did have lifelong experience perceiving and communicating in the visual modality, were actually the best at comprehending the homesign descriptions. This supports the idea that homesign systems are not completely transparent and that structure within a homesign system is not developed so that a homesigner can be understood by their communication partners, but instead perhaps represents how the homesigner mentally organizes concepts. This result is consistent with the idea that homesign systems are sufficiently similar to languages with longer histories and more developed structure that they also show hallmarks of a sensitive period for acquiring them among those who are exposed to them at different ages (Mayberry and Kluender 2018; Newport et al. 2001).

We focus on iconic handshape preference in the current study and ask whether or not iconic handshape preference is part of an individual system, and whether it is a structure that homesigners and communication partners share with one another. Further, we ask if the degree to which the iconic preference is shared in homesigners' families is stronger than that which occurs in families without a homesigner (in this case, from hearing non-signing Spanish-speaking Nicaraguan families).

1.5. The Current Study

By looking at the case of homesigners and communication partners as well as hearing non-signing adults, the current study aims to investigate the development of iconic handshape preferences for tools. Hwang et al. (2017) point out that comparisons across groups can provide "an opportunity to examine possible pathways for grammaticization and conventionalization from emergent to established sign language lexicons and grammars" (p. 578). We investigated several possible sources of handshape preference and conventionalization (Table 1). While signers may show a preference for either Handling or Object handshapes depending on the sign language they use, hearing gesturers (e.g., communication partners and hearing non-signers) typically tend to use Handling handshapes more often (Padden et al. 2015). Although communication partners have demonstrated conventionalization of some types of forms and structures, they often do not utilize it to the same extent as homesigners (e.g., communication partners use unpunctuated repetition in isolation but not in sentences like homesigners do, Coppola et al. 2013). Therefore, the user's relationship with the homesign system may be an important factor. By contrasting homesigning families with a hearing non-signing family, we can see if using a homesign system influences handshape preferences and conventionalization. Similarly, by comparing families with an unrelated group of hearing people, we can address whether communicative familiarity is a factor in handshape preference and conventionalization. We included both chronological age and years of experience with a homesign system as factors that might influence handshape preference and conventionalization, given the findings from Carrigan and Coppola (2017), which indicated that the younger a family member was when they first started interacting with their deaf homesigning relative, the better they understood them. This is also related to the sensitive period for language acquisition which research demonstrates is a relationship between the age of exposure to a language and the proficiency in that language (e.g., Newport 1990; Mayberry and Fischer 1989; Emmorey and Corina 1990). Lexical frequency (i.e., how often a word or sign is used) and type of noun (i.e., whether or not it is an instrument and what type of instrument it is) are additional factors related to the item itself that may also influence preferences and conventionalization.

In Study 1, we analyze participant characteristics, specifically looking at how factors related to the participants (e.g., age, experience with a homesign system) may influence handshape preferences for iconicity (Handling/Object) as well as general conventionality (e.g., average of family's shared handshape preferences regardless of actual handshape type) within and across groups of families with and without homesigners. In Study 2, we analyze item characteristics, specifically investigating how factors related to the stimulus items (e.g., lexical frequency, type of instrument) influence handshape preference and conventionality.

The questions we aim to address in the two studies are as follows:

(1a) Do homesigners and communication partners tend to express iconicity by using a Handling handshape or an Object handshape?
(1b) Do members of families with homesigners share this preference with each other?
(1c) Does a participant's age at the time of test, the age at which they begin using the homesign system, or the number of years they have been using the system affect handshape type and its conventionalization?
(2) Do some stimulus items elicit higher conventionality in iconic handshape preferences? Which factors are or are not associated with greater conventionality?

Table 1. Summary of potential sources of handshape preference and conventionalization.

Type of Specific Bias	Possible Sources of Handshape Preference	What We Will Look at
Participant (Study 1)	Using a Homesign System with Others	homesigning families vs. hearing non-signing family
	Communicative Familiarity with Others	families vs. unrelated group
	Relationship to Homesign System	primary user vs. communication partner vs. none
	Age	child/adolescent vs. adult; age at which first started using system; chronological age
Item (Study 2)	Lexical Frequency	English, Spanish and ASL word frequencies as proxies for homesign
	Type of Instrument	e.g., traditional tool vs. makeup vs. non-tool

2. Materials and Methods

2.1. Participants

Participants were recruited between 1996 and 2004 through personal visits to families living in both rural and urban areas of Nicaragua who were recruited via community contacts (see Table 2 for a summary of demographic information; see Gagne (2017) for more detailed information about the homesigners and their linguistic and educational experiences). The participants included eleven deaf homesigners (4 female, 7 male), aged 9 to 35 years at the time of testing. The homesigners had little to no formal education in written or spoken Spanish or Lengua de Señas Nicaragüense (NSL). Homesigners were further classified as either adult homesigners (4 participants, age 26 to 35) or child/adolescent homesigners (7 participants, age 9 to 14).

Table 2. Demographic information.

	N	Age (Years) (Mean, SD)	Gender (% Women)
Homesigners	11	19;1 (9.97)	36% (4)
Communication Partners	24	31;6 (17.1)	50% (12)
Hearing Non-Signers related (4); unrelated (4)	8	31;0 (12.5)	50% (4)
All Participants	43	28;3 (15.4)	47% (20)

A second set of participants were the 24 communication partners of these deaf homesigners (12 female, 12 male), who were aged 9 to 64 years at the time of testing. Communication partners (CPs) were defined as hearing family members and friends who had regular contact with and communicated frequently with one of the homesigner participants. All of the communication partners were native Spanish speakers who had no experience with any sign language and who were familiar with the homesign system used in their family.

The third set of participants included 8 hearing non-signing adults (4 female, 4 male) aged 20 to 52 at the time of testing. All of the hearing non-signing adults were native Spanish speakers with no regular experience with any sign language or homesign system.

The participants were grouped into 9 homesigning families (each family had only one homesigner), 1 hearing non-signing family made up of 4 members, and 1 group of 4 unrelated hearing non-signers. Note that the hearing non-signers who were from the same family did not have a homesigner in their family; further, none of the unrelated hearing non-signers had a homesigner in their families. Two homesigners who were in the original study did not have any communication partners to complete this task and therefore were excluded from group analyses.

2.2. Materials and Procedure

Participants were shown a slideshow consisting of photographs of items and asked to label them. Specifically, participants were shown a slide featuring three exemplars of the same tool, such as a hammer, and then were asked to sign what it was. After the participant had finished responding to the current image, the experimenter would move on to the next slide. All data were collected between 2011 and 2012, and each session was videotaped. All participants were tested individually and signed their responses to the experimenter in order to avoid influencing the responses of other members of their family.

The stimuli presented were 27 images of different tools and instruments: 6 items of clothing (pair of shoes, jacket, sock, hat, glove, pants), 8 grooming/cosmetic items (hairbrush, nail file, mascara, comb, hairdryer, nail polish, toothbrush, lipstick), 3 utensils (fork, spoon, knife), 9 handheld tools (scissors, broom, hammer, paintbrush, rake, screwdriver, vacuum cleaner, handsaw, mop), and 1 other handheld item (cellphone). This set of stimuli was also used in Padden et al. (2015). Every participant was shown the stimuli in the same order via the slideshow.

2.3. Transcription and Response Types

The participants' signs and gestures were transcribed using ELAN (Wittenburg et al. 2006), a program that facilitates the coding of simultaneous aspects of gesture and sign language production that is aligned with the video content. Each sign was glossed and coded for handshape representation type for both hands. The relevant handshape types were *Handling* (Figure 1a), in which the handshape reflects how one would hold the tool, and *Object* (Figure 1b), in which the handshape depicts the shape or form of the actual tool itself. Other handshape representation types included *Handling–Object-Simultaneous*, in which the participant simultaneously produces a Handling handshape with one hand and an Object handshape with the other hand, and *Handling–Object-Sequential*, in which the handshape sequentially transitions from one representation type to another, which we collapsed into *Handling+Object* (Figure 1c). Signs marked as *Other* (i.e., not specifically in reference to the tool or not iconic) were not included in the analysis.

For each item response, only one handshape type was annotated. If participants made multiple iconic signs/gestures while labeling the item, the response selected for coding was simplified to note just Handling or just Object if all of the signs fell under one type, or Handling+Object if both types of signs were used. Therefore, each participant had a maximum response of 27 handshapes, which we were then able to use to calculate the percentage of iconic handshape types in order to determine preferences.

Finally, we describe the types of responses participants produced. Most people produced single gestures/signs, with the exception of adult homesigners who produced multiple signs more often (Table 3). Although participants were shown all 27 items and asked to label them, a few items were not familiar to the participants (e.g., vacuum cleaner) and they did not produce a response to them. Factoring in all of the participants, the total expected number of responses was 1161. However, we only included a total of 1035 responses, because not every participant produced a response for every item (e.g., some participants did not recognize the vacuum cleaner) or did not produce a relevant iconic response (e.g., the response was a pointing gesture).

Figure 1. Examples for responses of iconic handshape types: (**a**) Handling [mop], (**b**) Object [hand saw], and (**c**) Handling+Object [rake]. See supplementary materials to view video clips of responses.

Table 3. Percentage of responses that were a single sign/gesture versus multiple signs/gestures for each group. Most common response type for each group is bolded.

	Responses Consisting of Single Gesture/Sign (Mean, SD)	Responses Containing Multiple Gestures/Signs (Mean, SD)
Adult Homesigners	32% (0.34)	**68%** (0.34)
Child/Adolescent Homesigners	**92%** (0.05)	8% (0.05)
Communication Partners	**80%** (0.26)	20% (0.26)
Hearing Non-Signers	**93%** (0.14)	7% (0.14)

3. Results

3.1. Study 1: Participant Characteristics

3.1.1. Do Homesigners and Communication Partners Tend to Express Iconicity by Using a Handling Handshape or an Object Handshape?

First, we want to clarify that we did not expect to see a strong overall preference for one iconic handshape type over the other, because many other features outside of the participant can influence preferences, primarily item characteristics, which we address in Study 2. While we do report overall preferences (i.e., the proportion of Handling, Object and combined Handling+Object responses across all items for each participant), it is important to keep in mind that features of specific items may also influence handshape preferences and are not captured by looking at overall preference.

There appears to be no universal preference across types of participants (e.g., homesigners or their communication partners) or across participant groups for one of the handshape types. Indeed, individuals varied greatly in whether they showed a preference, as well as which handshape type they preferred when they demonstrated a preference. We proceeded to undertake more detailed analyses of potential patterns within participant groups. Of the 11 homesigners, 5 showed a Handling preference, 4 of which were child/adolescent homesigners, as determined by binomial distribution tests (Table 4). In order to carry out the binomial distribution tests, we only compared two categories: Handling vs. Object; on trials in which a participant used a combined Handling+Object form, the response was counted as half a case of Handling and half a case of Object. For example, for a participant who produced 12 Handling handshapes, 7 Object handshapes, and 8 combined Handling+Object forms, their responses were simplified as 16 cases of Handling and 11 cases of Object handshape in the binomial test. Of the 24 communication partners, 5 showed a reliable Handling preference, and 2 showed a reliable Object preference. Of the 8 hearing non-signing adults, 1 showed a reliable Handling preference. Overall, the majority of participants did not show a handshape preference. Of the participants who did show a preference, a majority had a preference for Handling handshapes.

Table 4. Mean iconic handshape preferences of child/adolescent and adult homesigners, communication partners (CPs) and hearing non-signers (related and unrelated). H+O stands for combined Handling+Object handshape. See Appendix A for individual and group preferences.

Participant Type	Handling	Object	H+O
Child Homesigners	67%	29%	4%
CPs of Child Homesigners	53%	43%	4%
Adult Homesigners	47%	26%	27%
CPs of Adult Homesigners	56%	34%	11%
Hearing Family	51%	42%	8%
Hearing Unrelated	54%	37%	9%

3.1.2. Do Members of Families with Homesigners Share This Preference with Each Other?

Next, we looked at group preferences to assess how communicative familiarity and using a homesign system with others might influence handshape preferences. With regard to the homesigning families, 3 families showed a Handling preference, and the other 6 families showed no clear preference (see Appendix A). Additionally, neither of the groups of hearing people who had no regular communication with a homesigning family member (i.e., the all-hearing family and the group of unrelated hearing people) showed a clear preference. Note that, of the homesigning families that showed an overall Handling preference, two were families with child or adolescent homesigners, and one was a family with an adult homesigner.

We also examined the conventionality of iconic handshape preferences; instead of looking specifically at handshape type, we calculated the likelihood of participants within a group producing the same handshape type, at the item level, regardless of whether the handshape was Handling or Object. In order to calculate the conventionalization for each group, we compared each family member's responses to each other in a pairwise fashion. For each item, when two family members produced the same handshape type (e.g., both used Handling), the pair was assigned 1 point. If they produced different responses (e.g., one used Handling and one used Object), they were assigned 0 points. If one family member used a combination form (e.g., one used Handling+Object, while one just used Handling), they were assigned 0.5 points. For each family member pair, point values were totaled, and the percentage of similar response types was calculated. Once the similarity percentages were calculated for each pair of participants in each family group, the percentages were averaged for the entire group. For example, in Adult Homesigner 4's family, the homesigner and brother produced the same handshape type on 60% of items, the homesigner and mother produced the same handshape type for 63% of items, and the brother and mother produced the same handshape type on 56% of items, leading to an average of 60% conventionalization for the family. In other words, the members of Adult

Homesigner 4's family shared handshape preferences with one another, on average, 60% of the time. Overall, the conventionalization of iconic handshape type (i.e., Handling or Object) ranged from 48% to 71% across the groups (Table 5). Members of adult homesign families (n_1 = 4) were significantly more conventionalized than child/adolescent homesign families (n_2 = 5) (U = 1, $p < 0.05$, Mann–Whitney U test for small Ns).

Table 5. Average conventionalization of all family members for each group.

Group	Conventionalization (Mean, SD)
Child Homesigner 1	61% (0.12)
Child Homesigner 2	71% (0.10)
Child Homesigner 3	54% (0.14)
Child Homesigner 5	48% (0.15)
Child Homesigner 6	65% (0)
Adult Homesigner 1	70% (0.10)
Adult Homesigner 2	66% (0.03)
Adult Homesigner 3	69% (0.11)
Adult Homesigner 4	60% (0.40)
Hearing Related	59% (0.08)
Hearing Unrelated	70% (0.17)

3.1.3. Does a Participant's Age at the Time of Test, Age at Which They Begin Using a Homesign System, or the Number of Years They Have Used the System Affect Handshape Type and Conventionalization?

We assessed the relationships between the communication partners' conventionalization and (i) age at time of testing, (ii) years of experience with a homesign system, and (iii) age of first exposure to a homesign system. We used age two years as the "starting point" for homesign systems and based our calculations of age of exposure to the homesign system and years of experience with a homesign system on that value (see Carrigan and Coppola 2017). For the homesigners, years of experience using a homesign system corresponded to their age minus 2 years; for family members, years of experience using a homesign system corresponded to the family member's age, minus the homesigner's age, minus 2 years (the initial years of homesign development). Similarly, the variable of age of exposure to the homesign system also took this two-year period of initial, early homesign development into account. For example, the mother of a homesigner (aged 26) who was 54 at the time of testing would have been exposed to the homesign system at age 30 (i.e., (54 − 26) + 2 = 30). Younger siblings were assigned a value for age of exposure corresponding to their age (assuming they were born two or more years after the homesigner). Note that the age of the homesigner at the time of testing is a good approximation of how long the family has been co-constructing and using the homesign system.

We found moderate inverse correlations between conventionalization and age at the time of testing ($r_s = -0.49$, $p < 0.05$, Spearman's rho) and between conventionalization and years of experience using a homesign system ($r_s = -0.42$, $p < 0.05$). That is, higher conventionalization was associated with being younger when tested and with fewer years of experience using a homesign system. A weak inverse correlation was found between conventionalization and age of first exposure ($r_s = -0.22$, $p > 0.05$), showing that higher conventionalization was somewhat associated with being exposed to a homesign system from a young age. While these findings do not necessarily contradict one another, they do raise some questions which are considered in the discussion section. Linear regressions revealed that the communication partners' age at testing ($t = -2.51$, $p < 0.05$; $F(1, 22) = 6.35$, $p < 0.05$, $R^2 = 0.22$) and their years of experience interacting with a homesigner ($t = -2.33$,

$p < 0.05$; $F(1, 22) = 5.41$, $p < 0.05$, $R^2 = 0.20$) each significantly predicted conventionalization. The communication partners' age of first exposure to homesign did not predict conventionalization.

We also found differences across participants in how they used both Handling+Object handshapes within a single response. Adult homesigners produced this Handling+Object response type more often (M = 27% of items, SD = 0.18) compared to child homesigners (M = 6%, SD = 0.02), communication partners (M = 7%, SD = 0.09), and hearing non-signers (M = 8%, SD = 0.08).

3.2. Study 2: Item Characteristics

We now turn to the item analysis, to determine which individual objects and which semantic classes of object (clothing, grooming/cosmetic items, utensils, and handheld tools) exhibited a greater degree of conventionalization.

3.2.1. Do Some Stimulus Items Elicit Higher Conventionality in Iconic Handshape Preferences?

In order to examine item-specific biases, we conducted binomial distribution tests and found that many of the responses elicited by certain items were not at chance (50%) and, in fact, were biased towards one or the other iconic handshape class. Of the items not at chance, more items were more likely to have a Handling preference than Object (Table 6), and tools were more likely to exhibit a higher degree of conventionalization. None of the items at chance were classified as traditional tools.

Table 6. Binomial tests revealed that overall, 12 items were more likely to elicit a Handling handshape and 4 items were more likely to elicit Object handshapes, while 11 items were statistically at chance.

Handling Bias (12)	Object Bias (4)	Dependent on Chance (11)
Pants	Scissors	Nail File
Hammer	Knife	Cell Phone
Spoon	Handsaw	Hat
Sock	Paintbrush	Jacket
Mop		Mascara
Broom		Nail Polish
Hairbrush		Toothbrush
Screwdriver		Lipstick
Vacuum Cleaner		Rake
Hair Dryer		Glove
Fork		Shoe
Comb		

3.2.2. Which Factors Are or Are Not Associated with Greater Conventionality?

The participant families' degree of conventionalization varies; however, certain items may lend themselves to being consistently gestured or signed with one type of iconic handshape over the other. Participants converged on a handshape type for 22 of 27 items; that is, over 50% of the group members used the same handshape type. Traditional tools all had higher conventionalization (all >70%), while makeup items all showed lower conventionalization (Figure 2). As expected, the items that have higher conventionalization are also the items that are more likely to have a handshape bias.

We also considered lexical frequency as a possible motivation for conventionalization. Because we did not have homesign frequency counts, we used ASL, English, and Spanish word frequencies as proxies. We obtained measures of ASL sign frequency, English word frequency, and Spanish word frequency from Corpus del Español (Davies 2015). While ASL, English, and Spanish word frequencies were all moderately to strongly correlated with each other, none of the word frequency measures were correlated with the degree of conventionalization observed for a particular item. While these functional/semantic groupings did reveal some trends toward greater (e.g., traditional tools) or lesser (e.g., makeup items) conventionalization, they were fairly weak and do not seem to be explanatory.

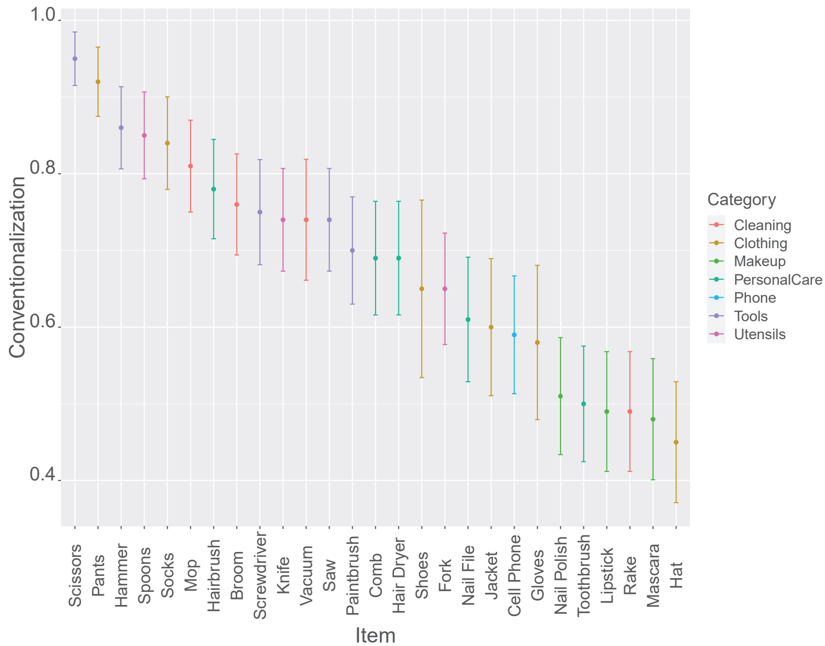


Figure 2. Items ordered by overall conventionality of handshape type across groups. Each category of object is shown in a different color. Dots represent the percentage of participants who used the most common handshape type for each item (Handling or Object). Lines represent standard error.

4. Discussion

In this paper, we used the phenomenon of iconic handshape contrasts (Handling vs. Object), a distinction used grammatically by many sign languages around the world, as a lens through which to examine the development of conventionalization in emerging sign languages. Specifically, we examined iconic handshape preferences in deaf homesigners and their hearing communication partners when naming objects used as tools (see Table 7 for a summary). Study 1 revealed that participant characteristics influence preference for handshape type. Among families with homesigners, we detected no universal handshape preference in either the homesigners or the communication partners, though several participants (many of them gesturers) tended to use more Handling forms. Within families with homesigners, we also observed variable levels of shared preferences for handshape type and the degree of conventionalization for handshape type. Among homesigners' families, time using the homesign system seems to be important, because adult homesigners' families demonstrated a higher degree of conventionalization than child homesigners' families. Study 2 found that traditional tools (e.g., scissors, hammer) tended towards higher conventionality than other items that were not traditional tools (e.g., mascara, hat). Proxy measures of lexical frequency did not show any correlation with the degree of conventionalization.

Table 7. Results summary.

Type of Specific Bias	Possible Sources of Handshape Preference	What We Found
Participant (Study 1)	Using a Homesign System with Others	Homesigning families varied just as much as the hearing family
	Communicative Familiarity with Others	Families varied just as much as the unrelated group of hearing people
	Relationship to Homesign System	No differences found between homesigners, CPs, and non-signers
	Age	Chronological age and years of experience predicted conventionalization; adult homesigners produced more Handling+Object responses
Item (Study 2)	Lexical Frequency	Proxy measures not related to conventionalization
	Type of Instrument	Traditional tools often more highly conventionalized than other items (e.g., makeup)

These findings suggest that there is no universal handshape preference among the different participant groups when naming tools, and that similarity of handshape type varies even within families. Both individuals and groups varied in terms of iconic handshape preference. The fact that a family did or did not have a homesigner or, taken as an isolated factor, communicative familiarity (i.e., families versus unrelated group of people), does not promote similarity or conventionalization of iconic handshape type; however, there is evidence that, among families with a homesigner, the longer the family uses the system, the more conventionalized it becomes (adult homesign families are more conventionalized than child homesign families). It may be that individual preference initially drives this type of iconic handshape preference.

4.1. Variation in Iconic Handshape Preference and Conventionalization

While more individuals (i.e., homesigners, communication partners, and hearing non-signing adults) produced more Handling than Object handshapes in their responses, as a group, fewer than half showed an overall Handling preference. In other words, while 25 of the 43 participants (58%) showed an individual Handling preference, only 4 of the 11 groups (36%) showed a clear overall Handling preference. The fact that a majority of the data points were from communication partners (i.e., gesturers) and that responses were overall more likely to use Handling handshapes aligns with the finding that generally gesturers, compared to signers, prefer Handling handshapes when labeling tools (Padden et al. 2015). The next step will be to see whether homesigners (particularly adult homesigners) and communication partners use the same specific handshapes, instead of merely the same type of handshape iconicity. In line with existing research, homesigners' responses exhibit more finger and joint complexity than the responses of hearing non-signers (Brentari et al. 2012; Coppola and Brentari 2014), but explicit comparisons of homesigners with communication partners have yet to be completed.

The fact that conventionalization varied greatly among homesigning families, ranging from 48% to 71% conventionalization, suggests that this phenomenon of patterned iconicity may emerge later. This is supported by evidence that families with adult homesigners were overall more highly conventionalized than families with child/adolescent homesigners. In groups where this was not the case, such as the family of child homesigner 2 and the group of unrelated hearing people (both of whom had some of highest conventionalization rates), something else might be influencing handshape conventionalization. We included the hearing non-signing family and the group of unrelated hearing non-signers in order to pull apart the influence of having a homesigner in a family versus generally interacting within a family; however, it was somewhat surprising that the unrelated hearing non-signers displayed such high conventionalization. Note that our measure of conventionalization does not take into account the complexity of the handshapes produced. Thus, the hearing people in our study may be producing the most straightforward and least complex handshape forms. In their context as hearing people who do not regularly communicate with a deaf person, they are not burdened with additional iconicity demands (e.g., using patterned iconicity systematically) and may therefore consider fewer, less complex handshape options. Since hearing non-signing gesturers already tend to both produce less finger and joint complexity than homesigners (Brentari et al. 2012; Coppola and Brentari 2014) and prefer Handling handshapes (Padden et al. 2015), this may partly be responsible for the convergence. In other words, the Handling handshape preference may also be generated independently in each individual rather than due to convergence in a group. In addition, it follows that they would exhibit restricted options for types of handshapes, and their productions, therefore, may appear more conventionalized, even if little actual conventionalization has occurred with the apparent similarity merely reflecting similar strategies. In other words, although the unrelated hearing non-signers may appear to be highly conventionalized, they are likely using the simplest forms at their disposal and, given their limited handshape options, just happen to be using the same simple handshape types.

This line of reasoning may also explain the finding that the less experience a communication partner has with a homesign system, the more conventionalized they are; essentially, these communication partners may be using the most straightforward or simplest approach without much true conventionalization happening (e.g., everyone converging on a shared complex handshape versus each person producing the simplest responses, which coincidentally happen to be similar). Previous work by Singleton et al. (1993) comparing the productions of the homesigner called David with those of his hearing sister showed that her gestures more closely resembled those of non-signers rather than those of her homesigning brother. Frequent and prolonged interaction between communication partners and homesigners does not appear to be enough to conventionalize gestures in a homesign system. As David was documented correcting his sister's gesture forms, so has Coppola observed adult homesigners correcting their family members, providing similar evidence of standards of form in homesign systems that communication partners do not always pick up on. The relationship between age and experience (discussed more below) could perhaps be explained by the association of younger age and simpler forms, and less to do with practice using the system. Uniformity due to simple forms may be masquerading as conventionalization.

4.2. Age and Experience as Factors in Conventionalization

We noticed some trends related to the age of the homesigner, mainly that, overall, adult homesigners used the combined Handling+Object form more than child homesigners, and that families with adult homesigners were significantly more conventionalized than families with child/adolescent homesigners. This tendency for a combined Handling+Object form to be produced by adult but not child homesigners is related to the finding that adult homesigners more often produced multiple signs or gesturers for single responses compared to child/adolescent homesigners, who typically produced just one sign or gesture per response. While the Handling+Object form clearly made up a portion of the adult homesigners' multiple signs/gestures per response, adult homesigners also tended to produce multiple of the same type of handshape in a single response, which child homesigners did not do frequently. Adult homesigners' more common use of a combined Handling+Object form has also been observed in independent groups of adult Nicaraguan signers and child homesigners in Nicaragua. Martin et al. (Forthcoming) found that 10 out of the 11 signing Nicaraguan adults in their study produced a combined Handling+Object form at a similar level to that of the adult homesigners in our study, but it was not robust in the responses produced by child homesigners or hearing gesturers.

This suggests that this combined form, which is present in adult homesigners and persists among Nicaraguan signers from the second and third cohorts (that is, among signers who entered the community after 1983), albeit at low levels, requires maturational time to develop and is not a response to a communicative context experienced by homesigners in which they are concerned about not being understood.

We also would like to note that we specifically refer to this response type as a combined form, not a compound form, because we did not rigorously assess each response to determine if they were true compound signs. Published criteria for identifying compound signs are limited, and the classification is commonly determined by intuition or judgments (i.e., Meir et al. 2010) or by comparing two-sign combinations in which the first stem is reduced to stand-alone versions of the same signs (Liddell and Johnson 1986). Note that existing criteria are difficult to implement in emerging languages, especially homesign systems, in which the forms themselves may be in flux. Further, traditional acceptability judgments and intuitions are difficult (though not impossible) to elicit from homesigners. In addition, the data collected in this sample did not allow the opportunity to compare single signs and two-sign combinations. Since this combined category included both simultaneous and sequential Handling+Object forms, we decided to refer to them as combined forms rather than teasing out which could be compounds and which were not. In some instances, participants produced a "sandwich form" such as Handling, Object, then Handling again. For example, Adult Homesigner 1 produced a Handling+Object + Handling form when labeling the rake. This strategy has the advantage of making it clear that this is the name of the item, not describing the action carried out by the item. These combined forms tend to be produced very quickly, with little to no pause between the signs. While this category of signs may be a candidate for compound forms, that analysis is outside of the scope of this paper.

Another age-related trend was that, among the families that showed a general preference for producing Handling handshapes, most were families with child homesigners. We did observe a preference for Handling handshapes among the communication partners of one of the adult homesigners; this family had the greatest number of communication partners (5, as opposed to 2 to 3 communication partners like the other adult homesigners). As hearing gesturers, who tend to produce more Handling responses, these communication partners drive up the mean of the overall use of Handling handshapes within the family. Might regular interactions with communication partners influence homesigners to be less consistent with their handshape preferences? Goldin-Meadow et al. (2015) found that homesigners' first inclination, before elaborating more extensively for their hearing communication partner, was to produce a pattern comparable to the pattern produced by ASL and NSL signers (i.e., more consistent). However, communicating with hearing partners, who sometimes struggle to comprehend homesigners' productions (as demonstrated in Carrigan and Coppola 2017), may make homesigners' systems appear less structured. This finding might provide an alternate explanation to the phenomenon of adult homesigners using the combined Handling+Object form more often than child homesigners; perhaps they are used to having to elaborate on initial signs when communicating with hearing partners, therefore they may be inclined to use a combined Handling+Object form in order to be more clear and to avoid having to repeat or elaborate. However, this explanation does not account for the persistence of this combined form among NSL signers over 30 years after the emergence of the community. Clearly, more research is warranted.

Homesign systems have the potential to conventionalize, albeit more slowly than a shared sign language used by a deaf community, since each system is only used primarily by a single homesigner (Richie et al. 2014). We found that participants' age at time of testing and their years of experience using a homesign system were negatively correlated with conventionalization. The younger a communication partner was and the fewer years they spent using a homesign system, the higher the degree of conventionalization. Given Goldin-Meadow et al. (2015) findings that homesigners' subsequent responses are much more variable than their first responses, it is possible that interacting with communication partners, who are not using the homesign system as their primary system, may hinder or even deconventionalize certain homesign patterns. It is also possible that, among a relatively small number of family members who interact regularly and whose communication is embedded with specific contexts, the lack of a conventionalized form is less of an issue. Future research should investigate how age and amount of time a person has been using a system influence conventionalization in homesign systems, in addition to other factors such as communicative closeness and the amount of time that communication partners actually spend interacting with a homesigner.

4.3. Item-Specific Biases and Proxy Measures

Although conventionalization varied within and across family groups, we did find that certain types of items were, overall, more highly conventionalized than others. Specifically, tools (e.g., scissors, hammer) had higher conventionalization than makeup (e.g., mascara, lipstick) or items of clothing. Similar findings of tools having higher convergence than other categories of items such as animals or food for homesigners from Nebaj, Guatemala, have also been reported (Horton 2018). This observation led us to consider word or gesture frequency; since not everyone uses or converses about makeup, perhaps that is why makeup items had generally lower conventionalization than more widely used items (e.g., scissors, spoons, socks). Unfortunately, it was not feasible to obtain a homesign frequency measure for each item for each family, so we used word frequency measures from ASL, English, and Spanish (all of which were correlated with each other) as a proxy for the frequency of use of such items in homesign systems. We found that conventionalization was not correlated with any measure of word frequency (or ASL iconicity); however, this does not necessarily mean word usage is not at all related to homesign conventionalization. Instead, it is possible that none of the proxy measures used here are actually representative of the frequency of such items in homesign systems. In order to truly understand the relationship between conventionalization and frequency, future studies should obtain iconicity ratings and a measure of homesign frequency from those using the homesign system and directly compare the conventionalization and usage in the system.

4.4. More Questions and Future Directions

In future work, we will study whether homesigners and communication partners use the same specific handshapes, in addition to the same type of handshape iconicity (i.e., Handling or Object). This would suggest that there is something shared among homesigners and communication partners that is at the level of phonetic form. Previous research (Brentari et al. 2012) showed that homesigners' responses show higher selected finger complexity than gesturers' responses; however, communication partners' productions have not been analyzed. We do not yet know if the productions of communication partners align more with the complexity levels of homesigners or with those of gesturers. Very preliminary analyses of the current data suggest that families that share a general iconic handshape type do not always produce the same specific handshape, for example, in response to the stimulus item eliciting 'saw', family members may all produce different versions of an Object handshape (e.g., B-handshape, H-handshape, or 1-handshape which all resemble a saw). To illustrate, Adult Homesigner 1 and his brother used the same general handshape type (i.e., Handling, Object, Handling+Object) for 19 items but only used the exact same specific handshape for 7 of those items (37%). In contrast, two unrelated hearing non-signers also used the same iconic handshape type for 19 items but used the same exact handshape for 12 of those items (63%). Further analysis will investigate whether the reported conventionalization of iconic handshape preferences is related to the conventionalization of specific handshapes.

Another question for future work is: Do conventionalization and similar handshape preferences actually improve comprehension between homesigners and communication partners? Previous research suggests that communication partners are not very good at comprehending homesign utterances that are shown to them without any context. Younger family members (e.g., siblings, especially younger ones) scored better on comprehension than older family members (e.g., parents). Deaf native ASL signers, who were not familiar with the homesign systems but did have lifelong experience perceiving and communicating in the visual modality, were actually the best at comprehending the homesign descriptions (Carrigan and Coppola 2017). Perhaps using similar handshape patterns could facilitate homesign comprehension and should be investigated further. It would also be useful to see how consistent personal handshape preferences are by gathering longitudinal data using these stimuli.

5. Conclusions

Investigating Handling–Object handshape contrasts and conventionalization in homesigners, hearing communication partners, and hearing non-signing adults has offered some insight into how this type of patterned iconicity develops. While there was a great deal of variation in handshape type preference, overall, gesturers tended to use more Handling forms. Age was the most influential participant characteristic, as the age of the homesigner and communication partner as well as the communication partners' years of experience using the homesign system were significant factors related to conventionalization. Although proxy measures of lexical frequency did not appear to be related to the degree of conventionalization, the instrument type did seem to make a difference to conventionalization. While families with adult homesigners were more conventionalized compared to families with child/adolescent homesigners, they still did not achieve anything close to full conventionalization. Compared to the trajectories in emerging sign languages, these handshape preferences and conventionalization do not seem to reliably appear within two to three decades of use in a family unit consisting of a single homesigner among hearing family members, when only the one deaf person uses the system as a primary system. Looking at the transition from homesign to Nicaraguan Sign Language will also shed light on the role of community participation in the development of iconic handshape preferences. Future research should aim to investigate how individual biases, item-specific biases, and shared/limited usage of a communication system influence these outcomes, both at the level of handshape class and at the level of specific handshape.

Supplementary Materials: The following supporting information are available online at https://www.mdpi.com/article/10.3390/languages7030156/s1, Video S1a: Handling [mop]; Video S1b: Object [handsaw]; Video S1c: Handling+Object [rake]; Video H+O-SIM [mascara].

Author Contributions: Conceptualization, D.B. and M.C.; methodology, D.B. and M.C.; formal analysis, M.Q.; investigation, M.C.; resources, M.C and D.B.; writing—original draft preparation, M.Q.; writing—review and editing, M.Q., D.B. and M.C.; visualization, M.Q.; supervision, D.B. and M.C.; funding acquisition, D.B. and M.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by NSF BCS-0547554 and BCS-1227908 (to D.B. and S. Goldin-Meadow) and by NIH P30 DC010751 (to M.C. and D. Lillo-Martin).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Purdue University (PURD0603003706 02/23/2011).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Datasets from this project are available on OSF at the following link: https://osf.io/db7yk/?view_only=1cf74efc936f45828abfc52fb22c3f9a.

Acknowledgments: We thank all of the homesigners, their friends and family members, and the hearing adults in Nicaragua for allowing us to learn from them. We are grateful to the directors and staff of the Center for Special Education in Estelí for their support of this project. Julia Adell, Emily Carrigan, and Deanna Gagne assisted with data collection, and Claudia Molina and Leybi Tinoco graciously provided data collection support in the field in Nicaragua. Tiffani Brophy and Julia Adell coded the video recordings. We also thank Laura Horton for providing feedback on prior drafts.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Iconic handshape preferences of child/adolescent and adult homesigners (HS), communication partners (CPs), and hearing non-signers (related and unrelated). Includes individual and group preferences. Family groups are ordered by the homesigner's age at time of testing; the groups of hearing participants are at the end and are also ordered by participant age. Participant preferences that were significantly above chance have an asterisk. Means for each type of participant are also included. (Note: Adult Homesigner 3 has been referred to in previous research as Adult Homesigner 5; similarly, Adult Homesigner 4 has been referred to previously as Adult Homesigner 3.)

Group	Age (Years)	Handling Responses	Object Responses	Handling+Object Responses
Child HS 1	9	82% *	14%	5%
Sister	14	67%	33%	0%
Mother	26	36%	60%	4%
Grandmother	50	54%	46%	0%
Mean		**64%**	**28%**	**8%**
Child HS 2	12	64%	28%	8%
Father	31	75% *	13%	13%
Mother	31	52%	44%	4%
Mean		**64%**	**28%**	**8%**
Child HS 3	12	36%	59%	5%
Brother	9	6%	89% *	6%
Friend	12	74%	26%	0%
Father	37	61%	35%	4%
Mean		***47%***	***50%***	***3%***
Child HS 4	12	76% *	24%	0%
Child HS 5	13	80% *	13%	7%
Brother	13	55%	45%	0%
Mother	33	17%	83% *	0%
Father	52	63%	31%	6%
Mean		**52%**	**45%**	**3%**
Child HS 6	13	81% *	15%	4%
Brother	14	75% *	10%	15%
Mean		**78%**	**13%**	**9%**
Child HS 7	14	53%	47%	0%
Overall mean, Child HS		***67%***	***29%***	***4%***
Overall mean, CPs of Child HS		**53%**	***43%***	***4%***

Group	Age (Years)	Handling Responses	Object Responses	Handling+Object Responses
Adult HS 1	26	69% *	23%	8%
Niece	9	77% *	23%	0%
Girlfriend	19	62%	35%	4%
Brother	28	73% *	23%	4%
Mother	54	58%	35%	8%
Father	64	50%	42%	8%
Mean		***64%***	***29%***	***7%***
Adult HS 2	30	36%	40%	24%
Sister	23	73% *	19%	8%
Brother	25	38%	29%	33%
Mother	46	38%	38%	23%
Mean		***47%***	***32%***	***22%***
Adult HS 3	34	56%	20%	24%
Brother	19	48%	44%	8%
Sister	29	59%	41%	0%
Mean		***54%***	***35%***	***11%***
Adult HS 4	35	26%	22%	52%
Brother	44	64%	28%	8%
Mother	61	27%	50%	23%
Mean		***38%***	***33%***	***28%***
Overall mean, Adult HS		***47%***	***26%***	***27%***
Overall mean, CPs of Adult HS		***56%***	***34%***	***11%***

Group	Age (Years)	Handling Responses	Object Responses	Handling+Object Responses
Hearing Related 1	23	36%	60%	4%
Hearing Related 2	26	62%	35%	4%
Hearing Related 3	48	31%	54%	15%
Hearing Related 4	52	74% *	19%	7%
Mean		**51%**	**42%**	**8%**
Hearing Unrelated 1	20	56%	32%	12%
Hearing Unrelated 2	22	56%	20%	24%
Hearing Unrelated 3	23	65%	35%	0%
Hearing Unrelated 4	34	38%	63%	0%
Mean		**54%**	**37%**	**9%**

References

Benedicto, Elena, and Diane Brentari. 2004. Where did all the arguments go?: Argument-changing properties of classifiers in ASL. *Natural Language & Linguistic Theory* 22: 743–810. [CrossRef]

Braithwaite, Ben. 2020. Ideologies of linguistic research on small sign languages in the global South: A Caribbean perspective. *Language and Communication* 74: 182–94. [CrossRef]

Brentari, Diane, Alessio Di Renzo, Jonathan Keane, and Virginia Volterra. 2015. Cognitive, cultural, and linguistic sources of a handshape distinction expressing agentivity. *Topics in Cognitive Science* 7: 95–123. [CrossRef] [PubMed]

Brentari, Diane, and Marie Coppola. 2013. What sign language creation teaches us about language. *WIREs Cognitive Science* 4: 201–11. [CrossRef] [PubMed]

Brentari, Diane, Marie Coppola, Laura Mazzoni, and Susan Goldin-Meadow. 2012. When does a system become phonological? Handshape production in gesturers, signers, and homesigners. *Natural Language & Linguistic Theory* 30: 1–31. [CrossRef]

Brentari, Diane, Marie Coppola, Pyeong Whan Cho, and Ann Senghas. 2017. Handshape complexity as a precursor to phonology: Variation, emergence, and acquisition. *Language Acquisition* 24: 283–306. [CrossRef] [PubMed]

Brentari, Diane, Laura Horton, and Susan Goldin-Meadow. 2020. Crosslinguistic similarity and variation in the simultaneous morphology of sign languages. *The Linguistic Review* 37: 571–608. [CrossRef]

Carrigan, Emily M., and Marie Coppola. 2017. Successful communication does not drive language development: Evidence from adult homesign. *Cognition* 158: 10–27. [CrossRef] [PubMed]

Coppola, Marie. 2002. The Emergence of Grammatical Categories in Home Sign: Evidence from Family-Based Gesture Systems in Nicaragua. Doctoral dissertation, University of Rochester, Rochester, NY, USA. unpublished.

Coppola, Marie. 2020a. Sociolinguistic sketch: Nicaraguan Sign Language and homesign systems in Nicaragua. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 439–50.

Coppola, Marie. 2020b. Gestures, homesign, sign language: Cultural and social factors driving lexical conventionalization. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 349–90. [CrossRef]

Coppola, Marie, and Diane Brentari. 2014. From iconic handshapes to grammatical contrasts: Longitudinal evidence from a child homesigner. *Frontiers in Psychology* 5: 830. [CrossRef]

Coppola, Marie, and Elissa L. Newport. 2005. Grammatical subjects in home sign: Abstract linguistic structure in adult primary gesture systems without linguistic input. *Proceedings of the National Academy of Sciences of the United States of America* 102: 19249–53. [CrossRef] [PubMed]

Coppola, Marie, Elisabeth Spaepen, and Susan Goldin-Meadow. 2013. Communicating about quantity without a language model: Number devices in homesign grammar. *Cognitive Psychology* 67: 1–25. [CrossRef] [PubMed]

Davies, Mark. 2015. Corpus del Español. Available online: https://www.corpusdelespanol.org/ (accessed on 11 October 2021).

Eccarius, Petra Nichole. 2008. A Constraint-Based Account of Handshape Contrast in Sign Languages. Order No. 3330229. Linguistics and Language Behavior Abstracts (LLBA); ProQuest Dissertations and Theses Global. 304501247. Available online: https://www.proquest.com/dissertations-theses/constraint-based-account-handshape-contrast-sign/docview/304501247/se-2?accountid=30699 (accessed on 11 October 2021).

Emmorey, Karen, and David Corina. 1990. Lexical recognition in sign language: Effects of phonetic structure and morphology. *Perceptual and Motor Skills* 71: 1227–52. [CrossRef] [PubMed]

Gagne, Deanna L. 2017. With a Little Help from My Friends: The Contributions of a Peer Language Network on the Conventionalization of Space in an Emerging Language. Doctoral dissertation, University of Connecticut, Storrs, CT, USA. unpublished. Available online: https://opencommons.uconn.edu/dissertations/1493/ (accessed on 11 October 2021).

