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Contribution of Nonverbal Cognitive Skills on Bilingual Children's Grammatical Performance: Influence of Exposure, Task Type, and Language of Assessment

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Abstract: This study explores the contribution of nonverbal working memory and processing speed on bilingual children's morphosyntactic knowledge, after controlling for language exposure. Participants include 307 Spanish–English bilinguals in Kindergarten, second, and fourth grade (mean age = 7;8, SD = 18 months). Morphosyntactic knowledge in English and Spanish was measured using two separate language tasks: a cloze task and a narrative language task. In a series of four hierarchical linear regressions predicting cloze and narrative performance in English and Spanish, we evaluate the proportion of variance explained after adding (a) English exposure, (b) processing speed and working memory, and (c) interaction terms to the model. The results reveal the differential contribution of nonverbal cognitive skills across English and Spanish. Cognition was not significantly related to performance on either grammatical cloze or narrative tasks in Spanish. Narrative tasks in English were significantly predicted by processing speed, after controlling for age and exposure. Grammatical cloze tasks in English posed an additional cognitive demand on working memory. The findings suggest that cognitive demands vary for bilinguals based on the language of assessment and the task.

1. Introduction

Cognition is intricately linked to bilingual development and to language development more broadly (Barac and Bialystok 2012). However, the extent to which distinct aspects of cognition—such as processing speed and working memory—explain bilinguals' language representations (e.g., morphosyntactic knowledge) in their first (L1) and second (L2) languages is not well understood. Our study asks: What is the nature of the relationship between nonverbal cognition and morphosyntactic knowledge, and how does this relationship change across languages and tasks?

1.1. The Role of Exposure on Bilingual Language Development

Bilingual language development is a dynamic process influenced by multiple factors, including the amount of a child's exposure to their L2, the age of a child's first L2 exposure, and the complexity of structures in the input (Bedore et al. 2012). Young Spanish-English bilinguals in the United States often begin to learn a second language while their first language is still being acquired, which can lead to highly variable performance across

the L1 and L2 (Sagarra and Herschensohn 2010). For many of these bilinguals in the U.S., L2 English learning occurs within the context of an immersive L2 environment, in either an early education or elementary school setting Oppenheim et al. 2020). A common pattern is that children receive support in their first language in early elementary school that is gradually withdrawn. As a consequence, many children shift dominance from one language to another over time (Bedore et al. 2012; Paradis 2010). Often, the L2 input that bilinguals encounter in their classrooms is more academic in nature. Academic language is characterized by decontextualized discourse, and by longer, more complex morphosyntactic structures (e.g., subordinate clauses) as compared to the more social and routinized discourse of the home language or English used in the wider community (Valdés 2004). Thus, for these learners, their first L2 exposure is different in terms of both language as well as discourse type.

Earlier age of L2 exposure has been frequently associated with higher L2 proficiency (Festman 2021). However, recent research informs the question of how exposure affects language development. For instance, one study shows that differential cross-linguistic performance is associated with both current exposure as well as linguistic domain (e.g., semantics, morphosyntax, and narrative) (Oppenheim et al. 2020). Others have found that opportunities to hear and use each language differentially predict language outcomes across domains. For instance, among Spanish–English school-age bilinguals, opportunities to hear each language have been associated with semantic performance, whereas opportunities to *use* each language have been associated with grammatical performance (Bedore et al. 2012; Ribot et al. 2018).

These domain-related differences can be observed within individuals, as well. Research by our lab, and others, has shown that bilinguals can be stronger in one area of language (i.e., semantics) in one of their two languages, while being dominant in another area (i.e., morphosyntax) in the other language (Bedore et al. 2012; Uccelli and Páez 2007; Paradis et al. 2003). While exposure may partially explain these "mixed dominance profiles" (Festman 2021), it is also possible that different areas of language tap different cognitive processes, such as working memory or metacognitive strategies (Duncan and Owen 2000). It remains an open question as to how different aspects of cognition interact with exposure to explain the language performance, including mixed dominance, of school-aged bilingual children.