Goldin-Meadow, Susan, Carolyn Mylander, Jill de Villiers, Elizabeth Bates, and Virginia Volterra. 1984. Gestural communication in deaf children: The effects and noneffects of parental input on early language development. *Monographs of the Society for Research in Child Development* 49: 1–151. [CrossRef]

Goldin-Meadow, Susan, Diane Brentari, Marie Coppola, Laura Horton, and Ann Senghas. 2015. Watching language grow in the manual modality: Nominals, predicates, and handshapes. *Cognition* 136: 381–95. [CrossRef] [PubMed]

Horton, Laura A. 2018. Conventionalization of Shared Homesign Systems in Guatemala: Social, Lexical, and Morphophonological Dimensions. Doctoral dissertation, The University of Chicago, Chicago, IL, USA. unpublished. Available online: https://knowledge.uchicago.edu/record/1321 (accessed on 11 October 2021).

Horton, Laura A. 2020. Representation strategies in shared homesign systems from Nebaj Guatemala. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 97–154.

Horton, Laura, Susan Goldin-Meadow, Marie Coppola, Ann Senghas, and Diane Brentari. 2015. Forging a morphological system out of two dimensions: Agentivity and number. *Open Linguistics* 1: 596–613. [CrossRef]

Hou, Lynn. 2018. Iconic Patterns in San Juan Quiahije Chatino Sign Language. *Sign Language Studies* 18: 570–611. [CrossRef]

Hunsicker, Dea, and Susan Goldin-Meadow. 2013. How handshape type can distinguish between nouns and verbs in homesign. *Gesture* 13: 354–76. [CrossRef] [PubMed]

Hwang, So-One, Nozomi Tomita, Hope Morgan, Rabia Ergin, Deniz Ilkbaşaran, Sharon Seegers, Ryan Lepic, and Carol Padden. 2017. Of the body and the hands: Patterned iconicity for semantic categories. *Language and Cognition* 9: 573–602. [CrossRef]

Le Guen, Olivier, Marie Coppola, and Josefina Safar. 2020. Introduction: How emerging sign languages in the Americas contributes to the study of linguistics and (emerging) sign languages. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 1–32.

Liddell, Scott K., and Robert E. Johnson. 1986. American Sign Language compound formation processes, lexicalization, and phonological remnants. *Natural Language and Linguistic Theory* 4: 445–513. [CrossRef]

Martin, Amber, Ann Senghas, and Carol Padden. Forthcoming. The Gestural Origins of Nouns in Nicaraguan Sign Language.

Mayberry, Rachel I., and Robert Kluender. 2018. Rethinking the critical period for language: New insights into an old question from American Sign Language. *Bilingualism: Language and Cognition* 21: 886–905. [CrossRef]

Mayberry, Rachel I., and Susan D. Fischer. 1989. Looking through phonological shape to lexical meaning: The bottleneck of non-native sign language processing. *Memory & Cognition* 17: 740–54.

Meir, Irit, Mark Aronoff, Wendy Sandler, and Carol Padden. 2010. Sign languages and compounding. In *Cross-Disciplinary Issues in Compounding*. Edited by Sergio Scalise and Irene Vogel. Philadelphia: John Benjamins Publishing, pp. 301–22.

Newport, Elissa L. 1990. Maturational constraints on language learning. *Cognitive Science* 14: 11–28. [CrossRef]

Newport, Elissa L., Daphne Bavelier, and Helen J. Neville. 2001. Critical thinking about critical periods: Perspectives on a critical period for language acquisition. In *Language, Brain and Cognitive Development: Essays in Honor of Jacques Mehler*. Cambridge: MIT Press, pp. 481–502.

Padden, Carol, Irit Meir, So-One Hwang, Ryan Lepic, Sharon Seegers, and Tory Sampson. 2013. Patterned iconicity in sign language lexicons. *Gesture* 13: 287–308. [CrossRef]

Padden, Carol, So-One Hwang, Ryan Lepic, and Sharon Seegers. 2015. Tools for language: Patterned iconicity in sign language nouns and verbs. *Topics in Cognitive Science* 7: 81–94. [CrossRef] [PubMed]

Richie, Russell, Charles Yang, and Marie Coppola. 2014. Modeling the emergence of lexicons in homesign systems. *Topics in Cognitive Science* 6: 183–95. [CrossRef] [PubMed]

Safar, Josefina, and Rodrigo Petatillo Chan. 2020. Strategies of noun-verb distinction in Yucatec Maya Sign Languages. In *Emerging Sign Languages of the Americas*. Edited by Olivier Le Guen, Josefina Safar and Marie Coppola. Berlin and Boston: De Gruyter Mouton, pp. 155–202. [CrossRef]

Senghas, Ann. 2019. How language learns: Linking universals to acquisition. In *Proceedings of the 43rd Boston University Conference on Language Development*. Edited by Megan M. Brown and Brady Dailey. Somerville: Cascadilla Press, pp. 1–10.

Senghas, Ann, and Marie Coppola. 2001. Children creating language: How Nicaraguan Sign Language acquired a spatial grammar. *Psychological Science* 12: 323–28. [CrossRef]

Senghas, Ann, Asli Ozyurek, and Sotaro Kita. 2005. Response to comment on "Children creating core properties of language: Evidence from an emerging sign language in Nicaragua". *Science* 309: 56. [CrossRef]

Singleton, Jenny L., Jill P. Morford, and Susan Goldin-Meadow. 1993. Once is not enough: Standards of well-formedness in manual communication created over three different timespans. *Language* 69: 683–715. [CrossRef]

Wittenburg, Peter, Hennie Brugman, Albert Russel, Alex Klassmann, and Han Sloetjes. 2006. ELAN: A professional framework for multimodality research. Paper presented at the 5th International Conference on Language Resources and Evaluation (LREC 2006), Genoa, Italy, May 22–28; pp. 1556–59.

Zheng, Mingyu, and Susan Goldin-Meadow. 2002. Thought before language: How deaf and hearing children express motion events across cultures. *Cognition* 85: 145–75. [CrossRef]

languages

MDPI

Article

Comparing Iconicity Trade-Offs in Cena and Libras during a Sign Language Production Task

Diane Stoianov [1,*], Diná Souza da Silva [2], Jó Carlos Neves Freitas [3], Anderson Almeida-Silva [4] and Andrew Nevins [1,5]

1 Department of Linguistics, University College London, London WC1N 1PF, UK; a.nevins@ucl.ac.uk
2 Faculty of Education, Science, and Linguistics, Universidade Estadual do Ceará, Iguatu 63502-253, Brazil; dina.silva@uece.br
3 Division of Student Affairs, Universidade Federal do Delta do Parnaíba, Parnaíba 64202-020, Brazil; jocarlos@ufpi.edu.br
4 Department of Biological Sciences, Universidade Federal do Delta do Parnaíba, Parnaíba 64202-020, Brazil; andersonalmeida@ufpi.edu.br
5 Department of Linguistics, Universidade Federal do Rio de Janeiro, Rio de Janeiro 21941-917, Brazil; andrewnevins@letras.ufrj.br
* Correspondence: diane.stoianov.15@ucl.ac.uk

Citation: Stoianov, Diane, Diná Souza da Silva, Jó Carlos Neves Freitas, Anderson Almeida-Silva, and Andrew Nevins. 2022. Comparing Iconicity Trade-Offs in Cena and Libras during a Sign Language Production Task. *Languages* 7: 98. https://doi.org/10.3390/languages7020098

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 15 October 2021
Accepted: 18 March 2022
Published: 15 April 2022

Abstract: Although classifier constructions generally aim for highly iconic depictions, like any other part of language they may be constrained by phonology. We compare utterances containing motion events between signers of Cena, an emerging rural sign language in Brazil, and Libras, the national sign language of Brazil, to investigate whether a difference in time-depth—a relevant factor in phonological reorganisation—influences trade-offs involving iconicity. First, we find that contrary to what may be expected, given that emerging sign languages exhibit great variation and favour highly iconic prototypes, Cena signers exhibit neither greater variation nor the use of more complex handshapes in classifier constructions. We also report a divergence from findings on Nicaraguan Sign Language (NSL) in how signers encode movement in a young language, showing that Cena signers tend to encode manner and path simultaneously, unlike NSL signers of comparable cohorts. Cena signers therefore pattern more like non-signing gesturers and signers of urban sign languages, including the Libras signers in our study. The study contributes an addition to the as-yet limited investigations into classifiers in emerging sign languages, demonstrating how different aspects of linguistic organisation, including phonology, can interact with classifier form.

Keywords: sign language; phonology; iconicity; classifiers; language change

1. Introduction

Classifiers present a ubiquitous, rich, and productive morphological category of structures within sign languages. Despite the myriad ways in which they exploit iconic properties of the referent they depict, similar to sublexical units of a language, their features may also be constrained by phonology. As phonological reorganisation takes place over time (Frishberg 1975; Brentari et al. 2012; Senghas et al. 2004), our study compares results from the same production task between signers of Cena, an emerging sign language of north-eastern Brazil in its third generation, and Libras, the national sign language of Brazil, to determine how handshape complexity and variation fare in two languages of different ages and sociolinguistic profiles. We aim to investigate the question of whether in a language of relative youth, we find more complex and varied classifier handshapes given that classifiers are likely unconventionalised, thus putting a greater burden on recoverability through strategies such as iconic depiction. We also explore how signers choose to encode manner and path in motion events. Considering existing findings from signers of Nicaraguan Sign Language (NSL) illustrating that later-cohort signers show a greater preference for encoding manner and path sequentially relative to earlier-cohort signers, we are interested in whether this departure from iconic depiction represents a developmental stage of emerging sign languages generally, or whether it may be specific to the conditions under which NSL emerged.

In Section 1, we provide background on classifiers in sign languages, providing a brief summary of common categorisations of classifier types. The section also details how the phonological features of classifier complexity may be reorganised in predictable ways over time and provides a model of quantifying complexity based on the prosodic model (Brentari 1998). Finally, Section 1 contextualises both languages in the study and the cultural contexts in which they are used. Section 2 details the Haifa Clips communicative production task, developed for Sandler et al. (2005), in which signers describe basic motion events to another native signer who must correctly identify the events, and our subsequent analysis methods. Section 3 provides results, finding that, overall, Cena signers do not appear to make as much use of more complex handshapes as we may have expected given young sign languages' propensity for iconic depiction (Sandler et al. 2011; Hou 2016), and although we do find more handshape variants in one type of classifier in Cena, these may be accounted for by assimilation. Our results also show how in their encoding of movement, both Libras and Cena signers pattern more like gesturers, early-cohort NSL signers, and signers of urban sign languages. Section 4 presents discussion of the findings. We consider and further break down results in terms of complexity and variation in this section, before discussing our conclusions in Section 5.

1.1. Classifiers in Sign Languages

1.1.1. An Overview

Classifiers are handshapes that denote a broad class of referents such as vehicles, people, or round objects within a given sign language. In this way, they function similarly to those of spoken languages, although in the interests of space we will not include a detailed comparison here[1]. Handshape is usually described as one of the sub-lexical building blocks of signs that combines with location and movement to form meaningful signs, much in the same way meaningless sounds combine to form words in spoken language. However, handshapes as they exist in classifiers are morphemic; simply put, they are meaningful. Classifiers may be combined with particular movement or location specifications to depict verb events, forming what we will call *classifier constructions*, although labels in the literature vary (c.f. Engberg-Pedersen 2010 for *classifier signs*; Cormier et al. 2012 for *depicting constructions*) depending on which model of proposed classifier representation and structure one may subscribe to. Examples of classifier constructions from British Sign Language (BSL) (Sutton-Spence and Woll 1999) and Hong Kong Sign Language (HKSL) (Tang and Yang 2007) are shown in Figures 1 and 2. In Figure 1, the signer first produces the lexical sign CAT in the image on the left, and on the right depicts an action performed by the referent with a BSL animal classifier and a motion verb. The construction in Figure 2 combines a vehicle classifier with a verb of motion producing *a vehicle arrives*. Both classifiers pick out some visual characteristic of the referent—the vehicle classifier depicts the overall shape, whereas the animal classifier highlights the salient property of its legs. This exemplifies what is known as *iconicity*, which features heavily in classifiers—some motivated relationship between form and meaning.

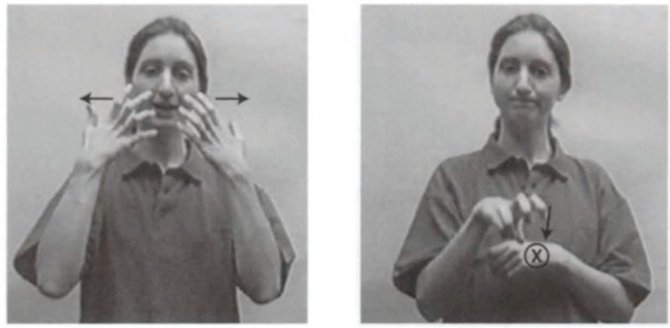


Figure 1. An animal classifier used in a classifier construction 'a cat sits' in BSL. Reprinted with permission from Sutton-Spence and Woll. Cambridge University Press 1999.

Figure 2. A vehicle classifier used in a classifier construction in HKSL. Reprinted with permission from Tang and Yang. 2007 Elsevier.

Classifiers vary in the properties of their referents they pick out and how they do so. In his early analysis of American Sign Language (ASL) classifiers, Supalla (1982, 1986) proposed five types: (i) size and shape specifiers (hereby SaSSes), which denote a referent by depicting its size or physical form; the hands may statically show the outer edges of the object to show its height or width (such as the thickness of a book), or they may trace its shape (such as the outline of a Christmas tree); (ii) semantic classifiers, depicting a general semantic class of objects such as an animal in Figure 1 or vehicle in Figure 2, but may be manipulated to show additional or specific details; Supalla (1986) gives the example of a tree classifier—a signer is free to modify this broad semantic category classifier to show the type of tree, be it a palm or weeping willow; (iii) body classifiers, which use the body of the signer to denote the whole body of an animate referent; (iv) body part classifiers in which parts of the body represent themselves; and (v) instrument classifiers, indirectly denoting a referent through depicting its handling or manipulation. In the manipulation of the referent object, the hands can represent themselves, or a tool being manipulated (one may think of a flat hand moved in a sawing motion to represent a knife).

Since Supalla's work, many other categories have been proposed for ASL and other languages, and terminology varies (see Tang et al. 2021 for a recent overview). Studies also vary in the number of proposed sub-types of classifiers, but the same two main types of classifiers persist throughout much of the literature even when additional categories are also proposed:

1. Whole entity classifiers, in which the hand or hands directly represent a whole object. They denote a general class of objects (e.g., people, vehicles, four-legged animals) using some aspect of their form, though their iconicity can vary in its transparency. Some consider this category to include SaSSes (e.g., Zwitserlood 2012), while others do not (Morgan and Woll 2007).
2. Handling classifiers, which denote an object through depicting the handling or manipulation of the object in question, e.g., holding a mobile phone, or turning a key. These often still provide some information about the size and/or form of the object, although indirectly.

Classifiers are often discussed as a freer class of items in a sign language relative to lexical signs, in that some (not all) featural specifications of the same classifier may vary across usages based on the semantic properties of the specific referent. The movement features for an entity classifier within a classifier construction depicting a person walking may depend on their style or speed of walking, just as the type of tree depicted may determine specifics of the chosen handshape. However, whilst a signer has relatively more articulatory choices at their behest when using classifiers, it is not completely unconstrained. They must become conventionalised within a given language. Classifiers for the same group of referents vary crosslinguistically and are not always transparent despite their tendency to take advantage of iconic relations—compare the BSL vehicle classifier handshape][2] to that of ASL .

This crosslinguistic variation might in part be due to the iconic capacity of handshape being more varied than that of movement and location. There are often many aspects of an entity available for iconic depiction, and choices are influenced by various factors including conceptual salience (Tkachman et al. 2020), i.e., which visual aspect of the referent may be most salient such as the beak of a chicken as opposed to its feet. The choices for movement and location are not so broad, if one wants to depict iconically. In reality, referents are only 'specified' (to use a phonological metaphor) for one location at any given time, relative to other potential referents. The same may be said about orientation, and to a lesser extent, movement[3]. It cannot be said that an entity is specified only for one shape, however. A human being or a car could be deconstructed into many shapes, including but not limited to their overall shape. The overall shape of a referent is merely one representational choice available out of many in constructing an entity classifier. This variety of choice can be observed in experimental contexts. Schembri et al. (2005) found that when depicting the same referents, the handshapes of classifiers used by signers of unrelated sign languages varied much more than their movement or location specifications. In short, handshapes for the same referent vary widely between languages. We turn next to what may influence system-wide choices in handshape in languages, particularly those of different ages and stages of conventionalisation.

1.1.2. The Phonology of Classifiers

Such variety of possibility in classifier handshape may serve as one motivation to stray further away from iconicity. As users of any communicative system mediated through anatomy, signers and speakers are subject to biological principles of energy conservation and a temptation towards the path of least resistance. It is known that signs become less iconic over time (Frishberg 1975), and that such phonological reorganisation can be motivated by ease of articulation. Eccarius (2008) notes the older form of the airplane classifier handshape in HKSL is the highly marked . Over time, young signers are replacing this handshape with , wherein the index finger is extended rather than the middle. What this newer variant may lose in iconicity, it gains in ease. Only the thumb, index, and pinky fingers are controlled by muscles that allow them to extend independently with no adjacent digit to support them (Ann 2006, p. 94). This pull towards articulatorily ease appears strong enough to transcend the lone domain of handshape. The movement features of VIDEOTAPE-RECORDER in ASL have shifted from being asymmetrical—depicting the way in which the reels really move—to being symmetrical (Figure 3). The motivation from articulatory ease is clear. Human physiology is marked by bilateral symmetry, and as such movements that are symmetrical from the midline of the body can be specified for only one path of movement, rather than the two that asymmetrical movements require. Empirically, studies on symmetry in gesture (in hearing non-sign language-learning infants) and sign (in deaf sign language-learning infants) in young children support the idea that two-handed symmetrical movement is articulatorily easier than two-handed asymmetrical movement (Fagard 1994; Cheek et al. 2001; Pettenati et al. 2010). We take this as strong evidence of their relative ease, analogously to how factors such as infant substitutions and error shape conclusions about the relative difficulty of sounds in spoken language.

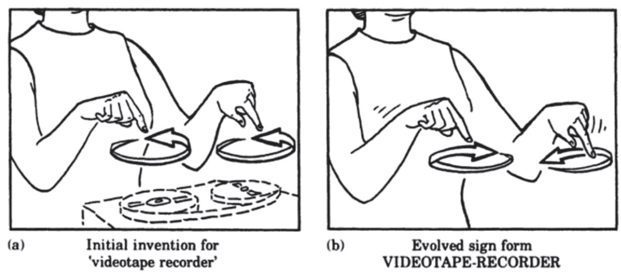
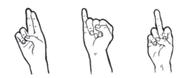
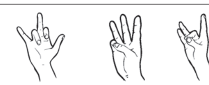


Figure 3. The evolution of ASL VIDEOTAPE-RECORDER. Adapted from Klima and Bellugi (1979). Reprinted with permission from Klima and Bellugi. 1979 Harvard University Press.

In short, the balance of the trade-off between faithfulness to iconicity and pressures of phonology may shift over time. Such an idea is also supported by more recent work. Brentari et al. (2012) present evidence that the phonological features of classifiers show a predictable distribution in terms of complexity. Naturally, a quantifiable measure of complexity is needed for such a claim. The authors compare two types of complexity—finger complexity and joint complexity—and define them as follows. Finger complexity is concerned with which fingers are selected for a given handshape, as articulatory difficulty varies in part because of how different muscle groups support the extension of the digits of the hand. For example, it is less strenuous for the middle, ring, and pinky fingers to all share the specification of flexion or extension in a handshape (see Ann 2006 for an anatomical explanation of why). Brentari and colleagues describe the different criteria one can use to arrive at a notion of low finger complexity in handshapes: early acquisition, crosslinguistic frequency, and representational simplicity—in this case under the prosodic model (Brentari 1998)[4]. These criteria all overlap to capture three selected finger groups of low complexity (all, index, and thumb) shown in Table 1. Handshapes with medium complexity are those that have a single non-radial finger extended, i.e., the middle, ring, or pinky finger. Additionally, the medium complexity category captures handshapes with two selected fingers. Representational complexity determines this criterion; medium finger complexity handshapes differ from low complexity handshape by one additional feature specification. The prosodic model utilises one of the central ideas of dependency phonology[5]: features dominate over other features to yield possible contrasts. This is analogous to representations of vowel systems wherein the place feature [high] alone might be realised as [i], but if [high] dominates over [low] this results in [ɪ]. For a handshape where the index and middle fingers are extended, for selected fingers [one] dominates [all]. Similarly, different place features combine in dominance relations to yield handshapes such as the ring finger alone being extended. As such feature interactions require two features, this additional feature forms the criteria for medium complexity. High complexity captures all other possible selected finger groups that differ in the type and number of additional feature configurations they need.

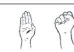
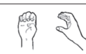
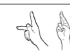
Table 1. Handshapes demonstrating finger complexity scores according to Brentari et al. (2012).

Finger Complexity	Handshape Examples
Low	
Medium	
High	

Whilst joint complexity was not the authors' focus, they define it as follows. Fully open and fully closed handshapes are given the lowest score of 1, in which the selected fingers are fully extended, or all fingers are fully closed respectively. Flat and spread handshapes receive a higher score of 2. Flat handshapes are formed by bending the finger(s) at the base joint while the other finger joints remain extended, and spread handshapes are any in which the extended fingers are spread apart from one another. Curved and bent handshapes receive a higher score still (3), wherein all the selected finger joints are flexed to a greater (bent) or lesser (curved) degree. The category of highest joint complexity, 4, is reserved for stacked (in which each selected finger is increasingly flexed) and crossed (when selected fingers are crossed) handshapes. Accompanying examples of all groups can be found in Table 2. These complexity scores are again based on a notion of representational complexity under the Prosodic Model (Brentari 1998), but the resulting stratification accurately predicts patterns we would expect given such categorisation (Brentari et al. 2016). In acquisition, the handshapes that are the earliest acquired by ASL- (Boyes Braem 1990) and BSL-learning children (Morgan et al. 2007) are of low joint complexity. Those that are of high joint complexity, conversely, are among the latest acquired and among the most infrequent crosslinguistically (Rozelle 2003). However, whilst all handshapes of low complexity may be those that are crosslinguistically frequent and earliest acquired, the reverse does not necessarily hold. That is, handshapes that may be frequent or easily acquired may not always receive scores of low complexity. One such exception is the curved  handshape[6], which is considered unmarked (Battison 1978) and is frequent crosslinguistically in classifiers (Zwitserlood 2012). Its relative frequency in classifiers across languages is likely at least partially grounded in its ubiquity as a manual configuration for handling objects. As the model of Brentari et al. is motivated primarily by representational complexity, such a model will overlook influences of this type.

Moving away from notions of complexity defined by linguistic criteria, Brentari et al.'s model generally overlaps with a model of articulatory ease based on the anatomy and physiology of the hand proposed by Ann (2006), with some minor differences[7]. Whilst keeping in mind that representational complexity is not automatically the same as articulatory difficulty, it is pertinent to determine to what extent a phonological measure of complexity overlaps with purely motoric articulatory difficulty. In this case, this model of representational complexity does largely overlap with conceptions of articulatory difficulty based on acquisition, crosslinguistic distribution, and anatomy.

Table 2. Handshapes demonstrating joint complexity scores according to Brentari et al. (2012).

Joint Complexity	Handshape Examples
1	
2	
3	
4	

Considering the findings of Eccarius (2008) and Brentari and Eccarius (2010), that handshapes in entity classifiers (or *object classifiers* as they call them) have greater finger complexity and handshapes in handling classifiers have greater joint complexity across unrelated sign languages, Brentari et al. (2012) compare hearing gesturers, homesigners, and ASL and Italian Sign Language signers to shed light on whether this pattern is one imposed by some aspect of the linguistic system, or a general tendency in codification shared by signers and non-signers alike, based on iconic properties available to all. The authors found the former: gesturers demonstrated the inverse of the results from the crosslinguistic studies (i.e., greater joint complexity in object handshapes and greater finger complexity in handling handshapes). The homesigners' results mirrored those of signers but with less polarised differences, and the signers in the study replicated findings from previous research. In other words, there is a unidirectional pattern of change in phonological complexity through gesturers, homesigners, and signers respectively. Finger complexity in entity classifier handshapes increases, as does joint complexity in handling classifier handshapes. Differences in finger complexity distribution across signers, homesigners, and gesturers found by Brentari et al. (2012) can be seen in Figure 4, in which the asterisk denotes a statistically significant difference. Taken together with examples from Frishberg (1975) and Eccarius (2008), this seems to suggest that even in a realm as iconic as classifiers, we still observe that something like handshape complexity is not distributed equally across classifier types and is subject to, at least in part, predictable phonological organisation. We take this as our starting point for the current study.

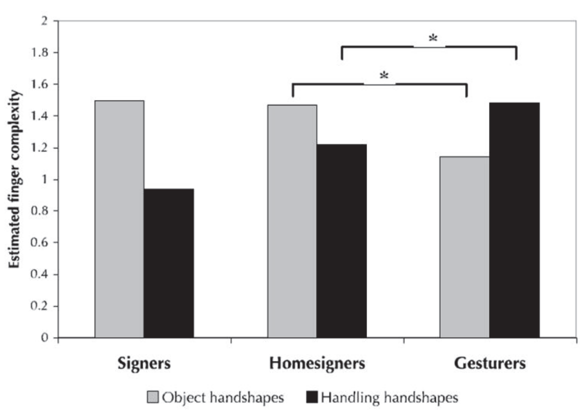


Figure 4. Finger complexity in object[8] and handling classifier handshapes across groups. Adapted from Brentari et al. (2012). Reprinted with permission from Brentari et al. 2012 Springer Nature.

1.1.3. Manner and Path in Motion Events

Entity classifiers allow signers to set up a referent in space and have it undergo or perform actions. As such, they are often used by signers to depict motion events. If motion occurred, there is always a start and end point between which a referent moved; this is what is referred to as *path* movement. There is also a *manner* of movement—how a referent got from A to B (such as rolling or walking). Perceptually, both these aspects of movement are perceived simultaneously and thus one might imagine that any linguistic expression of motion events would reflect this simultaneity. However, comparisons made among spoken languages demonstrate that they tend to segment a motion event into two linguistic structures, one encoding the path and another the manner (Talmy 1985). More recent research on signers and gesturers has aimed to answer the question on whether this tendency to segment and linearise is a general property of language, or an effect of modality. Visual information such as path and manner of movement can be easily 'stacked' in sign languages—encoded simultaneously mirroring the way it is visually experienced. Sequential encoding is of course equally possible (see Figure 5 for both methods). Nicaraguan Sign Language (NSL) offers a unique vantage point into the dynamic early stages of a developing sign language and how motion information is encoded (Senghas et al. 2004); much like hearing Spanish-speaking, non-signing gesturers, first-cohort child NSL signers tended to encode events holistically, representing the simultaneous exhibition of path and movement features as they occur in the real observed event. In second- and third-cohort child signers, significantly less simultaneous encoding was observed, and was replaced by sequential encoding at a comparable rate of frequency (Figure 6).

However, one should not rush to conclude that there is simply a unidirectional change in a language from simultaneous encoding towards sequential encoding as a language develops over time. When tested with the same materials as the NSL signers, signers of Spanish Sign Language encoded manner and path primarily simultaneously (Senghas and Littman 2004), demonstrating the tendency of urban sign languages to depict manner and path simultaneously rather than sequentially. There are mentions, however brief, in existing literature on other conditions in which linear segmentation of movement may occur. Supalla (1990) describes two types of constraints on simultaneity of manner and path in ASL classifiers: motoric constraints, where manner and path physically cannot be depicted simultaneously, and grammatical constraints, wherein existing constraints on movement prohibit a particular combination of a verb of motion with a selected classifier[9]. Newport and Meier (1985), De Beuzeville (2004), and Tang et al. (2007) all report instances of sign language-learning children breaking down motion events into linear constructions, the individual parts of which sequentially encode aspects of its path or manner. Newport and Meier (1985) argue that this is motivated by articulatory ease, that children may struggle to articulate classifier handshapes (which are often marked) and the path or manner of the motion verb simultaneously. Concerning the choice between linear segmentation and simultaneous encoding of manner and path, the latter is the more iconic choice in terms of temporality. That is, manner and path are simultaneous in a motion event itself, so to encode them as such is faithful to reality. Among children acquiring sign languages, in the trade-off between iconicity and articulatory ease, ease may prevail when certain aspects of manner or path are difficult to produce simultaneously for the young signer.

What the cases of later-cohort NSL signers and children in the acquisition stage seem to suggest is that segmentation is the exception rather than the rule. The language model available to later-cohort NSL signers (who exhibit linear segmentation of motion events) was one that was undergoing rapid and multifaceted restructuring as various homesigners came together. Children in the acquisition stage are also in an atypical linguistic situation relative to other language users; they are in a transitory and temporary period when they do not yet have a full grasp of their native language. What both these cases have in common is some unique environment in terms of language input and/or acquisition stage, and both cases involve child signers. None of this applies to signers in our study. On the other hand, further investigation may suggest that these are not conditioning factors in accounting for sequential encoding of manner and path, and the preference may be also found in second and third cohorts of adult signers of emerging sign languages. The current study takes one step towards answering this question.

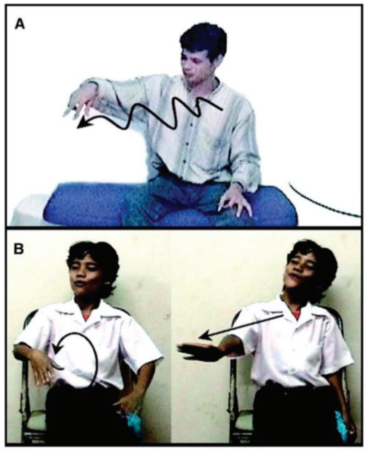


Figure 5. (**A**) A gesturer encoding manner and path simultaneously; (**B**) a NSL signer encoding manner and path sequentially. Adapted from Senghas et al. (2004). Reprinted with permission from (Senghas et al. 2004) The American Association for the Advancement of Science.

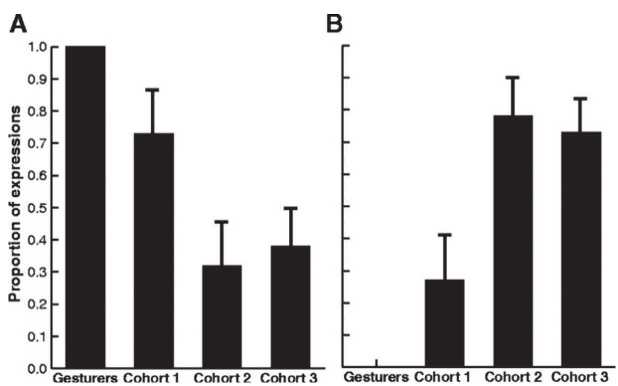


Figure 6. Proportion of simultaneous (**A**) and sequential (**B**) movement encoding across groups in Senghas et al. (2004). Reprinted with permission from (Senghas et al. 2004) The American Association for the Advancement of Science.

1.2. The Current Study

So far, we have presented evidence that classifiers are indeed an area in which the phonological domains of handshape and movement are subject to (re)organisation over time. Subsequently, we present an exploratory analysis of classifier handshape and movement in two sign languages differing in age and sociolinguistic profile. Existing work by Sandler et al. (2011) on Al-Sayyid Bedouin Sign Language (a village sign language of Israel, henceforth ABSL) in accounting for phonetic variation details how signers of an emergent sign language aim for highly iconic holistic depictions of referents, in lieu of contrastive primitives or phoneme-like units in a phonological system. This appears to be true of other typologically similar sign languages (e.g., Hou 2016). If it is the case that classifiers are subject to pressures from articulatory ease over time, and that signers of emerging sign languages tend to aim for holistic iconic depictions, we may expect greater complexity and variation in Cena considering its youth relative to Libras, as Cena signers aim for specific and unconventionalised iconic depictions.

To test this, we compare responses to a video depicting a bottle falling from Cena and Libras signers. In the stimulus, the bottle falls without intervention from a visible human agent so it elicited mostly entity classifiers and SaSSes (our criteria for assigning a classifier each of these labels is explained in Section 2.3). We present the analysis of these types separately, to tease apart the distribution of handshapes across different types of classifiers considering there may be aspects of each type of depiction (whole entity vs. size and shape) that may influence the selection of handshapes, as we have seen happens between entity and handling handshapes. The variants will be coded for complexity following Brentari et al. (2012) and Brentari (1998) and compared across languages. We will also assess variation by way of the number of handshape variants per language and their distribution. Last, we present an analysis of how movement manner and path are encoded in descriptions of motion events considering the relevant variable of language time-depth (cf. Senghas et al. 2004). The domain of classifiers is well-suited to our aims. The high degree of iconicity often found in classifiers provides an opportunity to observe other factors that may pull sign form away from faithfulness to semantics or an iconic representation, such as articulatory ease, or the emergence of sequential encoding.

Predictions

The conventionalisation of classifier form in languages over time is a process that allows signers to rely on convention to depict referents rather than only iconic resemblance, inviting the possibility for forms to become phonologically reorganised under the pressure of articulatory ease in cases where the two are indeed opposing forces. Of course, there are other forces influencing classifier form such as semantics, but pressures of ease function within such influences (there are articulatorily more and less difficult ways of picking out the same semantic property). Given the tendency for signs—including classifiers—to submit to pressures of articulatory ease as a system increases in time-depth and becomes more conventionalised, and given the holistic depictions found in village sign languages in lieu of robust systematic phonological structure (Sandler et al. 2011; Hou 2016), we predict that iconic depiction will triumph in any trade-off against articulatory ease. Our first hypothesis is as follows:

Hypothesis 1 (H1). *Cena classifiers will exploit handshapes of greater complexity than Libras.*

Since it is unlikely that a systematic level of phonological structure has emerged in a language of such an age and sociocultural profile, and that close-knit communities can tolerate great variation (Wray and Grace 2007) at higher rates than their national counterparts (Meir and Sandler 2019) over long periods of time (Meir et al. 2012), our second hypothesis is:

Hypothesis 2 (H2). *Cena classifier handshapes will exhibit greater intersigner variation than Libras.*

Last, we turn to the encoding of motion events. Whilst Cena signers have not yet been grouped into distinct cohorts by researchers, they are not homesigners; most of them grew up with an existing language model. However, this linguistic input is different to that of later-cohort NSL signers, who showed a greater preference for the linear sequencing of motion events relative to first-cohort signers. The vertical linguistic input of later-cohort signers was that of various unconnected homesigners whom the establishment of a school had brought together. Although we believe the majority of Cena signers in our study to be roughly second cohort, their language is not undergoing the intense restructuring of second-cohort NSL, or others in creolisation language contexts (though this may have been partly in play with the establishment of Libras over 150 years ago in its early development with the foundation of INES). Recall also that linear sequencing of motion events has been observed in children acquiring a sign language. As all signers in our study are well past the acquisition period, and given that Cena does not share its context of emergence with NSL and the subsequent type of restructing that follows, we predict Cena signers will prefer simultaneous encoding of manner and path. We also predict Libras signers will prefer this strategy, in line with data from signers of Spanish Sign Language. Our final hypothesis is as follows:

Hypothesis 3 (H3). *Both Cena and Libras signers will exhibit a preference for simultaneous encoding of motion events.*

1.3. Language Profiles

1.3.1. Libras

Libras—an abbreviation of its Portuguese name, Língua Brasileira de Sinais—is the official national sign language of Brazil, used in (but not limited to) institutions and urban centres across Brazil. Its establishment was associated with the foundation of the National Institute of Deaf Education (INES) in Rio de Janeiro in 1857. Since one of the original teachers at the institute was French, modern Libras has evolved from a mixture of French Sign Language and existing signs in use in the region (Xavier and Agrella 2015). In 2002, Libras was legally recognised as the language of many Brazilian deaf communities, reaffirming its cultural and linguistic importance as a natural language[10]. The legal recognition of Libras under the 'Libras Law' (as Federal Law 10.436 is known) and a resulting decree (5.626) has manifested basic deaf rights in Brazil, including rights to interpreters in official settings and the translation of official documents. In the wake of such legal recognition, Silva (2021) suggests we need to look anew at the sign languages of Brazil used outside of urban centres. Outside of legal protections and benefits, we have seen that their documentation paves the way for a richer and broader understanding of (sign) language typology (de Vos and Pfau 2015), phonology (see Sandler et al. 2011 for the emergence of), and syntax (Sandler et al. 2005 for word order; Meir 2010; Padden et al. 2010; Ergin et al. 2018 for argument structure). We compare Cena to Libras in the current study to control as many orthogonal variables as possible. Primarily, the comparison ensures that the repertoires of ambient gestures of the surrounding culture are closely matched. This is a known and significant influence on sign languages, as they absorb and reorganise gestures that are culturally specific even within the realms of classifiers (Nyst 2019). We know of at least one such borrowing in Cena, where the sign PAST/A-LONG-TIME is identical in form to a common Brazilian finger-snapping gesture relating to time passing. Therefore, although the desired comparison is primarily between a young emergent language and an urban sign language with greater time depth, we aim to minimise confounds from distinct gestural influences by comparing Cena to the most culturally similar language that otherwise meets our criteria.

1.3.2. Cena

Silva (2021, p. 107) details studies that deal with at least 21 sign languages used by deaf communities in Brazil (see Fusellier-Souza 2004; Stoianov and Nevins 2017; and Godoy 2020 for examples of linguistic investigation). However, such studies are still preliminary and in need of richer linguistic description. Among these emerging sign languages used by isolated communities far from urban centres we find Cena, literally *scene*, the word used to refer to what signers recount with their hands as they sign and the term that has come to be used as a name for the language in its community. Cena is a sign language in its third generation used by deaf (and many hearing) inhabitants of Várzea Queimada, a community with a population of about 900. Várzea Queimada is located in the eastern part of Piauí, a mostly landlocked state of north-eastern Brazil. Cena, like other languages of its kind, has emerged within a context of a high rate of congenital deafness and is unrelated to the national sign language of its country. It is in the PhD thesis of Everton Pereira (2013) that we find the first published mention of Cena[11]. From an anthropological perspective, he details the use of Cena as it interacts with aspects of daily life and society in Várzea Queimada: work, religious practices, family life, and local artisanal crafting. The majority of residents, deaf and hearing alike, subsist on agriculture, animal husbandry, local commerce, and government benefits[12]. In claiming that many hearing people sign, and in drawing any parallels between the work-related livelihoods of deaf and hearing inhabitants of the community, it is important to be careful to not perpetuate idealistic notions of a 'deaf utopia' in villages such as Várzea Queimada, as warned by Kusters (2010). She explains the risk of flattening many nuanced asymmetries between the social, economic, educational, and professional realities of deaf and hearing people in such contexts by over-emphasising the integration of deaf community members relative to Western urban contexts. In Várzea Queimada, deaf access to education has historically been subpar or non-existent, and the community is not immune to negative attitudes towards deafness from within their ranks. Anthropological and linguistic work on Cena is undoubtedly in its infancy, but suffice it to say for now that the gap of social and economic stratification between deaf and hearing inhabitants of Várzea Queimada is far smaller than that of urban centres around Brazil, which is of course in no small part likely due to the upper limits of such stratification within the confines of the village.

There are 34 known deaf inhabitants as of 2021[13], most of whom use Cena as their primary language although there is variation in the exposure to and use of Libras, particularly with younger signers. Most deaf inhabitants are clustered in three villages, each a few kilometres apart. The first deaf woman in the community was born in 1949, and soon after another six deaf children were born into a different family. Cena is not a homesign system, but we hypothesise that like many similar languages, it likely started as one. As is common with sign languages of this sociocultural context (de Vos and Pfau 2015), an unknown number of hearing people in the community sign to varying degrees of competency. Many deaf adults have hearing children—known as CODAs (children of deaf adults)—who are proficient signers, and some hearing members of deaf individuals' families are competent signers. At the time of publication, the youngest deaf signer is 15, with no other known deaf children born in the community since. There is some use of Libras among younger signers since many temporarily attended schools in the community, where they had weekly classes in Libras. Younger signers also have access to the internet and numerous social networks to varying degrees, and signers of a variety of ages use lexical borrowings from Libras. Despite the increased and perhaps increasing presence of Libras in the community through education and the internet, age remains a determining factor; older signers do not, and have not historically, attended school and thus use of Libras among them is often minimal.

Whilst Pereira's thesis discusses matters of deaf social life and integration in detail, Almeida-Silva and Nevins (2020) provide the first linguistic overview of the language. Their data is comprised of 330 signs including nouns, verbs, adverbs, adjectives, and functional items. Pronominal markers rather expectedly use self-anchored pointing to mark first person, and pointing using real-world location to mark the second or third person of any present referent. In all existing data including that in the current study, no absent third-person pronouns have been observed. The authors also present evidence of adverbial modification (shown in Figure 7) in the use of facial expression and body movement to intensify manual signs, much like uses of similar non-manual features for intensification purposes in other urban sign languages, such as the 'ee' mouth gesture in BSL (Sutton-Spence and Woll 1999) and Auslan (Johnston and Schembri 2007), and the furrowed brows and hunching of the torso used in intensification in Libras (Xavier 2017). Concerning word order, there appears to be little overall convergence. Yet 'overall' may be the operative word in this case, as work on Central Taurus Sign Language (Ergin et al. 2018) and ABSL (Meir 2010) suggests consistency of word order in emerging sign languages can be dependent on syntactical properties of the verb events in question, as well as on signing cohort. Almeida-Silva and Nevins (2020) encountered various minimal pairs such as the example shown in Figure 8, where one should note that the difference of left- and right-handedness between the signers is irrelevant to lexical contrast. As expected from languages that have emerged among low or unreliable rates of literacy, there is no manual alphabet nor any attested native alphabetised signs present thus far, though several signers know the Libras manual alphabet to varying extents—it is not uncommon for signers to use it for their own names or the names of others. Although there exist lexical borrowings from Libras, both the findings of Almeida-Silva and Nevins (2020) and data in the current study provide evidence for a vocabulary largely comprised of local Cena signs, including compounds unattested in Libras. Based on our observations over many field visits, signers are predominantly monolingual. This description is corroborated by self-reports from signers (Almeida-Silva, forthcoming), and by interviews with those who worked as teachers with the deaf members of the community, one going so far as to say Cena signers "reject" Libras (Franco 2022, p. 7).

intensification

MORNING

'very early'

Figure 7. A case of modification utilising the 'ee' mouth shape and body posture.

(**a**) (**b**)

Figure 8. A minimal pair in Cena differing in handshape: (**a**) GOAT; (**b**) TO BETRAY.

This preliminary linguistic sketch of Cena found considerable robustness of various domains of the lexicon, notably food, animals, and religious terminology (which details the numerous saints and religious festivals observed by the mostly Catholic inhabitants of the community). Despite this, variation prevails. It is primarily along inter-familial and inter-generational lines where lexical variation is found, but phonetic variation is widespread among signers. This comes as no surprise (cf. Israel and Sandler 2011 for ABSL). It is known that for language in general, degrees of social intimacy and shared communal knowledge has a bearing on the resulting types of linguistic structures (Wray and Grace 2007). The lives of the inhabitants of Várzea Queimada are highly intertwined. People spend a great deal of daily time in each other's company doing domestic or farm work. From this repeated interaction sprouts a high degree of knowledge and intimacy concerning the lives and families of others, shared reference points, events and practices of cultural importance, and a knowledge of the surrounding area. The communication patterns of Várzea Queimada would fall squarely into what Wray and Grace (2007) and Thurston (1989) call *esoteric*, inward-facing language use on topics of mutual familiarity among those who are known to each other. This shared knowledge and relative homogeneity is what enables languages in such communities to tolerate high rates of variation (Meir and Sandler 2019), and is primarily what motivates our Hypothesis 2, predicting greater variation in Cena.

1.3.3. Typological Considerations

Considering the above sociocultural and linguistic outline of Cena, we turn briefly to the issue of language typology. Typological classification is a useful exercise as it enables us to compare phenomena across languages of the same type. Of course, *type* can refer to many aspects of linguistic structure—tonal languages are a type, as well as those with or without agglutinative morphology. Given what is known about the effects of sociocultural and geographical context on linguistic structure in young sign languages, the existing literature has commonly sought to categorise them along these lines. Broadly speaking, two main categories appear in the literature following the distinction first made by Meir et al. (2010): *deaf community sign languages*, and what we will term *village sign languages* (although there is more debate around the labels for sign languages of this general kind). Deaf community sign languages are the result of a group of deaf people of varied backgrounds coming together for some (often institutional) purpose, and often coincide with the establishment of a deaf school. NSL is one often-cited example of a deaf community sign language (see Senghas 1995 and Kegl et al. 1999 for early work) as the establishment of the school that galvanised its development was relatively recent. The historical development of several national sign languages including ASL also meets the criteria for this label, though these are often referred to as *urban sign languages*.