1.2. The Role of Working Memory and Processing Speed in Bilingual Development

In educational contexts, cognition refers to the discrete and interactive mental processes that occur between the presentation of a sensory stimulus (e.g., visual or acoustic signal) and the production of a behavioral response (e.g., motor or spoken response). Bilingual language acquisition depends in part on verbal cognition, or the processing of information through the representation of concepts in morphemes (the smallest units of meaning) encoded by phonemes (the smallest contrastive units of sound) (Summers et al. 2010). Conversely, nonverbal cognition does not require the representation of linguistic information, such as morphemes or phonemes, and is generally thought to be independent of language (Bracken and McCallum 1998).

The theory of cognitive abilities by Cattell–Horn–Carroll (Cattell 1963; Flanagan and McGrew 1998) proposes that cognition is multidimensional, featuring domain-general aspects of cognition as well as domain-specific aspects of cognition. In this model, domain-general cognitive ability supports the more narrow, specified functions of cognition. For example, how we process incoming acoustic information and then store that information in working memory is domain-general, while the retrieval of information from the lexicon and the integration of semantic and morphosyntactic information is domain-specific. Two domain-general aspects of cognition are working memory and processing speed.

Working memory. Working memory refers to the ability to temporarily hold information for active use and manipulation. Working memory encompasses both domain-general (e.g., capacity limitations) and domain-specific processes (e.g., task-dependent coordination and

transformation of active information in working memory) (Oberauer 2004). According to Baddeley's seminal model (Baddeley 1992, 2012), working memory has two domain-specific components: visuospatial working memory, which stores and processes visual (nonverbal) information, and phonological working memory, which stores and processes speech (verbal) information. Both components of working memory support the retention of new information in long-term memory, where information is stored for later retrieval and use (Baddeley 1992, 2012). There is abundant evidence that verbal working memory impacts language performance (Gathercole and Baddeley 2014; Summers et al. 2010). In bilingual adults, greater verbal working memory is positively associated with the parsing of morphosyntactically complex sentences (e.g., Hopp 2015; Cunnings 2017). Evidence with bilingual children also shows that verbal working memory supports the short-term processing of the linguistic information often presented on language assessments (Oppenheim et al. 2020; Talli and Stavrakaki 2020).

While these studies show that working memory predicts morphosyntactic performance, all of them have targeted verbal working memory. Relevant to the present study, emerging research suggests that nonverbal working memory may also be implicated in bilinguals' language performance. Cognitive processing demands inherent to nonverbal tasks moderate success in retrieving information for a short time span (Jiao et al. 2019). For example, adult bilinguals have been observed to score higher on behavioral measures of nonverbal working memory after completing intensive interpreter training (Macnamara and Conway 2014). Evidence from bilingual children with language disorders has shown that nonverbal visuospatial working memory tasks are more difficult than processing speed tasks for children with language disorders (Durant et al. 2019). However, one explanation for this may be that bilingual children use self-talk as a language-based strategy to recall and recreate a sequence of pictures even though the task is elicited and performed nonverbally. Additional evidence links nonverbal working memory with morphosyntactic performance. In a study of 47 Spanish–English bilingual children with language disorders, Ebert (2014) showed that nonverbal working memory predicted unique variance in morphosyntactic performance in both languages, as measured by sentence repetition, after accounting for chronological age and verbal working memory. Another study that examined the differential contributions of non-verbal working memory to morphosyntactic processing using a grammaticality judgment task in school-aged monolingual and simultaneous bilingual children found that monolinguals were more sensitive to errors on the grammaticality judgement task than were their simultaneous bilingual counterparts (Gangopadhyay et al. 2016). Here, greater working memory was associated with performing the grammaticality judgment task only in bilinguals. The contribution of working memory to syntactic processing was found only in children with lower language skills.