It should already be clear that Cena is not a deaf community sign language. As it has emerged among its users of the same background within the community in which it is used, Cena does not meet this description. Concerning the second type, there are many overlapping terms, including *village sign language* (Zeshan 2011), *shared sign language* (Nyst 2012), *indigenous sign language* (Woodward 2000), and *micro-community sign language* (Schembri 2010), which generally overlap in their criteria of a high rate of congenital deafness and a geographically rural context. The label *shared sign language* foregrounds the tendency for a large number of hearing people in such communities to sign, with varying degrees of fluency and regularity. Similarly, the name *indigenous sign language* aims to highlight the origin of such languages as the same region or country as that in which they are used. All such features are true of Cena, meaning perhaps it is a question of what we to wish to foreground. For the current study, we follow Almeida-Silva and Nevins (2020) in using the label *emerging sign language* with the caveat that Cena does broadly fit the typical profile of a village sign language, since it is primarily the difference of time depth that is relevant for our aims. That is, we wish to compare Cena with a language in the same national and therefore to some degree cultural context, but one that has a stable and conventionalised lexicon and linguistic structure.

Whilst Almeida and Nevins provide an invaluable preliminary overview of the language, there is to date no mention of classifiers in any work on Cena. With the exception of Brentari et al. (2012)[14], there is little in the existing literature on classifiers in young or emerging sign languages. Although not an emergent language, in her description of Adamorobe Sign Language (a village sign language used in Ghana), Nyst (2007) details the gestural and linguistic resources signers exploit for depiction of size and shape. Nyst's striking finding that Adamorobe Sign Language lacks entity classifiers highlights the importance of village sign language data in investigations of language typology and in questioning linguistic universals. Similarly, de Vos (2012) describes some classifier constructions in Kata Kolok—another non-emergent village sign language (she posits that Kata Kolok is in its fifth generation) used on Bali, Indonesia. De Vos finds that entity classifiers in Kata Kolok exploit a more restricted set of handshapes than urban sign languages; instead of handshape, entity classifiers in Kata Kolok are primarily defined by different features of movement or orientation (cf. de Vos 2012, p. 101; Marsaja 2008). Again, her findings demonstrate that village sign languages can exhibit typologically unique or unusual properties in the realm of classifiers and the distribution of the features that comprise them[15]. The current study contributes another such investigation into classifiers in a young language, and the distribution of some elements that comprise them. It also provides the first English-language work on Cena, and the first comparative study of Cena with any other language.

2. Materials and Methods

2.1. Participants

The participants consisted of 19 deaf, predominantly monolingual Cena signers aged 13–59[16] who all live in or around Várzea Queimada, and 19 deaf adult native Libras signers based in Rio de Janeiro. Cena signers generally do not have fluency in written Portuguese, and many are not fully literate. The Libras participants in our study all have a strong grasp of written Portuguese as it forms a part of their daily lives.

2.2. Materials and Task

The current study used the Haifa Clips stimuli set, designed by Sandler et al. (2005), to elicit recounts of short events from participants. The task consisted of 30 short (1–3 s) video clips depicting a variety of intransitive, transitive, and ditransitive actions, such as a ball rolling, a woman looking at a man, and a man throwing a ball to a girl. Participants were asked to relay each event to an interlocutor, another deaf signer and native user of the language in question. Participants then later functioned as interlocutors for following participants. Although many hearing individuals can sign to varying degrees of competency within the community where Cena is used, we chose to limit participants to only deaf monolingual signers to avoid any potential effects of linguistic accommodation between deaf and non-native or non-fluent hearing signers. This also ensures the utterances most closely mirror language used in its natural form—in a communicative context with comprehension as a desired target. To maintain consistency across the two groups, all Libras signers in the study were also deaf native signers.

Once a participant had relayed the event to the interlocutor, the interlocutor chose the corresponding event from three options depicted in images. All response options were still images—no part of the form relied on written language. An example page of the interlocutor's task is shown in Figure 9. Usually, the options differed in one argument of the verb and/or the verb itself. For example, for the stimulus with a rolling ball, the events depicted in the three choices are a ball falling, a bottle rolling, or a ball rolling. Once the interlocutor made a choice, this response was recorded as the first attempt. If correct, the researchers showed the following clip. If the interlocutor did not understand or chose incorrectly, the participant was prompted to explain the clip again. Participants were allowed as many attempts as needed to relay the event successfully. If none of these were successful, the attempt was marked incorrect and we played the next clip. The data for both languages was glossed by two fluent hearing Libras signers who have exposure to and knowledge of Cena through fieldwork. In light of the ongoing COVID-19 pandemic and lack of internet connection in Várzea Queimada, it was unfeasible to have any native Cena signer or our bimodal bilingual consultant in the community involved in the glossing process.

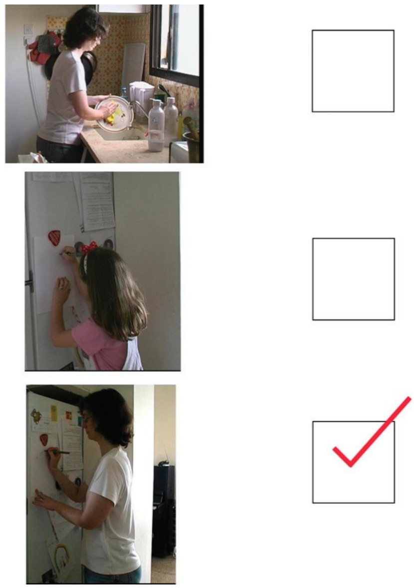


Figure 9. Multiple choice options for the stimulus 'woman writes on refrigerator'.

2.3. Analysis

In our investigation of classifier handshapes, we analyse responses to one stimulus clip of a bottle falling (shown in Figure 10). Finding a target item in our data set that consistenly elicited classifiers from a high number of signers was difficult, a problem made more obstructive by the small number of possible Cena participants. The bottle clip most consistently elicited use of classifiers, meaning that we had usable responses from all but one participant. We coded handshapes used to depict the referent when it is involved in some verb event as entity classifiers. Any classifiers that only depicted the extension of the object were coded as SaSSes. These could be static (perhaps depicting the height of the object) or have movement tracing its shape. For a classifier with movement to be classified as a SaSS, the movement must only depict the dimensions of the object, and no verb event. All tokens of a variable of interest in a participant's response were coded. For example, if a participant used two entity classifiers with different handshapes to represent the bottle (perhaps one as the bottle wobbled and one as it fell), both were coded separately and used in the analysis.

Figure 10. Still images from the stimulus video depicting a bottle falling.

In the analysis of movement, we looked at five of the Haifa clips: a ball bouncing, a ball rolling, a girl running in a circle, a woman walking, and a woman running. We assigned one possible value out of two for movement encoding: *simultaneous* in cases where path and manner were encoded in the same classifier construction, *sequential* when a verb event was split into two signs within a phrase, one providing the manner and the other the path. If a participant provided both a simultaneous and a sequential depiction of a verb event in their response, both were coded. In some responses, signers provided both a simultaneous encoding and another additional sign encoding manner or path only. For such responses the simultaneous construction was recorded, and the additional sign excluded from the analysis. Responses that only included manner or path were also excluded.

3. Results

3.1. Accuracy

We saw similar rates of response accuracy from interlocutors across both groups, with both Cena and Libras interlocutors identifying the correct target clip in 91% of cases. The similarity in these figures serves as a confirmation that the productions in response to the task were highly successful from a communicative standpoint. Correct comprehension tended to fail in cases of reversible transitive (such as *woman looks at man*) or ditransitive (*man throws ball to girl*) events or in non-agentive intransitive events (*ball rolls*). In transitive and ditransitive cases of communication breakdown, it was usually due to a need to disambiguate who was the subject and who was the object. We imagine that incorrect comprehension of non-agentive intransitive events may be because telling a friend or family member 'a ball rolled' with no additional information or context is a strange communicative interaction perhaps with the potential to confuse.

3.2. Handshape

First, we present results for the analysis of classifier handshapes. As a reminder, we coded handshapes that were used to depict that the referent in some verb event were coded as entity classifier handshapes. Handshapes used only in depicting the extension of the object (in other words, not in a verb event) were coded as size and shape specifier handshapes. We recorded 91 tokens of some type of classifier depicting the bottle from Cena signers, with at least one from every participant. Fourteen of these were handling classifiers used in a construction depicting the act of opening a bottle to specify the object; as we believe this is in the process of becoming a conventionalised lexical sign for *bottle*, we exclude this as a classifier variant. This leaves 77 tokens: 44 entity classifier handshapes used in verb events and 33 SaSS handshapes used only to depict the extension of the bottle. We observed five variants of entity classifier handshapes (Table 3) and four SaSS handshapes (Table 4) in the Cena data, displayed below with number of tokens and frequency, as well as the number of participants who used the variant.

Table 3. Cena entity classifier handshapes for the bottle stimulus.

Still Image	Handshape	Tokens	Proportion	No. of Signers
		15	0.34	12
		13	0.30	10

Table 3. *Cont.*

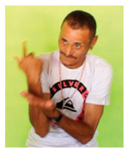
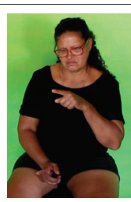
Still Image	Handshape	Tokens	Proportion	No. of Signers
		11	0.25	9
		3	0.07	2
		2	0.04	1

Table 4. Cena SaSS classifier handshapes for the bottle stimulus.

Still Image	Handshape	Tokens	Proportion	No. of Signers
		20	0.61	9
		6	0.18	5
		4	0.12	1
		3	0.09	3

For the Libras signers, we recorded 56 tokens of some classifier depicting the bottle, with at least one from every participant. In this case, the breakdown was 28 entity classifier handshape tokens used in some verb event and 27 SaSS handshape tokens used only to depict the extension of the referent. The 3 attested entity classifier handshape variants are shown in Table 5, and the 4 SaSS variants in Table 6.

Table 5. Libras entity classifier handshapes for the bottle stimulus.

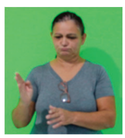
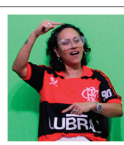
Still Image	Handshape	Tokens	Proportion	No. of Signers
		15	0.53	11
		8	0.29	8
		5	0.18	3

Table 6. Libras SaSS classifier handshapes for the bottle stimulus.

Still Image	Handshape	Tokens	Proportion	No. of Signers
		13	0.48	13
		7	0.26	5
		5	0.19	3
		2	0.07	1

Quantitively, we find more handshape variants in entity classifiers in Cena than in Libras. All handshapes used in entity classifiers in Libras form a subset of those used in the same context in Cena. Four handshape variants were attested in SaSSes in both Cena and Libras, with three of the four handshapes being the same across the two languages. The least frequent handshape in each varied only in its degree of openess, the thumb-opposed  handshape appearing in Cena entity classifiers, and the slightly open version  in Libras entity classifiers. At a glance, the results seem to support our prediction for Hypothesis 2 (that of greater intersigner variation in Cena) when considering entity classifiers, since more handshape variants were attested in Cena than Libras. For size and shape specifier handshapes, our prediction was not borne out as the number of handshapes attested across the languages was the same. An evaluation of Hypothesis 1 (that of greater handshape complexity in Cena classifier handshapes) requires assigning complexity scores and determining whether there is a statistically significant difference in the distribution of scores across the two languages, which follows in Section 4.1.

3.3. Movement

Next, we turn to movement feature encoding, where we predicted both languages to show a preference for simultaneous encoding of manner and path for the reasons outlined in Section 1.1.3. Figure 11 shows the proportion of movement encoding strategies across the two groups, demonstrating that in both languages, signers overwhelmingly preferred the simultaneous strategy: 80% of Cena tokens encoded movement manner and path simultaneously, compared to 94% in Libras.

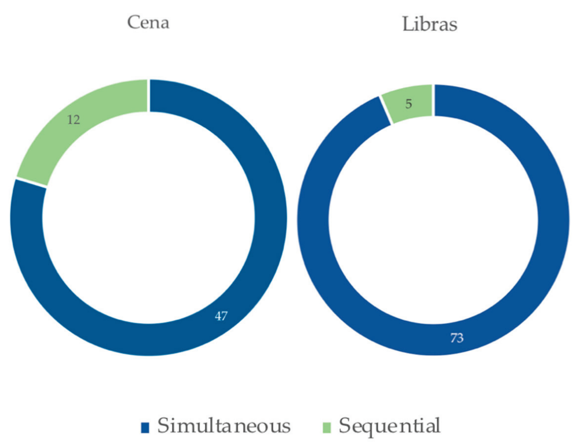


Figure 11. Movement encoding in Cena and Libras by token frequency.

4. Discussion

4.1. Handshape

In order to find out whether the handshapes observed in the data are articulatorily easy or simple, we return to the quantification of complexity formulated by Brentari et al. (2012), which we outlined in Section 1. All handshapes attested within entity classifiers in Cena and their resulting finger and joint complexity scores are shown in Table 7, listed in descending order of frequency. The three most frequent entity handshapes have the lowest possible finger and joint complexity scores. Only the two least frequent handshapes have a finger or joint complexity score above the lowest possible value. Such a distribution upholds the general prediction of phonological markedness (Battison 1978) that there should be an inverse relationship between frequency and complexity; that is, the more complex a handshape, the less frequent we expect it to be. Conversely, we expect the most frequent handshapes to be the least complex. This prediction is borne out in the results.

Table 7. Entity classifier handshapes in Cena with finger and joint complexity scores.

Handshape	Frequency	Finger Complexity	Joint Complexity
	0.34	Low	1
	0.30	Low [1]	1
	0.25	Low	1
	0.07	Medium	1
	0.04	Low	4

[1] Though not specified in Brentari et al. (2012), the closed-fist handshape meets all the listed criteria for low complexity: it is among those first acquired by learners (Boyes Braem 1981), one of the most frequently occurring crosslinguistically (Rozelle 2003), and has a relatively simple structure in the prosodic model of representation (Brentari 1998, p. 112).

Aside from influence from a preference for ease, we can speculate further about the distribution of the data and the presence of the two least frequent handshapes. If it is the case that over time signers may choose to substitute iconic but difficult handshapes for less iconic easier ones, this alone would not explain the presence of  in the data, which is a departure from both iconicity (having no obvious semantic motivation) and finger and joint simplicity. Looking at the classifier within the phrase provides clues. The handshape was only attested (n = 3 from two different participants) in cases where the sign WATER—which is specified for the same handshape, although the thumb is not visible in the first image in the following example—preceded the classifier. An example sequence is shown in Figure 12. This appears to be a case of handshape assimilation. Similar to spoken languages where a feature of a particular sound (such as place of articulation, or voicing) may spread onto its neighbour, sublexical features of a particular sign may also spread onto adjacent signs. In this case, the handshape in WATER remains throughout the following classifier.

WATER CL:UPRIGHT-OBJECT-FALLS

A water bottle falls

Figure 12. Handshape assimilation in an entity classifier.

Similarly, the curved handshape only appears as an entity classifier when preceded by a SaSS depicting the bottle's cylindrical shape using the same handshape (n = 4 from one participant), as in Figure 13. Of course, a phonological explanation is not the only type possible. Such variants could be motivated by reasons of semantics[17], in that the handshapes signers select may be motivated by semantic properties determined by certain experiences (or lack thereof) with objects, or certain semantic properties the signers feel to be salient in the object in the stimulus. To tease this apart, one could elicit depictions of different types of the same object, perhaps forms varying in colour, material, or intended use. This would not only foreground different semantic associations, but ideally also encourage varied lexical items preceding or following the classifiers to further investigate a hypothesis of assimilation. However, when we revisit one specific production, additional evidence for assimilation emerges. In Figure 14, a signer produces an account of the bottle falling. It begins with the sign WATER, with its handshape remaining over a string of several subsequent signs including a lexicalised sign, two classifiers, and an indexical point. DRINK, which appears in the middle of this string, is a conventionalised sign with the handshape, yet the presence of the extended index finger in this production is evident. We take this as robust evidence for assimilation, and thus apply the same hypothesis to the case of the curved handshape in entity classifiers, given its similar distribution only following another classifier with the same handshape. It seems that in entity classifiers that used and , any constraints on markedness or complexity were violated by virtue of other influences from phonology—assimilation. In the case of WATER, the influence of phonology in pulling sign form away from faithfulness to semantics or iconicity is particularly clear.

CL:SaSS(vertical trace) CL:OBJ-FALL H1
CL:FLAT-SURFACE_______________ H2

A cylindrical on a flat surface object falls.

Figure 13. Handshape assimilation of in an entity classifier.

WATER CL:SaSS(height) DRINK IX-COMPUTER CL:OBJ-FALL

The bottle of water falls

Figure 14. Handshape assimilation of  across several signs.

Turning to SaSS handshapes in Cena (Table 8), we see two handshapes with high joint complexity scores, both depicting the cylindrical shape of the bottle. The more frequent curved  handshape has only high joint complexity since all the fingers are selected and act in unison. The less frequent thumb-opposed  handshape scores highly both in finger and joint complexity. There are many handshapes available to signers to depict curvature: , ,  to list a few in addition to those in the data. Iconic depiction of curvature using handshape is likely to tip the balance out of favour with articulatory ease. As the quantification models of both Brentari et al. (2012) and Ann (2006) show, extended, closed, and flat handshapes all require less articulatory effort than curved ones. Within this small subcategory of handshapes in the data that depicted curvature, we still see the easiest one prevail—the curved  handshape. In the choice of handshape to depict the form of the bottle overall, iconicity may have won the trade-off initially, but within the variants selected for that choice, pressures from ease endure.

Table 8. SaSS classifier handshapes in Cena with finger and joint complexity scores.

Handshape	Proportion	Finger Complexity	Joint Complexity
	0.61	Low	3
	0.18	Low	1
	0.12	Low	1
	0.09	High	4

Next, we consider complexity in the Libras data. Complexity scores for Libras entity handshapes are given in Table 9, and SaSSes in Table 10. All entity classifier handshapes had all fingers or the index finger selected, resulting in the lowest possible finger complexity score. The curved  handshape is the only entity classifier handshape to receive a high joint complexity score. Every token of this entity classifier directly followed a SaSS depicting the object's curvature, of the form shown in Figure 13. This was a common strategy among Libras signers, to first depict the object's extension before depicting the verb event: 82% of Libras entity classifiers involved in verb events were directly preceded by a SaSS that depicted the size or form of the bottle, e.g., CL:SaSS(height) CL:TALL-OBJECT-FALL, as opposed to only 30% of Cena entity classifiers. The greater relative consistency with which Libras signers used this ordered construction may have had an effect on the distribution of handshapes with regards to assimilation, considering the evidence for assimilation in the same environment in Cena. Among the SaSSes, handshapes receiving high finger or joint complexity scores were involved in depictions of curvature. As the most frequent SaSS handshape fell into this category, the curved  handshape, it seems iconicity and semantics won this particular trade-off.

Table 9. Entity classifier handshapes in Libras with finger and joint complexity scores.

Handshape	Proportion	Finger Complexity	Joint Complexity
	0.53	Low	1
	0.29	Low	1
	0.18	Low	3

Table 10. SaSS classifier handshapes in Libras with finger and joint complexity scores.

Handshape	Frequency	Finger Complexity	Joint Complexity
	0.48	Low	3
	0.26	Low	1
	0.19	Low	1
	0.07	High	4

Last, we summarise the distribution of complexity scores (Figures 15 and 16) to return to Hypothesis 1—that of greater complexity in Cena classifier handshapes. Overall, classifier handshapes in Cena do not exhibit greater complexity relative to Libras. The languages showed a very similar distribution of finger complexity, in that handshapes across both languages in both types of classifiers were overwhelmingly of low finger complexity. In both languages, the depiction of curvature explains the presence of high finger complexity handshapes, which comprised roughly the same small proportion of SaSS handshapes across Cena (9%) and Libras (7%).

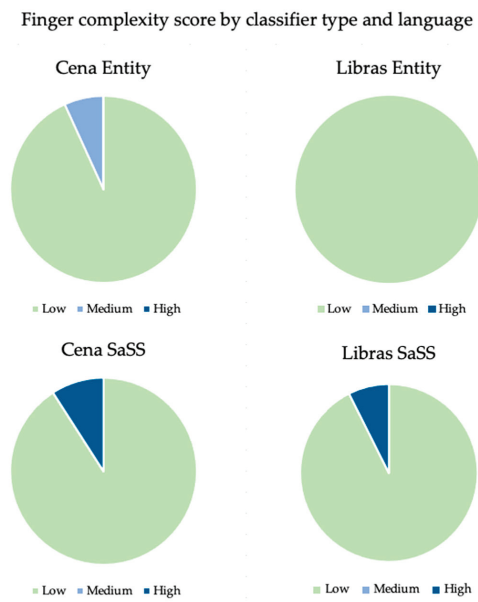


Figure 15. Finger complexity score by classifier type and language.

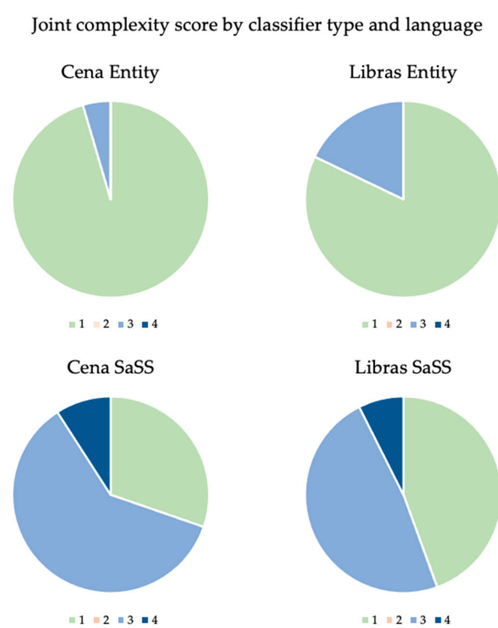


Figure 16. Joint complexity score by classifier type and language.

For joint complexity, the picture is not so similar, but the two languages still share some tendencies (Figure 16). Whilst entity classifier handshapes were predominantly of low joint complexity across both languages, we see more entity classifier handshapes with higher joint complexity in Libras. SaSS handshapes saw the highest proportion of handshapes with high joint complexity in both languages. The curved handshape was the most populous across both languages, accouting for the large proportion of scores of 3. Handshapes with the highest joint complexity (with a score of 4) were those that are stacked, also depicting the curvature of the referent.

In terms of our expectation to find greater complexity in Cena, there was no statistically significant difference between the two languages for finger or joint complexity, across both types of classifier. A Fisher's exact test was used in lieu of a chi-square, since the data set contains low numbers of observations in some cases. In comparing variance between languages for each type of complexity in each type of classifier, the p-value was greater than 0.05 in all cases. The high complexity scores in both groups shows plainly how the semantic property of curvature affected the distribution of handshape complexity in the trade-off between ease (or simplicity) and iconicity. Moreover, we argue the distribution of medium finger complexity and high joint complexity handshapes in entity classifiers in Cena can be partially accounted for by phonological assimilation. In some sense, this finding leads us even further away from our initial hypothesis, suggesting that in the absence of signs with marked handshapes earlier in the phrase, in other words all else being phonologically equal, like Libras signers Cena signers aim for simple unmarked handshapes. The prevalence of the curved handshape does not appear to exemplify this idea, seeing as it has a relatively high joint complexity score. However, if we recall that it is crosslinguistically frequent and is considered unmarked, it appears more as a discrepancy between using a model of complexity primarily based on representational simplicity, as opposed to models based on markedness or ease of articulation. That is, measures of complexity based on representational complexity (such as that of Brentari et al. 2012) do not capture certain realities of usage that likely affect handshape distribution in classifiers, including the pervasiveness of the curved handshape as a manual configuration for grasping objects outside of the linguistic system. The prevalence of such a handshape in the data may seem surprising when considered through the lens of complexity as defined by representational complexity alone, but its ubiquity both as a handshape crosslinguistically, and as a configuration for the non-linguistic manipulation of objects goes far in accounting for this.

Next, we address Hypothesis 2, which predicted greater intersigner variation in Cena. For size and shape specifier handshapes, we see the same number of variants in both languages, with a similarly proportional distribution. The picture is slightly different with entity classifier handshapes. Cena signers produced five variants in contrast to the three from Libras signers, and distribution of these variants patterns differently between the groups. In Cena, three variants accounted for 89% of tokens, with the proportion of each variant being fairly similar. For the Libras data, one variant accounts for over half the tokens (53%), showing greater consistency between signers in their selection of a handshape to represent the referent. Overall, the results do not demonstrate greater variation in Cena for handshapes in SaSSes, but for entity classifier handshapes we see more variants in Cena and more equal weighting between them in terms of proportion. However, considering that two variants (interestingly, the most complex variants) may be accounted for by assimilation, the presence of more variants does not necessarily mean that Cena signers have a larger and less conventionalised repertoire of handshapes available for depiction of whole entities.

4.2. Movement

Recall that the tendency to encode movement path and manner simultaneously was found more commonly in gesturers and earlier cohorts of NSL, whilst sequential encoding emerged increasingly with later cohorts. A linguistic context different to that of later-cohort signers for both Cena and Libras led us to Hypothesis 3, wherein we predicted a preference for simultaneous manner and path encoding in both Cena and Libras. Indeed, we found that 93% of Libras responses encoded path and manner simultaneously, as did 80% of Cena responses. In both languages, results pattern more akin to those of gesturers and first-cohort NSL signers, where temporal iconicity prevails in trade-offs against the potential articulatory difficulty of encoding manner and path together. Even in depicting the girl running in a circle, the majority of Cena and Libras signers chose an upright person classifier with running legs whilst moving their arm in a circle, despite this being articulatorily difficult (Mandel 1979).

However, results diverge from those of hearing gesturers in Senghas et al.'s (2004) study in the mere presence of linear segmentation (in Cena, Libras, and NSL alike), supporting the idea that there is something inherantly linguistic about such a process. We acknowledge possible influence from the fact that the stimuli clips were not designed with an analysis of movement in mind[18]. As such, clips may not be balanced in their likelihood to elicit either manner or path in a given clip or in the set as a whole. An entity moving along a marked path but in a predictable manner (e.g., a ball rolling in a zig-zag) may be more likely to elicit path than manner, for example. Indeed, we found that in a small number of cases, some tendencies emerged based on the stimulus item itself. As an example, the girl running in a circle was the most likely to elicit simultaneous encoding; 85% (29 out of 34) of responses across both groups depicted this using a person classifier running in a circle. The woman running was the most likely to be represented sequentially, with 27% (9 out of 33) of responses across both groups encoding in such a way. There may be some effect from telicity at play here, whereby telic predicates prefer sequential encoding. The woman running across the screen could be construed as the most goal-oriented of the stimuli we analysed. Conversely, the woman walking elicited the strongest preference for simultaneous encoding across both languages—both in proportion and the overall number of tokens, as almost every signer produced a response using this strategy. Many signers depicted the walking as continuous or aimless, with slow movement and pursed lips—both of which are attested markers of continuative aspect (e.g., Oomen 2016, who describes such marking in Sign Language of the Netherlands). The distribution of strategies in all responses by stimulus can be seen in Tables 11 and 12. Overall, both groups preferred simultaneous encoding, but we saw greater variation among Cena signers for the girl running in a circle and the woman running.

Table 11. Distribution of Cena encoding strategies by stimulus.

	Ball Bouncing	Ball Rolling	Girl Running in Circle	Woman Walking	Woman Running
Sim.	9	1	12	16	9
Seq.	0	0	4	1	7

Table 12. Distribution of Libras encoding strategies by stimulus.

	Ball Bouncing	Ball Rolling	Girl Running in Circle	Woman Walking	Woman Running
Sim.	16	8	17	18	14
Seq.	0	1	1	0	3

An ANOVA analysis of encoding strategy and age uncovered a statistically significant correlation ($p = 0.03$), in that older signers showed a greater tendency to encode sequentially (Figure 17). The signers in the upper age brackets in our study are roughly second cohort, as the first signer of Cena was born in 1949. This shows a pattern distinct from results of Senghas et al. (2004), in that it is older or earlier-cohort signers who display a preference for sequential encoding. As many homesigners with distinct idiolects come together, segmentation and linearisation may be but one effect of the rapid restructuring deaf community sign languages will undergo in their initial stages of emergence. Such restructuring may be phonological, grammatical, or otherwise. These are not the conditions under which Cena has emerged. Libras on the other hand does have an analogous genesis, but this initial period of restructuring likely took place well over a century ago. As such, our results do not suggest that the linear sequential encoding of motion events is a property that emerging languages in general will acquire as they develop, but perhaps rather a product of some specific environmental criteria that NSL, among its second and third cohorts, seemed to meet, and that Cena and Libras as they exist at this moment in time do not. Concerning the tendency of later-cohort child signers of NSL to reanalyse manner and path as sequential, Senghas et al. (2010) observe that "it is as if [the] children see structure where there is none". Perhaps because there are no child signers in our data, and as such we are not seeing widespread segmentation as a by-product of children restructuring language from an unconventionalised input, temporal iconicity is retained.

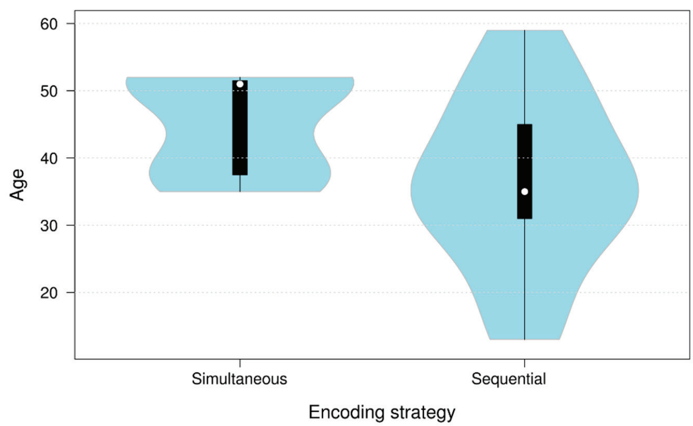


Figure 17. Violin plot of age and encoding strategy showing frequency along the X axis.

One question that emerged during analysis was whether the domain of non-manual features could encode the manner of motion as the hands encoded the path. In response to a stimulus clip of a plastic bag floating, multiple signers traced a path straight downwards with their hand (contrary to the floating motion in the clip) whilst puffing their cheeks or blowing. This stimulus clip did not form part of our chosen stimuli for the current study, and as such we made no decision on whether this non-manual information was aspectual, adverbial, or could otherwise be subsumed into a model of sequential movement encoding, but remaining open-minded as to what can be considered a viable slot for movement encoding will undoubtedly be pertinent in any future studies.

5. Conclusions

Overall, we see a very similar selection of handshape variants used in entity classifiers and size and shape specifiers across Cena and Libras. Thus, the distribution of complexity scores for classifier handshapes of each language largely resembled one another, by virtue of the same or similar handshapes populating each data set. Without additional data it is difficult to tell whether the similar attested handshapes across both groups are a product of the influence of ease of articulation, or semantic categorisation—perhaps both (one can imagine how a signer might choose an index finger extended handshape over a middle finger extended handshape for an upright long thin object, though both are iconic). What the results do tell us is that in this instance, there is no evidence for Cena signers prioritising iconic representation at the expense of ease, in lieu of conventionalised classifiers. We do, however, present evidence for another aspect of phonology having a direct influence on the handshapes selected for classifiers: assimilation. This phenomenon highlights the robustness of handshape as a phonological component in signs even in young sign languages that potentially lack systematic phonological organisation. We show how such assimilation may influence or even dominate handshape selection, in this case winning out over other influences from articulatory ease, iconic representation, or semantics that converge in a trade-off for handshape selection. This has implications for our findings on variation. Overall, we saw more handshape variants used by Cena signers in entity classifiers, but no difference between the groups for SaSSes. On the surface, a larger repertoire of handshapes in entity classifiers may suggest that classifier handshape is, for now, less restrained by conventionalisation in Cena. As we have shown, assimilation may account for this discrepancy in number of variants between groups. We conclude that we do indeed see one influence of phonology on the selection of classifier handshapes (as the  handshape of WATER spread over a whole phrase by one Cena signer), just not from the source we had anticipated.

Last, our results show a pattern different to that of NSL signers in the encoding of movement (Senghas et al. 2004), in that second- and third-cohort Cena signers prefer to encode manner and path simultaneously, akin to gesturers and signers of urban sign languages, including the Libras signers in our study, as well as first-cohort NSL signers. This does not reflect the preference for sequential linearisation of path and manner found in younger NSL signers, those of comparable cohorts to the Cena signers in our study. A relevant variable that differs between Cena and NSL signers is that, unlike Cena signers of a comparable cohort, the vertical language input[19] that second-cohort NSL signers received was from previously unconnected homesigners. The different preferences between Cena and Libras on one hand and NSL on the other in encoding manner and path could well be a result of the rapid restructuring a language undergoes in response to relatively disorganised vertical input from disparate homesigners, in which some motivation other than temporal iconicity tips the balance of the trade-off between encoding strategies. Cena signers did not receive such vertical input. Such an explanation would account for why later-cohort NSL signers seemed to be the exception in their preferences for linear sequencing, and why Cena and Libras signers patterned akin to all other groups. We also found a significant correlation between age and movement encoding strategy, with older Cena signers segmenting manner and path in motion events at a greater rate than younger Cena signers. Such inter-signer variation (in this case along the axis of age) invites future questions about whether this pertains to other domains such as syntax. We have seen in other studies using the Haifa clips that different preferences in word order and argument structure disambiguation emerge at different rates among cohorts of signers of emerging sign languages when compared to those of the corresponding national sign language of their country (Meir 2010). Considering the existence of several studies on young sign languages using the Haifa clips for this aim (Meir et al. 2017; Ergin et al. 2018), we hope that word order elicitation along these lines may yield further opportunities to draw direct comparisons between an incipient sign language and a national sign language on the same basis.

Author Contributions: Conceptualisation, A.N., D.S. and A.A.-S.; methodology, A.N. and D.S.; data glossing, J.C.N.F., D.S.d.S. and A.A.-S.; data analysis D.S.; writing—original draft preparation, D.S.; writing—review and editing, D.S., A.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This study was conducted with approval from the UCL Research Ethics Committee (Project ID: 19269/001, approved on 2 February 2021).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Signed (in lieu of written) informed consent has been obtained from the participant(s) to publish this paper.

Data Availability Statement: Supplementary data in the form of video examples of all discussed phenomena and corresponding glosses can be found at: https://github.com/ucjudst/Cena-Data.

Acknowledgments: We wish to thank the inhabitants of Várzea Queimada for their time and participation, as well as our team in Brazil: Carlos Douglas Carvalho de Macêdo and Iago Pedro Mendes Pires Veras for Cena images; and Telma Franco, Bruna da Silva Neres, Nádia Fernanda Martins de Araújo, Dona Silvana Barbosa, and Marcilene Barbosa for demographic information. We are very grateful to Gabrielle Hodge and Nick Palfreyman for their insights into this project in its initial stages, and for those of Anne Senghas into the encoding of motion events. We thank the Centre for Sign Linguistics and Deaf Studies, CUHK for the handshape font (available at http://www.cslds.org/v4/resources.php?id=1, accessed 1 September 2021).

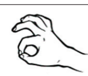
Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Handshape Index.

Handshape	Example in Text
	BSL vehicle classifier/Cena SaSS
	ASL vehicle classifier
	HKSL airplane classifier (old)
	HKSL airplane classifier (new)
	Low finger complexity handshape/Cena entityclassifier
	Low finger complexity handshape
	Medium finger complexity handshape
	Medium finger complexity handshape
	High finger complexity handshape

Table A1. *Cont.*

Handshape	Example in Text
	High finger complexity handshape
	High finger complexity handshape
	Flat handshape
	Extended handshape
	Curved handshape
	Bent handshape
	Stacked handshape
	Crossed handshape
	Cena SaSS
	Libras SaSS

Notes

1 See Zwitserlood (2012, p. 175) for discussion of the similarities and differences of classifiers in signed and spoken languages.

2 See Appendix A for a list of all handshapes appearing in the text.

3 Entities can be specified for manner and path movement features, which may or may not be encoded at all, and if so, sequentially or simultaneously. Therefore signers have more choices available in the encoding of movement features. Discussion on this topic will follow later in this section.

4 See Brentari et al. (2012, p. 7) for a justification of this choice concerning potential alternate results using other models.

5 We guide the reader to Van der Hulst and van de Weijer (2017) for an overview of the theory of Dependency Phonology.

6 We thank the editor for this observation.

7 The most notabe being that in Ann's model, flat handshapes receive a difficulty score one increment lower than that of extended handshapes.

8 Recall that *object classifiers* broadly correspond to entity classifiers.

9 Supalla (1990, p. 132) provides 'person limping in a circle' as one such example in ASL.

10 cf. de Quadros (2020) for a recent and detailed volume dedicated to studies on Libras.

11 We also direct readers to the short film *Jogos Dirigidos* ('Directed Games') by Jonathas de Andrade (Internationale Filmfestspiele Berlin 2020), in which deaf signers recount narratives and play theatre games in Várzea Queimada.

12 Introduced in 2003, the Bolsa Famíla program provides financial aid to low-income families provided they meet certain conditions, such as sending their children to school. Many families in Várzea Queimada are recipients, travelling to the nearest city Jaicós to collect this aid.

13 We thank Telma Franco, Bruna da Silva Neres, Silvana, and Marcilene for recording the census data with the community.

14 Meir and Sandler (2019) discuss a classifier-like suffix in ABSL in the context of compound formation.

15 The implications within language typology from the study of Kata Kolok and Adamorobe Sign Language are still very relevant to our study since Cena and Libras do not just differ in age, but also along the axis of being a village and an urban sign language, respectively.

16 Ages are approximate as reported verbally to our research team by members of the community.

17 We thank our reviewer for this insightful suggestion.

18 We guide readers interested in a stimuli set specifically designed to elicit linguistic and gestural depictions of motion events with a focus on manner and path towards Özyürek et al. (2001).Few tokens appear for the ball rolling stimulus, as signers often only depicted the path of the movement or the cause of the event, i.e., BALL THROW. As these are neither simultaneous or sequential, we excluded such responses from the analysis.

19 See Brentari et al. (2021) for discussion of the importance of vertical contact in the emergence and development of various levels of linguistic structure in young sign languages.

References

Almeida-Silva, Anderson. Forthcoming. *Avaliação de Comunidades Surdas Urbanas e Isoladas*. Unpublished Project PRPPG/UFPI—CRMV 003/2013. Piauí: Universidade Federal do Piauí.

Almeida-Silva, Anderson, and Andrew Ira Nevins. 2020. Notas sobre a estrutura linguística da Cena: A língua de sinais emergente da Várzea Queimada (Piauí, Brasil). *Linguagem & Ensino* 23: 1029–53. [CrossRef]

Ann, Jean. 2006. *Frequency of Occurrence and Ease of Articulation of Sign Language Handshapes: The Taiwanese Example*. Washington, DC: Gallaudet University Press.

Battison, Robbint. 1978. *Lexical Borrowing in American Sign Language*. Silver Spring, MD: Linstok Press.

Boyes Braem, Penny. 1981. Distinctive Features of the Handshapes of American Sign Language. Ph.D. dissertation, University of California, Berkeley, CA, USA.

Boyes Braem, Penny. 1990. Acquisition of the handshape in American Sign Language: Preliminary analysis. In *From Gesture to Language in Hearing and Deaf Children*. Edited by Virginia Volterra and Carol J. Erting. Heidelberg: Springer, pp. 107–27.

Brentari, Diane. 1998. *A Prosodic Model of Sign Language Phonology*. Cambridge: MIT Press.

Brentari, Diane, Marie Coppola, Laura Mazzoni, and Susan Goldin-Meadow. 2012. When does a system become phonological? Handshape production in gesturers, signers, and homesigners. *Natural Language and Linguistic Theory* 30: 1–31. [CrossRef] [PubMed]

Brentari, Diane, and Petra Eccarius. 2010. Handshape contrasts in sign language phonology. In *Sign Languages*. Edited by Diane Brentari. Cambridge: Cambridge University Press, pp. 284–311.

Brentari, Diane, Marie Coppola, Pyeong Whan Cho, and Anne Senghas. 2016. Handshape complexity as a precursor to phonology: Variation, emergence, and acquisition. *Language Acquisition* 24: 283–306. [CrossRef] [PubMed]

Brentari, Diane, Rabia Ergin, Anne Senghas, Pyeong Whan Cho, Eli Owens, and Marie Coppola. 2021. Community interactions and phonemic inventories in emerging sign languages. *Phonology* 38: 571–609. [CrossRef]

Cheek, Adrianne, Kearsy Cormier, Ann Repp, and Richard P. Meier. 2001. Prelinguistic Gesture Predicts Mastery and Error in the Production of Early Signs. *Language* 77: 292–323. [CrossRef]

Cormier, Kearsy, David Quinto-Pozos, Zed Sevcikova, and Adam Schembri. 2012. Lexicalisation and de-lexicalisation processes in sign languages: Comparing depicting constructions and viewpoint gestures. *Language & Communication* 32: 329–48. [CrossRef]

De Beuzeville, Louise A. 2004. A description of the acquisition of classifiers in Auslan (Australian Sign Language) by deaf and hearing children of deaf parents. *Australian Journal of Education of the Deaf* 10: 43–50.

de Quadros, Ronice M. 2020. *Brazilian Sign Language Studies*. Berlin and Boston: De Gruyter Mouton. [CrossRef]

de Vos, Connie. 2012. Sign-Spatiality in Kata Kolok. Ph.D. dissertation, Radboud University Nijmegen, Nijmegen, The Netherlands.

de Vos, Connie, and Roland Pfau. 2015. Sign Language Typology: The Contribution of Rural Sign Languages. *Annual Review of Linguistics* 1: 265–88. [CrossRef]

Eccarius, Petra. 2008. A Constraint-Based Account of Handshape Contrast in Sign Languages. Ph.D. dissertation, Purdue University, West Lafayette, Indiana.

Engberg-Pedersen, Elisabeth. 2010. Factors that form classifier signs. In *Sign Languages*. Edited by Diane Brentari. Cambridge: Cambridge University Press, pp. 252–83. [CrossRef]

Ergin, Rabia, Irit Meir, Deniz Ilkbaşaran, Carol Padden, and Ray Jackendoff. 2018. The development of argument structure in Central Taurus sign language. *Sign Language Studies* 18: 612–39. [CrossRef]

Fagard, Jacqueline. 1994. Manual strategies and interlimb coordination during reaching, grasping, and manipulating throughout the first year of life. In *Interlimb Coordination: Neural, Dynamical, and Cognitive Constraints*. Edited by Stephan P. Swinnen, H. Heuer, Jean Massion and P. Casaer. Cambridge, MA: Academic Press, pp. 439–60. [CrossRef]

Franco, Telma. 2022. Escolarização do surdo plurilíngue de Várzea Queimada/PI (concepção dos professores). Unpublished postgraduate thesis, Universidade Federal do Piauí, Piauí, Brazil.

Frishberg, Nancy. 1975. Arbitrariness and iconicity: Historical change in American Sign Language. *Language* 51: 696–719. [CrossRef]

Fusellier-Souza, Ivani. 2004. Sémiogenèse des langues des signes: Étude de langues des signes primaires (LSP) pratiquées par des sourds brésiliens. Ph.D. dissertation, Université Paris 8, Paris, France.

Godoy, Gustavo. 2020. Os Ka'apor: Seus gestos e sinais. Ph.D. dissertation, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

Hou, Lynn Yong-Shi. 2016. "Making Hands": Family Sign Languages in the San Juan Quiahije Community. Ph.D. Dissertation, University of Texas, Austin, TX, USA.

Internationale Filmfestspiele Berlin. 2020. *Jogos Dirigidos*. Available online: https://web.archive.org/web/20211013080727/https%3A%2F%2Fwww.berlinale.de%2Fen%2Farchive-selection%2Farchive-2020%2Fprogramme%2Fdetail%2F202011689.html (accessed on 10 October 2021).