The contribution of nonverbal working memory on distinct types of language tasks used to measure morphosyntactic knowledge, however, remains relatively unknown. As language tasks become more complex, the cognitive and linguistic task demands are likely to increase, necessitating multiple retrievals from working memory within a short time frame (Archibald 2017). It is possible that a sentence repetition task, similar to the one used in Ebert (2014), may tap nonverbal working memory differently than a sentence completion (cloze) task or narrative recall or generation task. Additional empirical research is needed to understand how nonverbal working memory is associated across different tasks of morphosyntax administered to young bilingual children.

Processing speed. Processing speed refers to the automaticity in the access, retrieval, and integration of information (Bracken and McCallum 1998). It is generally measured by how quickly an individual is able to successfully complete a task. As with working memory, processing speed is both domain-general and domain-specific (and verbal or nonverbal), depending on its reliance on language knowledge. Examples of processing speed tasks that interact with language include lexical naming tasks, such as rapid naming tasks (McMillen et al. 2020). Examples of processing tasks that purport to be nonverbal limit the amount of language used in the presentation and administration of the task and

are designed to elicit a nonverbal (motor) response, such as orienting a shape to complete a puzzle (Bracken and McCallum 1998).

It is generally understood that processing speed is related to the efficiency with which bilinguals comprehend and produce language (Clahsen and Felser 2006). The processing of morphosyntactic information may be less automatic for bilinguals with reduced L2 proficiency (see Sabourin et al. 2003; Weber-Fox and Neville 1996, for examples of ERP studies with adult bilinguals). However, this may be due to differences in the task type, as there may be costs to processing speed when tasks obligate production versus comprehension of language (Paradis 2010). In online processing tasks that require children to judge the grammaticality of sentences, bilingual children demonstrate longer processing times than their monolingual peers (Chondrogianni et al. 2015a). They are also more accurate in these types of comprehension tasks in comparison to production tasks. This gap between accuracy of performance on comprehension tasks in comparison to accuracy of performance on production tasks is larger for bilinguals than for monolinguals. This asymmetrical performance, where superior performance is found on comprehension, suggests that bilingual children have the morphosyntactic representation, but may have difficulty with the retrieval process necessary for speedy production (Chondrogianni and Marinis 2012; Chondrogianni et al. 2015a, 2015b; Paradis 2010). Nonetheless, sensitivity to L2 grammaticality is dependent upon the grammatical structure being tested and the L2 learner's proficiency (for an example with adults, see Van Patten et al. 2012). In a comparison of simultaneous and sequential bilingual children, Lemmerth and Hopp (2019) demonstrated that sequential bilinguals may rely on their L1 morphosyntactic knowledge to processes morphosyntactic information in their L2. This indirect processing route may slow the processing of morphosyntax.

1.3. Morphosyntactic Task Complexity and Cognitive Demands

In educational contexts, language assessments are used to measure morphosyntactic knowledge using a variety of tasks. These tasks can elicit responses both at the sentence level (e.g., aural/oral cloze tasks) as well as at the level of discourse (e.g., narratives). Cloze tasks are perhaps the most commonly used task for evaluating morphosyntactic knowledge (Levenston et al. 1984). During a cloze task, children are presented with a picture and asked to respond to a prompt with the morphosyntactic form that is obligated by the picture and prompt. For example, the Bilingual English Spanish Assessment (BESA; Peña et al. 2018) probes use of past tense *-ed* by prompting, "Today, he is walking the dog. Yesterday, he did it, too. What did he do yesterday? Yesterday, he … " The expected answer is "walk*ed* the dog". In order to complete a cloze task, children must integrate the semantic and morphosyntactic information presented in the prompt, anticipate and produce a semantically related word to complete the sentence, and include any obligatory inflectional morphemes. In adult L2 learners, anticipatory language processing, which is needed to generate the targeted word form in the cloze task, is supported by high levels of working memory capacity as well as exposure (Hopp 2015; Sagarra and Herschensohn 2010).