Israel, Assaf, and Wendy Sandler. 2011. Phonological category resolution in a new sign language: A comparative study of handshapes. In *Formational Units in Sign Languages*. Edited by Rachel Channon and Harry van der Hulst. Berlin: De Gruyter, pp. 177–202.

Johnston, Trevor, and Adam Schembri. 2007. *Australian Sign Language (Auslan): An Introduction to Sign Language Linguistics*. Cambridge: Cambridge University Press.

Kegl, Judy, Anne Senghas, and Marie Coppola. 1999. Creation through contact: Sign language emergence and sign language change in Nicaragua. In *Language Creation and Language Change: Creolization, Diachrony, and Development*. Edited by Michel DeGraff. Cambridge, MA: MIT Press, pp. 179–237.

Klima, Edward S., and Ursula Bellugi. 1979. *The Signs of Language*. Cambridge: Harvard University Press.

Kusters, Annelies. 2010. Deaf utopias? Reviewing the sociocultural literature on the world's "Martha's Vineyard situations". *Journal of Deaf Studies and Deaf Education* 15: 3–16. [CrossRef] [PubMed]

Mandel, Mark A. 1979. Natural constraints in sign language phonology: Data from anatomy. *Sign Language Studies* 24: 215–29. [CrossRef]

Marsaja, I. Gede. 2008. *Desa Kolok—A Deaf Village and Its Sign Language in Bali, Indonesia*. Nijmegen: Ishara Press.

Meir, Irit. 2010. The Emergence of Argument Structure in Two New Sign Languages. In *Syntax, Lexical Semantics, and Event Structure*. Edited by Malka R. Hovav, Edit Doron and Ivy Sichel. Oxford: Oxford University Press, pp. 101–13.

Meir, Irit, Assaf Israel, Wendy Sandler, Carol Padden, and Mark Aronoff. 2012. The influence of community on language structure: Evidence from two young sign languages. *Linguistic Variation* 12: 247–91. [CrossRef]

Meir, Irit, and Wendy Sandler. 2019. Variation and conventionalization in language emergence. In *Language Contact, Continuity and Change in the Genesis of Modern Hebrew*. Edited by Edit Doron, Malka Rappaport Hovav, Yael Reshef and Moshe Taube. Amsterdam: John Benjamins Publishing Company, pp. 285–301. [CrossRef]

Meir, Irit, Mark Aronoff, Carl Börstell, So One Hwang, Deniz Ilkbaşaran, Itamar Kastner, Ryan Lepic, Adi Lifshitz Ben-Basat, Carol Padden, and Wendy Sandler. 2017. The effect of being human and the basis of grammatical word order: Insights from novel communication systems and young sign languages. *Cognition* 158: 189–207. [CrossRef] [PubMed]

Meir, Irit, Wendy Sandler, Carol Padden, and Mark Aronoff. 2010. Emerging Sign Languages. In *The Oxford Handbook of Deaf Studies, Language, and Education*. Edited by Marc Marschark and Patricia E. Spencer. Oxford: Oxford University Press, vol. 2, pp. 267–80.

Morgan, Gary, Sarah Barrett-Jones, and Helen Stoneham. 2007. The first signs of language: Phonological development in British Sign Language. *Applied Psycholinguistics* 28: 3–22. [CrossRef]

Morgan, Gary, and Bencie Woll. 2007. Understanding sign language classifiers through a polycomponential approach. *Lingua* 117: 1159–68. [CrossRef]

Newport, Elissa L., and Richard P. Meier. 1985. The acquisition of American Sign Language. In *The Crosslinguistic Study of Language Acquisition*. Edited by Dan I. Slobin. Mahwah: Lawrence Erlbaum Associates Inc., vol. 1, pp. 881–938.

Nyst, Victoria. 2007. A Descriptive Analysis of Adamorobe Sign Language (Ghana). Ph.D. dissertation, University of Amsterdam, Amsterdam, The Netherlands.

Nyst, Victoria. 2012. Shared sign languages. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: Walter de Gruyter, pp. 552–74.

Nyst, Victoria. 2019. The impact of cross-linguistic variation in gesture on sign language phonology and morphology: The case of size and shape specifiers. *Gesture* 18: 343–69. [CrossRef]

Oomen, Marloes. 2016. The marking of two aspectual distinctions in Sign Language of the Netherlands (NGT). *Linguistics in Amsterdam* 9: 30–55.

Özyürek, Asli, Sotaro Kita, and Shanley Allen. 2001. *Tomato Man Movies: Stimulus Kit Designed to Elicit Manner, Path and Causal Constructions in Motion Events with Regard to Speech and Gestures*. Nijmegen: Max Planck Institute for Psycholinguistics, Language and Cognition group.

Padden, Carol A., Irit Meir, Wendy Sandler, and Mark Aronoff. 2010. Against All Expectations: Encoding Subjects and Objects in a New Language. In *Hypothesis A/Hypothesis B: Linguistic Explorations in Honor of David M. Perlmutter*. Cambridge, MA: MIT Press, pp. 383–400. [CrossRef]

Pereira, Éverton L. 2013. Fazendo cena na cidade dos mudos: Surdez, práticas sociais e uso da língua em uma localidade no sertão do Piauí. Ph.D. dissertation, Universidade Federal de Santa Catarina, Florianópolis, Brazil.

Pettenati, Paola, Silvia Stefanini, and Virginia Volterra. 2010. Motoric characteristics of representational gestures produced by young children in a naming task. *Journal of Child Language* 37: 887–911. [CrossRef]

Rozelle, Lorna. 2003. The Structure of Sign Language Lexicons: Inventory and Distribution of Handshape and Location. Ph.D. dissertation, University of Washington, Washington, DC, USA.

Sandler, Wendy, Irit Meir, Carol Padden, and Mark Aronoff. 2005. The emergence of grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences of the United States of America* 102: 2661–65. [CrossRef] [PubMed]

Sandler, Wendy, Mark Aronoff, Irit Meir, and Carol Padden. 2011. The gradual emergence of phonological form in a new Language. *Natural Language and Linguistic Theory* 29: 503–43. [CrossRef] [PubMed]

Schembri, Adam. 2010. Documenting sign languages. In *Language Documentation and Description*. Edited by P. K. Austin. London: SOAS, vol. 7, pp. 105–43.

Schembri, Adam, Caroline Jones, and Denis Burnham. 2005. Comparing action gestures and classifier verbs of motion: Evidence from Australian Sign Language, Taiwan Sign Language, and nonsigners' gestures without speech. *Journal of Deaf Studies and Deaf Education* 10: 272–90. [CrossRef] [PubMed]

Senghas, Anne, Asli Özyurek, and Susan Goldin-Meadow. 2010. The evolution of segmentation and sequencing: Evidence from homesign and Nicaraguan Sign Language. In *The Evolution of Language*. Edited by Andrew D. M. Smith, Marieke Schouwstra, Bart de Boer and Kenny Smith. Singapore: World Scientific Publishing Co., pp. 279–89.

Senghas, Anne, and Sarah Littman. 2004. Segmentation in the expression of motion events in co-speech gesture, Nicaraguan Sign Language (NSL) and Spanish Sign Language (LSE). Presented at the Eighth International Conference on Theoretical Issues in Sign Language Research (TISLR8), Barcelona, Spain, 30 September–2 October.

Senghas, Anne. 1995. Children's contribution to the birth of Nicaraguan Sign Language. Ph.D. dissertation, Massachusetts Institute of Technology, Cambridge, MA, USA.

Senghas, Anne, Sotaro Kita, and Asli Özyürek. 2004. Children creating core properties of language: Evidence from an emerging sign language in Nicaragua. *Science* 305: 1779–82. [CrossRef]

Silva, S. Diná. 2021. Inventário das línguas de sinais dos vilarejos brasileiros: O caso da Cena (Jaicós—PI) e da língua de sinais de Caiçara (Várzea Alegre—CE). Ph.D. Dissertation, Universidade Federal de Santa Catarina, Florianópolis, Brazil.

Stoianov, Diane, and Andrew Nevins. 2017. The phonology of handshape distribution in Maxakalí sign. In *Sonic Signatures*. Edited by Geoff Lindsey and Andrew Nevins. Amsterdam: John Benjamins, pp. 232–62.

Supalla, Ted. 1982. Structure and Acquisition of Verbs of Motion and Location in American Sign Language. Ph.D. dissertation, University of San Diego, San Diego, CA, USA.

Supalla, Ted. 1986. The Classifier System in American Sign Language. In *Noun Classes and Categorization: Proceedings of a Symposium on Categorization and Noun Classification, Eugene, Oregon, October 1983*. Edited by Colette G. Craig. Amsterdam: John Benjamins, pp. 181–215.

Supalla, Ted. 1990. Serial Verbs of Motion in ASL. In *Theoretical Issues in Sign Language Research. Vol. 1: Linguistics*. Edited by Susan Fischer and Patricia Siple. Chicago: University of Chicago Press, pp. 172–52.

Sutton-Spence, Rachel, and Bencie Woll. 1999. *The Linguistics of British Sign Language: An Introduction*. Cambridge: Cambridge University Press.

Talmy, Leonard. 1985. Lexicalization patterns: Semantic structure in lexical forms. In *Language Typology and Syntactic Description, Vol. 3: Grammatical Categories and the Lexicon*. Edited by Timothy Shopen. New York: Cambridge University Press, pp. 57–149.

Tang, Gladys, and Gu Yang. 2007. Events of motion and causation in Hong Kong Sign Language. *Lingua* 117: 1216–57. [CrossRef]

Tang, Gladys, Felix Sze, and Scholastica Lam. 2007. Acquisition of simultaneous constructions by deaf children of Hong Kong sign language. In *Simultaneity in Signed Languages: Form and Function*. Edited by Myriam Vermeerbergen, Lorraine Leeson and Onno Crasborn. Amsterdam: John Benjamins, pp. 283–316.

Tang, Gladys, Jia Li, and Jia He. 2021. Classifiers—Theoretical perspectives. In *The Routledge Handbook of Theoretical and Experimental Sign Language Research*. Edited by Josep Quer, Roland Pfau and Annika Herrmann. Oxford: Routledge, pp. 139–73.

Thurston, William R. 1989. How exoteric languages build a lexicon: Esoterogeny in West New Britain. In *VICAL 1: Oceanic Languages. Papers from the Fifth International Conference on Austronesian Linguistics*. Edited by Ray Harlow and Robin Hooper. Auckland: Linguistics Society of New Zealand, pp. 555–79.

Tkachman, Oksana, Emily Sadlier-Brown, and Carla Hudson Kam. 2020. Conceptual salience in sign language forms. Paper presented at the UK Cognitive Linguistics Conference, Online, University of Birmingham, July 27–29.

Van der Hulst, Harry, and Jeroen van de Weijer. 2017. Dependency Phonology. In *The Routledge Handbook of Phonological Theory*. Edited by Stephen J. Hannahs and Anna R. K. Bosch. London: Routledge, pp. 325–59.

Woodward, James. 2000. Sign languages and sign language families in Thailand and Viet Nam. In *The Signs of Language Revisited: An Anthology to Honor Ursula Bellugi and Edward Klima*. Edited by Karen Emmorey and Harlan Lane. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Wray, Alison, and George W. Grace. 2007. The consequences of talking to strangers: Evolutionary corollaries of socio-cultural influences on linguistic form. *Lingua* 117: 543–78. [CrossRef]

Xavier, Andre. 2017. A expressão de intensidade em libras. *Revista do Programa de Estudos Pós-Graduados em Linguística Aplicada e Estudos da Linguagem* 36: 1–25.

Xavier, Andre, and Regiane Agrella. 2015. Brazilian Sign Language (Libras). In *Sign Languages of the World: A Comparative Handbook*. Edited by Julie Bakken Jepsen, Goedele De Clerck, Sam Lutalo-Kiingi and William B. McGregor. Boston: De Gruyter Mouton, pp. 129–58. [CrossRef]

Zeshan, Ulrike. 2011. Village sign languages: A commentary. In *Deaf around the World: The Impact of Language*. Edited by Donna J. Napoli and Gaurav Mathur. Oxford: Oxford University Press, pp. 221–30.

Zwitserlood, Inge. 2012. Classifiers. In *Sign Language*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin and Boston: De Gruyter Mouton, pp. 158–87.

languages

MDPI

Article

Shared Context Facilitates Lexical Variation in Sign Language Emergence

Katie Mudd [1,*], Connie de Vos [2] and Bart de Boer [1]

[1] AI Lab, Vrije Universiteit Brussel, 1050 Elsene, Belgium; bart@ai.vub.ac.be
[2] Tilburg Center for Cognition and Communication, Tilburg University, 5037 AB Tilburg, The Netherlands; c.l.g.devos@tilburguniversity.edu
* Correspondence: katie.mudd@ai.vub.ac.be

Abstract: It has been suggested that social structure affects the degree of lexical variation in sign language emergence. Evidence from signing communities supports this, with smaller, more insular communities typically displaying a higher degree of lexical variation compared to larger, more dispersed and diverse communities. Though several factors have been proposed to affect the degree of variation, here we focus on how shared context, facilitating the use of iconic signs, facilitates the retention of lexical variation in language emergence. As interlocutors with the same background have similar salient features for real world concepts, shared context allows for the successful communication of iconic mappings between form and culturally salient features (i.e., the meaning specific to an individual based on their cultural context). Because in this case the culturally salient features can be retrieved from the form, there is less pressure to converge on a single form for a concept. We operationalize the relationship between lexical variation and iconic affordances using an agent-based model, studying how shared context and also population size affects the degree of lexical variation in a population of agents. Our model provides support for the relationship between shared context, population size and lexical variation, though several extensions would help improve the explanatory power of this model.

Keywords: sign language; social structure; lexical variation; agent-based modeling

Citation: Mudd, Katie, Connie de Vos, and Bart de Boer. 2022. Shared Context Facilitates Lexical Variation in Sign Language Emergence. *Languages* 7: 31. https://doi.org/10.3390/languages7010031

Academic Editors: Wendy Sandler, Mark Aronoff, Carol Padden, Juana M. Liceras and Raquel Fernández Fuertes

Received: 4 October 2021
Accepted: 24 January 2022
Published: 10 February 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

In sign language emergence, linguistic variation at the lexical level appears to be the default, where synonyms for a word coexist within a population. However, over time, certain pressures seem to push towards lexical uniformity (Meir et al. 2012). We can thus imagine two extreme cases as languages evolve: one in which the variation present in language emergence is fully retained and a second where all the variation is lost in favor of uniformity. What are the pressures that may drive languages away from linguistic variability? It has been proposed that the communicative context in which languages are used shapes the features of a language (Lupyan and Dale 2010; Trudgill 2011; Wray and Grace 2007). Specifically in this paper, we explore how shared social and psychological information makes it possible to use iconic signs and how this may be a driving factor in retaining the lexical variation present in language emergence.

Traditionally, in the study of lexical variation in spoken languages, it has been assumed that true synonyms do not exist (Clark 1987). Rather, it is accepted that synonyms for a concept coexisting in a population would be conditioned by sociolinguistic and pragmatic factors. However, in the first stage of language emergence, where individuals improvise forms to refer to concepts, it appears that synonyms can coexist. It is possible that the iconic affordances of the manual modality facilitate the coexistence of synonyms in a population. Without data on the emergence of spoken languages, it is unclear how iconic affordances play a role in their emergence. For these reasons, in this paper, we focus on the emergence of sign languages and how different factors influence the degree of lexical variability across a population.

de Vos (2011) suggests that a high degree of variation at the lexical level may be characteristic of sign languages used in communities with a small population size and a high degree of shared context. Here, we refer to sign languages in such communities as *shared sign languages*, following Nyst (2012). For instance, Ergin et al. (2021) report that the shared sign language Central Taurus Sign Language is "remarkable in its mixture of more or less conventionalized[1] signs or sign sequences, improvised sign sequences, and competing lexical variants".

Similarly, in Kata Kolok, a sign language which emerged in a relatively small, insular village community in northern Bali due to a high incidence of hereditary deafness (de Vos 2012; Marsaja 2008), a high degree of lexical variation has been observed (Mudd et al. 2020); in response to a picture description task, up to nine lexical variants for a stimulus were produced, while other stimuli in the task elicited a uniform response (Mudd et al. 2020). This high degree of lexical variation seems typical of shared sign languages and has also been reported in Al-Sayyid Bedouin Sign Language (ABSL) (Meir et al. 2012), San Juan Quiahije Chatino Sign Language (SJQCSL) (Hou 2016) and Providence Island Sign Language (PISL) (Washabaugh 1986), to name a few.

In contrast, sign languages used predominantly by a large and dispersed group of deaf individuals, most of whom are born to hearing parents, or *Deaf community sign languages* (Meir et al. 2010; Mitchell and Karchmer 2004), appear to exhibit lower levels of lexical variation than shared sign languages (Meir et al. 2012). However, it should be noted that this claim is mostly based on anecdotal evidence (for one exception, see Washabaugh 1986). What can be said is that variation in this category of sign languages is typically structured along different sociolinguistic lines than in shared sign languages, as variation is often the result of schooling practices (Meir et al. 2010). For example, gender-based school segregation in Dublin has resulted in a gendered Irish Sign Language lexicon (LeMaster 2006), and different varieties of American Sign Language (ASL) have emerged due to race-based school segregation (McCaskill et al. 2011).

There undoubtedly also exists structured variation in shared sign languages, such as within families (Sandler et al. 2011) and also along sociolinguistic lines (Mudd et al. 2020). Despite evidence of structured variation, it seems like the degree of lexical variation in shared sign languages is higher within a small community across the board, with frequent interlocutors using different forms to refer to a concept (de Vos 2011). Crucially, despite the existence of multiple forms associated with a concept, signers are able to understand each other. Tkachman and Hudson Kam (2020) posit that a decrease in lexical variation may only be necessary in cases where communication fails. This may be less the case in shared sign language, where pressures for convergence seem to be somewhat alleviated. Meanwhile, in Deaf community sign languages, frequent interlocutors seem to have more synchronized lexical preferences, with higher degrees of variation evident when comparing larger, more dispersed subgroups of the community. What aspects of shared signing communities could reduce the pressure for linguistic uniformity?

One possibility that we explore in the present study is that shared context alone, allowing for the use of iconic forms, may be sufficient to maintain high degrees of lexical variation in a community (Sandler et al. 2011; Tkachman and Hudson Kam 2020). In tight-knit communities, individuals can make use of shared social and psychological information, facilitating the use of strategies such as pointing to concepts and using iconic signs (de Vos 2011). Iconic signs, in which aspects of a sign's form resemble aspects of that sign's meaning (Dingemanse et al. 2015), would only be successfully communicated (if not already conventionalized) when individuals share the same salient features (specific to the individual) associated with a concept (the entity or concept in the real world). For instance, in the shared sign language ABSL, the sign for kettle was shown to differ across families, but within families, members were uniform in their productions (Sandler et al. 2011). Regarding this variation, Sandler et al. (2011) state: "It is likely that all the different versions would be intelligible across the community, due to iconicity, context, or the existence of synonymy in the signers' mental lexicons—possibly all the of the above". We refer to these as *productive synonyms*, i.e., variants that may be used interchangeably, in contrast to *perceptual synonyms*, i.e., variants which signers may be aware of in a more abstract sense but not use (Mudd et al. 2020).

Figure 1 shows three signs for *pig* used in the Kata Kolok community. Many villagers in this community make a living as farmers, and this is reflected in the iconic motivations underlying the forms produced for PIG-1 and PIG-2. Given that the members of this community share a high degree of cultural context, it is probable that individuals exploit iconic mappings, understanding each other by retrieving the meaning (comprised of culturally salient features) from the form even if they have not seen or produced the form themselves. On the other hand, when shared context is not available (i.e., individuals are from different backgrounds and have different experiences), there is no advantage to using iconic signs, as the culturally salient features of interlocutors are different. Continuing with this example, imagine someone from a different community who does not have experience with farming. The underlying iconic motivations related to this practice will be meaningless to them, and therefore, the meaning comprised of culturally salient features to the individual in the farming community which are expressed in the form (e.g., PIG-1, whose underlying iconic motivation refers to how pigs are killed) would not be understood unless the mapping is learned. As explained by Occhino et al. (2017), iconicity is subjective as it is dependent on one's language and culture-specific experience.

Figure 1. Three variants for *pig* in Kata Kolok produced in response to a picture description task (Lutzenberger et al. 2021; Mudd et al. 2020). The iconic motivation underlying PIG-1 is how a pig is killed, for PIG-2 is how a pig eats and for PIG-3 is the ears of a pig. It is clear that the cultural context of the Kata Kolok community has shaped lexical preferences, illustrated with iconic signs (i.e., mappings between culturally salient features and forms). For instance, the iconic motivations of PIG-1 and PIG-2 stem from farming practices in the community.

Here, we aim to operationalize the relationship between shared context (allowing for iconic mappings) and lexical variation using an agent-based model. In our model, the language representation is adapted from the semiotic triangle (Ogden and Richards 1925). Traditionally, the semiotic triangle consists of a referent (something concrete or abstract referred to in a particular instance of a conversation), a meaning (a representation of that referent by a given individual) and a form (the signal conveyed) (terminology following Steels and Kaplan 1999, definitions following Vogt 2002; Vogt and Divina 2007). The relationship between these components has been used to study the symbol grounding problem (Harnad 1990), i.e., the problem that symbols are internal representations but need to be linked to entities in the real world (Vogt 2002).

In the semiotics literature, there is a heavy emphasis on the conventionalized and/or arbitrary link between the form and referent (see Pierce 1931), which is unsurprising considering the long-held assumption that arbitrariness is a design feature of language (de Saussure 1916; Hockett and Hockett 1960). However, the emphasis on arbitrariness has been reduced due to the overwhelming presence of iconic forms in sign languages as well as in spoken languages (see Perniss et al. 2010 for a review). It should be noted that the role of iconicity in language emergence may differ in signed and spoken languages, given the different affordances of the modalities, which may have ramifications on the degree of lexical variability.

In the present study, we adapt the semiotic triangle to reflect what we posit is representative of the linguistic situation in sign language emergence. The semiotic triangle presented here consists of three components: (1) a concept, i.e., an abstract notion; (2) culturally salient features, i.e., culturally salient features of a concept; and (3) a form, i.e., the signal conveyed. For example, a hypothetical semiotic triangle from an individual in the Kata Kolok community could consist of (1) the concept *pig*, an abstract representation of the animal; (2) culturally salient features of a pig in this farming community, such as how a pig is killed and how a pig eats; and (3) the form PIG-1 (see Figure 1), whose iconic motivation stems from how a pig is killed. Notably, the inclusion of culturally salient features in the language model allows for the use of iconic mappings between the culturally salient features and the form. As such, the original contributions of this model are the introduction of culturally salient features and the *iconic–inferential pathway* (presented in the right triangle in Figure 2). In addition to the *conventional link* between form and concept, the iconic–inferential pathway goes from form to culturally salient features to concept (or vice versa). Here, an individual can make use of the culturally salient features (unique to them depending on their culture and experiences), which can be retrieved from the form given that cultural knowledge is shared.

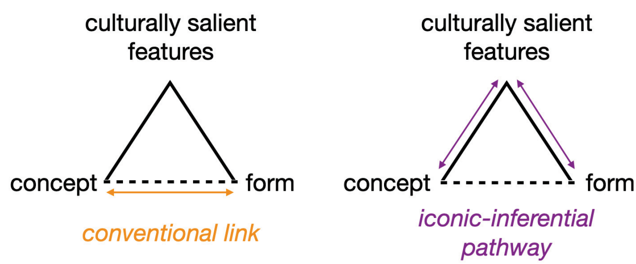


Figure 2. The semiotic triangle used in the current study, consisting of a concept, culturally salient features and a form. The triangle on the left shows the traditional view of the relationship, in which an arbitrary link between the form and concept are made. Depicted in the triangle on the right, we present an alternative route to connecting the form to the concept, through culturally salient features, which we call the iconic–inferential pathway. Figure based on Vogt and Divina (2007), adapted from Ogden and Richards (1925), updated with terminology used in the current study.

Here, we provide an example of how these pathways could be used in interaction with the example of pig again from the Kata Kolok community, using a hypothetical conversation between individual A and individual B, both from this community. In conversation, individual A uses the sign PIG-1 (iconic motivation referring to how a pig is killed). However, individual B is not familiar with this form and, using the conventional link (form to concept), does not know at this stage what individual A is referring to. Subsequently, individual B uses the iconic–inferential pathway to consider if the form produced by individual A overlaps with the culturally salient features of any concept. Because individual B is from the Kata Kolok community, where individuals have knowledge about farming, including the way in which pigs are killed, individual B recognizes that the form PIG-1 produced by individual A refers to how a pig is killed, and thus likely refers to pig. In this way, when individuals share a cultural context, the iconic–inferential pathway can serve as a supporting route in case the conventional pathway fails. In the event that neither of these pathways lead individual B to the concept *pig*, it is probable that these individuals will need to initiate repair in order to understand each other. Though many strategies may be used, one option would be for individual B to learn the form produced by individual A. Although in the operationalization of this model the conventional link has priority over the iconic–inferential pathway, in the real world, meaning can also undoubtedly be inferred using the iconic–inferential pathway prior to the conventional link or a combination of both.

This theory generates a prediction about the level of iconicity present in different types of communities. Frishberg (1975) showed that in ASL, a Deaf community sign language, signs tend to become less iconic over time. Pleyer et al. (2017) point out that studies from young sign languages and homesign systems show that "signs gradually shed their iconic mapping", potentially in favor of facilitating a larger vocabulary (Gasser 2004). However, what about for shared sign languages? Does the level of iconicity remain high or decrease over time? We predict that in shared sign languages, the level of iconicity will remain relatively high because iconic forms are successfully communicated, as community members share a high degree of cultural context. In contrast, in Deaf community sign languages, we predict that iconicity will decrease, as found by Frishberg (1975) for ASL, because in these larger communities, individuals typically come from diverse backgrounds. Therefore, retrieving culturally salient features from the form will not be useful when communicative partners do not share cultural context. Rather, individuals are more likely to adapt their form moving closer to the form of their communicative partner. This helps them to successfully communicate, as their forms move towards becoming aligned. However, as individuals do not likely share a cultural context (and hence likely have different salient features), adapting one's form would typically result in a move away from its initial highly iconic state. Iconicity is often talked about on a large scale, irrespective of individual experience. While iconic affordances can be grounded in human experience (e.g., men have beards), it must be stressed that iconicity remains subjective (Occhino et al. 2017). Thus, here, iconicity is considered on an individual level, as opposed to across entire communities where individuals may not share much cultural context.

In sum, we propose that in communication individuals may exploit an iconic–inferential pathway, making use of iconic mappings between a form and culturally salient features if a conventional pathway is not available. In communities such as shared signing communities where individuals share psychological and social information, we predict that communicative partners will successfully communicate using the iconic–inferential pathway if the conventional pathway fails. Because communication can succeed using these two routes, lexical variation should remain high, as well as the degree of iconicity in the community. On the other hand, in communities such as those with Deaf community sign languages, because there is less shared information, the iconic–inferential pathway is less useful. Hence, in the case of failure using the conventional pathway, individuals are more likely to proceed to adapt their lexical form in order to be understood. Hence, we predict that communities with little shared context will move towards lexical uniformity and low degrees of iconicity.

In addition to shared context, it has been proposed that population size may affect linguistic features (Lupyan and Dale 2010; Wray and Grace 2007). In sign languages, anecdotal evidence suggests that small populations exhibit a higher degree of lexical variation than large populations (Meir et al. 2012). The relationship between population size and lexical variation has been supported by a recent computational model (Tkachman and Hudson Kam 2020), though previous computational models have found that conventions emerge faster in smaller populations (Baronchelli et al. 2006). Although not the main focus of this study, we also consider the effect of population size on the degree of lexical variability, as typically shared sign languages emerge in smaller populations, and Deaf community sign languages emerge in larger populations. Modeling shared context and population size may help to tease apart the contribution of each on the degree of lexical variation.

In the next section, we describe how this theory is operationalized using an agent-based model. Following this, we begin the results section with two example model runs focusing on the results of the language game component of the model. Then, we study the effect of shared context on lexical variation by altering the number of groups in the model, which determines how many agents share the same cultural context. Concluding the results section, we briefly consider the effect of population size on lexical variation. Finally, in the discussion section, we first focus on comparing the model results to the evidence from variation in signing communities. Then, we discuss the limitations of this model and how it can be extended to account for these limitations.

2. Model Description

The model description is inspired by the ODD (Overview, Design concepts, Details) protocol for describing agent-based simulations (Grimm et al. 2006; Grimm et al. 2010). The description has been adapted to include links between the model and real world examples, to hopefully make for a more understandable model description. The model was implemented in Mesa, a Python framework for agent-based modeling (Kazil et al. 2020). The model code is available on figshare: https://doi.org/10.6084/m9.figshare.15163872.v1, accessed on 23 January 2022.

Purpose. The purpose of this model is to investigate how shared context affects lexical variation in sign language emergence. As shown in Figure 3, the agent-based model takes the following values as input parameters:

- The number of concepts (*n_concepts*);
- The number of bits (*n_bits*): the number of bits (0 or 1) in the culturally salient features and form (i.e., the length of a word);
- The number of agents in the model (*n_agents*) (i.e., the population size);
- The number of groups (*n_groups*): agents are assigned to a group, which determines which features of a referent are culturally salient to an agent;
- The initial degree of overlap between the culturally salient features and form (*initial_degree_of_overlap*) (the parameter simulating iconicity);
- The number of time steps in the model (*n_steps*).

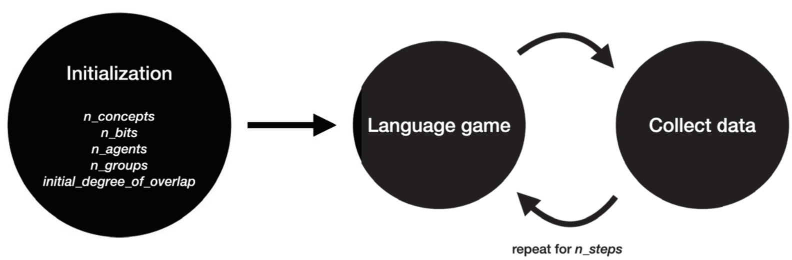


Figure 3. Visualization of the steps and parameters in the agent-based model. During the initialization phase, the number of groups (*n_groups*) determines how many subsets of the population have the same set of identical culturally salient features associated with concepts. Then, a number of agents are created (*n_agents*). Each agent is randomly assigned to a group, and their language representation is set given the following parameters: the number of concepts (*n_concepts*), the number of bits (*n_bits*) and the initial degree of overlap between the culturally salient features and form (*initial_degree_of_overlap*). At each time step, all agents initiate a language game (i.e., they take a turn as the sender). At the end of each time step, data on the mean degree of iconicity and the mean lexical variability are calculated. The model continues for a number of steps (*n_steps*).

Entities, state variables and scales. The only entity in the model is the agent, which is the entity in the model that represents one individual in the real world. Agents consist of a unique id and a group that they are assigned to during the initialization stage (first stage of the model). Furthermore, each agent has a language representation which is explained in the initialization below. Figure 4 shows an example of an agent.

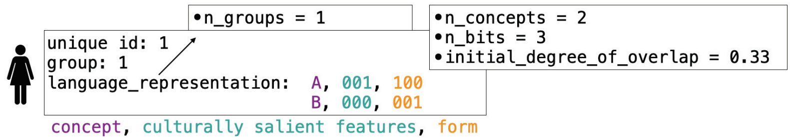


Figure 4. Example of an agent.

The agent's unique id is 1 as it is the first agent created in this run of the model. In this example, there is only one group (*n_groups* = 1), so the agent is assigned to group 1. As there is only one group, all agents in the model would have the same culturally salient features corresponding to each concept. This is akin to individuals of a population having shared social and psychological information, thus they are likely to have similar notions for a given concept. Some examples of concepts in real life are *pig*, *tree* and *destiny*, as discussed in the introduction. In the example in the figure, there are two concepts (*n_concepts* = 2); each concept is associated with culturally salient features and a form, both of which are made up of three bits (*n_bits* = 3). For each bit of the form, the probability that it will have the same value as the corresponding bit in the culturally salient features is determined by *initial_degree_of_overlap*. Hence, the form, corresponding in real life to a sign produced or a word uttered, is determined by the association with the culturally salient features. The idea is that when individuals initially improvise forms, the forms often bear some degree of resemblance to culturally salient features of the concept. For example, in Kata Kolok, signs for *pig* refer to how a pig is killed, how a pig eats or a pig's ears—features that are culturally salient in the Kata Kolok community.

Process overview and scheduling. The set-up of the model is outlined in initialization below. After the initialization phase, each time step consists of the processes outlined in Table 1. For details of these processes, see the Submodels sections. A schematic overview of the order of processes and parameter input is provided in Figure 3.

Initialization. For each group (*n_groups*), a bit vector of length *n_bits* is generated per concept (*n_concepts*). Following the example provided in Figure 4, the culturally salient features associated with concept A is 001 and concept B is 000. In the real world, this could be analogous to two concepts, say, *pig* and *butterfly*, which have different culturally salient features (dependent on the background of a person), such as wings for a butterfly and pigs rolling in mud or how they are killed in farming. Roughly, the string of 0s and 1s representing the culturally salient features can be thought of as a unique representation of the characteristics of that concept, given the group one is in.

Each agent has a language representation which consists of, for each concept, a set of culturally salient features and a form, as shown in Figure 4. *n_concepts* determines the number of concepts in the language representation. This is akin to the number of words in a person's vocabulary. Each concept is associated with culturally salient features and a form, each consisting of a number of bits (0 s and 1 s), determined by *n_bits*. The culturally salient features corresponding to each concept are fixed, based on the group that the agent belongs to. The culturally salient features and concepts are never updated or changed throughout the simulation. Only the forms can be updated. The idea here is a simplification of reality, in which an individual is born in a certain context, determining what features are salient culturally for the entirety of their life (e.g., in communities where farming is practiced, one's concept of an animal is likely related to how that animal is farmed). However, despite this, the form (produced sign or uttered word) can change over the course of one's life (e.g., I may say "rad", "radical" or "cool" to refer to the same concept).

Table 1. Processes, scheduling, pseudo-code and parameters.

Process	Pseudo-Code	Parameters
	for each group G in *n_groups*	
	for each concept C in *n_concepts*	
	set the culturally salient features for concept C in group G to a list of length *n_bits* of randomly chosen 0s and 1s	
	create a population with size *n_agents*	
	for each agent A in the population	*n_groups*
	randomly assign agent A to a group	*n_agents*
Initialization	set all culturally salient features based on assigned group	*n_concepts*
	for each concept C	*n_bits*
	for each culturally salient features F associated with concept C	*initial_degree_of_overlap*
	for each bit B of culturally salient features F	
	with probability *initial_degree_of_overlap* set bit B of corresponding form to bit B of culturally salient features F	
	else	
	set bit B of corresponding form to 0 or 1 with equal probability	
Step	repeat for *n_steps*	*n_steps*
Language game	**for each** agent A in the population	
	randomly choose another agent and play the language game	
Collect data	calculate the mean iconicity and lexical variability across the population	

Iconicity is represented in the model by the similarity between the forms (sign produced or word uttered) and the culturally salient features for a concept. For example, if a butterfly's wings are salient in one's culture and the sign for butterfly refers to the wings of the insect, then the similarity between the culturally salient features and the form is strong and thus highly iconic for individuals with the same background. In the model, to understand how iconicity affects lexical variability, the parameter determining the degree of overlap between forms and culturally salient features is varied. This is operationalized in the model in the following way: The relationship between each bit of the culturally salient features and the form is determined by the *initial_degree_of_overlap*, such that the probability that the form's bit is the same as the bit from the culturally salient features is equal to the value of *initial_degree_of_overlap*. For a bit of the form that is not chosen to be the same as the bit of the culturally salient features in the initial event, then that bit is randomly[2] assigned a 0 or 1. As such, a non-iconic form does not have a structured relationship between the form and the culturally salient features; rather, its relationship is arbitrary. If the *initial_degree_of_overlap* is set to 1, then there is a 100% chance that each bit of the form will be the same as that of the culturally salient features. If the *initial_degree_of_overlap* is set to 0, then each bit of the form is randomly assigned a 0 or 1.

To illustrate with an example following Figure 4, take concept A, which is associated with the culturally salient features 001. Before assigning the forms, the language representation looks like this: A, 001, NA NA NA, with 001 referring to the culturally salient features and NA NA NA referring to placeholders for each bit of the form. Starting with the first bit of culturally salient features (0), there is a 33% chance that the corresponding bit of the form will be identical to the bit of the culturally salient features in this initial event. The outcome of this event is that the bit of the culturally salient features and of the form are not identical. From here, a new event occurs, randomly assigning a 0 or 1 to this bit; a 1 is randomly assigned (note that at this stage a 0 could also be chosen randomly). Now, the language representation looks like this: A, 001, 1 NA NA. The same process is repeated to determine the second bit of the form, and here the outcome of this event is that this bit is identical, i.e., the second bit of the form is set to 0 as the second bit of the culturally salient features is 0. Finally, this process is repeated a third time, and here the outcome of this event is that the bit of the culturally salient features and of the form are not identical. From here, a new event occurs, randomly assigning a 0 or 1 to this bit; here, it happens to be a 0 that is chosen (note that at this stage, a 1 could also be chosen randomly). Thus, the final language representation of this agent for concept A is: A, 001, 100.

Submodel Language game. The language games consist of two agents interacting—a sender and a receiver, simulating a simplified exchange between two individuals. At each time step in the model, all agents take one turn as a sender in the language game. As shown in Figure 5, the language game consists of four steps. First, the sender randomly chooses a concept and produces the corresponding form. In Figure 5, the sender has randomly chosen concept A. In real life, this would be analogous to an individual wanting to communicate about a given concept and producing the corresponding sign or uttering the corresponding word.

Second, in the language game, the receiver selects the form which is closest to the form of the sender, by calculating the distance between the sender's form to all of the forms of the receiver. Crucially, in this model, the distance is calculated by comparing the bits at the same index. In the event of a tie between two or more forms as having most in common with the form of the sender, a form that tied is randomly chosen. Following the example provided in Figure 5, the sender's form is 100. The distance to the receiver's first form 001 is 2/3 and the distance to the receiver's second form is 100 is 0/3, so the second form is selected. The concept of the selected form of the receiver is then compared to the chosen concept of the sender. If the concept of the sender and receiver are the same, then the language game is over and no update is made. When the language game succeeds here, we refer to this as *form success*. However, if the concepts of the sender and receiver do not match (as is the case in the example presented in Figure 5 where the sender chose concept

A and the receiver's closest match is concept B), then the language game proceeds to the third step. Success at this step of the language game represents the conventional link or memorizing the association between a concept and a form. Typically in language games, it is the conventional link that is modeled.

This next step presents the original contribution of this model, which models the ability of individuals to make use of iconic affordances. In this third step, the form of the sender is compared to all the sets of culturally salient features of the receiver. As performed in step two between forms, the distances between the form of the sender and all of the sets of culturally salient features of the receiver are calculated, and the closest culturally salient features are selected. Again, following the example in Figure 5, the sender's form is 100. The distance to the receiver's first culturally salient features 001 is 2/3, and the distance to the receiver's second culturally salient features is 000 is 1/3, so the second culturally salient features are selected. As in step two, the concept of the receiver's selected culturally salient features is compared to the sender's chosen concept. If these concepts are the same, then the language game is over and no update is made. When the language game succeeds here, we refer to this as *culturally salient features success*. Success at this step of the language game represents the iconic–inferential pathway, where a form and concept are linked via the cultural salient features. Crucially, no memorization is required. However, at this stage, if the concepts of the agents do not match (as is the case in the example presented in Figure 5 where the sender chose concept A and receiver's closest match is concept B), then the language game proceeds to the fourth step.

The last step of the language game represents when communication is unsuccessful via the conventional link and the iconic–inferential pathway. In this case, as is typical in language games, one agent updates their form to hopefully allow for successful communication in the future. In real life, this corresponds to aligning speech with an interlocutor. Concretely, in this fourth step, for the sender's chosen concept (concept A), the receiver updates one bit of the form which is different from the form of the sender. If the language game advances to this stage, we call this *bit update*. In Figure 5, the sender's form corresponding to concept A is 100. The receiver's form corresponding to concept A is 001. The bits that are different between the sender's and the receiver's form are identified (the first and third bits), and one is randomly selected to be changed to correspond to the sender's. In the example, the first bit was chosen and is changed to a 1; now, the receiver's form for concept A is 101.

1. Sender chooses a concept (A) and produces the corresponding form (100)
2. Receiver finds their closest form (100)
   If concepts match, result = *form success*

Sender

concept	culturally salient features	form
A	001	100
B	000	001

Receiver

concept	culturally salient features	form
A	001	001
B	000	100

3. If concepts don't match (here A =/= B), receiver finds closest culturally salient features (000)
   If concepts match, result = *culturally salient features success*

concept	culturally salient features	form
A	001	100
B	000	001

concept	culturally salient features	form
A	001	001
B	000	100

4. If concepts don't match (here A =/= B), update bit of receiver's form (001→101)
   result = *bit update*

concept	culturally salient features	form
A	001	100
B	000	001

concept	culturally salient features	form
A	001	101
B	000	100

Figure 5. The steps of the language game with an accompanying example.

Submodel Collect data. In the data collection phase of each time step, two calculations are made: the mean degree of iconicity and the mean lexical variability. Calculation examples are demonstrated with the agents in Figure 6.

agent 1

concept	culturally salient features	form
A	001	100
B	000	001

agent 2

concept	culturally salient features	form
A	001	001
B	000	100

Figure 6. Example agents for calculating the mean degree of iconicity and the mean lexical variability.

First, the mean degree of iconicity is calculated for each concept of each agent and averaged across all agents. To calculate the degree of iconicity for a concept, the culturally salient features and the form are compared at each index, with the similarity (or overlap) calculated. For example, for agent 1 in Figure 6, for concept A, the associated culturally salient features are 001 and the form is 100. The similarity between these is 1/3. For concept B, the similarity is 2/3. Thus, the mean degree of iconicity for agent 1 is 1/2.

Next, the mean lexical variability in the population is calculated by comparing all forms for each concept between all pairs of agents in the population. If the agents' forms for a concept are the same, i.e., all bits match at each index, then the distance between the productions is 0. If two agents' forms for a concept are not the same, i.e., the bits differ at one index or more, then the distance between the productions is 1. Thus, the result of the comparison between two agents' forms is binary (distance of 0 or 1)[3]. For each pair, the mean of the distances is taken. We will illustrate this calculation with the agents depicted in Figure 6: For concept A, agent 1's form is 100 and agent 2's form is 001. As these forms differ at the first and last positions, the distance between them is 1. Subsequently, for concept B, agent 1's form is 001 and agent 2's form is 100, which differ at the first and last positions, so the distance between them is 1. Thus, the mean lexical variability between these agents is 1.

3. Results

In this section, we first present results of two single runs in order to explain the measures used and to give an intuition as to what one single run of the model looks like. Here, we explain the results of the language games—that is, for each language game, it is recorded if the game ends at form success (step two from Figure 5), culturally salient features success (step three from Figure 5) or bit update (step four from Figure 5). Additionally, we show the mean degree of iconicity and the mean lexical variability for each run.

Following these examples, the role of shared context is investigated by altering the number of groups (*n_groups*) and the effect of population size is investigated by altering the number of agents (*n_agents*). We consider the effect of these parameters on the mean lexical variability and the mean degree of iconicity. The model simulations presented are of 100 repetitions. The remainder of the parameter explorations can be found in Appendix A, which investigate the effect of the number of concepts (*n_concepts*), the number of bits (*n_bits*) and the initial degree of overlap between the culturally salient features and the form (*initial_degree_of_overlap*).

Additional parameter explorations studying the role of *initial_degree_of_overlap*, *n_concepts* and *n_bits* on lexical variability and iconicity can be found in Appendix A.

3.1. Two Example Runs

To show what one run of the model entails, we present the results from two single model runs. Both model runs differ only in one parameter, the number of groups (*n_groups*), which determines which set of culturally salient features an agent has. The first run presented consists of one group and the second run presented consists of ten groups. The other parameters are the following:

- The number of concepts (*n_concepts*): 10;
- The number of bits (*n_bits*): 10;
- The number of agents in the model (*n_agents*): 10;
- The initial degree of overlap between the culturally salient features and form (*initial_degree_of_overlap*): 0.9;
- The number of steps in the model (*n_steps*): 2000.

3.1.1. Language Game Results

First, we present a model run consisting of one group (*n_groups* = 1), meaning that all agents belong to the same group. This results in all agents having the same set of culturally salient features.