Narrative tasks present a more integrated semantic, morphosyntactic, and pragmatic task. Such tasks can include the retelling of a story previously heard using one's own words or the telling of an original story, often using picture cues. Children have the freedom to respond using self-determined words and sentences, with little structure provided by the assessor or imposed by the task itself. Children's narratives are often mined for information about their morphosyntax knowledge and lexical-semantic knowledge (microstructure) as well as use of story structure (macrostructure). Elements of microstructure include grammaticality, mean length of utterance, and clausal density (Hipfner-Boucher et al. 2015; Gagarina et al. 2015).

Performance on grammatical cloze and narrative tasks can reflect a wide range of morphosyntactic abilities. On one end of the spectrum are cloze tasks, which are highly constrained so as to elicit a single, inflexible response (i.e., walk*ed*, marked for past tense *-ed*). On the other end are narrative tasks, which are open-ended and virtually unconstrained

as they allow the speaker to select from grammatically accurate options to express the narrative content. The two types of tasks also differ in their contextualization. Whereas cloze tasks offer limited context (often only a picture and a brief prompt), narrative tasks tend to be highly contextualized, with elaborate pictures and/or plots.

Given these differences, it is reasonable to expect that the cognitive demands across these two different morphosyntactic tasks may differ (Field 2011). Neuroimaging studies have observed higher levels of neural activity for cloze tasks than for multiple choice items targeting the same information (Mizumoto et al. 2016). This is hypothesized to reflect both domain-general (e.g., attention, processing speed) and domain-specific cognitive processes (e.g., grammatical inferencing), as well as working memory. Furthermore, research with bilinguals suggests that assessments in the L1 and L2 may pose distinct processing demands. Evidence from both sentence repetition tasks (Pratt et al. 2020) and narratives (Gutiérrez-Clellen and Peña 2001) show there is an additional processing cost associated with language tasks when administered in L2 English to sequential Spanish–English bilingual children.

1.4. Present Study

Previous literature shows that the extent to which bilinguals' nonverbal working memory and processing speed contribute to performance on tasks of morphosyntax may be influenced by the age of the learner, their language exposure, and the type of task being performed. The present study focuses on nonverbal cognition, as nonverbal cognition is thought to be most independent of language and consequently demonstrative of domain-general cognitive abilities (Bracken and McCallum 1998; Cattell 1963). Specifically, we pose the following research questions:

(1) To what extent does exposure, working memory, and processing speed explain variability in school-age Spanish–English bilinguals' performance on cloze and narrative tasks?

(2) To what extent does exposure, working memory, and processing speed explain variability in school-age Spanish–English bilinguals' performance on these tasks when administered in the first versus second language?

We hypothesize that students' nonverbal abilities will differentially interact with their language exposure as they complete two kinds of tasks: grammatical cloze tasks and narrative tasks.

More specifically, we hypothesize that there are distinct nonverbal demands on processing speed and working memory. In this study, we ask (a) whether a grammatical cloze task and a narrative task pose distinct nonverbal cognitive demands and (b) whether these cognitive demands differ across children's first (L1) and second (L2) languages.

2. Materials and Methods

2.1. Participants

Data for this study were obtained from a larger longitudinal investigation evaluating spoken language trajectories for young school-age Spanish–English bilingual children, *Cross-Language Outcomes of Typical and Atypical Development in Bilinguals* (Peña et al. 2010). Of the 360 children who originally participated in the study, children were excluded from this study if they were missing language exposure data (*n* = 44), missing data on the UNIT (*n* = 8), missing morphosyntax cloze and/or TNL data (English *n* = 1; Spanish *n* = 53). Our participants were Spanish–English bilingual children (163 girls, 144 boys) in kindergarten through fourth grade recruited from the Central Texas area. Children in this age range were included in the current investigation because their profiles of language skills and shifting language dominance are representative of the broader population of young school-age bilinguals in the United States (for an illustration with an overlapping sample of children, see Oppenheim et al. 2020). All children were learning Spanish in the home environment as their first language (age of English acquisition *M* = 2.3 years, *SD* = 1.92) and had a range of English exposure (*M* = 56.84%, *SD* = 26.85). Children attended a variety of educational programs, including one and two-way dual immersion programs, as well as English as a second language programs, and some children were in