In the language game step of the model, as shown in Figure 5, there are three ways in which the language game can end: 1. there is a match between the concepts associated with the sender's form and the receiver's closest form to the sender's form (*form success*, step 2 Figure 5); 2. there is a match between the concepts associated with the sender's form and the receiver's closest culturally salient features to the sender's form (*culturally salient features success*, step 3 Figure 5); or 3. for the form of the receiver corresponding to the concept associated with the form communicated by the sender, a bit which does not match the sender's is updated (*bit update*, step 4 Figure 5). These three steps where the language game can end are visualized in Figure 7 for the first 10 stages (left) and over all 2000 model stages (right). To further explain, in each time step, each of the 10 agents initiates 1 language game, which may end in form success, culturally salient features success or bit update. At each time step, the proportions of these language game results are visualized as a barplot. For example, in the run presented in Figure 7, at stage 1 out of the 10 language games played, 8 resulted in form success, 1 resulted in culturally salient features success and 1 resulted in a bit update.

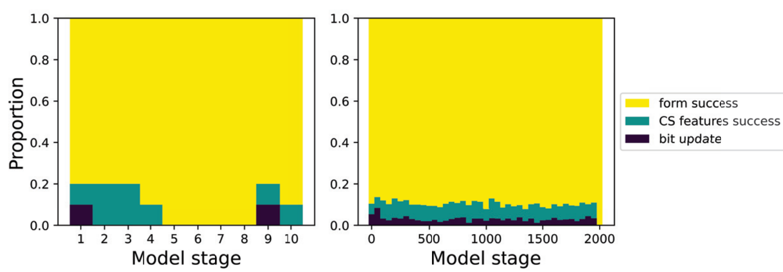


Figure 7. The proportion of language game results (form success, culturally salient features success or bit update) with 10 agents all belonging to the same group (*n_groups* = 1) for the first 10 model stages (**left**) and over the 2000 stages (**right**). At each stage, 10 language games were played. The x-axis starts at stage one because in stage zero there is only model set up and no language game. Across all stages of this run, the majority of the language games end with form success, with a small proportion ending with culturally salient features success (here abbreviated as CS features success). Over 2000 stages, shown on the right, the results were averaged over 50 consecutive model stages (i.e., each bar of the histogram represents the mean of 50 stages).

It is apparent that the vast majority of language games in this run of the model end after form success. In this run of the model, as all agents share the same set of culturally salient features (*n_groups* = 1) and because all agents create their forms to be highly iconic (*initial_degree_of_overlap* = 0.9), the forms of agents will be highly similar at the start of the simulation. The similarity between the agent's forms results in a majority of language games that are ended with form success. Thus, even though the forms stay highly iconic (they are not changed as there is hardly any bit updating), the agents do not use the iconicity present (language games ending in culturally salient features success) as the language game typically ends with form success. However, throughout the simulation there is still a small proportion (around 10%) of language games ending after culturally salient features success. Few language games end with a bit update.

Second, we present a model run consisting of 10 groups (*n_groups* = 10), meaning that each agent is randomly assigned to 1 of the 10 groups. Because agents are randomly assigned to a group, this does not guarantee that all agents are in a different group. Once assigned to a group, agents are initialized with the set of culturally salient features generated for that group.

Figure 8 shows the results of the language games of 1 model run with 10 agents and 10 groups for the first 10 stages (left) and over 2000 stages (right). For example, in stage 1, 8 language games end with a bit update, 1 ends after culturally salient features success and 1 ends after form success. Over the 2000 stages, it is evident that the proportion of runs ending in a bit update decreases and the proportion of runs ending in form success increases. Over time, form success becomes the most prominent result of the language game, though a considerable amount of language games ending in bit update remains. On the other hand, there are fewer language games ending in *culturally salient features success*; it is clearly the most infrequent result.

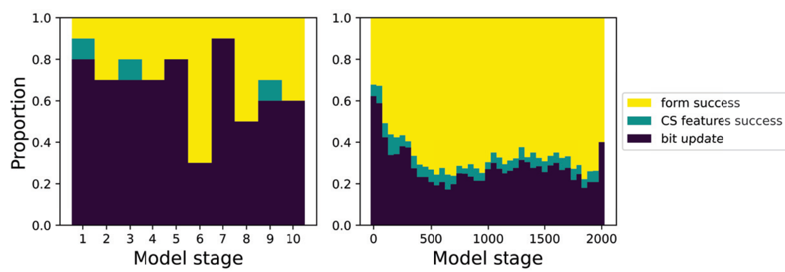


Figure 8. The proportion of language game results (form success, culturally salient features success or bit update) for a model run with 10 agents randomly assigned to 1 of 10 groups (*n_groups* = 10) for the first 10 model stages (**left**) and over the 2000 stages (**right**). At each stage, 10 language games were played. The x-axis starts at stage one because in stage zero there is only model set up and no language game. The majority of the language games at the start of the simulation end with bit update, while later, more end with form success and still a considerable amount end with bit update. Few language games end with culturally salient features success (here abbreviated as CS features success). Over 2000 stages, shown on the right, the results were averaged over 50 consecutive model stages (i.e., each bar of the histogram represents the mean of 50 stages).

In comparing these two example runs, it is evident that the results of the language games with 1 group and 10 groups are different. With 10 groups, bit updates happen much more often than for the run with one group. This is because with one group, if form success is not possible, then culturally salient features success often is as all agents share the same set of culturally salient features. However, with 10 groups, if form success is not possible, agents are likely to end the game with a bit update because it is unlikely that agents share the same culturally salient features, so culturally salient feature success is unlikely to occur. Thus, these two model runs demonstrate how the number of groups (determining the set of culturally salient features of the agents) affect the results of the language games, which in turn affect the degree of lexical variability and iconicity across the population.

3.1.2. Lexical Variability and Iconicity

Figure 9 shows the mean lexical variability and iconicity over the 2000 model stages for the run with 1 group (left) and with 10 groups (right). As previously mentioned, the mean lexical variability is calculated by comparing each bit of each form per pairs of agents (the distance is 0 if all bits match or 1 if more than 1 bit differs), averaged over all agents at each stage. The mean iconicity is calculated by comparing the degree of overlap between each form and corresponding culturally salient features in an agent's language representation, averaged over all agents at each stage.

First, when all 10 agents belong to 1 group (as can be seen on the left in Figure 9), the degree of iconicity remains constant throughout the run, above 0.9. The mean lexical variability drops slightly and then stabilizes around 0.5. In contrast, when agents are randomly assigned to 1 of 10 groups, the picture is drastically different; as can be seen on the right in Figure 9, both the mean lexical variability and degree of iconicity decrease more than when all agents are assigned to the same group. Initially in this case, the lexical variability across the population is nearly at 1, i.e., the maximum distance possible between the forms of agents. As the forms of agents are initialized on the basis of their culturally salient features, it makes sense that the lexical variability is maximal given that (most) agents are assigned to different groups. From there, the mean lexical variability drops sharply, indicating that there is more lexical similarity across the population over time. The degree of iconicity also drops but stabilizes above 0.5. Given that the degree of iconicity calculation is performed on a bit by bit basis comparing the form to the culturally salient features, 0.5 would represent chance, i.e., an unstructured relationship between the bits of the form and culturally salient features. Though the degree of lexical variability is initially higher when agents are assigned to 1 of 10 groups, the degree of lexical variability decreases much faster and continues to do so, whereas when agents all belong to the same group, the degree of lexical variation (after a short drop in the first 100 stages) remains relatively stable.

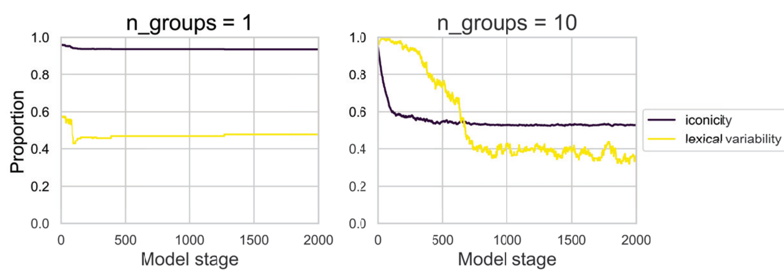


Figure 9. The mean lexical variability and iconicity over the 2000 model stages for one run with 1 group (**left**) and 10 groups (**right**). With all agents belonging to the same group (*n_groups* = 1), the degree of iconicity remains high, and the mean lexical variability across the population remains relatively constant, with more than half of the forms across the population being different. With 10 groups that agents could be assigned to (*n_groups* = 10), the degree of iconicity drops and then stabilizes slightly above 0.5, with 0.5 representing an unstructured relationship between the bits of the form and culturally salient features. The mean lexical variability across the population drops sharply and then continues to drop slowly, indicating that forms become more and more uniform in the population over time.

Now that two examples with just one run have been discussed, we will show the results from 100 repetitions averaged per run with a focus on lexical variation.

3.2. The Effect of Multiple Groups on Lexical Variation

Figure 10 shows different group sizes (*n_groups* = 1, 2, 5 and 10) and the mean degree of lexical variability and iconicity over 100 repetitions. The results from the examples in the previous section are in line with what is shown here; when there is only one group (i.e., all 10 agents have the same set of culturally salient features) at stage 0, there is already some overlap between forms in the population—a lexical variability value of approximately 0.6, indicating that 40% of forms associated with a concept are identical across the population at the start of the run. Over time, the mean lexical variability does not drop below 0.5. The degree of lexical variability in the population stabilizes more quickly and higher than in the simulations with other groups sizes.

In populations with more groups, the mean lexical variability at the start of the run is high (between 0.8 and 1), as agents belong to different groups and their culturally salient features and hence their forms differ. From this initial point of high lexical variability, there is a sharp decrease in lexical variability. Thus, these populations move quickly towards more uniform form–concept pairings. The number of groups in the population determines at which point the mean lexical variability stabilizes. When there are more groups, the mean lexical variability stabilizes at a lower point. In other words, with more groups, there is more lexical uniformity.

In populations with more groups and hence more culturally salient features, agents cannot rely on shared culturally salient features to communicate. Thus, more often, as shown in the previous section, agents update their forms to be able to successfully communicate with other agents, which results in more uniform form–concept pairings across the population.

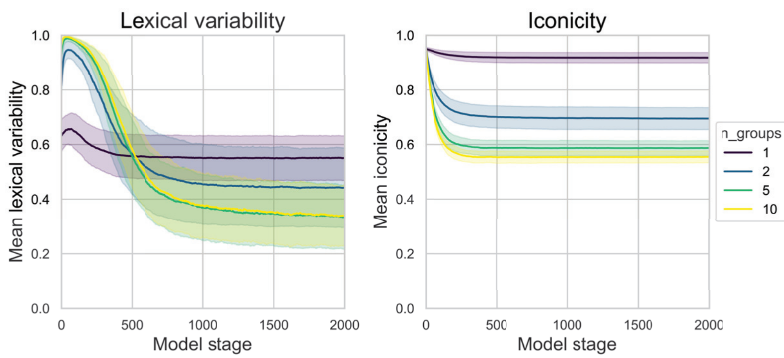


Figure 10. The mean lexical variability over the 2000 model stages for 100 repetitions of a run with 10 agents being assigned to different groups depending on the run. The dark line represents the mean and the shaded area represents the standard deviation of the 100 repetitions. It is evident that there is a relationship between the number of groups and the speed of the decrease of lexical variability, as well as the final amount of lexical variability in the population: The more groups in the population, the higher the initial lexical variability (at stage 0) but the lower the final lexical variability (at stage 2000). In addition, when there are fewer groups, the degree of iconicity is higher.

Additionally, there is a clear relationship between the number of groups and the degree of iconicity: With fewer groups in the population, the degree of iconicity is higher. As predicted, when there are fewer groups, iconic mappings are more useful as more sets of culturally salient features are shared across the population, and therefore the degree of iconicity remains higher. Moreover, as the number of groups increases, the additional difference in lowered iconicity is smaller (e.g., the difference in iconicity between 1 and 2 groups is larger than the difference in iconicity between 5 and 10 groups). In contrast to the lexical variability values, the degree of iconicity quickly stabilizes within the first few hundred stages.

3.3. The Effect of Population Size on Lexical Variation

In this section, we explore the effect of population size on lexical variation for different group sizes. Figure 11 shows different population sizes over time, considering populations consisting of 5, 10, 20, 50 and 100 agents.

In the early stages of the simulation, larger populations exhibit a higher degree of lexical variability than smaller populations. However, over time, larger populations exhibit a steeper decrease in lexical variability compared to smaller populations. In the final stages of the simulation, the larger population sizes exhibit the lowest degree of lexical variability (i.e., the most lexical uniformity). What can explain this?

In larger populations, there are initially more forms per concept (as forms are generated on an individual level). With agents in a larger population communicating with a larger number of agents, this results in more bit updates. In turn, bit updates typically decrease the degree of iconicity, thereby decreasing the chance of successfully communicating with culturally salient features success. This leads to a feedback loop whereby the frequent bit updates lead to a decrease in the possibility for communicating with culturally salient features success. This process is visualized in Figure 12. On the other hand, in smaller populations, there are initially fewer forms per concept. As agents communicate with a smaller number of agents, less bit updates occur. With fewer bit updates occurring, a higher degree of iconicity is retained, and thus the use of the iconic–inferential pathway (language games ending in culturally salient features success) can be successfully used.

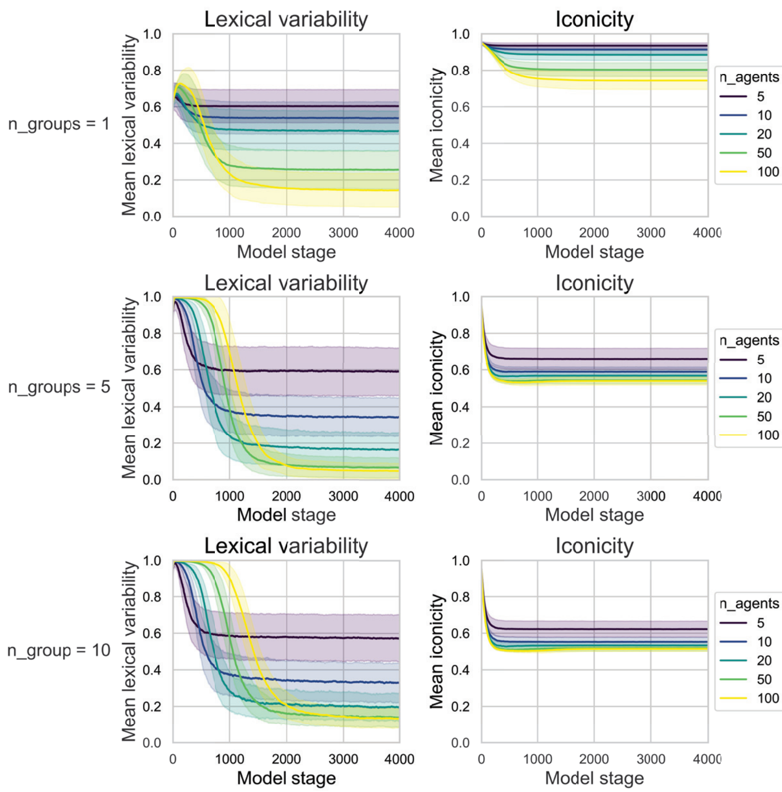


Figure 11. The mean lexical variability over 4000 model stages for different population sizes (*n_agents*), showing three different group values (*n_groups*) determining the sets of culturally salient features of the agents. The dark line represents the mean and the shaded area represents the standard deviation of the 100 repetitions. Regardless of the number of groups, it is clear that the larger population sizes exhibit a lower mean lexical variability than small population sizes. In addition, when there are more agents, the level of iconicity is lower.

Across all population sizes, the more groups, the lower the mean iconicity level is (see Figure 11 iconcity for *n_groups* = 10 vs. *n_groups* = 1), as discussed in the previous section. In addition to this, it is apparent that population size and the number of groups interact in determining iconicity levels. When all agents belong to one group (*n_groups* = 1), there are larger differences in the mean iconicity level in the population than compared to when agents can be assigned to different groups (*n_groups* = 5 and *n_groups* = 10). The explanation for this relates to the feedback loop mentioned where a lower degree of iconicity stems from more bit updates. When there are more groups, regardless of the population size, agents cannot rely on the iconic–inferential pathway to successfully communicate (language games ending in culturally salient features success) because their sets of culturally salient features differ. With more groups, the feedback loop is present across all population sizes: A lower degree of iconicity stems from more bit updates, here due to the inability of using the iconic–inferential pathway.

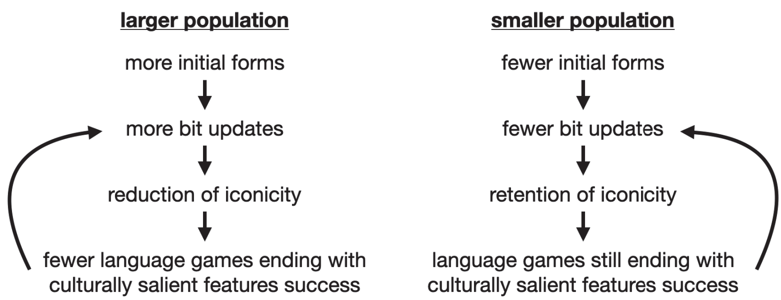


Figure 12. The feedback loop from bit updating to the use of culturally salient features success visualized.

4. Discussion

Here, we present a first step in developing a model of how shared cultural context (allowing for the use of iconic mappings) may influence lexical variation in sign language emergence. We have shown that in a model where agents can rely on iconic mappings between a form and culturally salient features in addition to form–concept mappings, populations with a high degree of shared context (operationalized in the model as a smaller number of groups determining the culturally salient features of agents) retain a higher degree of lexical variation. In contrast, populations with many different cultural contexts do not retain the high degree of lexical variation present in language emergence; instead, because these populations cannot rely on iconic mappings between form and culturally salient features, the language becomes more uniform overtime. Overall, these results provide support for the idea that shared context facilitates a high degree of lexical variation (de Vos 2011; Meir et al. 2012).

The main contribution of this model is a novel representation of iconicity, operationalized as a mapping between the bits of the culturally salient features and forms. This has allowed us to consider how iconic properties allow for the retention of lexical variation in culturally homogeneous groups. Crucially, without the iconic–inferential pathway, individuals would need to rely on the conventional link requiring memorizing the association between concepts and forms. Though not tested here, we speculate that a model with only the conventional link would predict a lower degree of lexical variability in communities with more shared context, or at least a comparable degree of lexical variability to communities with less shared context.

In addition to the degree of lexical variability, the model generates predictions about how iconicity is retained in the early stages of language evolution. In populations with a high degree of shared context (i.e., a smaller number of groups), a higher degree of iconicity is exhibited. These populations largely retain the iconicity present in language emergence because agents initially have similar forms (in the model, there was a high degree of initial overlap between forms and culturally salient features), and hence they can typically use the conventional pathway, but if their forms do not match, they can often rely on the iconic–inferential pathway. As agents rarely need to update their forms, a high degree of iconicity is retained. For populations with more diverse backgrounds (i.e., a larger number of groups), the degree of iconicity in the population decreased compared to more homogenous populations. We are unaware of studies comparing iconicity levels across signing communities with different social structures, but the model generates a prediction which could be empirically tested. It should be noted that in real life, the dynamics of the language game with respect to the two pathways are likely different, as the conventional link has priority over the iconic–inferential pathway in the model. In real life, rather, we assume there is more flexibility with regards to which route is used. We do not expect that the order of the conventional link and the iconic–inferential pathway in the language game has a strong effect on the model results, given that both occur before the form updating step, the step which has ramifications on the degree of lexical variation and iconicity.

We have also explored how population size, in addition to the number of groups, affects lexical variation. We find that larger groups exhibit more lexical uniformity than smaller groups, as found by another computational model in which the lexical variant chosen by the sender depends on their familiarity with the receiver, as agents keep track of individual preferences as well as a group-level preference (Thompson et al. 2020). Interestingly, our model finds the same result without storing information about the frequency of interaction between agents. Instead, the group that agents belong to determines the initial similarity between forms and the ability for agents to rely on the iconic–inferential pathway. All in all, our model provides support for the theories proposing that shared context and population size have an effect on lexical variation in situations of language emergence. Further work must be conducted to determine the precise contribution of each.

The current model is simple—the language model is basic, and there are few model parameters. Simple models permit us to formalize and understand the relationships present in complex systems (Smaldino 2017), such as in the emergence of language. In this way, the relationship between shared context and lexical variability can be studied with minimal confounding factors. However, the model presented here inherently lacks much of the complexity present in signing communities, factors which may have an effect on the degree of lexical variability and iconicity. This model admittedly has several shortcomings, which we discuss and either propose as future model extensions or as general limitations of the model.

One of the biggest shortcomings of this model is that agents only store one form per concept. All sign languages exhibit lexical variation, and while the nature of this variation is still being determined, it is clear that individuals sometimes use multiple forms per concept (i.e., productive synonyms) or understand multiple forms per concept (i.e., perceptual synonyms, see Discussion in Mudd et al. 2020). With regards to productive synonyms, chaining forms has been attested in several shared sign languages, such as in ABSL (Meir et al. 2010), SJQCSL (Hou 2016), in the sign language of Amami Island in Japan (Osugi et al. 1999) and in Kata Kolok (Lutzenberger et al. 2021; Mudd et al. 2020). In addition, compounding is a strategy that has been observed in CTSL (Ergin et al. 2021), SJQCSL (Hou 2016), in the sign language of Amami Island in Japan (Osugi et al. 1999), in ABSL (Meir et al. 2010) and in Kenyan Sign Language (Morgan 2015). For chaining variants together and for compounding, it is necessary that the language representation in the model allows for storing several forms per concept. Hence, the model does not account for productive synonyms. On the other hand, for perceptual synonyms, where an individual can learn a form–concept association even though they might not use it (unless retrieved using the iconic–inferential pathway), it is also necessary to store multiple forms per concept. In the model, perceptual synonyms can be accounted for when agents use the iconic–inferential pathway; the agents have not stored an additional form mapping for a concept, but they may be able to retrieve it. However, in real life, it is much more probable that individuals retain multiple forms associated with a concept even though they have a preference for one form. Thus, in order to account for these different types of synonyms, multiple forms would need to be stored per concept. However, doing so would complicate the dynamics of the language component of the model; it would be necessary to assign weights to each form, as well as assigning a weighing factor for taking iconic affordances into account.

In addition, the update rule in interaction models adapting one's variant in an extremely simplistic, perhaps unrealistic manner. In the case of a bit update (if communication at the form and culturally salient features level has not been successful), the receiver always adapts to the sender. There are many reasons why one individual may adapt their linguistic preferences, such as due to a frequency bias or prestige bias (Boyd and Richerson 1988). Here, agents do not keep track of how many times they have heard a certain variant, nor do agents have varying levels of prestige in the community. The agents simply update if communication has failed. Currently, the language update rule in the model is most akin to explicit feedback from the sender to the receiver. Though explicit feedback is one mechanism used in repair, it is not the only avenue by which individuals come to successfully communicate. Research from the repair sequences in cross-signing, where deaf signers with different native languages meet and communicate, offers an insight into the process of language grounding in its initial stages (Byun et al. 2018). In short, signers anticipate difficulties in communicating and typically produce "try markers" to signal this. The individual producing a try marker essentially asks their communicative partner to produce a grounding sequence, such as an affirmation that their production was understood or a request for clarification. This example highlights that negotiation and repair are complex and nuanced. One way in which the model can be extended is to have more variety in who updates and why exactly, following research from communication in contexts of language emergence and cultural evolution.

Related to this, the update rule dictates that the receiver changes one bit to match the corresponding bit of the sender. In a way, this could be akin to moving phonetically closer to the sender's form. However, this is unrealistic in cases where two forms are very different. Take the example of "sofa" and "couch", both forms referring to the same concept. In the event of communicative failure, it would not make much sense for an individual to adapt only part of the word (e.g., "couch" becomes updated to "souch"). Rather, what would make more sense in this situation is for one individual to learn and potentially use the form sofa from now on. For a more accurate model of human communication, the update rule needs to account for different situations (from learning an entirely new lexical variant to adapting one's existing form phonetically). More research into findings from language acquisition, psycholinguistics and sociolinguistics is necessary in order to adapt this element of the model.

Another unrealistic aspect of this model is that in reality between individuals from different cultures there is likely overlap between the culturally salient features corresponding to concepts, something that is not present in the model as all culturally salient features are generated independently for each group. Returning to the example of *pig*, two individuals from different cultural contexts (e.g., one from a farming community and another from an urban area) are both likely to have salient features comprised of the shape of the pig, the appearance of the animal's face with ears and a snout, the fact that it is an animal, as well as culturally specific points. Though there is undoubtedly overlap in salient features across cultures, for some cultures certain aspects may be more salient than for others. In an urban community with less interaction with pigs, the facial features or the fact that it is food might be more salient, while for a farming community, how it is killed could be more salient. Yet another consideration is how easy it is to represent different facets of culturally salient features. It has been shown in different sign languages that certain semantic categories prompt preferences in production, called patterned iconicity (Padden et al. 2013). For example, across languages signers prefer to use personification (where the culturally salient features are mapped onto the signer's body) for animal signs (Hwang et al. 2017). In the model, as all culturally salient features are generated for specific groups, there is no relationship between the culturally salient features across groups. Given that certain aspects of culturally salient features are typically shared cross-culturally and that patterned iconicity exists, a natural extension of the model would be to model culturally salient features as related, with some degree of overlap between the groups. Better yet, the culturally salient features should even be different for each individual, though more similar for those in the same group. One final point about the culturally salient features is that in the model only forms can be updated. However, which features are culturally salient in real life become adapted over time, and thus, in the model, this may be important as well. How exactly to model this remains an open question.

Though there are undoubtedly many more ways in which the model can be updated to more closely resemble signing communities and the interaction occurring within them, one final point to address is interaction in the model. In this version of the model, agents all have an equal probability of interacting. This is not the case in real communities—individuals are more likely to interact with some than others. The dynamics in shared signing communities and Deaf community sign language communities with regards to interaction may differ or may be shaped merely because of the size. As shared sign languages are typically small, insular communities, there is more community-wide interaction. On the other hand, in Deaf community sign language communities, which often span entire countries, individuals would typically interact with those in their same city and/or school. This is reflected in the variation observed in these communities; for example, in BSL, a Deaf community sign language, as individuals are more likely to interact with those in their same region, there is substantial regional variation (Stamp et al. 2014). In terms of adding this element of interaction to the model, it would be possible to have agents prefer to select those nearest to them to interact with. This implementation detail may have consequences for the degree and speed of lexical variability and should thus be the subject of future work.

All in all, this research is a first step in developing a model to formalize how shared context affects the degree of lexical variation in sign language emergence. It is unclear to what extent these results may extend to language emergence in our earliest language-using ancestors, who lived in small, insular communities, or esoteric communities (Wray and Grace 2007) and whose communication was likely multi-modal (Levinson and Holler 2014; Perlman 2017). It has been proposed that iconic signs are at the root of proto-language emergence (Számadó and Szathmáry 2012). In addition to the iconic affordances of the manual modality, there is ample evidence that iconicity is also possible and used in the vocal modality and has been shown in spoken languages (Johansson and Zlatev 2013; for a review, see Perniss et al. 2010). As proposed by Meir et al. (2012), it seems plausible that our earliest language-using ancestors residing in small, insular groups had a highly variable lexicon, which may have become more systematic over time. By considering different parameter settings, this model may also provide insights for investigations into what language might have looked like in early human evolution.

5. Conclusions

In this paper, we have presented a model about how lexical variation is affected by societal structure, with an emphasis on shared context. The model validates theories from situations of sign language emergence which find that smaller, insular communities with high degrees of shared context exhibit high degrees of lexical variation, while larger, dispersed communities with more diverse backgrounds (and hence less shared context) exhibit more lexical uniformity. We have shown that shared context, as well as population size, are probable factors influencing lexical variability. Though several additions to the model would yield a more realistic language representation and hence a more valid model, this simple model provides a first step.

Author Contributions: Conceptualization, K.M., B.d.B. and C.d.V.; methodology, K.M., B.d.B. and C.d.V.; software, K.M.; analysis, K.M.; visualization, K.M.; writing—original draft preparation, K.M.; writing—review and editing, K.M, B.d.B. and C.d.V.; funding acquisition, B.d.B. and C.d.V.; All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by FWO-NWO grant number [NWO 326-70-002; FWO G0B4317] "The emergence of phonology within six generations" awarded to Bart de Boer, Paula Fikkert, and Connie de Vos, and by ERC under the ERC Starting Grant [ELISA—852352] "Emergence of Language in Social Interaction" awarded to Connie de Vos, as well as by the Flemish AI plan.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Model code and instructions on how to run the model and produce the plots can be found at: https://doi.org/10.6084/m9.figshare.15163872.v1.

Acknowledgments: We would like to thank Peter Dekker, Marnix Van Soom and Yannick Jadoul for helpful feedback in the initial stages of model development and to Marnix van Soom, Heikki Rasilo, Andrea and Alex Mudd for feedback on and help with producing the plots.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Parameter Exploration

Appendix A.1. Initial Degree of Iconicity

The fixed parameters during this parameter exploration are: *n_concepts* = 10, *n_bits* = 10, *n_agents* = 10, *n_steps* = 4000. The parameters that are varied are *n_groups* and *initial_degree_of_overlap*.

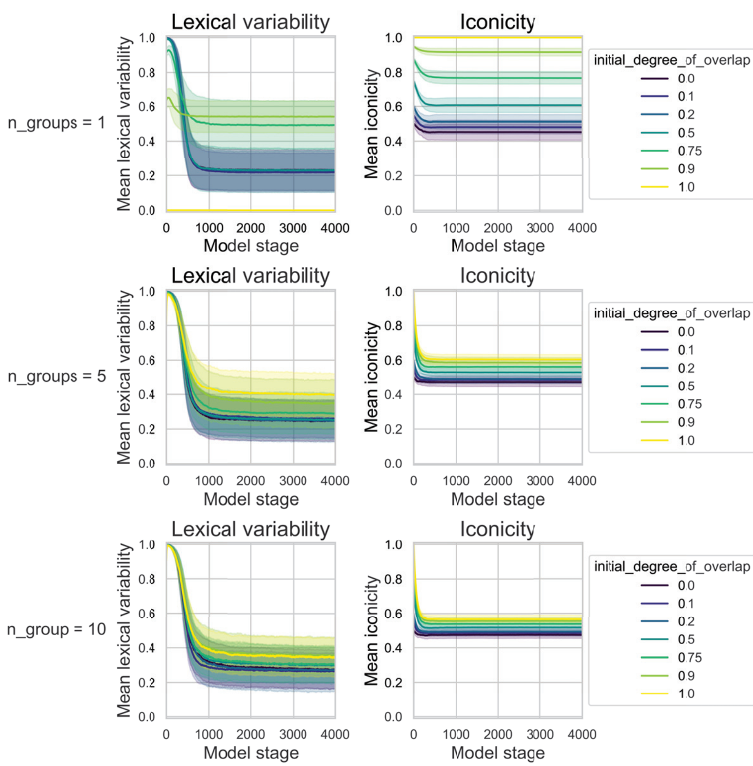


Figure A1. The mean lexical variability over the 2000 model stages for different numbers of groups that agents can be assigned to (*n_groups*): 1, 5 and 10, while varying the degree of overlap between the form and culturally salient features at the start of the run (*initial_degree_of_overlap*). The dark line represents the mean and the shaded area represents the standard deviation of the 100 repetitions. With one exception (*n_groups* = 1 and *initial_degree_of_overlap* = 1), the higher the initial degree of overlap between form and culturally salient features, the lower the mean lexical variability. In addition, the higher the initial overlap between form and culturally salient features, the higher the degree of iconicity.

As shown in Figure A1, when there is only one group where the form and culturally salient features completely overlap, lexical variability is 0 (i.e., all agents have the exact same form for each concept). Except in this case, for all group sizes, smaller overlaps between the form and culturally salient features (*initial_degree_of_iconicity*) result in a lower level of lexical variability. In other words, less lexical similarity initially leads to more uniform productions. With regards to the degree of iconicity, the degree of iconicity is higher in populations with a more initial overlap between form and culturally salient features.

Appendix A.2. The Number of Concepts

The fixed parameters during this parameter exploration are: *n_bits* = 10, *n_agents* = 10, *n_groups* = 5, *initial_degree_of_iconicity* = 0.9, *n_steps* = 2000. The number of concepts is the only parameter that varied.

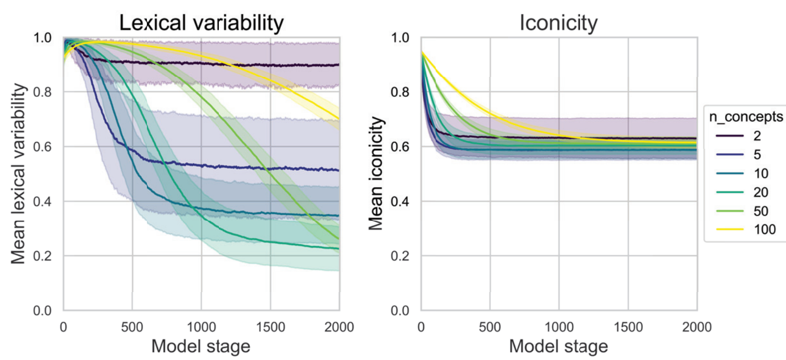


Figure A2. The mean lexical variability over the 2000 model stages for numbers of concepts (*n_concepts*): 1, 5, 10, 20, 50, 100. The dark line represents the mean and the shaded area represents the standard deviation of the 100 repetitions. When there are more concepts, the initial value of lexical variability increases. While the runs with few concepts quickly stabilize at a fairly high degree of lexical variability, the runs with more concepts have a lexical variability value which continues to decrease. The degree of iconicity is comparable across runs with different numbers of concepts, though runs with more concepts retain a higher degree of iconicity longer before stabilizing.

Figure A2 shows the model results of how a different number of concepts affects lexical variation over time. Beginning with runs with a low number of concepts, the lexical variability value quickly stabilizes near the starting lexical variability value. However, in runs with more concepts, the mean lexical variability initially increases before decreasing. The runs with 50 and 100 concepts do not stabilize after 2000 stages. However, it is clear that runs with a larger number of concepts ultimately results in a lower lexical variability value. Why would this be? When there are 2 concepts and 10 bits, because there are only 2 concepts needed to successfully communicate, there is less pressure for the forms to be identical. With few competing concepts, this means that as long as the form from one is different enough from the form of the other, communication will be successful. However, with more concepts, there is more pressure towards uniformity due to the number of competing concepts. In addition, the final degree of iconicity is comparable across runs with different numbers of concepts. However, for runs with more concepts, the degree of iconicity remains higher for longer before reaching a stable point. This is likely because each step of the model only has one language game and hence one chance to update a form. Thus, with more concepts, it takes longer for all forms in the population to update and move away from the initial level of iconicity.

Appendix A.3. The Number of Bits

The fixed parameters during this parameter exploration are: *n_concepts* = 10, *n_agents* = 10, *initial_degree_of_iconicity* = 0.9, *n_steps* = 2000. The parameters that are varied are *n_groups* and *n_bits*.

Figure A3 shows how lexical variability is affected by the number of bits of the forms and culturally salient features. The number of bits affects lexical variability at stage 0, with more bits yielding a higher lexical variability value. Overtime, the more bits there are the more lexical variability is maintained. When there are few bits (*n_bits* = 5), the lexical variability value quickly decreases, before stabilizing above 0. It is probable that these stark differences are the result of using a binary distance measure and the amount of stages that the model was run for: With more bits, more time is needed to make the forms the same. The non-binary distance measure would reveal more similarities across forms. There is, of course, a relationship between the number of bits and the number of concepts in the model; for example, with a large number of bits and few concepts not all bits of a form would need to be identical across the population for the same concept. As long as communication is successful given the pressures imposed by the bits and concepts, there will not be pressure for the population to fully converge on the exact same form for each concept. Thus, for when there are many bits for the form and culturally salient features (when there are few concepts), it would make more sense to have a more nuanced distance measure, taking into account the degree of overlap between forms produced across the population for a given concept.

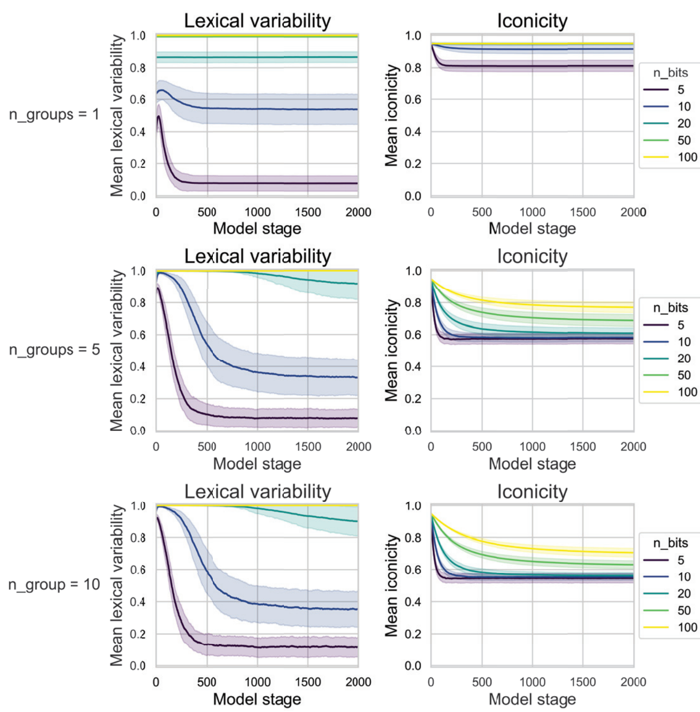


Figure A3. The mean lexical variability over the 2000 model stages for runs with a different number of bits (*n_bits*): 5, 10, 20, 50, 100 and for different numbers of groups that agents can be assigned to (*n_groups*): 1, 5, 10. The dark line represents the mean and the shaded area represents the standard deviation of the 100 repetitions. The lexical variability value is higher when there are more bits. The number of bits also affects the lexical variability value at stage 0. The more bits, the higher the iconicity level.

Finally, with regards to iconicity, the more bits there are, the higher the degree of iconicity. When the language game ends with a bit update, only one bit is updated regardless of the number of bits. Hence, with more bits, it will take longer for the forms to move away from their iconic starting point. In addition, the level of iconicity interacts with the number of groups: With fewer groups, the iconicity remains higher than with more groups. For instance, when all agents belong to the same group, their forms are similar and they are likely to additionally make use of the iconic–inferential pathway. Without the need for bit updating in the case of communicative failure, the level of iconicity in the population remains high.

Notes

1. We refer to cases with only one form per concept as *uniform*, while some researchers use the term *conventionalized*. Here, we use the term conventionalized for cases when form-concept pairings are generally accepted, so this would apply to cases where there are potentially more than one existing form associated with a concept as long as the form is used and understood. For example, Figure 1 shows three variants for *pig* in Kata Kolok which are conventionalized but not uniform.
2. We opted not to assign the opposite bit if the initial event fails (and to instead randomly assign 0 or 1) because assigning the opposite bit (0 for 1 and 1 for 0) would still result in a structured relationship. For example, if the culturally salient features are 1111 and the *initial_degree_of_iconicity* = 0, in the current version of the model, this means that the form is comprised of four random bits (ex. 1001), while if the opposite had been assigned, the form would be 0000, where there is still a structured relationship between the culturally salient features and form.
3. We chose to use a binary distance measure to calculate the lexical variability between agents, as opposed to a continuous distance measure, because lexical variants in the literature about sign languages are often treated categorically. This is true especially in studies of shared sign languages which consider the iconic motivation of signs (e.g., Ergin et al. 2021; Mudd et al. 2020). Unless two forms are identical, in the model, we treat them as different: Two different forms have a lexical variability score of 1, while identical forms have a lexical variability score of 0. However, with larger values of *n_bits*, it may make more sense to use a continuous distance measure for lexical variability. With larger values of *n_bits*, the individual bits may come closer to representing phonetic variation, and hence a continuous distance measure may be more appropriate.

References

Baronchelli, Andrea, Maddalena Felici, Vittorio Loreto, Emanuele Caglioti, and Luc Steels. 2006. Sharp transition towards shared vocabularies in multi-agent systems. *Journal of Statistical Mechanics: Theory and Experiment* 2006: P06014. [CrossRef]

Boyd, Robert, and Peter J. Richerson. 1988. *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

Byun, Kang-Suk, Connie de Vos, Anastasia Bradford, Ulrike Zeshan, and Stephen C. Levinson. 2018. First Encounters: Repair Sequences in Cross-Signing. *Topics in Cognitive Science* 10: 314–34. [CrossRef] [PubMed]

Clark, Eve. 1987. The principle of contrast: A constraint on language acquisition. In *Mechanisms of Language Acquisition*. Edited by Brian MacWhinney. Mahwah: Lawrence Erlbaum Associates.

de Saussure, Ferdinand. 1916. Nature of the linguistic sign. *Course in General Linguistics* 1: 65–70.

de Vos, Connie. 2011. Kata Kolok Color Terms and the Emergence of Lexical Signs in Rural Signing Communities. *The Senses and Society* 6: 68–76. [CrossRef]

de Vos, Connie. 2012. Sign-Spatiality in Kata Kolok: How a Village Sign Language of Bali Inscribes Its Signing Space. Ph.D. dissertation, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands.

Dingemanse, Mark, Damián E. Blasi, Gary Lupyan, Morten H. Christiansen, and Padraic Monaghan. 2015. Arbitrariness, Iconicity, and Systematicity in Language. *Trends in Cognitive Sciences* 19: 603–15. [CrossRef]

Ergin, Rabia, Leyla Kürşat, Ethan Hartzell, and Ray Jackendoff. 2021. Central Taurus Sign Language: On the Edge of Conventionalization. *PsyArXiv*. [CrossRef]

Frishberg, Nancy. 1975. Arbitrariness and Iconicity: Historical Change in American Sign Language. *Language* 51: 696. [CrossRef]

Gasser, Michael. 2004. The Origins of Arbitrariness in Language. Paper presented at the Annual Meeting of the Cognitive Science Society, UC Merced, Chicago, IL, USA, August 4–7; pp. 434–39.

Grimm, Volker, Uta Berger, Donald Lee DeAngelis, Gary Polhill, Jarl Giske, and Steven Floyd Railsback. 2010. The ODD protocol: A review and first update. *Ecological Modelling* 221: 2760–68. [CrossRef]

Grimm, Volker, Uta Berger, Finn Bastiansen, Sigrunn Eliassen, Vincent Ginot, Jarl Giske, John Goss-Custard, Tamara Grand, Simone K. Heinz, Geir Huse, and et al. 2006. A standard protocol for describing individual-based and agent-based models. *Ecological Modelling* 198: 115–26. [CrossRef]

Harnad, Stevan. 1990. The symbol grounding problem. *Physica D* 42: 335–46. [CrossRef]

Hockett, Charles Francis, and Charles D. Hockett. 1960. The Origin of Speech. *Scientific American* 203: 88–97. [CrossRef]

Hou, Lynn Yong-Shi. 2016. "Making Hands": Family Sign Languages in the San Juan Quiahije Community. Ph.D. dissertation, The University of Texas at Austin, Austin, TX, USA.

Hwang, So-One, Nozomi Tomita, Hope Morgan, Rabia Ergin, Deniz Ilkbaşaran, Sharon Seegers, Ryan Lepic, and Carol Padden. 2017. Of the body and the hands: Patterned iconicity for semantic categories. *Language and Cognition* 9: 573–602. [CrossRef]

Johansson, Niklas, and Jordan Zlatev. 2013. Motivations for sound symbolism in spatial deixis: A typological study of 101 languages. *Public Journal of Semiotics* 5: 3–20. [CrossRef]

Kazil, Jackie, David Massad, and Andrew Crooks. 2020. Utilizing Python for Agent-Based Modeling: The Mesa Framework. In *Social, Cultural, and Behavioral Modeling*. Edited by Robert Thomson, Halil Bisgin, Christopher Dancy, Ayaz Hyder and Muhammad Hussain. Cham: Springer International Publishing, pp. 308–17.