English-only instruction. Thus, children had between 0 and 100% exposure to Spanish and English at school. For this study, we had complete data for 307 children for the English analyses and 254 children from the Spanish analyses. See Table 1 for demographic data. Approximately 14% of the children participating in the larger longitudinal study were diagnosed with developmental language disorder (DLD), based on converging evidence about language ability from licensed speech-language pathologists. Aligned with recent criteria for diagnosis of DLD (i.e., Bishop et al. 2017, we did not exclude children who performed 1.5 standard deviations below the mean on our nonverbal intelligence measure (see Table 1 for descriptive information on nonverbal IQ scores for our sample). Based on these criteria, this prevalence rate is slightly elevated from recent population studies, evaluating the prevalence of DLD (Norbury et al. 2016). In the larger study from which these data are derived, we sampled children at risk for DLD, based on their screening scores in year 0. For the current study, we did not exclude these children as they are representative of an educational sample featuring the full range of cognitive and linguistic abilities.

Table 1. Descriptive demographic information.

Demographic Information			
	Range	**Mean**	**(SD)**
Age (months)	61–138	92.22	(18.67)
English exposure (% week)	0–100	56.84	(26.85)
Age of 1st English exposure (years)	0–6	2.30	(1.92)
SES [a]	0–7	3.01	(1.73)
Nonverbal IQ [b]	60–132	100.48	(14.57)
Gender		47% male	
Ethnicity		99% Hispanic	

Note: [a] = Hollingshead score (Hollingshead 1973); [b] = scores derived from the abbreviated nonverbal IQ composite on the *Universal Nonverbal Intelligence Test* (UNIT; Bracken and McCallum 1998).

2.2. Procedures

All data were collected during the first year of the longitudinal study. Testing occurred in quiet locations within the children's schools over 4–5 sessions lasting 30 to 45 min each. The order and language of testing was randomized across participants, and tests were administered by trained bilingual examiners and certified speech language pathologists who had experience working with bilingual school-age children. Measures of nonverbal ability were originally given in additional to the comprehensive battery of language measures to better inform how domain general and specific factors impact children's performance on language-based tasks, including tasks on the BESA. Descriptions of tasks that are of interest for the current study are as follows. Procedures were approved by the Institutional Review Board of The University of Texas at Austin, 2009-11-0110.

2.3. Language Exposure

Children's language exposure was collected using the *Bilingual Input–Output Survey* (BIOS; Peña et al. 2018). Parents reported on each child's language input and output in the home environment on an hour-by-hour basis during a typical weekday and a typical weekend day. Language input and output was also obtained from teachers for children's typical school day. Language input at home and school was combined to create a composite language exposure measure and averaged across the week for a percent exposure for each language. For this study, we used percentage of English exposure as the variable in our statistical analyses.

2.4. Measures of Nonverbal Cognitive Ability

Nonverbal cognitive ability was measured using the *Universal Nonverbal Intelligence Test* (UNIT; Bracken and McCallum 1998), which is a measure of general intelligence for children 5 to 17 years of age. Critically, the administration of this test does not require

language, and children are not required to respond verbally. Nonverbal working memory and processing speed are the two cognitive constructs measured by the subtests in the UNIT. The two subtests on the UNIT in the abbreviated IQ composite are (1) symbolic memory, which assesses working memory via short-term visual recall of content, location, and sequence, and (2) cube design, which assesses processing speed via pattern processing, problem solving, understanding of relationships, and planning abilities.