LeMaster, Barbara. 2006. Language Contraction, Revitalization, and Irish Women. *Journal of Linguistic Anthropology* 16: 211–28. [CrossRef]

Levinson, Stephen C., and Judith Holler. 2014. The origin of human multi-modal communication. *Philosophical Transactions of the Royal Society B: Biological Sciences* 369: 20130302. [CrossRef]

Lupyan, Gary, and Rick Dale. 2010. Language Structure Is Partly Determined by Social Structure. *PLoS ONE* 5: e8559. [CrossRef]

Lutzenberger, Hannah, Connie de Vos, Onno Crasborn, and Paula Fikkert. 2021. Formal variation in the kata kolok lexicon. *Glossa: A Journal of General Linguistics* 6. [CrossRef]

Marsaja, I. Gede. 2008. *Desa Kolok: A Deaf Village and Its Sign Language in Bali, Indonesia*. Nijmegen: Ishara Press.

McCaskill, Carolyn, Ceil Lucas, Robert Bayley, and Joseph Hill. 2011. *The Hidden Treasure of Black ASL: Its History and Structure*. Washington: Gallaudet University Press.

Meir, Irit, Assaf Israel, Wendy Sandler, Carol A. Padden, and Mark Aronoff. 2012. The influence of community on language structure: Evidence from two young sign languages. *Linguistic Variation* 12: 247–91. [CrossRef]

Meir, Irit, Wendy Sandler, Carol Padden, and Mark Aronoff. 2010. Emerging Sign Languages. In *The Oxford Handbook of Deaf Studies, Language, and Education*. Edited by Marc Marschark and Patricia Elizabeth Spencer. New York: Oxford University Press, vol. 2, pp. 267–80.

Mitchell, Ross E., and Michael Karchmer. 2004. Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the united states. *Sign Language Studies* 4: 138–63. [CrossRef]

Morgan, Hope E. 2015. When Does a Word Emerge? Lexical and Phonological Variation in a Young Sign Language. *San Diego Linguistic Papers* 2–17. Available online: https://escholarship.org/uc/item/0dg6475 (accessed on 23 January 2022).

Mudd, Katie, Hannah Lutzenberger, Connie de Vos, Paula Fikkert, Onno Crasborn, and Bart de Boer. 2020. The effect of sociolinguistic factors on variation in the Kata Kolok lexicon. *Asia-Pacific Language Variation* 6: 53–88. [CrossRef]

Nyst, Victoria. 2012. Shared sign languages. In *Sign Language: An International Handbook*. Berlin: Mouton de Gruyter, pp. 552–74.

Occhino, Corrine, Benjamin Anible, Erin Wilkinson, and Jill P. Morford. 2017. Iconicity is in the eye of the beholder: How language experience affects perceived iconicity. *Gesture* 16: 100–26. [CrossRef]

Ogden, Charles K., and Ivor A. Richards. 1925. *The Meaning of Meaning: A Study of the Influence of Language upon Thought and of the Science of Symbolism*. San Diego: Harcourt, vol. 29.

Osugi, Yutaka, Ted Supalla, and Rebecca Webb. 1999. The use of word elicitation to identify distinctive gestural systems on Amami Island. *Sign Language & Linguistics* 2: 87–112. [CrossRef]

Padden, Carol A., Irit Meir, So-One Hwang, Ryan Lepic, Sharon Seegers, and Tory Sampson. 2013. Patterned iconicity in sign language lexicons. *Gesture* 13: 287–308. [CrossRef]

Perlman, Marcus. 2017. Debunking two myths against vocal origins of language: Language is iconic and multimodal to the core. *Interaction Studies* 18: 376–401. John Benjamins. [CrossRef]

Perniss, Pamela, Robin L. Thompson, and Gabriella Vigliocco. 2010. Iconicity as a General Property of Language: Evidence from Spoken and Signed Languages. *Front. Psychology* 1. [CrossRef]

Pierce, Charles Sanders. 1931. *Collected Papers*. Cambridge: Harvard University Press.

Pleyer, Michael, Stefan Hartmann, James Winters, and Jordan Zlatev. 2017. Interaction and iconicity in the evolution of language: Introduction to the special issue. *Interaction Studies* 18: 303–13. [CrossRef]

Sandler, Wendy, Mark Aronoff, Irit Meir, and Carol Padden. 2011. The gradual emergence of phonological form in a new language. *Natural Language & Linguistic Theory* 29: 503–43.

Smaldino, Paul E. 2017. Models Are Stupid, and We Need More of Them. *Computational Social Psychology* 311–31. [CrossRef]

Stamp, Rose, Adam Schembri, Jordan Fenlon, Ramas Rentelis, Bencie Woll, and Kearsy Cormier. 2014. Lexical Variation and Change in British Sign Language. *PLoS ONE* 9: e94053. [CrossRef]

Steels, Luc, and Frederic Kaplan. 1999. Situated grounded word semantics. Paper prensented at the IJCAI 99, San Mateo, CA, USA, July 2; Burlington: Morgan Kaufmann, p. 4.

Számadó, Szabolcs, and Eörs Szathmáry. 2012. Evolutionary biological foundations of the origin of language: The co-evolution of language and brain. In *The Oxford Handbook of Language Evolution*. Edited by Kathleen R. Gibson and Maggie Tallerman. Oxford: Oxford University Press. [CrossRef]

Thompson, Bill, Limor Raviv, and Simon Kirby. 2020. Complexity can be maintained in small populations: A model of lexical variability in emerging sign languages. Paper prensented at the the 13th International Conference on the Evolution of Language, Brussels, Belgium, April 14–17. [CrossRef]

Tkachman, Oksana, and Carla L. Hudson Kam. 2020. Measuring lexical and structural conventionalization in young sign languages. *Sign Language & Linguistics* 23: 208–32. [CrossRef]
Trudgill, Peter. 2011. *Sociolinguistic Typology: Social Determinants of Linguistic Complexity*. Oxford: OUP Oxford.
Vogt, Paul. 2002. The physical symbol grounding problem. *Cognitive Systems Research* 3: 429–57. [CrossRef]
Vogt, Paul, and Federico Divina. 2007. Social symbol grounding and language evolution. *Interaction Studies* 8: 31–37. [CrossRef]
Washabaugh, William. 1986. *Five Fingers for Survival*. Ann Arbor: Karoma.
Wray, Alison, and George W. Grace. 2007. The consequences of talking to strangers: Evolutionary corollaries of socio-cultural influences on linguistic form. *Lingua* 117: 543–78. [CrossRef]

languages

Article

The Vulnerability of Emerging Sign Languages: (E)merging Sign Languages?

Marah Jaraisy [1,*] and Rose Stamp [2]

[1] Department of English Language and Linguistics, University of Birmingham, Birmingham B15 2TT, UK
[2] Department of English Literature & Linguistics, Bar-Ilan University, Ramat Gan 5290002, Israel; rose.stamp@biu.ac.il
* Correspondence: mxj150@student.bham.ac.uk

Abstract: Emerging sign languages offer linguists an opportunity to observe language emergence in real time, far beyond the capabilities of spoken language studies. Sign languages can emerge in different social circumstances—some in larger heterogeneous communities, while others in smaller and more homogeneous communities. Often, examples of the latter, such as Ban Khor Sign Language (in Thailand), Al Sayyid Bedouin Sign Language (in Israel), and Mardin Sign Language (in Turkey), arise in communities with a high incidence of hereditary deafness. Traditionally, these communities were in limited contact with the wider deaf community in the region, and so the local sign language remained relatively uninfluenced by the surrounding signed language(s). Yet, in recent years, changes in education, mobility, and social communication patterns have resulted in increased interaction between sign languages. Rather than undergoing language emergence, these sign languages are now facing a state of "mergence" with the majority sign language used by the wider deaf community. This study focuses on the language contact situation between two sign languages in Kufr Qassem, Israel. In the current situation, third-generation deaf signers in Kufr Qassem are exposed to the local sign language, Kufr Qassem Sign Language (KQSL), and the dominant sign language of the wider Israeli deaf community, Israeli Sign Language (ISL), both of which emerged around 90 years ago. In the current study, we analyzed the signing of twelve deaf sign-bilinguals from Kufr Qassem whilst they engaged in a semi-spontaneous task in three language conditions: (1) with another bilingual signer, (2) with a monolingual KQSL signer, and (3) with a monolingual ISL signer. The results demonstrate that KQSL-ISL sign-bilinguals show a preference for ISL in all conditions, even when paired with a monolingual KQSL signer. We conclude that the degree of language shift in Kufr Qassem is considerable. KQSL may be endangered due to the risk of social and linguistic mergence of the KQSL community with the ISL community in the near future.

Keywords: language shift; mergence; Israeli Sign Language; Kufr Qassem Sign Language; bilinguals; language preference

Citation: Jaraisy, Marah, and Rose Stamp. 2022. The Vulnerability of Emerging Sign Languages: (E)merging Sign Languages?. *Languages* 7: 49. https://doi.org/10.3390/languages7010049

Academic Editors: Mark Aronoff, Wendy Sandler and Carol Padden

Received: 26 October 2021
Accepted: 25 January 2022
Published: 24 February 2022

1. Introduction

Emerging sign languages have received increased attention in the field of linguistics in recent decades (see Snoddon and De Meulder 2020). Studies on emerging sign languages predominantly focus on the "emerging" element of these languages; in other words, how these sign languages offer us a unique opportunity to observe the emergence of languages. However, the vulnerability of these languages within an emerging context is often overlooked. From an outsider's perspective, some of these languages appear to be thriving in a regionally bound community in which deaf and hearing individuals sign. However, the language vitality for many emerging sign languages is not as stable as it may appear. By the time linguists are aware of their presence, they may already be at risk of merging with the national sign language in the region, as has been reported in a few sign languages (Dikyuva 2012; Jaraisy 2021; Nonaka 2004; Stamp and Jaraisy 2021).

In this paper, we focus on the sociolinguistic situation of emerging sign languages and potentially the biggest threat to their vitality: language shift. The threat of language shift occurs when a community gradually increases their use of a particular language at the expense of their own (Karan 2011). For example, Nonaka (2004, 2012) describes the situation of an emerging sign language[1], Ban Khor Sign Language (BKSL), used in the Ban Khor village in northeastern Thailand, and its increased contact with Thai Sign Language (TSL), the national sign language of Thailand. She argues that younger generations of deaf people in Ban Khor are shifting from the use of BKSL towards TSL as their primary language. In her study, she describes the increased use of language contact phenomena such as code-switching and lexical borrowing from TSL as one indication that language shift is taking place. This case of language shift, along with similar cases in other language communities, have been attributed to increased social mobility and the recent establishment of deaf classes in rural areas, which in turn leads to increased contact between smaller local sign languages and larger national sign languages (Nonaka 2012, 2014; Stamp and Jaraisy 2021). Because many emerging sign languages are characterized by smaller communities and a lack of prestigious status and institutional support, the social status of emerging sign languages when in contact with a larger national sign language is reduced to that of a minority language. Therefore, when contact occurs, some emerging sign languages can be considered as endangered as soon as they arise.

In this paper, we look at the language contact situation taking place in Kufr Qassem, Israel, between Kufr Qassem[2] Sign Language (KQSL) and Israeli Sign Language (ISL)—two emerging sign languages with different social characteristics. While both sign languages are of a similar age—less than 100 years old (Kastner et al. 2014)—they emerged into communities with different social situations, as we describe in Section 1. Following this, we provide details about the factors that influence language vitality (Section 2.1), and we give different examples of language shift presented in the sign language literature (Section 2.2). In the current study, we examine language shift by looking at the distribution of ISL and KQSL lexical signs in the sign language repertoires of young bilinguals who reside in Kufr Qassem, Israel. In Section 3, we provide a detailed description of the methods used to elicit a range of productions by experimentally manipulating the interlocutor. We present the results in Section 4, which show a strong preference among KQSL-ISL sign-bilinguals towards the use of ISL, even when they converse with a monolingual KQSL signer. In the Discussion, in Section 5, we suggest that language shift is taking place in Kufr Qassem, and we discuss the considerations one should make when working with emerging sign languages. In Section 6, we consider language endangerment within the broader context of language vitality—looking at the life cycle of sign languages from their emergence to their *mergence*.

2. Background

Emerging sign languages are defined in the literature as "new" sign languages, which emerge when deaf people with no shared means of communication form a community and they have the necessity to communicate using a visual language (Meir et al. 2010). There has been debate in the literature as to what degree we can describe these languages as "new" (Russo and Volterra 2005). When sign languages emerge, users have at their disposal the gestural repertoires of the wider community to build on (Coppola and Senghas 2010; Mesh 2017; Mesh and Hou 2018; Polich 2005; Senghas et al. 2004). In fact, all sign languages, emerging and otherwise, are considered to be young when compared with spoken languages, which often developed from older languages or were in contact with other languages. British Sign Language (BSL), for example, which is one of the oldest recorded sign languages, is estimated to be only 260 years old. Emerging sign languages, however, often include signers from the first generation of the language. This gives linguists the chance to track emergence in "real time" by examining how the language changes from its first generation to the current one. Often, emerging sign languages are contrasted with established ones, which, although young, are more difficult to trace back to their first generations (e.g., BSL). Recently, scholars have problematized the different ways in which researchers classify sign languages (e.g., Hou and de Vos 2021). The term “emerging”, for example, is a rather broad classification, grouping together sign languages in terms of their relative youth (“emerging” vs. “established”) (Fenlon and Wilkinson 2015; Le Guen et al. 2020; Zeshan and de Vos 2012), regardless of their different social circumstances. Other studies classify sign languages based on the community size: “macro” vs. “micro” (Schembri 2010), the geographical location: “urban” or “rural” (de Vos 2011), or their distribution and status: “national” (Woodward 2000). For the purpose of this study, “emerging” does not capture the difference we see between two sign languages of a similar age (such as the two sign languages under investigation in this study: Israeli Sign Language and Kufr Qassem Sign Language). These two languages exist in different social conditions, and it is these social conditions that are important in the discussion of their vulnerability. Therefore, in this study, we use terminology which refers to the social situations of different types of emerging sign languages, those known as “deaf community” and “village” sign languages (Meir et al. 2010). We argue that the vulnerability of each type of emerging sign language is different and cannot be determined by the languages’ “emerging” status alone, but rather based on their relative status and contact with other sign languages. In other words, when two sign languages co-exist geographically, often one is dominant in relation to the other, leading to a situation of language shift.

In this paper, we examine the vulnerability of emerging sign languages which fall into two types: deaf community sign languages and village sign languages. A deaf community sign language emerges when deaf people from different backgrounds come together in a local deaf school, thereby forming a deaf community. For example, in Nicaragua, the educational system for deaf people was oralist, and the language of instruction was Spanish until the 1970s (Polich 2005). Teachers observed deaf children’s use of gestures to communicate with each other, although there was no conventional language at a community level (Polich 2005). In 1977, a new educational program opened in Nicaragua, and a larger number of deaf students enrolled. Signing gradually made its way into the classroom; teachers started using signs and gestures with the students, and students increased their use of sign and gesture with one another, both inside and outside of the classroom. This change created an environment for a sign language to emerge (Polich 2005; Senghas 1995). Nicaraguan Sign Language (NSL) as it is known today is mainly linked to the establishment of the deaf community in a school environment.

Emerging sign languages of the second type, village sign languages, originate under different social conditions and are not linked to the establishment of a school community (Meir et al. 2010). Rather, a sign language arises in a small community into which several deaf children are born. This is more likely to occur in communities with consanguineous marriage in which the gene for congenital deafness is often passed on within the family (Meir et al. 2010). In these communities, because of the high numbers of deaf people, a sign language emerges. Often, hearing relatives sign with varying degree of proficiency. For this reason such languages are also described as “shared sign languages” (Kisch 2008; Nyst 2010). Al-Sayyid Bedouin Sign Language (ABSL), which emerged in a Bedouin community located in the Negev desert in Southern Israel[3], is one example of a village sign language. The community has a much higher incidence of deafness (2.89%) compared to the other communities around the world (e.g., 0.07% in the USA, Marazita et al. 1993), with around 130 deaf people in a population of 4500 (Kisch 2012). It is claimed that ABSL first emerged around 90 years ago when four deaf children were born into the same family. Now, in its fourth generation, ABSL has been studied extensively by researchers of emerging sign languages (Kisch 2008, 2012; Meir et al. 2010; Sandler 2012).

Deaf community sign languages and village sign languages exist in different sociolinguistic situations. The former, deaf community sign languages, are often used by larger communities, with heterogeneous language and social backgrounds and relatively limited shared knowledge, while the latter, village sign languages, are used by smaller, close-knit communities with shared culture and knowledge. For these reasons, studies show that there are observable differences in the linguistic structure of these two types of sign languages, most notably in terms of linguistic convergence (Meir and Sandler 2019). In a study by Meir and Sandler (2019), the authors compared two emerging sign languages in Israel, both of a similar age: one, a deaf community sign language, ISL, and the other a village sign language, ABSL. Specifically, they found that ABSL was characterized by more variability than ISL at all levels of the language, and that some linguistic structures developed earlier in ISL than in ABSL (Meir and Sandler 2019; Sandler 2012). The authors argue that these linguistic differences are attributed to the different social contexts of ISL and ABSL, claiming that there is a stronger pressure towards conventionalization in a deaf community sign language than in a village sign language. Table 1 summarizes some of the key differences between deaf community and village sign languages.

Table 1. Social situation of deaf community and village sign languages (Meir et al. 2010).

	Deaf Community Sign Languages	**Village Sign Languages**
Size of the community	Larger	Smaller
Distribution of deaf people	Dispersed	Close-knit
Shared knowledge	Less shared knowledge	More shared knowledge
Composition of community	Mostly deaf	Deaf and hearing (in many cases)

In another study, which compared ABSL with another village sign language used in Israel, Kufr Qassem Sign Language (KQSL), differences were also found (Stamp and Sandler 2021). The results of the study showed that ABSL was conventionalizing at a faster pace than KQSL. The authors attributed this difference to the distinctive social dynamics of ABSL and KQSL. Although these two sign languages are of a similar age (i.e., 90 years old) and language type (i.e., village sign language), they differ in the proportion of deaf people in relation to the general population. In Kufr Qassem, the proportional population is much smaller than in Al Sayyid, with 120 deaf people in a general population of 23,000 compared to 130 deaf people in a general population of 4500, respectively. This may have an impact on language contact and transmission patterns, known to influence rates of conventionalization (Nonaka 2012; Richie et al. 2014). In summary, the social situation of emerging sign languages is fundamental to their character, more so than their language age, and factors including community size, social structure, and status are key measures of language vitality, to which we turn next.

2.1. Sign Language Endangerment & Ethnolinguistic Vitality

Some scholars argue that all sign languages are endangered (e.g., Schembri 2010), and yet sign language endangerment has been a relatively under-studied topic (Braithwaite 2019) until recently (see Snoddon and De Meulder (2020)). In an attempt to better understand a language's level of endangerment, several assessments of language vitality have been applied to sign languages, including ones by Ethnologue (Eberhard et al. 2021), UNESCO's endangered language survey (Safar and Webster 2014; Webster and Safar 2019), and the Ethnolinguistic Vitality Model (Giles et al. 1977). Ethnologue, which publishes an annual list of living languages, developed an adapted method for assessing the vitality of sign language communities (Bickford et al. 2015; Eberhard et al. 2021). A summary of several sign languages listed within Ethnologue appears in Table 2. Importantly, while most deaf community sign languages are rated as "developing"[4] (e.g., ISL), not all village sign languages reach the same status. In fact, in comparison, KQSL, which was added to Ethnologue in 2020, is classified as "threatened"[5].

Table 2. Ethnolinguistic status of several sign languages.

Language	Language Type	Community Size	Language Status (according to Ethnologue)	Language Status (according to UNESCO)
Kufr Qassem Sign Language (Israel)	Village	120 deaf people (Sarsour 2020)	6b (Threatened)	n/a
Al Sayyid Bedouin Sign language (Israel)	Village	140 deaf people (Sandler et al. 2005)	6a (Vigorous)	3—definitely endangered
Kata Kolok (Bali)	Village	1500 signers (Senghas 2021)	5 (Developing)	3—definitely endangered
Ban Khor Sign Language (Thailand)	Village	400 signers (Nonaka 2012)	6a (Vigorous)	2—severely endangered
Nicaraguan Sign Language (Nicaragua)	Deaf community	3000 signers (Parks 2012)	5 (Developing)	n/a
Israeli Sign Language (Israel)	Deaf community	10,000 signers (Meir et al. 2010)	5 (Developing)	n/a

Another tool for assessing language vitality is UNESCO's endangered languages survey "Language vitality and endangerment". Until recently, this list only included spoken languages, but in 2011, it was adapted for signed languages (Safar and Webster 2014; Webster and Safar 2019). The adapted survey included questions about a variety of factors, including the size of a community in relation to the wider community, language use across age groups, domains of use (e.g., home vs. school), institutional attitudes and policies, community members' attitudes towards the language, etc. The scoring process resulted in a rating from 0 to 5, with zero as "extinct" and five as "safe". Findings on the analysis of an initial 15 sign languages revealed that not a single sign language was rated as "safe" (see scores for relevant sign languages in Table 2). More specifically, it was found that village sign languages were threatened by the dispersal of the language community, changes in marital patterns, and decreasing birth rates of deaf children (Braithwaite 2019; Safar and Webster 2014; Zeshan and Dikyuva 2013). In contrast, deaf community sign languages were threatened by advancements in cochlear implants and the loss of sign language in schools (Johnston 2006). The languages most threatened by extinction were the ones with the smallest community sizes (i.e., 40–100).

Clearly, more work is necessary as the ratings for some sign languages across Ethnologue and UNESCO are unaligned. For example, according to Ethnologue, Kata Kolok (KK) is rated as "developing", a relatively positive rating, but according to UNESCO, it is "definitely endangered". The results show that while both deaf community sign languages and village sign languages are endangered, the reasons for their endangerment may differ.

According to Giles et al.'s (1977) Ethnolinguistic Vitality Model, a language community's vitality is measured on three parameters: demographics (i.e., the community's size), institutional support, and status. In other words, smaller language communities with less widely distributed populations have lower ethnolinguistic vitality than larger communities with more widely distributed populations. Language communities with limited institutional support—whether financial, legal, or educational—are considered to have a lower vitality. Finally, language communities with a lower status, in terms of political, economic, and social status, have a lower vitality. Put in these ethnolinguistic vitality terms, we ask: which factors might affect the vitality of emerging sign languages? We consider each of Giles et al.'s (1977) factors below within the context of these sign language types:

2.1.1. Demographics: Community Size

Community size refers to the number of language users (speakers or signers). When sign languages first emerge, they are likely to arise with small numbers of signers, regardless of the sign language type. However, there are other ways of viewing community size besides numbers of signers. Community size can be described in relative terms—e.g., percentage of deaf members within the wider community—and when this approach is taken, the community size is much higher in village sign languages compared to deaf community sign languages. Moreover, community size can also be considered in terms of longevity; that is, the transmission of the language. Is the community likely to grow in forthcoming generations? Language transmission is one of the most important factors in preventing the decline of a language (Fishman 1991), and perhaps even more crucial for sign languages which often face an unusual situation of language transmission (McKee and Manning 2015). This unusual situation is manifested in the fact that most deaf children are born to hearing parents (Mitchell and Karchmer 2004), and therefore many deaf people may not encounter sign language until they enter school, at which point they acquire sign language horizontally from their peers (Hoffmeister 2007). Contrary to this, in village sign languages, due to the higher numbers of adult signers, both hearing and deaf, this is less likely to be the case (Zeshan and de Vos 2012). In summation, community size in terms of absolute number of users renders all emerging sign languages as low in ethnolinguistic vitality. However, in terms of the relative proportion of deaf people in the wider community or language transmission patterns, village sign languages can appear to be more resilient than deaf community sign languages.

2.1.2. Institutional Support

Deaf community sign languages emerge as a result of the establishment of educational institutions (Meir et al. 2010), which can be one of the major driving forces in receiving institutional support. For example, in Israel, both ISL and ABSL emerged at similar times, and yet ISL is used in many formal contexts such as education, interpreting programs, and in the media, while ABSL is not. It is worth noting that ISL is not officially or financially supported, as is the case in some other sign languages (e.g., Sign Language of the Netherlands (NGT)); however, ISL is informally recognized as being the national sign language of Israel. The lack of institutional support for ABSL and other village sign languages that emerged in Arab towns and villages in Israel is often politically motivated. That is, in Israel, the Palestinian indigenous minoritized society has a much lower political, social, economic, and linguistic status compared to that of Israeli Jewish majority because of the political situation in the country. These differences in political forces are often reflected in policies and practices implemented by the Israeli government in many domains, including language. Languages used by the Jewish majority, mainly Hebrew, receive more institutional and academic support than languages used by the Palestinian indigenous minorities, mainly Arabic (for more information on the linguistic inequality in Israel, see Amara (2002, 2006), Saban and Amara (2002); Shohamy and Ghazaleh-Mahajneh (2012)). These differences in institutional support can also be seen in village sign languages and their deaf communities.

Institutional support can also be informal, e.g., within industry, religion, culture, etc. In the adaptation of the UNESCO assessment of language vitality, Webster and Safar (2019) point out that the use of a language in public domains (e.g., education, media, etc.) is viewed as a determining factor of strong language vitality compared to the use of a language in private domains (e.g., home), despite the importance of the home in language transmission in village sign language communities. Additionally, they state that the importance of organizations and activities is often overlooked in these assessments. In Kufr Qassem, for example, the deaf club, set up in 1996, has become the cornerstone of the deaf community. There is an important relationship between status and institutional support in that sign languages which receive institutional support are likely to have a higher status, or vice versa, to which we turn next.

2.1.3. Status of the Language

Status may refer to economic, social, sociohistorical, political, or linguistic status. Language status and institutional support are closely related. When one language receives support, this can create an association between one particular language and progress (e.g., the use of ISL and obtaining a job or education). In such cases, other languages in the region may be viewed as outdated and unnecessary by default (May 2012). As described in Section 2.1.2, the difference in political power leads to a situation of linguistic inequality, and lower sociopolitical and economic status (among other types of inequality and discrimination), in which village sign languages are viewed as lower in status than deaf community sign languages (such as ISL).

Linguistic status can be viewed from inside and outside of the community (Giles et al. 1977). In other words, the status of a village sign language may be viewed positively from inside of the community, including the hearing community, but negatively outside of the community by the wider deaf and hearing communities. In village sign language communities, for example, there is usually less stigma around the notion of deafness and the use of sign languages. However, the status of the village sign language from outside of the community might be relatively low. That said, an in-depth investigation to determine the attitudes and ideologies in relation to KQSL is necessary, similar to studies by Safar (2015) and Moriarty Harrelson (2017).

According to Giles et al.'s Ethnolinguistic Vitality Model, emerging sign language communities, mainly village sign language communities, are low in ethnolinguistic vitality. What is more important, though, is the relative ethnolinguistic vitalities of language communities in a contact situation. In cases where a deaf community sign language is in contact with a village sign language, the latter is usually more vulnerable, and its users are likely to shift towards the language with a higher vitality. We discuss this topic below.

2.2. Language Contact and Shift

When two or more languages are in contact, language users in this community often become efficient users of these languages. Continual contact between the languages can result in language contact phenomena such as code-switching and borrowing, or even language shift (Milroy and Muysken 1995; Thomason 2001). Language shift occurs when one language is increasingly used at the expense of the other, leading to a shift in usage (Kulick 1992). Even though this is one of the most common causes of language endangerment in spoken languages (Austin and Sallabank 2013), it is claimed that it may be occurring more rapidly for sign languages (Braithwaite 2019). In particular, when village sign languages are in contact with national sign languages, they are more likely to undergo language shift towards the latter, due to the former's minority status.

Language shift has been reported in several sign language communities which at first had little contact with the wider deaf community. Due to changes in social mobility in recent years, they are now in contact with the national sign language (Groce 1985; Yoel 2009). A famous case is Martha's Vineyard Sign Language (MVSL), a sign language which emerged on Martha's Vineyard Island located off the shores of Connecticut, USA. Nora Groce's (1985) book, entitled "Everyone Here Spoke Sign Language", reports that due to the relatively high incidence of hereditary deafness in the population, a sign language emerged on the island. MVSL was used by both deaf and hearing islanders, which facilitated communication, and thereby minimized some of the limitations typically faced by deaf people. MVSL use gradually declined due to a number of reasons, including changes in marital practices and movement to the mainland for work. In 1817, the first deaf school was opened in Hartford, Connecticut on the mainland, and was attended by many deaf children from Martha's Vineyard. It was claimed that several signing practices, including home signs, MVSL, and French Sign Language (i.e., the teacher's language in the first class), merged to form what we know today as American Sign Language (ASL) (Padden 2010; Romm 2015). In 1952, the last fluent signer of MVSL died, which marked the extinction of MVSL. Similar contact scenarios are evident in the history of other sign languages, such as Maritime Sign Language, which developed due to migration of deaf people from the UK and US to Canada (Yoel 2009).

Another example is the case of Ban Khor Sign Language (BKSL), a village sign language used in Thailand. BKSL emerged around 80–100 years ago (Nonaka 2004, 2012) in a small rice-cultivating population with a relatively high percentage of deaf people (i.e., 1 in 100). The deaf community in Ban Khor was once isolated from the wider deaf community, and therefore uninfluenced by the national sign language, Thai Sign Language (TSL). However, in recent years, deaf people in Ban Khor became increasingly mobile for work and education, leading to an increased contact between BKSL and TSL. Nonaka (2012) also claims that due to the promotion of TSL by educational and governmental institutes, the status of TSL increased within the BKSL community. This has led to a rise in language contact phenomena such as code-switching and lexical borrowing from TSL into BKSL, even within the core vocabulary. Nonaka (2004, 2012) argues that the increase in language contact phenomena serve as evidence of language shift from BKSL to TSL.

Evidence of language shift has also been reported in Israel, the site of the current study. Israel is known for its sign language diversity, hosting both indigenous and migrant sign languages. Algerian–Jewish Sign Language (AJSL), a sign language used by a Jewish community who immigrated from Ghardaia, Algeria to Israel, has been the subject of studies on language survival and extinction. Lanesman and Meir (2012) reported that when the first generation of AJSL signers moved to Israel, they married outside of their community and increasingly interacted with the wider deaf ISL community for work and education. Consequently, the younger generation shifted towards the use of ISL. As a result, Lanesman and Meir (2012) predict that AJSL will inevitably become extinct. In a similar case, Yoel (2007) found evidence of language shift and attrition of Russian Sign Language (RSL) in Israel. In the 1990s, a large wave of Russians immigrated to Israel, resulting in a community of Russian Sign Language (RSL) users of around one thousand. Yoel (2007), who found a decline in the use of RSL, interpreted her results in light of Giles et al.'s (1977) Ethnolinguistic Vitality Model, arguing that the higher ethnolinguistic vitality of ISL (compared to RSL) led to first language (L1) attrition among RSL signers. These results were evident in a number of ways, one of which is an increase in language contact phenomena, such as code-switching from ISL to RSL.

The use of a national sign language in deaf education can also result in a rapid shift from one language to another. Many first-generation deaf signers in Israel did not receive a formal education, and some did not receive any education. This was especially the case in village sign language communities, such as Al-Sayyid and Kufr Qassem. Nowadays, it is common that younger deaf people attend school in both urban and rural parts of Israel. Deaf children in Al-Sayyid and Kufr Qassem have been in contact with other deaf children from outside of their community since the 1980s, and communication mostly takes place in ISL. As a result, younger generations of deaf signers in Al-Sayyid, for example, are now bilingual in ABSL and ISL, and in some cases, even monolingual in ISL (Kisch 2012). Kisch (2012) describes how ABSL and ISL are used in different settings (domains): ABSL is used mostly in informal settings, such as exchanges in shops, conversations, and storytelling; and ISL is used mostly in formal settings for a diverse range of exchanges (e.g., medical, legal, education). Language shift from ABSL to ISL is underway in the ABSL deaf community, but the degree of this shift among younger generations has yet to be investigated.

2.3. The Current Study

In the current study, we explore the degree of language shift taking place in the Kufr Qassem deaf community in Israel, in which the younger generation are now exposed to two sign languages, the local sign language, Kufr Qassem Sign Language (KQSL), and the national sign language of Israel, Israeli Sign Language (ISL). We focus on the signing behaviors of twelve KQSL-ISL sign-bilinguals from Kufr Qassem in order to assess the impact of increased contact between KQSL and ISL. We ask the following research questions: Is there evidence of language shift in the signing behavior among the younger generations of the Kufr Qassem deaf community? If yes, what is the degree of this language shift? What can this tell us about the vulnerability of emerging sign languages (in contact situations)?

To this end, we quantify the language used by our KQSL-ISL bilinguals in three language interaction conditions: with another bilingual, a monolingual ISL signer, and a monolingual KQSL signer, thereby eliciting a wide range of repertoires from these young deaf signers. We predict that signers will accommodate their signing behaviors in accordance with the interlocutor's language background in each condition: i.e., using ISL predominantly in the ISL condition and KQSL predominantly in the KQSL condition.

3. Methods

In this section, we give an overview of the sign language communities under investigation: KQSL and ISL. Following this, we describe the methods in this study including details about participants, stimuli, procedure, and data coding and analysis.

3.1. Communities under Investigation

Israel is home to several smaller sign language communities—in Kufr Qassem, Al-Sayyid, Abu Kaf, Ein Mahel, and Arab Al-Naim among others, all of which emerged in the early 20th century in what is known today as Israel (see Figure 1). Kufr Qassem is a Palestinian–Arab town which has existed for hundreds of years, situated in the Southern Triangle area in Central Israel, around 20 km northeast of Tel-Aviv. As a result of the relatively high incidence of hereditary deafness in Kufr Qassem, a local village sign language, known as Kufr Qassem Sign Language (KQSL), emerged around 90 years ago. It is claimed that this sign language arose when a deaf woman from the Negev area married a hearing man from Kufr Qassem and they had deaf children together (Kafr Qasem Sign Language Dictionary—Sign Language Research Lab 2013). The deafness gene was passed on from one generation to the next and, gradually, the deaf population grew from 12 in the 1960s to 30 in the 1970s. With the increasing deaf population came the necessity for a class for deaf children, which was opened in 1979 in the local school in Kufr Qassem (Kafr Qasem Sign Language Dictionary—Sign Language Research Lab 2013). In 1985, ISL was introduced to the deaf class when a teacher competent in ISL joined the class. Today, of its 23,000 residents (Central Bureau of Statistics: Kfar Qassem 2019), approximately 120 are deaf, spanning four generations (Sarsour 2020). Deaf and hearing people sign with varying degrees of proficiency.

Over the last fifty years, there have been significant changes in the social mobility and educational policies for deaf children across Israel, including in Kufr Qassem. Deaf people from the first generation of KQSL signers, now elderly members of the community, did not attend school and therefore remained relatively uninfluenced from other signed and spoken languages[6]. Some deaf signers of the second generation attended the first deaf class in Kufr Qassem. Others attended the deaf class after 1985 when a teacher competent in ISL joined the class, and therefore they were exposed to ISL within the classroom (Kafr Qasem Sign Language Dictionary—Sign Language Research Lab 2013). Recent studies show that changes are taking place in the signing behavior of the first- and second-generation deaf signers in Kufr Qassem (Jaraisy 2021; Stamp and Jaraisy 2021). While the first- and second-generation of deaf signers are predominantly KQSL monolinguals, their signing behavior shows evidence of language contact phenomena such as code-switching and lexical borrowing from ISL (an average of 15% of the overall lexical signs produced) (Jaraisy 2021; Stamp and Jaraisy 2021). Third and fourth generations of deaf people in Kufr Qassem are exposed to ISL at school and in the wider deaf community, within the medical, sports, legal, and interpreting services, as well as social media. Moreover, younger deaf people are also exposed to other languages, including Arabic (Colloquial Arabic and Modern Standard Arabic), Hebrew, and English. Mostly through international travel and social media (e.g., TV, internet, Twitter), some young signers are exposed to other signed languages used in different countries—such as ASL, BSL, etc. Despite this, signers are exposed to these sign languages intermittently and in some cases without interaction (e.g., television). For this study, we do not examine the effects of exposure to other signed languages, used predominantly outside of Israel, on the signing behavior of the young signers of Kufr Qassem deaf community, although this may be of interest for future studies.

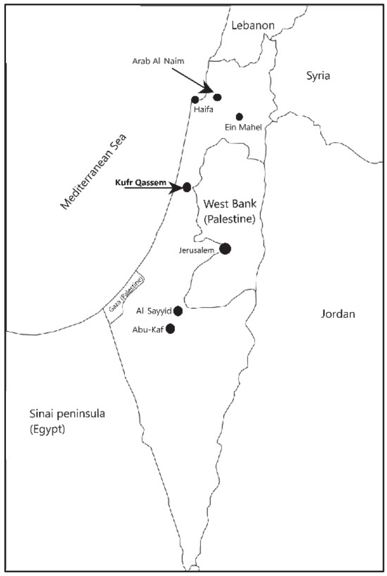


Figure 1. Map of Israel with the locations of several sign language communities.

Today, younger deaf people in Kufr Qassem are multilingual in several sign languages, as well as written and spoken languages. In this study, we explore the effect of language contact between KQSL and ISL on sign language use and preferences among KQSL-ISL deaf sign-bilinguals. While ISL and KQSL are estimated to be of the same age, the sociolinguistic situation of each community is vastly different, as outlined in Section 2. ISL is a deaf community sign language which arose with the formation of the deaf community in Israel in the 1930s. It is often dated to the establishment of the first school for the deaf set up in 1932 in Jerusalem. Previous studies have likened the emergence of ISL to the process of creolization because of the influence of many different signing systems on the lexicon of ISL, including signs from Germany and other European countries, but also from Morocco, Algeria, and Egypt (Aronoff et al. 2008; Sandler 2013). Today, ISL is widely used by around 10,000 signers (Kastner et al. 2014). In contrast, KQSL is an example of a village sign language used by a much smaller population. Despite their shared geography and age, KQSL and ISL are historically unrelated. A lexical comparison study conducted by Kastner et al. (2014) confirmed that KQSL is independent from ISL and also ABSL. Table 3 presents a comparison of the characteristics of ISL and KQSL.

Table 3. Comparison of ISL and KQSL characteristics.

Israeli Sign Language (ISL)	Kufr Qassem Sign Language (KQSL)
Larger heterogeneous population (Meir et al. 2010) Used by ~10,000 signers (Kastner et al. 2014) Used widely within media, education and interpreting General population (Israel): Roughly 9 million (Population of Israel on the Eve of 2020 2019)	Smaller homogeneous population (Meir et al. 2012) Deaf population: 120 (Sarsour 2020) Used only in informal contexts: the local community General population (Kufr Qassem): roughly 23,000 (Central Bureau of Statistics: Kfar Qassem 2019)

3.2. Participants

Twelve deaf bilingual signers (5 female: 7 male) were recruited for this study, ranging in age from 22 to 46 years (average age: 29 years). All participants are self-reported KQSL-ISL sign-bilinguals, and this was further corroborated by our deaf contact person from the community who is also a KQSL-ISL sign-bilingual. Participants completed a questionnaire about their family background, language preferences and use, and educational experience. They all grew up in Kufr Qassem, exposed to KQSL in the community and/or through family and friends. Most participants graduated from different mainstream high schools where the language of instruction was predominantly ISL. Participant 01 received formal education in the first deaf class before ISL was introduced, and she reported that she acquired ISL later in life through friends and social interaction with the wider deaf community. Some were taught in designated deaf classes in mainstream schools, while others had access to an ISL interpreter in the classroom. Participant characteristics are summarized in Table 4.

Table 4. Participant characteristics.

Participant	Age	Gender	Language of Instruction
01	46	F	KQSL
02	32	F	ISL
03	30	M	ISL
04	26	M	ISL
05	26	M	ISL, signed Hebrew, signed Arabic
06	22	F	ISL
07	37	F	ISL
08	24	M	ISL, written and signed Arabic
09	37	F	ISL
10	24	M	ISL, written and spoken Hebrew, written and spoken Arabic
11	25	M	ISL, written and spoken Hebrew
12	23	M	ISL

In addition to the twelve deaf bilinguals, two sign-monolinguals were recruited to act as consistent conversational partners in the semi-spontaneous task, described in Section 3.3 below. Each of these conversational partners represented a different language condition, one for KQSL and one for ISL. The KQSL sign-monolingual (female, 44 years old) is a second-generation deaf KQSL signer with KQSL as her first language, who attended the deaf class in Kufr Qassem when ISL was yet not used. The ISL sign-monolingual (female, 31 years old) is a deaf ISL signer (ISL as her first language) from a deaf family with no previous knowledge of KQSL. Each of the monolinguals were instructed to use their L1 sign languages and to simply engage in the conversational task with each new participant.

Filming took place in the deaf club in Kufr Qassem. A deaf contact person was responsible for recruiting participants and running the tasks. Participants signed a consent form before taking part in this study. Consent forms and questionnaire were offered in Arabic and in Hebrew, and all instructions were explained to the participants in their preferred language. This study was approved by the Ethics Committee at Bar-Ilan University. All participants were compensated for their time.

3.3. Stimuli

Participants completed three tasks. Only the spot the difference task was analyzed as part of this study. The material in this study—i.e., the cartoon illustrations—were designed and created by the first author as part of her MA studies. The design of these illustrations were based on similar material in previous studies (Baker and Hazan 2011; Stamp 2013). The task was designed specifically to create a semi-spontaneous interaction while controlling for the production of a number of lexical items. These target items are lexical signs that differ between KQSL and ISL, and thereby created a situation of lexical competition. For example, in the left picture shown in Figure 2, a signer can describe the dog sleeping under the table by producing a lexical sign for "dog", which is signed differently in KQSL and ISL. There was a total of 32 items and concepts in the pictures, which are signed differently in ISL compared to KQSL. However, many items were repeated during the task, and all were analyzed. The items were chosen carefully based on a number of resources, including online dictionaries and material, a KQSL dictionary (Kafr Qasem Sign Language Dictionary—Sign Language Research Lab 2013), an ISL dictionary (Israeli Sign Language Dictionary 2015), and an online resource on some lexical differences between ISL and KQSL (Berger 2017); in addition to data from previous studies (Jaraisy 2021; Stamp and Jaraisy 2021), and consultation with deaf L1 signers in the KQSL and ISL communities, respectively.

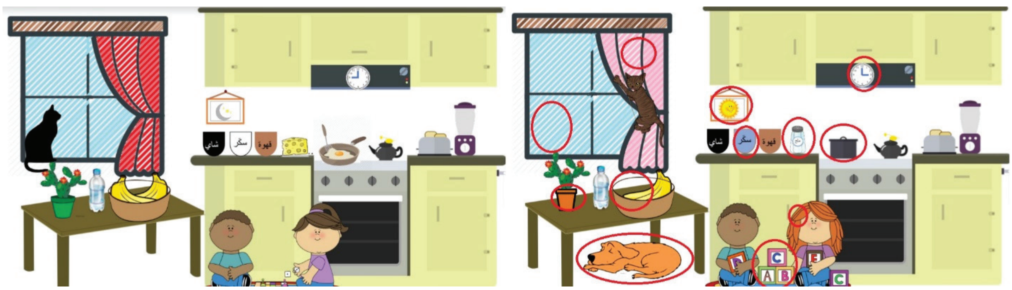


Figure 2. Example of a completed picture scene (kitchen scene); on the right is the picture with twelve differences circled.

3.4. Procedure

Signers performed the task in a dyadic setup, in which they were requested to find a total of twelve minor differences between two versions of an altered cartoon illustration of a scene (see Figure 2 as an example) by conversing with their interlocuter. The pictures were presented on laminated sheets, and each signer could only see their own picture and not the picture of their partner. One signer was given the role of circling the differences. This role was alternated between scenes in the task (i.e., different cartoon illustrations). The task was repeated twice with the same interlocutor, each time using a different cartoon illustration.

Participants completed this task in three conditions: (1) with another KQSL-ISL bilingual signer, (2) with a monolingual KQSL signer, and (3) with a monolingual ISL signer. Therefore, there was a total of six picture scene pairs: (1) kitchen (as in Figure 2), (2) field, (3) street, (4) beach, (5) living room, and (6) riverbank. Participants engaged in other tasks in between conditions, to ensure that the task was not repetitious.

3.5. Data Coding and Analysis

On average, the completion of all three scenes took 15 min, ranging from 8–20 min. Data were coded using ELAN, a video annotation software (Crasborn and Sloetjes 2008). Only the target lexical items, which differ between KQSL and ISL, were coded for this task. Language preference was quantified across individuals and conditions based on the percentage of the lexical signs in each language from the overall produced lexical signs. For example, if the signer produced a total of 80 tokens in their retelling task, of which 63 are KQSL (78.75%), then the preferred language is KQSL.