Symbolic Memory. This subtest measures nonverbal working memory. The child is presented with a series of simple pictures and asked to replicate the sequence. The child replicates the sequence of drawings using cards featuring the drawings.

Cube Design. This subtest is a timed measure of processing speed. The child uses colored blocks to replicate a pictured model. The child sees pictures of green and white blocks arranged in a specific structure. Then, the child must use green and white blocks to replicate the model structure in the picture within a limited amount of time (Bracken and McCallum 1998). See Durant et al. (2019) for additional information concerning administration and reliability with Spanish–English bilingual children.

2.5. Morphosyntactic Ability

Cloze. Cloze items were derived from children's performance on the morphosyntax subtests of the *Bilingual English Spanish Assessment* (BESA; Peña et al. 2018) and the *Bilingual English Spanish Assessment—Middle Extension Field Test Version* (BESA-ME; Peña et al. 2016). The BESA was used for children ages 4;0 to 6;11 while the BESA-ME was used with children 7;0 to 11;0. The BESA presents 18 grammatical cloze items in English and 19 grammatical cloze items in Spanish; the BESA-ME contains 37 grammatical cloze items in English and 38 grammatical cloze items in Spanish. Differences in the number and type of cloze items were included for each language to account for cultural- and language-based variations in children's knowledge. Morphosyntactic constructions in each language that are known to be challenging for bilingual children with language impairment (e.g., past tense *-ed*, third person present tense *-s*, and copula in English; direct object clitics, passives, and subjunctive in Spanish) and serve as clinical markers for DLD (see Bedore et al. 2018, for additional discussion of clinical markers) are specifically targeted within these tests to maximize differences by language ability. An example of a cloze item targeting irregular past tense in English includes "Today, she is eating a banana. And yesterday, she did it too. What did she do yesterday? Yesterday she_____" (response: *ate* the banana). Children's raw scores across all items were summed and divided by the total possible score, yielding a percent accuracy for the cloze task.

Narratives. Children also completed the *Test of Narrative Language* in English (TNL; Gillam and Pearson 2004) and in Spanish (TNL-S; Gillam et al. Forthcoming, in development). The TNL is a standardized measure used to assess multiple aspects of children's narrative production and comprehension, including listening comprehension, sequencing, short-term memory, and story cohesion and coherence. The TNL-S is an experimental measure comprising stories and narrative tasks that are as nearly identical in structure and type to those on the TNL English version. The present study compiled test items, specifically targeting morphosyntactic forms which capture children's morphosyntactic knowledge; these items comprise a morphosyntactic composite.

The morphosyntactic composite, described in Table A1 in Appendix A, is derived from children's performance on two narrative production tasks in each language. In the first task, children tell a story based on a sequence of a pictures; in the second task, children tell a story about a single picture. The composite includes nine items per language: two items assessing temporal relationships, two items assessing causal relationships, two items assessing grammaticality, two items assessing use of tense, and one item assessing the consistent use of references/pronouns. All items are scored on a 3-point scale, such that a 0 indicates absent/poor performance, a 1 indicates incomplete/inconsistent performance, and a 2 indicates complete/accurate performance. For instance, the item evaluating grammaticality reads, "0 = three or more grammatical errors; 1 = one or more grammatical

errors; 2 = no grammatical errors". Children's raw scores ranged from 0 to 18 in each language. Scores were summed and divided by 18 to yield a percentage accuracy for each language. (For further information see Table A2 in Appendix B).

2.6. Analytical Strategy

Less than 20% of data for each variable of interest was missing and missing data were deleted listwise. Prior to exploring concurrent relationships between morphosyntactic variables and predictor variables, we conducted zero-order correlations to explore the bivariate relationships between morphosyntactic scores on grammatical cloze tasks and narrative tasks in both languages with each of the predictors: English input/output, working memory, and processing speed. Four hierarchical linear regressions were conducted as a follow-up analysis to the correlation analysis, as this analysis allows us to assess the unique contribution of each independent variable to morphosyntax, relative to other predictors. After controlling for age, we entered in subsequent blocks (a) English exposure, (b) processing speed and working memory, and (c) interactions between exposure and cognition, to find the combination of variables most highly associated with morphosyntax scores in each language. We then considered the role of language input and cognition on morphosyntax using children's scores from their stronger vs. weaker language performance.

3. Results

The present study aimed to explore the effects of exposure and cognition on bilingual children's performance on two tasks measuring morphosyntax: a grammatical cloze task and a narrative task. Prior to the main analyses, we conducted a preliminary examination of central tendencies of the data. Histograms and Q-Q plots showed normal distribution of scores on all measures in both languages, skewness and kurtosis fell within the acceptable range of −2 to 2, and Shapiro–Wilk statistical tests of normality were non-significant at an alpha of 0.05. Ranges, means, and standard deviations for all child-direct measures are presented in Table 2. On average, participants scored near 50% on both morphosyntax tasks, with large standard deviations. The range of scores spanned floor (0%) to ceiling (100%), as is characteristic of school-based bilingual population.

Table 2. Morphosyntactic performance (by language) and nonverbal cognitive performance.

Morphosyntax		English:		Spanish:		Best Language:	
	Range	Mean	(SD)	Mean	(SD)	Mean	(SD)
Cloze [a] (% correct)	0–100	53.36	(29.28)	48.42	(25.52)	66.19	(20.70)
Narrative [b] (% correct)	0–100	43.23	(23.89)	54.68	(23.67)	61.78	(18.47)
Cognition							
	Range	Mean	(SD)				
Working memory [c]	0–25	9.28	4.53				
Processing speed [c]	0–43	16.22	8.08				

Note: [a] = scores derived from BESA (Peña et al. 2018) or BESA-ME (Peña et al. 2016); [b] = scores derived from TNL (Gillam and Pearson 2004) and TNL-S (Gillam et al. Forthcoming; in development); [c] = scores derived from the Symbolic Memory Symbolic Memory (working memory) and Cube Design (processing speed) subtests on the UNIT (Bracken and McCallum 1998).

Bivariate correlations between age, English exposure, and all observed morphosyntactic and cognitive variables are presented in Table 3. Age was significantly and positively related to all measures, with the exception of the Spanish cloze task, with effect sizes ranging from moderate (age; $r = 0.39$, $p < 0.01$) to large (processing speed; $r = 0.60$, $p < 0.01$). Thus, partial correlations between English exposure and all observed morphosyntactic and cognitive variables, controlling for age, are also presented in Table 3 below the diagonal.

Table 3. Bivariate correlations above the diagonal; partial correlations, controlling for age, below the diagonal.

		2. Exp	3. WM	4. PS	5. Eng. cl	6. Sp cl	7. Eng. narr	8. Sp. narr.
1.	Age	0.36 **	0.57 **	0.60 **	0.57 **	−0.04	0.53 **	0.39 **
2.	Exposure	–	0.14 *	0.26 **	0.63 **	−0.44 **	0.46 **	0.00
3.	Working memory	−0.02	–	0.51 **	0.40 **	0.10	0.39 **	0.27 **
4.	Processing speed	0.06	0.25 **	–	0.46 **	−0.02	0.46 **	0.23 **
5.	English cloze	0.35 **	0.20 **	0.21 **	–	−0.05	0.68 **	0.28 **
6.	Spanish cloze	−0.24 **	0.10	0.03	0.15 *	–	−0.03	0.52 **
7.	English narrative	0.25 **	0.12	0.20 **	0.53 **	0.10	–	0.26 **
8.	Spanish narrative	−0.28	0.06	0.00	0.04	0.60 **	0.04	–

$* = p < 0.05$; $** = p < 0.01$.