We carried out multivariate statistical analyses of the data using Rbrul (Johnson 2009). Similar to GoldVarb program developed by Rand and Sankoff (1991), Rbrul can quantitatively evaluate the influence of multiple factors on variation. In addition, Rbrul uses mixed-effects modeling to group individual responses accounting for the effects of individual differences (Baayen et al. 2008; Jaeger 2008).

4. Results

The results are presented here in terms of language preference across with the condition (i.e., participants conversed with another KQSL-ISL bilingual, a KQSL monolingual, and an ISL monolingual). A total of 2754 tokens were included as part of this analysis.

Table 5 shows the individual differences in KQSL use in each condition, and on average (for all three conditions). The use of KQSL lexical signs among bilinguals ranged from 2.8 to 63.6%, with an average of 17.1%. On average, most participants preferred the use of ISL in all conditions, with the exception of one participant—KQSL-ISL bilingual no. 06—who used more KQSL on average (63.6%) than ISL, although less KQSL than ISL in the monolingual ISL condition.

Table 5. Individual variation of KQSL.

Participant	Tokens	% of KQSL (All Conditions)	Condition		
			Bilingual	Mono KQSL	Mono ISL
01	142	37.3%	56%	44%	5%
02	174	31.6%	70%	20%	3%
03	207	7.2%	13%	8%	0%
04	212	9.4%	8%	14%	4%
05	324	17.3%	42%	5%	3%
06	302	63.6%	71%	74%	31%
07	253	5.5%	17%	0%	0%
08	212	7.5%	0%	13%	0%
09	265	11.7%	14%	19%	3%
10	262	7.3%	5%	13%	2%
11	142	2.8%	2%	5%	2%
12	259	4.6%	0%	11%	3%

KQSL lexical sign use varied across participants depending on the condition. In Figure 3, the percentage of KQSL lexical sign use is presented by individual (1–12 on the X axis) and by condition (blue is the bilingual condition, orange is the monolingual KQSL condition, and gray is the monolingual ISL condition). As shown in Figure 3, KQSL was rarely used in the monolingual ISL condition (i.e., all grey bars are low). For the other two conditions, some participants used more KQSL lexical signs in the monolingual KQSL condition than in the bilingual condition, while others showed the reverse pattern. For example, bilingual 01 shows a decline in KQSL lexical sign use as follows: bilingual > monolingual KQSL > monolingual ISL; while bilingual 06 shows a decline in KQSL lexical sign use in a different order: monolingual KQSL > bilingual > monolingual ISL. In some cases, e.g., bilinguals 02 and 10, participants showed a strong increase in KQSL in the monolingual KQSL condition, but overall, showed a preference for ISL. In contrast, several participants did not change their signing across conditions, using ISL predominantly regardless of whom they interacted with (see Table 5).

We conducted a multiple regression analysis to test whether participants' use of KQSL was predictable by condition. Use of KQSL was included as the dependent variable, and condition as the independent variable. Participant was included as a random effect. The results indicated a significant effect of condition on the use of KQSL at a significance level of $p < 0.001$ (1.46×10^{-40}). In the bilingual condition, KQSL lexical signs constituted an average of 24% of the overall lexical sign production, 20.6% in the KQSL monolingual condition, and only 4.8% in the ISL monolingual condition. Table 6 presents the results, including the log odds, number of tokens analyzed, percentage of KQSL lexical signs, and the centered weight (with KQSL lexical signs as the application value). Results with a positive log-odd and a factor weight over 0.5 indicate an increased likelihood that KQSL will be used; while a negative log-odd and a factor weight below 0.5 indicate an increased likelihood that ISL will be used.

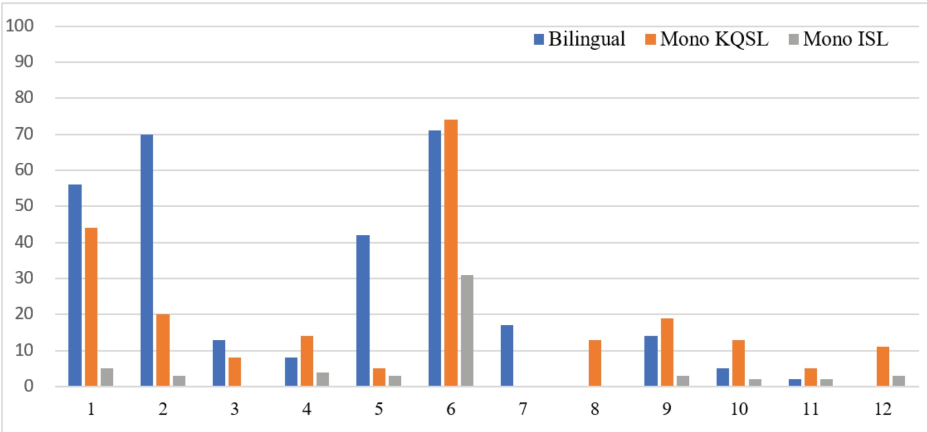


Figure 3. Percentage of KQSL lexical sign use by individual, presented across conditions.

Table 6. Significant Rbrul results (by condition).

Factor Group	Log-Odds	Tokens	% of KQSL	Centered Weight
Condition				
Bilingual	0.966	965	24.2%	0.724
Monolingual KQSL	0.481	1057	20.6%	0.618
Monolingual ISL	−1.447	732	4.8%	0.191

Application value: KQSL signs. Significant at $p < 0.01$. 2754 tokens. Random (participant) standard deviation = 1.225.

5. Discussion

This study explored the language contact situation in the Kufr Qassem deaf community. More specifically, the study focused on the younger deaf people who are now exposed to at least two sign languages: the local sign language: KQSL, and the deaf community sign language: ISL, which is used by the wider deaf Israeli community. We examined the linguistic situation for these deaf sign-bilinguals by considering one of the biggest threats to KQSL's continuity: language shift. To return to the question posed earlier in the paper: Is there evidence of language shift in the signing behavior among the younger generations in the Kufr Qassem deaf community? The answer is yes. What is the degree of this language shift? Language shift can be measured in terms of language preference as well as the existence of language contact phenomena, including code-switching and lexical borrowing. The results of our study focus on language preference in a range of language conditions which elicit a wide use of KQSL and ISL. Previous studies have shown that KQSL monolinguals from the first and second generations are KQSL dominant with an average of 85% of their overall lexical sign use from KQSL (Jaraisy 2021; Stamp and Jaraisy 2021). Therefore, our findings from the third generation provide evidence of an extreme language shift taking place in the Kufr Qassem deaf community, from predominantly using the local village sign language in the first and second generations (Jaraisy 2021; Stamp and Jaraisy 2021), to predominantly using the national sign language, ISL, by the third generation, with an average of 83% across all conditions (i.e., 17% KQSL lexical signs on average).

Increased code-switching and lexical borrowing from one language to the other can also be an indication of language shift (Kisch 2012; Nonaka 2004; Yoel 2007). Previous studies show an increase in code-switching and lexical borrowing among the younger bilinguals in Kufr Qassem. Code-switching from ISL into KQSL was more prevalent in the third-generation signers (27%) than in the first and second generations (15%) (Jaraisy 2021;

Stamp and Jaraisy 2021). For example, the sign for "girl", when repeated in a compound meaning "spouse" in KQSL, was replaced with the ISL sign with the equivalent meaning in 62% of the cases produced by bilinguals, compared to 5% and 26% of the first and second generations, respectively (Stamp and Jaraisy 2021). While code-switching and lexical borrowing are types of lexical replacement and language change, they differ in their permanency status in the recipient language (Haspelmath 2009; Myers-Scotton 1992). Code-switching is a temporary language change, while lexical borrowing is more permanent. Evidence of lexical borrowing was found in the first generation of KQSL signers (Stamp and Jaraisy 2021), suggesting that permanent change as a result of language contact is underway. The data in this current study show similar results, with 83% of the cases of the sign "girl" produced in ISL by bilinguals across all language conditions.

The language shift observed here highlights the vulnerability of KQSL as a minority village sign language in Israel. The social assimilation of the KQSL deaf community into the wider deaf community in Israel, mainly through education, work, and other social interactions, has been increasing since the 1980s, beginning with the first deaf class in Kufr Qassem. This social assimilation is reflected in the linguistic mergence evident in this study. It is worth noting that this linguistic mergence is gradual and domain specific. That is, KQSL is used at home and with hearing and deaf relatives by some bilinguals, while ISL is used in wider domains, such as education and work. In another study, it was found that KQSL and ISL are used in different topics of discussion. When examining the language use by bilingual KQSL-ISL signers during guided conversations, KQSL was used more when discussing "local" topics (e.g., local foods, traditions) than "global" topics (e.g., education, travel) (Haj Dawood, in prep[7]). The reasons for such language shift may vary, but the higher ethnolinguistic vitality of ISL compared to KQSL is a clear factor. Learning ISL has numerous benefits for members of the deaf community in Kufr Qassem, especially younger ones, including access to education, interpreting services, and social interaction with the wider deaf community in Israel. Furthermore, the deaf club in Kufr Qassem, while central to the social interaction of the community and serving as a proud advocate for KQSL, provides ISL classes as part of its social activities. This reflects the fact that ISL receives institutional support, including funding for deaf teachers and interpreters, while KQSL does not (see Sections 2.1.2 and 2.1.3 on motives for this kind of imbalance).

According to Mufwene (2017), one should consider language endangerment within the broader context of language vitality, that is, the entire life cycle of a language from its birth to its death. The term "merging" was used in this study to describe the situation in Kufr Qassem to highlight the threatened status of these sign languages, which might be predictable by some of the characteristics relating to the social situation of emergence (e.g., the relatively small community size), and to the wider general social changes underway, including the increase in social mobility and changes in educational practices. The mergence picture, however, is more complex than presented here. As mentioned in Section 3.1, the participants in this study, as most of the young deaf people in Kufr Qassem, are bimodal multilinguals who make the most of their multilingualism by translanguaging on a daily basis (De Meulder et al. 2019; Kusters et al. 2017). Most younger signers are exposed to Colloquial Arabic, Modern Standard Arabic, Hebrew, and in some cases, English. Changes in education in the Kufr Qassem deaf community not only increased exposure to ISL, but also changed the nature and degree of exposure to Arabic—which is more systematic and extensive now compared to that which was experienced by the older generations (Jaraisy 2021). We suggest that future studies examine the situation in more depth by considering the language situation in terms of multimodality and translanguaging practices (De Meulder et al. 2019; Kusters et al. 2017). Our data show that young signers use multiple languages when signing, in both manual and non-manual features: KQSL, ISL, Arabic mouthing, and Hebrew mouthing[8]. Mouthing patterns and frequency are beyond the scope of this paper; for a detailed account as to the language contact situation between KQSL and Arabic and Hebrew, see Jaraisy (2021) and Jaraisy and Stamp (in prep).

The bigger picture question here might be: Is language shift inevitable for emerging sign languages? Despite the language shift situation for KQSL signers, the answer more generally is no. As discussed in the background, the ethnolinguistic vitality of an emerging sign language community is, in part, dependent on the type of emerging sign language found in a language contact situation. Village sign languages are at a greater risk than deaf community sign languages because of their relative low vitality in terms of their demographics, institutional support and status when in contact with a national majority sign language. Both languages examined in this study, ISL and KQSL, can be classified as emerging but while KQSL is merging towards ISL, ISL is thriving. In other words, the social situation of the sign language community is key. It is for this reason, that we return to the issue we raised at the beginning of the paper with regards to terminology. We emphasize here that it is not necessarily "emerging" sign languages that are vulnerable; it is the social dynamics of the sign language communities involved, and the language contact situation in which they exist. When discussing language shift, the language contact situation in which a sign language exists is important. In other words, the vitality of any sign language is dependent on what it is in contact with. In the past, it was quite possible for one community to remain relatively isolated from another; however, it is difficult to imagine a scenario nowadays without language contact. In fact, many young deaf people are exposed to multiple languages via social media and changing patterns of social interaction (e.g., international deaf events). This, however, is beyond the scope of this paper and we hope that future studies will consider the bigger picture that is taking place, including processes of globalization.

Deaf community sign languages, whilst potentially having their own language endangerment concerns, are less likely to face the threat of sign language shift compared to village sign languages. That said, recent studies show that some deaf community sign languages may be at risk from contact with other sign languages used over a wider global distribution. Recent papers have highlighted the use of ASL (McKee and McKee 2020; Moriarty 2020) and International Sign (Kusters 2020) and their impact on deaf community sign languages in different countries. While village sign languages might be at a greater risk of merging than deaf community sign languages, it is important to consider whether all village sign languages face the same level of risk of discontinuity. To answer our question, language shift does not have to be inevitable for minority village sign languages, even when the ethnolinguistic vitality may predict it. For example, Kusters (2014) claims that Adamorobe Sign Language (AdaSL), a village sign language used in Ghana, continues to thrive, regardless of its contact with Ghanaian Sign Language (GSL). Although deaf children from Adamorobe attend a residential school where they are exposed to GSL, they switch back to AdaSL when they return home (Kusters 2014). Furthermore, people in Adamorobe value AdaSL and sign bilingualism (Kusters 2014). Considering the situation of village sign languages in Israel more specifically, previous studies show that even two village sign languages within Israel may face different social situations, as is the case with ABSL and KQSL (Stamp and Sandler 2021), and that this is an important factor in the rate of language emergence. These same social factors might also determine a language's rate of mergence. Therefore, every language must be examined on an individual basis to truly understand the situation more sensitively than has been achieved so far (Braithwaite 2019; Webster and Safar 2019, 2020). Despite this, there is a sense of inevitability that so long as ISL is thriving and no other signed languages in Israel are given recognition and support, smaller sign languages might soon disappear.

In summary, no two sign languages are alike, and we cannot assess the vulnerability of all emerging sign languages as one group. Languages exist in different countries with different cultural norms, different levels of accessibility, different attitudes and ideologies towards languages and minority rights, and different legal frameworks. As expressed by Webster and Safar (2019), the vitality of a language is not easy to quantify in a numerical score. It is more complex than that; a language might be endangered based on one factor but thriving based on another, and so each language needs to be assessed based on its own complexities. The deaf club in Kufr Qassem shows the presence of a thriving deaf community whose members translanguage, using ISL, KQSL, Arabic, among other languages and signing practices. That said, having assessed the situation in KQSL, if we consider the long-term status of this community in relation to the wider deaf community in Israel, the continuity of KQSL is at risk.

6. Conclusions

This paper has considered the vulnerability of emerging sign languages in terms of their sociolinguistic contexts and how this might impact their endangerment and continuity. We focused on the case of the deaf community in Kufr Qassem in which the younger generation are now exposed to two sign languages: a local village sign language, KQSL, and a national deaf community sign language, ISL. We see that some emerging sign languages, such as KQSL, face the threat of language shift when they socially and linguistically merge with the wider deaf community in Israel. Some of the sociolinguistic characteristics of some emerging sign languages, like village sign languages,—such as smaller community size and lack of institutional support—are the very factors that lead to its vulnerability when in contact with a national sign language. At the same time, this fate is not inevitable for all emerging sign languages. Without language contact, many emerging sign languages may not necessarily be at risk.

The focus on emerging sign languages has typically been on the "emerging" element—based on the fact that young languages may shed light on what the language once looked like and under what conditions they were able to develop and thrive. However, perhaps now is the time to focus on the "sign languages" themselves by documenting them before it is too late—as Nonaka (2004, p. 759) suggests: *"many sign languages are dying out or are on the verge of disappearing without ever being recorded or described—a fact that underscores the urgency of remembering these forgotten endangered languages"*.

The irony is that when linguists learn of an emerging sign language, this might be because it is no longer as isolated as it once was. Thus, when linguists begin conducting studies on these "new" languages it might already be too late. This raises an important question: Should linguists intervene in a situation such as this? Many linguists prefer to document and not to intervene (Flores Farfan and Ramallo 2010) and to leave intervention to the community itself (Braithwaite 2020). There is still much more work to be conducted on emerging sign languages, and the findings from this paper simply emphasize the urgency of this.

Author Contributions: Conceptualization, M.J. and R.S.; methodology, M.J. and R.S.; formal analysis, M.J.; investigation, M.J.; resources, R.S.; data curation, R.S.; writing—original draft preparation, R.S.; writing—review and editing, M.J. and R.S.; visualization, M.J.; supervision, R.S.; funding acquisition, R.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Israeli Science Foundation grant number [2057/20].

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Bar-Ilan University (protocol code 182021 and 08.11.2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical and privacy reasons.

Acknowledgments: We wish to thank Rawan Sarsour and Tayyeb Badawi for their help with recruitment and running the tasks, in addition to their feedback on certain issues in the data. We also would like to thank Wehda Sarsour, the founder and current manager of the deaf club in Kufr Qassem who was very generous and opened the doors of the deaf club for us during the data collection process. We are grateful to Dalal Sarsour and Ora Ohanin who acted as language consultants from the KQSL and the ISL community, respectively. We thank Roni Beit-Hallahmi who helped, as a fluent ISL signer, to provide different variations of ISL signs as well as information about language use in the general Israeli deaf community. Lastly, we wish to thank the deaf community in Kufr Qassem and the participants without whom this study would have never been possible.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

1 Nonaka (2004) refers to Ban Khor Sign Language as a young indigenous sign language. However, in this paper we use the term "emerging" to focus on the language age.

2 Kufr Qassem is often represented in the literature and in official documents with different orthographies, including Kfar Qassem, Kafr Qassem, Kafr Qasem, Kafr Qassim, Kufr Qassem, etc. In most cases these different spellings represent the pronunciation in different languages (e.g., English, Hebrew, Arabic). In this paper, the orthography follows the Arabic pronunciation to reflect how deaf and hearing people in the community under investigation refer to the name of their hometown (as shown on Ethnologue 2020).

3 When the language first emerged, the region was known as Palestine.

4 According to Ethnologue, a "developing" language is in vigorous use, with standardized literature used by some but not widespread. It has a rating of 5 in the 13-point scale in which 0 is "international" and 10 is "extinct".

5 "Threatened" is rating 6b in the 13-point scale and it is described as a language used for face-to-face communication within all generations, but with reducing numbers of users.

6 "Relatively" uninfluenced here means that they were not formally taught any sign language or spoken language. However, KQSL emerged in an Arabic-speaking community and therefore, contact between KQSL and Arabic is inevitable, though under-researched (for discussion of mouthing, see Jaraisy 2021; Jaraisy and Stamp in prep.).

7 Haj Dawood (in prep) The effects of conversation topic (global vs. local) and conversation interlocutor (monolingual vs. bilingual) on code switching. [MA thesis] Univeristy of Haifa.

8 Mouthing is the silent articulation of spoken words usually produced simultaneously with signs. It is an outcome of cross-modal language contact i.e., contact between a spoken language and a signed one (Johnston et al. 2016).

References

Amara, Muhammad. 2002. The place of Arabic in Israel. *International Journal of the Sociology of Language* 158: 53–68. [CrossRef]

Amara, Muhammad. 2006. The vitality of the Arabic language in Israel from a sociolinguistic perspective. *Adalah's Newsletter* 29: 1–11.

Aronoff, Mark, Irit Meir, Carol Padden, and Wendy Sandler. 2008. The roots of linguistic organization in a new language. In *Holophrasis, Compositionality and Proto Language, Special Issue of Interaction Studies*. Edited by Derek Bickerton and Michael Arbib. Amsterdam: John Benjamins, vol. 9, pp. 133–49.

Austin, Peter Kenneth, and Julia Sallabank. 2013. Endangered languages: An introduction. *Journal of Multilingual and Multicultural Development* 34: 313–16. [CrossRef]

Baayen, Rolf Harald, Doug J. Davidson, and Douglas M. Bates. 2008. Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59: 390–412. [CrossRef]

Baker, Rachel, and Valerie Hazan. 2011. DiapixUK: Task materials for the elicitation of multiple spontaneous speech dialogs. *Behavior Research Methods* 43: 761–70. [CrossRef] [PubMed]

Berger, Noga. 2017. *The Secret of the Hidden Language of the Deaf of Kufr Qassem*. Tel-Aviv: Ha-Makom. Available online: https://www.ha-makom.co.il/article/noga-berger-sign-language-kfar-qasem (accessed on 11 November 2021).

Bickford, J., Albert M. Paul Lewis, and Gary F. Simons. 2015. Rating the vitality of sign languages. *Journal of Multilingual and Multicultural Development* 36: 513–27. [CrossRef]

Braithwaite, Ben. 2019. Sign language endangerment and linguistic diversity. *Language* 95: e161–87. [CrossRef]

Braithwaite, Ben. 2020. Ideologies of linguistic research on small sign languages in the global South: A Caribbean perspective. *Language & Communication* 74: 182–94. [CrossRef]

Central Bureau of Statistics: Kfar Qassem. 2019. Available online: https://www.cbs.gov.il/he/Settlements/Pages/%D7%99%D7%99%D7%A9%D7%95%D7%91%D7%99%D7%9D/%D7%9B%D7%A4%D7%A8%20%D7%A7%D7%90%D7%A1%D7%9D.aspx (accessed on 23 November 2020).

Coppola, Marie, and Ann Senghas. 2010. The Path from Point A to Point B: How Gestures Became Language in Nicaraguan Signing. In *The Evolution Of Language*. Utrecht: World Scientific, pp. 385–86.

Crasborn, Onno, and Han Sloetjes. 2008. Enhanced ELAN functionality for sign language corpora. Paper presented at the 6th International Conference on Language Resources and Evaluation (LREC 2008)/3rd Workshop on the Representation and Processing of Sign Languages: Construction and Exploitation of Sign Language Corpora, Marrakech, Morocco, May 26–June 1; pp. 39–43.

De Meulder, Maartje, Annelies Kusters, Erin Moriarty, and Joseph J. Murray. 2019. Describe, don't prescribe. The practice and politics of translanguaging in the context of deaf signers. *Journal of Multilingual and Multicultural Development* 40: 892–906. [CrossRef]

de Vos, Connie. 2011. Kata Kolok Color Terms and the Emergence of Lexical Signs in Rural Signing Communities. *The Senses and Society* 6: 68–76. [CrossRef]

Dikyuva, Hasan. 2012. Mardin Sign Language: Signing in a "deaf family". *Sign Languages in Village Communities: Anthropological and Linguistic Insights* 4: 395.
Eberhard, David M., Gary F. Simons, and Charles D. Fennig, eds. 2021. *Ethnologue: Languages of the World*, 24th ed. Dallas: SIL International. Available online: http://www.ethnologue.com (accessed on 15 December 2021).
Fenlon, Jordan, and Erin Wilkinson. 2015. Sign languages in the world. In *Sociolinguistics and Deaf Communities*. Edited by Adam C. Schembri and Ceil Lucas. Cambridge: Cambridge University Press, pp. 5–28.
Fishman, Joshua A. 1991. *Reversing Language Shift: Theoretical and Empirical Foundations of Assistance to Threatened Languages. Multilingual Matters*. Clevedon: Multilingual Matters Ltd., vol. 76.
Flores Farfan, José Antonio, and Fernando Ramallo. 2010. Exploring links between documentation, sociolinguistics, and language revitalization. In *New Perspectives on Endangered Languages*. Edited by José Antonio Flores Farfan and Fernando Ramallo. Worcester: John Benjamin, pp. 1–12.
Giles, Howard, Richard Bourhis, and Donald Taylor. 1977. Towards a theory of language in ethnic group relations. In *Language, Ethnicity and Intergroup Relations*. Edited by Howard Giles. London: Academic Press, pp. 307–48.
Groce, Nora Ellen. 1985. *Everyone Here Spoke Sign Language: Hereditary Deafness in Martha's Vineyard*. Cambridge: Harvard University Press.
Haspelmath, Martin. 2009. Lexical borrowing: Concepts and issues. In *Loanwords in the World's Languages: A Comparative Handbook*. Berlin: Walter de Gruyter, pp. 35–54.
Hoffmeister, Robert. 2007. Language and the deaf world: Difference not disability. In *Language, Culture, and Community in Teacher Education*. Edited by Maria Estela Brisk. Mahwah: Lawrence Erlbaum Associates.
Hou, Lina, and Connie de Vos. 2021. Classifications and typologies: Labeling sign languages and signing communities. *Journal of Sociolinguistics*, 1–8. [CrossRef]
Israeli Sign Language Dictionary. 2015. Israeli Sign Language Dictionary. Available online: https://isl.org.il/en/home-page-2/ (accessed on 31 January 2021).
Jaeger, T. Florian. 2008. Categorical Data Analysis: Away from ANOVAs (transformation or not) and towards Logit Mixed Models. *Journal of Memory and Language* 59: 434–46. [CrossRef]
Jaraisy, Marah. 2021. Language Change in Kufr Qassem Deaf Community: Intra- and Inter-Modal Language Contact. Master's thesis, Bar-Ilan University, Ramat Gan, Israel.
Johnson, Daniel Ezra. 2009. Getting off the GoldVarb Standard: Introducing Rbrul for Mixed-Effects Variable Rule Analysis. *Language and Linguistics Compass* 3: 359–83. [CrossRef]
Johnston, Trevor. 2006. W(h)ither the deaf community?: Population, genetics, and the future of Australian sign language. *Sign Language Studies* 6: 137–73. [CrossRef]
Johnston, Trevor, Jane Van Roekel, and Adam Schembri. 2016. On the conventionalization of mouth actions in Australian Sign Language. *Language and Speech* 59: 3–42. [CrossRef] [PubMed]
Kafr Qasem Sign Language Dictionary—Sign Language Research Lab. 2013. Available online: https://signlab.haifa.ac.il/index.php/dictionarytest-2 (accessed on 20 December 2021).
Karan, Mark E. 2011. Understanding and forecasting Ethnolinguistic Vitality. *Journal of Multilingual and Multicultural Development* 32: 137–49. [CrossRef]
Kastner, Itamar, Irit Meir, Wendy Sandler, and Svetlana Dachkovsky. 2014. The emergence of embedded structure: Insights from Kafr Qasem Sign Language. *Frontiers in Psychology* 5: 525. [CrossRef]
Kisch, Shifra. 2008. "Deaf Discourse": The Social Construction of Deafness in a Bedouin Community. *Medical Anthropology* 27: 283–313. [CrossRef]
Kisch, Shifra. 2012. Demarcating generations of signers in the dynamic sociolinguistic landscape of a shared sign language: The case of the Al-Sayyid Bedouin. In *Sign Languages in Village Communities: Anthropological and Linguistic Insights*, 1st ed. Edited by Ulrike Zeshan and Connie de Vos. Berlin: De Gruyter, pp. 87–126. Available online: https://www.jstor.org/stable/pdf/j.ctvbkjwzx.7.pdf (accessed on 10 June 2020).
Kulick, Don. 1992. Anger, gender, language shift and the politics of revelation in a Papua New Guinean village. *Pragmatics* 2: 281–96. [CrossRef]
Kusters, Annelies. 2014. Language ideologies in the shared signing community of Adamorobe. *Language in Society* 43: 139–58. [CrossRef]
Kusters, Annelies. 2020. The tipping point: On the use of signs from American Sign Language in International Sign. *Language & Communication* 75: 51–68. [CrossRef]
Kusters, Annelies, Massimiliano Spotti, Ruth Swanwick, and Elina Tapio. 2017. Beyond languages, beyond modalities: Transforming the study of semiotic repertoires. *International Journal of Multilingualism* 14: 219–32. [CrossRef]
Lanesman, Sara, and Irit Meir. 2012. The survival of Algerian Jewish Sign Language alongside Israeli Sign Language in Israel. In *Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Connie de Vos and Ulrike Zeshan. Berlin: De Gruyter Mouton, pp. 153–80.
Le Guen, Olivier, Marie Coppola, and Josefina Safar. 2020. Introduction: How emerging sign languages in the Americas contributes to the study of linguistics and (emerging) sign languages. In *Emerging Sign Languages of the Americas*. Edited by O. Le Guen, J. Safar and M. Coppola. Berlin: De Gruyter Mouton, pp. 1–32.

Marazita, Mary L., Lynn M. Ploughman, Brenda Rawlings, Elizabeth Remington, Kathleen S. Arnos, and Walter E. Nance. 1993. Genetic epidemiological studies of early-onset deafness in the US school-age population. *American Journal of Medical Genetics* 46: 486–91. [CrossRef] [PubMed]

May, Stephen. 2012. *Language and Minority Rights: Ethnicity, Nationalism and the Politics of Language*. London: Routledge.

McKee, Rachel Locker, and Victoria Manning. 2015. Evaluating Effects of Language Recognition on Language Rights and the Vitality of New Zealand Sign Language. *Sign Language Studies* 15: 473–97. [CrossRef]

McKee, Rachel, and David McKee. 2020. Globalization, hybridity, and vitality in the linguistic ideologies of New Zealand Sign Language users. *Language & Communication* 74: 164–81. [CrossRef]

Meir, Irit, Assaf Israel, Wendy Sandler, Carol A. Padden, and Mark Aronoff. 2012. The influence of community on language structure: Evidence from two young sign languages. *Linguistic Variation* 12: 247–91. [CrossRef]

Meir, Irit, and Wendy Sandler. 2019. Variation and conventionalization in language emergence. In *Language Contact, Continuity and Change in the Genesis of Modern Hebrew*. Edited by Edit Doron, Malke Rappaport, Yael R. Hovav and Moshe Taube. Amsterdam: John Benjamins Publishing Company, pp. 337–63. Available online: https://benjamins.com/catalog/la.256.13mei (accessed on 13 October 2020).

Meir, Irit, Wendy Sandler, Carol Padden, and Mark Aronoff. 2010. Emerging sign languages. In *Oxford Handbook of Deaf Studies, Language, and Education*. Oxford: Oxford University Press, vol. 2.

Mesh, Kate. 2017. Points of Comparison: What Indicating Gestures Tell Us about the Origins of Signs in San Juan Quiahije Chatino Sign Language. Ph.D. thesis, The University of Texas, Austin, TX, USA.

Mesh, Kate, and Lina Hou. 2018. Negation in San Juan Quiahije Chatino Sign Language: The integration and adaptation of conventional gestures. *Gesture* 17: 330–74. [CrossRef]

Milroy, Lesley, and Pieter Muysken. 1995. Introduction: Code-switching and bilingualism research. In *One Speaker, Two Languages: Cross-Disciplinary Perspectives on Code-Switching*. Cambridge: Cambridge University Press, pp. 1–14.

Mitchell, Ross E., and Michael A. Karchmer. 2004. When Parents Are Deaf Versus Hard of Hearing: Patterns of Sign Use and School Placement of Deaf and Hard-of-Hearing Children. *The Journal of Deaf Studies and Deaf Education* 9: 133–52. [CrossRef]

Moriarty Harrelson, Erin. 2017. Deaf people with “no language”: Mobility and flexible accumulation in languaging practices of deaf people in Cambodia. *Applied Linguistics Review* 10: 55–72. [CrossRef]

Moriarty, Erin. 2020. “Sign to me, not the children”: Ideologies of language contamination at a deaf tourist site in Bali. *Language & Communication* 74: 195–203. [CrossRef]

Mufwene, Salikoko. 2017. Language Vitality: The Weak Theoretical Underpinnings of What Can Be an Exciting Research Area. *Language* 93: e202–23. [CrossRef]

Myers-Scotton, Carol. 1992. Comparing codeswitching and borrowing. *Journal of Multilingual and Multicultural Development* 13: 19–39. [CrossRef]

Nonaka, Angela. 2004. The forgotten endangered languages: Lessons on the importance of remembering from Thailand’s Ban Khor Sign Language. *Language in Society* 33: 737–67. [CrossRef]

Nonaka, Angela. 2012. Language ecological change in Ban Khor, Thailand: An ethnographic endangerment. In *Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Edited by Connie de Vos and Ulrike Zeshan. Berlin: De Gruyter Mouton, pp. 277–312. [CrossRef]

Nonaka, Angela. 2014. (Almost) everyone here spoke Ban Khor Sign Languaged Until they started using TSL: Language shift and endangerment of a Thai village sign language. *Language & Communication* 38: 54–72.

Nyst, Victoria. 2010. Sign language in West Africa. In *Sign Languages: A Cambridge Language Survey*. Edited by Diane Brentari. Cambridge: Cambridge University Press, pp. 405–32.

Padden, Carol A. 2010. Sign language geography. In *Deaf around the World: The Impact of Language*. Edited by Gaurav Mathur and Donna Jo Napoli. Oxford: Oxford University Press, pp. 19–37.

Parks, Elizabeth. 2012. The Deaf People of Nicaragua. SIL Electronic Survey Report 2012-004. Available online: https://www.academia.edu/download/60283335/The_Deaf_People_of_Nicaragua20190813-124553-2lv6qk.pdf (accessed on 5 January 2022).

Population of Israel on the Eve of 2020. 2019. Available online: https://www.cbs.gov.il/en/mediarelease/Pages/2019/Population-of-Israel-on-the-Eve-of-2020.aspx (accessed on 14 May 2021).

Polich, Laura. 2005. *The Emergence of the Deaf Community in Nicaraugua: “with Sign Language You Can Learn So Much”*. Washington: Gallaudet University Press.

Rand, David, and David Sankoff. 1991. *GoldVarb 2.1: A Variable Rule Application for Macintosh*. Montréal: Université de Montréal, Centre de Recherches Mathématiques.

Richie, Russell, Charles Yang, and Marie Coppola. 2014. Modeling the Emergence of Lexicons in Homesign Systems. *Topics in Cognitive Science* 6: 183–95. [CrossRef]

Romm, Cari. 2015. The Life and Death of Martha’s Vineyard Sign Language. *The Atlantic*. Available online: https://www.theatlantic.com/health/archive/2015/09/marthas-vineyard-sign-language-asl/407191/ (accessed on 14 October 2020).

Russo, Tommaso, and Virginia Volterra. 2005. Comment on “Children Creating Core Properties of Language: Evidence from an Emerging Sign Language in Nicaragua”. *Science* 309: 56–56. [CrossRef]

Saban, Ilan, and Muhammad Amara. 2002. The Status of Arabic in Israel: Reflections on the Power of Law to Produce Social Change. *Israel Law Review* 36: 5–39. [CrossRef]

Safar, Josefina. 2015. Eine Analyse von Diskursen über Chicán Sign Language (Mexiko). *Das Zeichen* 101: 434–46.
Safar, Josefina, and Jenny Webster. 2014. *Cataloguing Endangered Sign Languages at iSLanDS*. Preston: University of Central Lancashire.
Sandler, Wendy. 2012. Dedicated gestures and the emergence of sign language. *Gesture* 12: 265–307. [CrossRef]
Sandler, Wendy. 2013. Vive la différence: Sign language and spoken language in language evolution. *Language and Cognition* 5: 189–203. [CrossRef]
Sandler, Wendy, Irit Meir, Carol Padden, and Mark Aronoff. 2005. The emergence of grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences* 102: 2661–65. [CrossRef] [PubMed]
Sarsour, Meyad. 2020. *Voices of Sign Langauge Communities: Kufr Qassem Sign Language and Deaf Community*. Deaf Communities: Past, Present and Future. Haifa: Haifa University.
Schembri, Adam. 2010. Documenting sign languages. In *Language Documentation and Description*. Edited by Peter K. Austin. London: SOAS, vol. 7, pp. 105–43.
Senghas, Ann. 1995. Children's Contribution to the Birth of Nicaraguan Sign Language. Ph.D. thesis, MIT, Cambridge, UK.
Senghas, Ann. 2021. Connecting Language Acquisition and Language Evolution. In *Minnesota Symposia on Child Psychology*. Edited by Maria D. Sera and Melissa Koenig. Hoboken: John Wiley & Sons, Ltd., pp. 57–85. [CrossRef]
Senghas, Ann, Sotara Kita, and Asli Özyürek. 2004. Children Creating Core Properties of Language: Evidence from an Emerging Sign Language in Nicaragua. *Science* 305: 1779–82. [CrossRef]
Shohamy, Elana, and Marwan Abu Ghazaleh-Mahajneh. 2012. Linguistic landscape as a tool for interpreting language vitality: Arabic as a 'minority' language in Israel. In *Minority Languages in the Linguistic Landscape*. London: Palgrave Macmillan, pp. 89–106.
Snoddon, Kristin, and Maartje De Meulder. 2020. Introduction: Ideologies in sign language vitality and revitalization. *Language & Communication* 74: 154–63. [CrossRef]
Stamp, Rose. 2013. Sociolinguistic Variation, Language Change and Dialect Contact in the British Sign Language (BSL) Lexicon. Ph.D. dissertation, University College London, London, UK.
Stamp, Rose, and Marah Jaraisy. 2021. Language Contact between Israeli Sign Language and Kufr Qassem Sign Language. *Sign Language Studies* 21: 455–91. [CrossRef]
Stamp, Rose, and Wendy Sandler. 2021. The emergence of referential shift devices in three young sign languages. *Lingua* 257: 103070. [CrossRef]
Thomason, Sarah Grey. 2001. *Language Contact*. Edinburgh: Edinburgh University Press.
Webster, Jennifer, and Josefina Safar. 2019. Scoring sign language vitality: Adapting a spoken language survey to target the endangerment factors affecting sign languages. *Language Documentation & Conservation* 13: 346–83.
Webster, Jenny, and Josefina Safar. 2020. Ideologies behind the scoring of factors to rate sign language vitality. *Language & Communication* 74: 113–29. [CrossRef]
Woodward, James. 2000. Sign languages and sign language families in Thailand and Vietnam. In *The Signs of Language Revisited*. Edited by Karen Emmorey and Harlan Lane. New York: Psychology Press, pp. 23–47.
Yoel, Judith. 2007. Evidence for first-language attrition of Russian Sign Language among immigrants to Israel. In *Sign Languages in Contact*. Edited by David Quinto-Pozos. Washington, DC: Gallaudet University Press, pp. 153–91.
Yoel, Judith. 2009. Canada's Maritime Sign Language. Ph.D. thesis, University of Manitoba, Winnipeg, MB, Canada.
Zeshan, Ulrike, and Connie de Vos. 2012. *Sign Languages in Village Communities: Anthropological and Linguistic Insights*. Berlin: De Gruyter.
Zeshan, Ulrike, and Hasan Dikyuva. 2013. Documentation of endangered sign languages: The case of Mardin Sign Language. In *Keeping Languages Alive: Documentation, Pedagogy and Revitalization*. Edited by Mari Jones and Sarah Ogilvie. Cambridge: Cambridge University Press, pp. 29–41. [CrossRef]

languages

MDPI

Article

Spoken and Sign Language Emergence: A Comparison

John McWhorter

Center for American Studies, Columbia University, New York, NY 10027, USA; jm3156@columbia.edu

Abstract: A comparison of emerging signed languages and creole languages provides evidence that, when language is emerging, it prioritizes marking the novelty of information; is readily recursive; favors the manner of action (aspect) over the time of action (tense); develops inflection readily only in a visual, as opposed to aural, mode; and develops derivational opacity only as the result of drift over long periods of time.

Keywords: creole; pidgin; word order; embedding; aspect; inflection

1. Introduction

While there has been some controversy since the turn of this century as to whether it is definitional to creole languages that they emerge from pidgin varieties, it is empirically documented that certain creoles have done so. Examples include the Bislamic creoles such as Tok Pisin (Mühlhaüsler 1986), the central African creole Sango (Samarin 2000), and Hawaiian Creole English (Roberts 2000). There are also traits in all creole languages beyond these that indicate ancestry either in pidginization or other degrees of the interrupted transmission of language (cf. McWhorter 2018). It is therefore possible to reconstruct structural developments typical of the pathway from pidgin to a full language.

In the tradition of previous studies such as Fischer (1978) and Meier (1984), but utilizing data and perspectives developed since, this study will compare the manifestation of six grammatical features in creoles and signed languages. The features will be six that have been widely addressed in the literature on the pathway from pidgin to creole. The goal will be to establish both parallels and contrasts between these processes in the two types of language, in order to assess which processes may be universal to the language competence and which are conditioned by the difference between the spoken and manual modalities.

The presentation will proceed upon certain assumptions about creole languages, which follow.

(1) Creoles are the product of broken transmission of a significant degree, such that creole genesis constitutes the re-emergence of a language. Creole genesis is not solely a combinatory process of hybridization between languages, within which second-language acquisition plays but a marginal role (cf. Mufwene 2001).

(2) The traditional classification of Pacific varieties such as Tok Pisin as "pidgins" born of a process distinct from the one that yielded the Atlantic "creoles" is artificial. Tok Pisin and its sister languages have now been spoken natively for generations and qualify as *creole* languages having developed in an analogous fashion to languages such as Papiamentu and Haitian Creole. Any apparent genealogical difference between the Pacific and the Atlantic varieties is due only to the fact that for the latter, the genesis process is largely lost to written history.

(3) Creoles constitute a synchronic type of language. This is not in the presence of "creole" features unknown in other languages, but in the combined *absence* of certain features, at least some of which are always present in older languages not born of severely interrupted transmission (cf. McWhorter 1998, 2018).

(General statements about creole traits are based on the author's knowledge, confirmed by consultation with the Atlas of Pidgin and Creole Language Structures Online [ApiCS].)

Citation: McWhorter, John. 2022. Spoken and Sign Language Emergence: A Comparison. *Languages* 7: 184. https://doi.org/10.3390/languages7030184

Academic Editors: Wendy Sandler, Mark Aronoff and Carol Padden

Received: 14 February 2022
Accepted: 17 June 2022
Published: 18 July 2022

2. Word Order

Neither creoles nor signed languages offer direct evidence of one word order being fundamental to language, either diachronically or synchronically. However, signed languages possibly lend more insight on this issue than creoles.

2.1. Word Order in Creoles

It has often been claimed that creolization yields SVO order regardless of the word orders of the source languages, with this suggesting that SVO is language's fundamental word order in, for example, Universal Grammar (cf. Bickerton 1981). An especially interesting piece of evidence for this idea is Berbice Creole Dutch, with SVO order despite its main and possibly only substrate language being the SOV African language Ijo, and even its lexifier language Dutch being partly SOV.

However, in a broader view, creoles' word order is determined considerably by the degree of contact with their source languages after genesis. For example, the Indo-Portuguese creoles have emerged with Portuguese's SVO despite the SOV order of their Indo-Aryan and Dravidian substrate languages. However, Portuguese itself has exerted heavy pressure upon many of them during their lifespans (for example, Korlai Portuguese emerged amidst Catholic religious instruction (Clements 1996)), and notably, the Korlai variety has moved towards SOV as it is increasingly used only among speakers of its substrate Marathi. These creoles have offered little indication of what a "basic" word order would be.

In the same way, Berbice Creole Dutch, for which all but no historical sources survive, may have begun as SOV but moved towards SVO under pressure from English and Guyanese Creole English over time. Similarly, the creolized version of the pidgin Chinook Jargon was SVO despite Chinook itself being VSO, but then its speakers' dominant language was English. It is sparsely discussed that Philippine Creole Spanish is VSO as are its substrate languages; however, these indigenous Philippines languages have always been spoken alongside it.

All other creoles are the product of source languages that are all (or in the case of Hawaiian Creole English, mostly) SVO. There has been properly no case in which an SOV lexifier and an SOV substrate is documented to have yielded an SVO creole. The Berbice Dutch case is closest, but besides it possibly having emerged as SOV, Dutch is SOV in embedded rather than matrix clauses, meaning that the elementary input from it would have been SVO in any case.

2.2. Word Order in Signed Languages

In contrast, signed languages' word order is obviously much less affected by spoken languages in terms of grammar, and they are often SOV in contrast to the spoken languages in their contexts. This includes Italian Sign Language (Fischer 2014), Al-Sayyid Bedouin Sign Language (Sandler et al. 2005), Nicaraguan Sign Language (Flaherty 2014), and the signed language of Providence Island (Washabaugh 1986), where hearing signers used SOV order when in daily contact with the deaf but tended more towards SVO otherwise, this being the order of the English and Spanish spoken on the island.

However, many signed languages have been argued to have SVO as their fundamental order, such as American Sign Language (henceforth ASL). Furthermore, within individual signed languages, the manual modality allows a good deal of heterogeneity in word order, depending, for example, on whether or not the object is human (Meir et al. 2017), or because of the possibility of the simultaneity of expression (e.g., of a verb and its object, or of a non-manual sign extending over the duration of the others), or agreeing verbs favoring SOV order while plain ones favor SVO (e.g., in Flemish Sign Language Vermeerbergen et al. 2007). Because of factors such as these, Bouchard and Dubuisson (1995) question whether signed languages can be analyzed as having a basic word order at all, arguing that the manual modality leaves the sequence of elements less important than in the spoken language.

2.3. Implications for the Language Faculty

However, no analyst has proposed a reason for why the manual modality would especially favor verb-finality itself, as opposed to word order heterogeneity. Given that SOV is such a common basic word order among signed languages (although hardly a universal), signed languages demonstrate, at least, that there are no grounds for an assumption that SVO order is a default setting upon which SOV is a variation (cf. Flaherty et al. 2016 for evidence that silent gesturing favors SOV). This can be taken as lending indirect but useful support to the idea of SOV as human language's diachronically original, and perhaps even synchronically fundamental, word order (cf. Givon 1971; Gell-Mann and Ruhlen 2011).

3. Determiners

3.1. Determiners in Creoles

A classic summary description of determiners in creoles is Bickerton's (1981) claim that these languages instantiate a "bioprogram" that yields overt definite and indefinite determiners for specific meaning and zero marking for non-specific (or "generic") meaning. However, with the broader perspective on creoles possible today, decades later, this formulation is as questionably "universal" as the one stipulating SVO as fundamental.

Bickerton's characterization applies largely to Atlantic English- and French-based creoles, as well as the West African English-based creoles descended from the former such as Krio and Nigerian "Pidgin," and the Indian Ocean French creoles of Mauritius and Seychelles. However, all of the English-based creoles here are descendants of a single original language (Hancock 1987; McWhorter 1995; Baker 1999), such that they cannot be analyzed as all manifesting a trait independently. All of the French-based creoles of the Caribbean are likely descendants of a single original language (McWhorter 2000, pp. 146–94). Thus, all of these creoles could be seen as manifesting the determiner pattern just 2 times rather than in cross-creole fashion over 25 or more times.

Moreover, the English-based creoles are most imprinted substratally by African languages of the Kwa clade in Niger–Congo, which happen to display the determiner pattern Bickerton observed. Arguments that French creole substrates were similar would also be relevant, with the Gbe languages of Kwa specified by Lefebvre (1998) for Haitian and by Jennings (1995) for French Guyanais. Thus, genetic relationships and substrate influence render the prevalence of this determiner pattern less unexpected than it would seem.

Then, beyond these creoles, the bioprogram determiner pattern is barely in evidence at all. Portuguese-based creoles do not have a definite determiner, with the distal demonstrative instead "bleeding" into a role intermediate between demonstrative and determiner as needed. These languages instead have only an indefinite determiner. Tok Pisin and its sisters also have only an indefinite determiner. Creolized Chinook Jargon had only a definite one, although studies are unclear as to whether this was a demonstrative or a true determiner, given that it was derived from an original demonstrative (*ukuk*) and its phonetic erosion to *uk* cannot be taken alone as an indication that it had changed its grammatical status.

The determiner configuration that Bickerton identified is so common among creoles because the Atlantic English ones are the product of lexifier and substrate languages that all happen to have overt definite and indefinite determiners, with the substrate languages tending to zero-mark the generic. However, this combination of source languages did not always produce the Bickerton configuration (viz. the Portuguese creoles of the Gulf of Guinea, with Edo, having definite and indefinite specific determiners, as its primary substrate). The French creoles, apart from being all likely tracing to a single ancestor (McWhorter 2000, pp. 146–94 argues that even the Indian Ocean creoles trace to the same ancestor as the Atlantic French-based creoles), have always existed amidst heavy contact with French, thus making it especially likely that they would all have definite and indefinite determiners.

Beyond these creoles, among those born of different kinds of source languages, the visible tendency is that creolization most readily yields an indefinite determiner. For example, the Atlas of Pidgin and Creole Language Structures Online survey reveals but one language with a definite but not an indefinite determiner, and this is a pidgin rather than a creole (Yimas-Arafundi Pidgin). Indefinite determiners are a form of new information marking, and there is evidence that markings of this emerge in creoles before markings of given information (cf. McWhorter 2009 on new information marking in Saramaccan).

3.2. Determiners in Signed Languages

There has not yet been as much cross-linguistic research on determiners in signed languages as on creoles. However, the work that exists suggests that the situation is rather similar.

ASL, for example, has a definite and indefinite determiner (Bahan et al. 1995; MacLaughlin 1997). However, in ASL and signed languages more generally, determiners do not mark generic (non-specific) referents (De Vriendt and Rasquinet 1989), and even specific referents are not marked as obligatorily as in many spoken languages, since they must incorporate referential information (Neidle and Nash 2012, p. 274).

Just as many creoles have definite determination only via recruitment of the distal demonstrative in especially grammaticalized meaning, the distinction between demonstrative and determiner in signed languages is also often a matter defined by a continuum (ibid. p. 271). There is evidence, on the other hand, that in signed languages as in creoles, indefinite determination is entrenched more quickly. Catalan Sign Language, for example, has a richer array of constructions for indefinite determination than for definite (Barberà 2016).

3.3. Implications for the Language Faculty

A tentative conclusion from creoles and signed languages is that emergent language develops the overt marking of new information before the overt marking of given information. This is consonant with a conception of it being central to language to transmit information, as well as to continuously justify calling upon and sustaining the interlocutor's attention. Also relevant here is Scott-Phillips' argument (Scott-Phillips 2015) that language would have emerged from an ostensive imperative of seeking attention for information transfer, such that pragmatics of this kind are fundamental to human language while syntax and morphology are ontogenetically secondary.

4. Subordinate Clauses

4.1. Subordination in Creoles

The overt marking of subordination is universal in creoles. They differ only in the obligatoriness of the marking (which tends to be modest) and in how wide a range of subordination constructions is marked.

All known creoles have an overt relativizer, either a pronoun or "particle." This element is almost always optional, but nevertheless robustly conventionalized, as in Saramaccan:

(1) Dí mujɛ́ɛ (dí) mi lóbi hánsɛ.
DEF woman REL I love pretty
"The woman (whom) I love is pretty."

In Tok Pisin, the development of such marking from the pidgin to the creole stage has been observed, with one relativizing strategy grammaticalizing a pragmatic usage of *ya* "here":

(2) Meri ya i stap long hul ya em i hangre.
woman REL SM stay in hole REL 3S SM hungry
"The woman who stayed in the hole was hungry." (Sebba 1997, p. 114)

Most creoles also have an overt marker of sentential complementation. This has often been grammaticalized from the verb "talk" or "say," and in many creoles beyond the literal semantics of speech; cf. *táa* (> *táki*) in Saramaccan:

(3) Mi sábi táa i tá wóoko.
I know COMP you IMPF work
"I know that you are working."

Other creoles grammaticalize other words for the function, such as "how" in Santome Creole Portuguese:

(4) Ê na ta sêbê ku(ma) kwa sa pe dê fa.
he NEG PAST know COMP thing be father his NEG
"He didn't know that it was his father." (APiCS)

Only in many of the Atlantic French-based creoles is there no reported marker of sentential complementation, including claims that recruitments of French *que* as *ki* are borrowings rather than integral to the creole (Peleman 1978).

Thus, while pidgins indeed tend to lack overt markers of subordination, creole languages offer, for example, no support to claims that embedding is incidental rather than integral to the language faculty (Sampson 2005; Everett 2005).

This could be treated as evidence of a transfer from the source languages. However, creoles only incorporate a subset of the grammatical features their source languages offer, *even when all of the languages offer the same feature* (McWhorter 2012). For example, creoles can lack definite or indefinite determiners even if their lexifiers and/or substrate had them (cf. above). However, creoles do not eschew the overt marking of subordination in contrast to such marking in source languages. Such marking would appear to be integral to spoken languages' emergence and genesis.

4.2. Subordination in Signed Languages

In signed languages, too, there is evidence that the development of embedding is fundamental to the emergence of language (cf. Liddell 1980).

In the youngest signed languages such as certain village-based ones, embedding is absent in the first generation (cf. Sandler et al. 2011). An especially useful study is Kastner et al. (2014), documenting the emergence of subordination in the young Kafr Qasem Sign Language, which has begun at what could be called a "pidgin" stage but has developed its own type of subordination through prosodic blending of the embedded modifying expression, accompanied by non-manual signals.

In an older sign language like ASL, analysts have documented that along with a raised brow (Liddell 1980), backwards head tilt, and raised upper lip, relativization can be indicated with an overt "complementizer" sign, a postposed manifestation of "that" (ibid. p. 150):

(5) IX FEED DOG BITE CAT THAT THAT
"I fed the dog that bit the cat."

Branchini and Donati (2009) also note a sentence-final relativization particle in Italian Sign Language, and manual signs for relative clauses have also been described in German Sign Language (Leuninger 2005) and Hong Kong Sign Language (Tang and Lau 2012). In older signers of Israeli Sign Language, there was no systematic marking of relative clauses. Nonmanual markers for relative clauses (Nespor and Sandler 1999) only became systematic in the second generation of the emergence of this language, and in the third generation, a manual relative pronoun emerged (Dachkovsky 2020. Both manual and nonmanual markers of relative clauses in ISL are seen in Figure 1.

GIRL EAT-ICE-CREAM rel pron SWING

Figure 1. 'The girl who is eating ice cream is swinging'. The relative clause is marked nonmanually by squint and head movement forward to the end of the clause, and manually by the clause-final relative pronoun pointing sign. There is a prosodic break between the relative clause (GIRL EAT-ICE-CREAM IX) and the rest of the sentence (SWING). (Dachkovsky 2020). Pictures courtesy of the Sign Language Research Lab, University of Haifa.

The overt marking of sentential complementation is documented in many signed languages. Padden (1988) notes that ASL marks sentential complementation with a final pronoun copy that refers to the first, matrix subject in embedded structures (6a), but must refer to the subject of the second clause in coordinate structures, so that (6b) is ungrammatical.

(6) (a) $_1$INDEX DECIDE $_i$INDEX SHOULD $_i$DRIVE$_j$ SEE CHILDREN $_1$INDEX
"I decided he ought to drive over to see his children, I did."
(b) *$_1$HIT$_i$, $_i$INDEX TATTLE MOTHER $_i$INDEX
"I hit him and he told his mother, I did."

Strategies for marking sentential complementation are multifarious in signed languages; however, the ASL construction is in no sense a default. In Israeli Sign Language, a relativizer has developed in a fashion familiar in spoken language: from a locative deictic sign (Dachkovsky 2020). But in Dutch Sign Language, direct speech complements can be marked with the sign for "attract attention" (Dutch *roepen*) (Van Gijn 2004, p. 36):

(7) $_{right}$ASK$_{signer}$ ATTRACT-ATTENTION$_{signer}$ IX$_{addressee}$ WANT COFFEE
"He/she asks me 'Do you want any coffee?'"

In Hong Kong Sign Language, embeddedness reveals itself in otherwise unexplainable ungrammaticalities. Examples can be found in direct argument questions, in which wh-words can be sentence-initial or sentence-final, but when embedded can only be sentence-final (Tang and Lau 2012, p. 353):

(8) FATHER WONDER *(WHO) HELP KENNY WHO
"Father wondered who helped Kenny."

In Hong Kong Sign Language, as in others, sentential complement subordination can also be accompanied by non-manual signs such as shakes of the head, leaning of the body.

4.3. Implications for the Language Faculty

If, as Everett (2005) famously argued, the Amazonian language Pirahã lacks embedding, his proposition that this invalidates the idea of embedding (and thus recursion in general) as a feature of Universal Grammar is not supported by emergent languages of either the spoken or manual modality. Creole languages develop overt markers of subordination quite readily in the transition from pidgin to creole: no creole could be recruited as support for a claim that Universal Grammar lacks recursion. Meanwhile, signed languages also quickly develop markers of both relativization and sentential complementation, with only the youngest sign languages lacking these (just as pidgins do in contrast to creoles).

5. Tense and Aspect Marking

5.1. Tense and Aspect Marking in Creoles

Bickerton (1981) claimed that creoles universally share a three-way contrast between three preposed "particles" marking:

(1) anterior past, marking dynamic verbs as past-before-past and stative ones as simple past;
(2) nonpunctual, both the progressive and the habitual;
(3) irrealis, and that these combine in orders uniform across creoles to lend various aspects and moods (e.g., Sranan's *a ben sa e waka* "He would have been walking" contains the equivalent particles in the same order as in Haitian Creole's expression of the same sentence, *li t'av ap mache*).

Predictably, creoles' marking of tense and aspect has been shown to be less uniform than Bickerton implied. Not all creole past markers are "anterior" ones that express a past-before-past with dynamic verbs (Mauritian Creole French's *ti* dose not, for example). Saramaccan has dedicated habitual markers, one of them well-entrenched in the grammar (*ló* > *lóbi* "love"), rather than expressing the habitual via context with the progressive marker *tá*. Many creoles do not have a single irrealis marker but distinct ones for future and potential (cf. Saramaccan's *gó* vs. *sá*), etc.

However, missed amidst the critiques but worthy of remark is the fact that creoles do share a core of three markers of, roughly, past, progressive, and future. As ordinary as this may seem superficially, the questions are why:

(1) no attested creole marks only aspect and not tense the way Chinese and many Southeast Asian languages do. Only creolized Chinook Jargon lacked tense marking, and there is a question as to how far from the pidgin this variety was.
(2) no attested creole has a future marker but not a past marker as Vietnamese, Ewe, and many languages do not.
(3) no attested creole has simply not developed markers of tense or aspect at all, the way the Papuan language Maybrat has not (Dol 2007).
(4) no creole expresses the habitual specifically with zero marking the way English does.

Instead, even creoles of a non-Indo-European lexical base converge on sharing the same basic trio of markers, including Nubi Creole Arabic.

If creoles actually were not distinguishable as a class, then they would presumably diverge considerably in their choices of tense and aspect markers, just as older languages do.

A riposte could be that creoles were too recently imprinted by their source languages to have morphed grammar-internally to this extent. But if source languages determined which tense and aspect markers each creole had, we would still expect much more variation. Why does there not exist an English-based creole in which the habitual is dedicatedly marked with zero as it is in English, or in which the progressive marker is extended beyond the continuative to the present as it is in English? To extend the analysis to mood, why has no creole emerged with a monomorphemic marker of the conditional as there is in western European languages, except ones highly decreolized towards, for example, English?

Creoles have instead regularly selected from their source languages three features, while omitting to incorporate the many others. Bickerton's characterization of these three elements was too specific, but the heart of his observation was correct.

5.2. Tense and Aspect Marking in Signed Languages

In signed languages, the expression of aspect is universal, but many do not obligatorily express tense overtly (Friedman 1975), instead using adverbials where necessary (such as Israeli Sign Language (Meir and Sandler 2008, p. 89)). Where some signed languages are claimed to express tense, it is on subsets of verbs rather than all of them. ASL has what Aarons et al. (1995) term lexical tense markers, distinguishable from adverbials in occurring inside the VP, while Jacobowitz and Stokoe (1988) identified flexion as marking past and extension as marking future in a subset of ASL verbs. British Sign Language has some verbs that have distinct signs in the present and past (Sutton-Spence and Woll 1999, p. 116).

However, signed languages have richer arrays of ways to mark aspect than tense, often combining manual and non-manual signs (Pfau et al. 2012a, p. 196). For example, Israeli Sign Language, while leaving tense unmarked, has three aspectual markers (Meir and Sandler 2008, p. 91). In addition to the common marking of the continuous and the habitual, for example, with repetitive movements and different path shapes (e.g., Klima and Bellugi 1979; Meir and Sandler 2008), one of Israeli Sign Language's aspectual markers is a perfect marker glossed ALREADY (Meir 1999), somewhat similar to the ASL marker FINISH. Whereas signed languages typically restrict tense marking, if present, to a subset of verbs, Sign Language of the Netherlands has a habitual affix for verbs whose signs cannot by iterated physically (Hoiting and Slobin 2001). Signed languages seem as prone to develop aspectual marking as creoles are to developing a trio of markers of past, progressive, and future. Examples of temporal aspect marking in ASL are shown in Figure 2.

(**a**) (**b**) (**c**) (**d**)

Figure 2. Temporal aspects in American Sign Language (Klima and Bellugi 1979) (**a**) LOOK (citation form), (**b**) LOOK Habitual, (**c**) LOOK Durational, (**d**) LOOK Continuative. (With permission from Urusula Bellugi).

5.3. Implications for the Language Faculty

Signed languages, in particular, suggest that despite the traditional centrality of tense to the analysis and pedagogy of Indo-European languages, aspect is more fundamental to the human language capacity. There is typological support for this as well, in that while there exist languages that mark aspect but not tense (Chinese and many East Asian languages), there seem to be few to none that mark tense but not aspect.

Creole languages regularly mark tense as well as aspect. However, the bias in extant creoles' source languages may play a part here similar to the part it plays in word order and the presence of overt determiners. In any known language emerging from a pidgin-level variety, all or at least most of the source languages have both past and future markers (one exception being that Niger-Congo's Ewe lacks a past marker, but no creole is known to have had this language as its main substrate as opposed to one of many). For example, there is no creole based on languages like Chinese and Vietnamese, which might show us a creole emerging with no marking of tense.

The closest example is varieties of Malay/Indonesian born of second-language acquisition by various peoples of Indonesia and contiguous areas. Some of these have been classified as creoles. Baba Malay, for example, is Malay acquired incompletely and affected by transfer from Hokkien Chinese. Baba Malay has a marker of perfective aspect rather than past tense, and no grammaticalized marker of futurity as a category (Lee forthcoming). However, the incomplete acquisition in Malay/Indonesian cases like these was not as extreme as pidginization, and both the perfective marker and the adverbially marked future are Malay/Indonesian features.

Still, there are suggestions even within creoles of the centrality of aspect. In creolized Chinook Jargon, as well as the pidgin variety, amidst the highly limited amount of grammatical machinery there was an aspect marker but no tense markers. Also, creoles develop new aspectual constructions more readily than new tenses.

In Saramaccan, beyond the past, future, and progressive markers, the ones in this table have emerged as well, via grammaticalization of verbs, as shown in Table 1:

Table 1. Aspect and mood markers in Saramaccan beyond the "big three".

ló wáka	> lóbi "love"	walks (as a habit)
náa wáka	> tá a "stand at"	used to walk
sá wáka	> sábi "know"	can walk
mú wáka	> músu "must"	must walk
wáka **kaa**	> kabá "finish"	done walking
wáka **gó dóu**	> "go through"	keep walking

Of the six, four are aspectual. Saramaccan has not developed a pluperfect, remote future, or narrative-present construction. Aspect would seem to have been felt more urgent to express.

6. Inflection

6.1. Inflection in Signed Languages

An often-noticed contrast between signed languages and creoles is that while creoles have little or no inflectional morphology, signed languages are rich in it (cf. Aronoff et al. 2005).

First, most established signed languages have a class of verbs referred to in much of the literature as agreeing verbs (Padden 1988; Meir 2002; Lillo-Martin and Meier 2011), mostly verbs of transfer (literally and metaphorically) such as *give*, *send*, *take*, *help*, and *tell*, which have affixes indexed to the verb's arguments. Verb agreement in ASL is exemplified in Figure 3. The phenomenon differs in detail from sign language to sign language, but it is present in many established sign languages that have been studied. Meir (2012) documents the emergence of this kind of inflection in Israeli Sign Language, in which such verbs come to be rendered from and to points in space referring to the arguments. Emergent sign languages may not have agreeing verbs at the outset (Padden et al. 2010; Meir and Sandler 2008, p. 87); however, Rathmann and Mathur (2008) demonstrate that once established, this kind of marking becomes more complex over time.

Figure 3. Some examples of verb agreement in ASL. (**a**) I-GIVE-YOU, (**b**) I-GIVE-HIM, (**c**) (I-)GIVE-ALL. With permission from Carol Padden. (Spatial agreement with subjects other than first person, not pictured, also occurs regularly in ASL and other sign languages).

Second, signed languages develop a type of classifiers that manifest "depiction" verbs, of motion and location (cf. Emmorey 2013). That they belong to a discrete set which can occur redundantly with the specific nouns they refer to indicates their status as agreement inflection (Supalla 1996). The motions and locations that attach to these classifiers elaborate the meaning (cf. Meir and Sandler 2008, p. 111 for a useful cataloguing of classifiers in

Israeli Sign Language). Signed languages also indicate aspect inflectionally as shown in Figure 2 above.

6.2. Inflection in Creoles

The pidginization process eliminates all or most inflectional affixation, and it only re-emerges in creoles very slowly. In some, sustained contact with a source language preserves a small amount of inflection, or allows it to be borrowed over time, often reanalyzing its behavior and function. For example, in Mauritian Creole, the French distinction between finite and infinitive verb stems is preserved as short and long forms derived from them, respectively, but reanalyzed; the long form carries what can be analyzed as an affix, with the occurrence of the forms determined by syntax, as shown in Table 2.

Table 2. Short and long verb forms in Mauritian Creole French.

short	long	
briz	brize	break
brije	brije	mix
van	vãde	sell
ɛgzis	ɛgziste	exist
vin	vini	come

Otherwise, inflection in creoles tends to occur in highly proscribed contexts. In Santome Portuguese Creole, *ba* "go" occurs as *be* when followed by an adjunct (*E* ***ba*** *ke* "He went home;" *E* ***be*** *d'ai* "He went from here" (APiCS)). In Saramaccan, with the same verb, "go," the imperfective proclitic *tá* occurs as *nán-*: *Mi tá wáka* "I am walking;" *Mi* ***nán****gó* "I am going."

Saramaccan also has what can be analyzed as an object agreement marker, in the specific context of shared object serial verb constructions. In the sentence below, the low tones of "turtle" are fixed and thus do not participate in the rightward spread of high tone through the sentence. However, the high tone spread "jumps" over this object and alights upon the first syllable of the second verb *kulé*, which in citation form has a high tone only on its second syllable. Thus the tonal spread is a kind of object agreement.

(9)	Mi ó	nák**í** dí	lògòsò k**ú**lé gó a	mí wósu
	1S FUT hit	DEF turtle	run	go LOC my house
	'I will hit the turtle and run to my house.' (Rountree 1972, p. 325)			

6.3. Implications for the Language Faculty

The relative richness of inflection in signed languages makes it clear that it is an over-generalization to stipulate that emergent languages must be low on inflection. However, modality is the reason for the contrast between spoken and signed languages here.

For one, in signed languages inflection can be readily indicated iconically, via hand position or movement, or in the case of shape classifiers, by lexical signs recruited as inflections (Meir et al. 2010). In spoken language, inflection most readily emerges from a long-term process: the grammaticalization of lexical items. Also, as Poizner and Tallal (1987) noted, while visual processing of language is ill-suited to linear processing as rapid as what is possible in spoken language, "Signed languages have the potential for multiple channels for encoding grammatical information: face, head, torso, eyes, and various joints of the two arms can realize morphemically distinct information simultaneously" (cf. also Aronoff et al. 2005; Sandler 2018).

Language processed through the eye, then, develops inflection readily upon emergence; language processed through the ear does not. As such, inflection in emergent spoken languages (i.e., creoles) is unexpected; in signed languages, what would be unexpected is its absence. However, Aronoff et al. (2005) note the relevance of the difference between simultaneous and sequential morphology. The latter, developed via grammaticalization of erstwhile unbound morphemes, is much less common in signed languages, with the reason for this being their youth. In this sense, signed languages parallel creoles, as they so often do. (However, just as creoles are usually not completely devoid of new affixation, Polish Sign Language has developed several grammaticalized affixes marking negation, degrees of time, and "not yet" (Tomaszewski and Eźlakowki 2021a, 2021b).)

7. Derivational Compositionality

McWhorter (1998, 2012) argues that creoles are the world's only languages which combine three features:

(1) morphologically—very little or no inflectional morphology, bound or free
(2) phonologically—very little or no lexical or grammatical tone
(3) semantically—non-compositional derivational combinations.

We might ask the extent to which signed languages, as new languages, conform to this prototype.

As seen above, they do not, in terms of inflectional morphology. Also, obviously, the tonal aspect is irrelevant to signed languages. However, in terms of derivation, signed languages and creoles appear to pattern similarly.

7.1. Derivational Compositionality in Creoles

Derivational processes leave a cline of compositionality in older languages, such as in English, where we can identify four degrees:

1. Predictable: *recount*;
2. Unpredictable, but recoverable: *overlook*, *transmission* (in reference to cars), sometimes termed *institutionalization* (Bauer 1983, p. 38);
3. Analyzable: i.e., as involving morphology, but with the specific meaning of one or more elements now opaque: *understand*, *make up*;
4. Fossilized: *sloth* < *slow* + *th*.

In creole languages, born recently of pidgins, there are always cases of unpredictability in derivation, as no language could exist without them given the realities of culture and the vagaries of labelling. However, not enough time has passed for the emergence of cases of Level 3, where elements of a derived word have lost their synchronic meaning.

While generally overlooked in grammatical descriptions, cases like this are typical of languages that have existed for countless millennia (i.e., most human languages). They occur not only in combinations of roots with derivational prefixes, but in compounding, as in these Mandarin cases (Packard 2000, p. 222), given in Table 3:

Table 3. Analyzable but opaque compounds in Mandarin.

wù-sè	thing-color	search
yā-gēn	pressure-root	completely
zuǒ-yòu	left-right	influence
lì-ba	strength-close	clumsy

Creoles that have co-existed with their lexifiers borrow Level 3 cases from them, as in French creoles (explaining data regarding the prefixes *de-* and *re-* adduced by DeGraff 2005). However, in creoles that have not co-existed with their lexifiers, Level 3 cases are rare to nonexistent. For example, in Saramaccan there are only cases of Level 2—institutionalizations—rather than Level 3 (McWhorter 2013), as shown in Table 4. This is due to Saramaccan's emergence from a pidgin just some centuries ago.

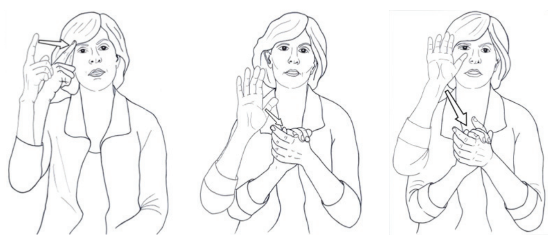
Table 4. Level Two compounding in Saramaccan Creole.

baái máũ	wide hand	slap
babúnú fáka	baboon knife	kind of grass
bɛ wòjo	red eye	threaten
boòkò hèdi	break head	worry

7.2. Derivational Compositionality in Signed Languages

Compositional derivational morphology occurs in signed languages, but is limited (Aronoff et al. 2005; Sandler and Lillo-Martin 2006). However, compounding is very common in signed languages; e.g., compounds were 40% of the lexicon of the signed language of Providence Island in the Caribbean. However, studies suggest that signed language compounds are of the Level 2 type rather than Level 3.

Emergent compounds have predictable meanings, such as ASL's BLUEˆSPOT "bruise," FACEˆNEW "stranger," LOOKˆSTRONG "resemble," REDˆFLOW "blood," and SEEˆMAYBE "check" (Klima and Bellugi 1979; Valli et al. 2011, p. 68; Sutton-Spence and Woll 1999, p. 102). Then, "frozen" compound signs develop, in which the meaning is less predictable, and the phonology differs from that which would express the elements in simple combination (Liddell and Johnson 1986), for example, BELIEVE from THINKˆMARRY in ASL, shown in Figure 4. However, signers often remain aware of the meaning of the elements within these frozen signs (Brennan 1990; Pfau et al. 2012b, pp. 171–72). In emerging signed languages, compounding often occurs productively, if erratically, on the fly.



(**a**) (**b**) (**c**)

Figure 4. ASL compound. The constituents (**a**) THINK and (**b**) MARRY, and the compound (**c**) BELIEVE. Images courtesy of the Sign Language Research Lab, University of Haifa.

This is equivalent to Level 2 compounding in spoken languages. Thus signed languages appear to conform to the Creole Prototype in this regard.

8. Conclusions

The goal of this exploration has not been to merely show that creoles and signed languages have much in common. For one, the case that signed languages are emergent languages would seem unexceptionable. Then, while the case that creoles are products of emergence rather than simply mixture is less universally accepted, the traditional pidgin-to-creole life cycle is empirically documented for some creoles and reconstructed for others with argumentation thus far unaddressed by critics in its details (cf. McWhorter 2018).

Thus, we would expect signed languages and creoles to share many features. The goal in this paper is to examine whether, on the basis of these similarities (as well as the dissimilarities), these two kinds of language can shed light on the nature of emergent human language in general.

The conclusions to draw from the findings here suggest that:

1. There is no reason to suppose that SVO is a "default" word order.
2. Because indefinite markers convey new information, their stronger likelihood of early emergence in both creoles and signed languages can be analyzed as evidence that emergent languages develop the overt marking of new information before that of given information. This hypothesis is reinforced by evidence that creoles develop dedicated markers of new information before markers of given information.
3. Clause embedding develops as a rule in emergent languages, contra hypotheses that embedding is one of the many structures a language might choose from and is especially encouraged by writing conventions. Under this analysis, languages that lack embedding exemplify not the essence of language, but a departure from it.

4. Aspect marking develops before, and then more richly than, tense marking.
5. Inflection develops slowly in spoken languages because of the nature of speech processing but can proliferate quickly even in the emergent speech of the manual modality.
6. While derivational combinations in language are often less than optimally transparent even upon emergence, because of inevitable idiosyncrasies in the connection between label and concept (*overlook* as to neglect rather than to gaze beyond), derivational *opacity* (i.e., *understand*) emerges only over time, via semantic drift (i.e., of the type documented in Israeli Sign Language by Meir and Sandler 2008, pp. 229–31) combined with cultural change.

In sum, when language is emerging, it prioritizes marking the novelty of information (confirming Scott-Phillips 2015); is readily recursive (contra Everett 2005); favors the manner of action (aspect) over the time of action (tense); develops inflection readily only in a visual, as opposed to aural, mode; and develops derivational opacity only as the result of drift over long periods of time.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The author declares no conflict of interest.

References

Aarons, Debra, Benjamin Bahan, Judith Kegl, and Carol Neidle. 1995. Lexical tense markers in American Sign Language. In *Language, Gesture, and Space*. Edited by Karen Emmorey and Judy S. Reilly. New York: Psychology Press.

Aronoff, Mark, Irit Meir, and Wendy Sandler. 2005. The paradox of sign language morphology. *Language* 81: 301–44. [CrossRef] [PubMed]

Bahan, Benjamin, Judy Kegl, Dawn MacLaughlin, and Carol Neidle. 1995. Convergent evidence for the structure of determiner phrases in American Sign Language. In *Proceedings of the Sixth Annual Meeting of the Formal Linguistics Society of Mid-America*. Edited by Leslie Gabriele, Debra Hardison and Robert Westmoreland. Bloomington: Indiana University Linguistics Clubs Publications.

Baker, Philip. 1999. Investigating the origin and diffusion of shared features among the Atlantic English Creoles. In *St. Kitts and the Atlantic Creoles*. Edited by Phillip Baker and Adrienne Bruyn. London: Westminster University Press, pp. 315–64.

Barberà, Gemma. 2016. Indefiniteness and specificity marking in Catalan Sign Language. *Sign Language and Linguistics* 19: 1–36. [CrossRef]

Bauer, Laurie. 1983. *English Word Formation*. Cambridge: Cambridge University Press.

Bickerton, Derek. 1981. *Roots of language*. Ann Arbor: Karoma.

Bouchard, Denis, and Colette Dubuisson. 1995. Grammar, order & position of wh-signs in Quebec Sign Language. *Sign Language Studies* 87: 99–139.

Branchini, Chiara, and Caterina Donati. 2009. Relatively different: Italian Sign Language relative clauses in a typological perspective. In *Correlatives Cross-Linguistically*. Edited by Aniko Liptak. Amsterdam: John Benjamins, pp. 157–91.

Brennan, Mary. 1990. *Word Formation in British Sign Language*. Stockholm: Stockholm University Press.

Clements, Clancy. 1996. *The Genesis of a Language: The Formation and Development of Korlai Portuguese*. Amsterdam: John Benjamins.

Dachkovsky, Svetlana. 2020. From a demonstrative to a relative clause marker. *Sign Languages and Linguistics* 23: 142–70. [CrossRef]

De Vriendt, Sera, and Max Rasquinet. 1989. The expression of genericity in sign language. In *Current Trends in European Sign Language Research: Proceedings of the 3rd European Congress on Sign Language Research*. Edited by Siegmund Prillwitz and Tomas Volhaber. Hamburg: Signum Verlag, pp. 249–55.

DeGraff, Michel. 2005. Morphology and word order in "creolization" and beyond. In *Oxford Handbook of Comparative Syntax*. Edited by Guglielmo Cinque and Richard S. Kayne. Oxford: Oxford University Press, pp. 293–372.

Dol, Philomena. 2007. *A Grammar of Maybrat*. Canberra: Pacific Linguistics.

Emmorey, Karen, ed. 2013. *Perspectives on Classifier Constructions in Sign Languages*. New York: Psychology Press.

Everett, Daniel. 2005. Cultural constraints on grammar and cognition in Pirahã: Another look at the design features of human language. *Current Anthropology* 46: 621–46. [CrossRef]

Fischer, Susan. 1978. Sign language and creoles. In *Understanding Language Through Sign Language Research*. Edited by Patricia Siple. New York: Academic Press, pp. 309–31.

Fischer, Susan. 2014. Constituent order in sign languages. *Gengo Kenkyu* 146: 1–12.

Flaherty, Molly. 2014. The Emergence of Argument Structural Devices in Nicaraguan Sign Language. Ph.D. dissertation, University of Chicago, Chicago, IL, USA.

Flaherty, Molly, Katelyn Stangl, and Susan Goldin-Meadow. 2016. Do lab attested biases predict the structure of a new natural language? In *Proceedings of the Eleventh Evolution of Language Conference*. Edited by Seán Roberts, Christine Cuskley, Luke McCrohon, Lluís Barceló-Coblijn, Olga Fehér and TessaVerhoef. Singapore: World Scientific Publishing Co.

Friedman, Lynn. 1975. Space, time, and person reference in American Sign Language. *Language* 51: 940–61. [CrossRef]

Gell-Mann, Murray, and Merrit Ruhlen. 2011. The origin and evolution of word order. *Proceedings of the National Academy of Sciences* 108: 17290–95. [CrossRef]

Givon, Talmy. 1971. Historical syntax and synchronic morphology: An archeologist's field trip. *Chicago Linguistic Society* 7: 394–415.

Hancock, Ian. 1987. A preliminary classification of the Anglophone Atlantic creoles with syntactic data from thirty-three representative dialects. In *Pidgin and Creole Languages: Essays in Memory of John E. Reinecke*. Edited by Glenn Gilbert. Honolulu: University of Hawaii Press, pp. 310–97.

Hoiting, Nini, and Dan Slobin. 2001. Typological and modality constraints on borrowing: Examples from the Sign Language of the Netherlands. In *Foreign Vocabulary in Sign Languages: A Cross-Linguistic Investigation of Word Formation*. Edited by Diane Brentari. Mahwah: Erlbaum, pp. 121–37.

Jacobowitz, Lynn, and William Stokoe. 1988. Signs of tense in ASL verbs. *Sign Language Studies* 60: 341–40. [CrossRef]

Jennings, William. 1995. Saint-Cristophe: Site of the first French creole. In *From Contact to Creole and Beyond*. Edited by Philip Baker. London: University of Westminster Press, pp. 63–80.

Kastner, Itamar, Irit Meir, Wendy Sandler, and Svetlana Dachkovsky. 2014. The emergence of embedded structure: Insights from Kafr Qasem Sign Language. *Frontiers in Psychology* 5: 1–15. [CrossRef] [PubMed]

Klima, Edward, and Ursula Bellugi. 1979. *The Signs of Language*. Cambridge: Harvard University Press.

Lee, Nala H. forthcoming. *A Grammar of Baba Malay*. Berlin: Mouton de Gruyter.

Lefebvre, Claire. 1998. *Creole Genesis and the Acquisition of Grammar*. Cambridge: Cambridge University Press.

Leuninger, Helen. 2005. *Gebärdensprachen: Struktur, Erwerb, Verwendung (Linguistische Berichte—Sonderhefte)*. Hamburg: Buske.

Liddell, Scott. 1980. *American Sign Language Syntax*. The Hague: Mouton.

Liddell, Scott, and Robert Johnson. 1986. American Sign Language compound formation processes, lexicalization, and phonological remnants. *Natural Language and Linguistic Theory* 4: 445–513. [CrossRef]

Lillo-Martin, Diane, and Richard Meier. 2011. On the linguistic stats of 'agreement' in sign languages. *Theoretical Linguistics* 37: 95–142. [CrossRef] [PubMed]

MacLaughlin, Dawn. 1997. The Structure of Determiner Phrases: Evidence from American Sign Language. Ph.D. dissertation, Boston University, Boston, MA, USA.

McWhorter, John. 1995. Sisters under the skin: A case for genetic relationship between the Atlantic English-Based Creoles. *Journal of Pidgin and Creole Languages* 10: 289–333. [CrossRef]

McWhorter, John. 1998. Identifying the creole prototype: Vindicating a typological class. *Language* 74: 788–818. [CrossRef]

McWhorter, John. 2000. *The Missing Spanish Creoles*. Berkeley: University of California Press.

McWhorter, John. 2009. Oh, Noo! A bewilderingly multifunctional Saramaccan word teaches us how a creole language develops complexity. In *Language Complexity as an Evolving Variable*. Edited by Geoffrey Sampson, David Gil and Peter Trudgill. Oxford: Oxford University Press, pp. 141–63.

McWhorter, John. 2012. Case closed? Testing the feature pool hypothesis. (Guest Column No. 1). *Journal of Pidgin and Creole Languages* 27: 171–82. [CrossRef]

McWhorter, John. 2013. Why noncompositional derivation isn't boring: A second try on the "other" part of the Creole Proptotype Hypothesis. *Journal of Pidgin and Creole Languages* 28: 167–79. [CrossRef]

McWhorter, John. 2018. *The Creole Debate*. Cambridge: Cambridge University Press.

Meier, Richard. 1984. Sign as creole. *Behavioral and Brain Sciences* 7: 201–2. [CrossRef]

Meir, Irit. 1999. Thematic structure and verb agreement in Israeli Sign Language. *Sign Language and Linguistics* 2: 263–70. [CrossRef]

Meir, Irit. 2002. A cross-modality perspective on verb agreement. *Natural Language and Linguistic Theory* 20: 413–50. [CrossRef]

Meir, Irit. 2012. Word classes and word formation. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter, pp. 77–112.

Meir, Irit, and Wendy Sandler. 2008. *A Language in Space*. New York: Psychology Press.

Meir, Irit, Wendy Sandler, Carol Padden, and Mark Aronoff. 2010. Emerging sign languages. In *The Oxford Handbook of Deaf Studies, Language, and Education 2*. Edited by Marc Marschark and Patricia Elizabeth Spencer. Oxford: Oxford University Press.

Meir, Irit, Mark Aronoff, Carl Börstell, So-One Hwang, Deniz Ilkbasaran, Itamar Kastner, Ryan Lepic, Adi Lifshitz Ben-Basat, Carol Padden, and Wendy Sandler. 2017. The effect of being human and the basis of grammatical word order: Insights from novel communication systems and young sign languages. *Cognition* 158: 189–207. [CrossRef] [PubMed]

Mufwene, Salikoko. 2001. *The Ecology of Language Evolution*. Cambridge: Cambridge University Press.

Mühlhaüsler, Peter. 1986. *Pidgin and Creole Linguistics*. Oxford: Basil Blackwell.

Neidle, Carol, and Joan Nash. 2012. The noun phrase. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter, pp. 265–92.

Nespor, Marina, and Wendy Sandler. 1999. Prosodic phonology in Israeli Sign Language. *Language and Speech* 42: 143–176. [CrossRef]

Packard, Jerome. 2000. *The Morphology of Chinese: A Linguistic and Cognitive Approach*. Cambridge: Cambridge University Press.
Padden, Carol. 1988. *Interaction of Morphology and Syntax in American Sign Language*. London: Routledge.
Padden, Carol, Irit Meir, Mark Aronoff, and Wendy Sandler. 2010. The grammar of space in two new sign languages. In *Sign languages: A Cambridge Survey*. Edited by D. Brentari. New York: Cambridge University Press, pp. 573–95.
Peleman, Louis. 1978. *Diksyonne Kreol-Franse (French Creole Dictionary)*. Port-au-Prince: Bon Nouvel.
Pfau, Roland, Markus Steinbach, and Benicie Woll. 2012a. Tense, aspect and modality. In *Sign Language*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter, pp. 186–204.
Pfau, Roland, Markus Steinbach, and Benicie Woll. 2012b. *Sign Language: An International Handbook*. Berlin: De Gruyter.
Rathmann, Christian, and Gaurav Mathur. 2008. Verb agreement as a linguistic innovation in signed languages. In *Signs of the Time: Selected Papers from TISLR 2004*. Edited by Josep Quer. Hamburg: Signum, pp. 191–206.
Poizner, Howard, and Paula Tallal. 1987. Temporal processing in deaf signers. *Brain and Language* 30: 52–62. [CrossRef]
Roberts, Sarah J. 2000. Nativization and the genesis of a Hawaiian Creole. In *Language Change and Language Contact in Pidgins and Creoles*. Edited by John McWhorter. Amsterdam: John Benjamins, pp. 257–300.
Rountree, S. Catherine. 1972. Saramaccan tone in relation to intonation and grammar. *Lingua* 29: 308–25. [CrossRef]
Samarin, William. 2000. The status of Sango in fact and fiction. In *Language Change and Language Contact in Pidgins and Creoles*. Edited by John McWhorter. Amsterdam: John Benjamins, pp. 301–34.
Sampson, Geoffrey. 2005. *The 'Language Instinct' Debate*. London: Continuum.
Sandler, Wendy. 2018. The body as evidence for the nature of language. *Frontiers in Psychology* 9: 1782. [CrossRef]
Sandler, Wendy, and Diane Lillo-Martin. 2006. *Sign Language and Linguistic Universals*. Cambrdige: Cambridge University Press.
Sandler, Wendy, Irit Meir, Carol Padden, and Mark Aronoff. 2005. The emergence of grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences* 102: 2661–65. [CrossRef]
Sandler, Wendy, Irit Meir, Svetlana Dachkovsky, Carol Padden, and Mark Aronoff. 2011. The emergence of complexity in prosody and syntax. *Lingua* 121: 2014–33. [CrossRef]
Scott-Phillips, Thomas. 2015. *Speaking Our Minds*. London: Macmillan Education UK.
Sebba, Mark. 1997. *Contact Languages: Pidgins and Creoles*. New York: St. Martin's.
Supalla, Ted. 1996. The classifier system in American Sign Language. In *Noun Classes and Categorization*. Edited by Colette Craig. Amsterdam: Benjamins, pp. 181–214.
Sutton-Spence, Rachel, and Bencie Woll. 1999. *The Linguistics of British Sign Language: An Introduction*. Cambridge: Cambridge University Press.
Tang, Gladys, and Prudence Lau. 2012. Coordination and subordination in sign languages. In *Sign Language: An International Handbook*. Edited by Roland Pfau, Markus Steinbach and Bencie Woll. Berlin: De Gruyter, pp. 340–64.
Tomaszewski, Piotr, and Wiktor Eźlakowki. 2021a. Negative affixation in Polish Sign Language. *Sign Language Studies* 21: 290–332. [CrossRef]
Tomaszewski, Piotr, and Wiktor Eźlakowki. 2021b. Temporal affixation in Polish Sign Language. *Sign Language Studies* 22: 106–31. [CrossRef]
Valli, Clayton, Ceil Lucas, Kristin J. Mulrooney, and Miako Villanueva, eds. 2011. *Linguistics of American Sign Language: An Introduction*. Washington, DC: Gallaudet University Press.
Van Gijn, Ingeborg. 2004. *The Quest for Syntactic Dependency: Sentential Complementation in Sign Language of the Netherlands*. Utrecht: LOT.
Vermeerbergen, Myriam, Mieke Van Herreweghe, Philemon Akach, and Emily Matabane. 2007. Constituent order in Flemish Sign Language and South African Sign Language: A cross linguistic study. *Sign Language and Linguistics* 10: 23–54. [CrossRef]
Washabaugh, William. 1986. *Five Fingers for Survival*. Ann Arbor: Karoma.

MDPI
St. Alban-Anlage 66
4052 Basel
Switzerland
Tel. +41 61 683 77 34
Fax +41 61 302 89 18
www.mdpi.com

Languages Editorial Office
E-mail: languages@mdpi.com
www.mdpi.com/journal/languages

MDPI
St. Alban-Anlage 66
4052 Basel
Switzerland

Tel: +41 61 683 77 34

www.mdpi.com

ISBN 978-3-0365-6246-9