3.1. Hierarchical Multiple Regressions

A series of hierarchical multiple regression models were computed to predict grammatical cloze and narrative morphosyntax scores in both English and Spanish. Predictor variables were added one block at a time in order to evaluate the unique contribution of each additional predictor to the model. In all models, age was entered first to control for developmental effects in subsequent blocks. All models featured the same forced entry of predictors across four blocks: (1) at block one, age was entered; (2) at block two, English exposure was entered; (3) at block three, the two nonverbal cognitive variables were entered (working memory and processing speed); (4) finally, at block four, the two interaction terms between input and each of the cognitive variables were entered. We centered all variables in the analyses. Centered variables were calculated by subtracting the mean (a constant) from each score, X. Centering is an important step when testing interaction effects of XY in multiple regression, as using uncentered scores can affect collinearity and the interpretation of interaction results in hierarchical multiple regression (Aiken et al. 1991).

We tested for multicollinearity upon running the hierarchical regression models, using variance inflation factors (VIF) and tolerance. As recommended, VIF was computed only after first centering variables (Freund et al. 2003). When VIF values exceed 4.00 or tolerance levels are less than 0.20, the assumptions of non-collinearity may be violated (Hair et al. 2013). For our data, all VIF values were less than 2.28 and all tolerance values were greater than 0.44.

3.2. Predicting Performance on Cloze Tasks in English and Spanish

English cloze results are shown in the upper half of Table 4. The addition of predictor variables at all four blocks yielded significant improvement in variance explained. At block one, age accounted for 33% (adjusted $R^2 = 0.32$) of the variation in children's English cloze scores, $F (1, 302) = 145.35$, $p < 0.01$. At block two, English exposure explained an additional 21% of variance (adjusted $R^2 = 0.53$), $F (1, 301) = 133.10$, $p < 0.01$. At block three, working memory and processing speed accounted for 3% of additional variance (adjusted $R^2 = 0.56$), $F (2, 299) = 10.07$, $p < 0.01$. At block four, the interaction terms of exposure-by-working memory and exposure-by-processing speed accounted for an additional 1% of variance, $F (2, 297) = 4.55$, $p = 0.01$. However, examination of univariate *t*-tests reveals that exposure-by-processing speed is the only interaction term with univariate significance (part correlation = −0.08, see Figure 1). After four blocks, the resulting model accounted for approximately 57% of variability in children's English cloze scores, with age, exposure, working memory, processing speed, and exposure-by-processing speed retaining individual significance.

Table 4. Model summaries of regressions predicting morphosyntax using cloze tasks.

|		Block 1		Block 2		Block 3		Block 4	
		β	t	β	t	β	t	β	t
	English cloze								
1.	Age	0.57	11.99 **	0.39	9.25 **	0.24	4.35 **	0.24	4.54 **
2.	Exposure to English	–	–	0.49	11.53 **	0.49	11.93 **	0.47	11.14 **
3.	Working memory	–	–	–	–	0.13	2.76 **	0.14	2.86 **
	Processing speed	–	–	–	–	0.13	2.62 **	0.13	2.69 **
4.	Exp. * Working mem.	–	–	–	–	–	–	−0.03	0.74
	Exp. * Processing sp.	–	–	–	–	–	–	−0.09	2.11 *
	R^2		0.32		0.53		0.56		0.57
	R^2 change		0.32 **		0.21 **		0.03 **		0.01 *
	Spanish cloze								
1.	Age	−0.04	−0.66	0.18	3.06	0.09	1.22	0.10	1.27
2.	Exposure to English	–	–	−0.5	−8.77 **	−0.51	−8.58 **	−0.52	−8.20 **
3.	Working memory	–	–	–	–	0.13	1.90	0.13	1.85
	Processing speed	–	–	–	–	0.02	0.24	0.00	0.01
4.	Exp. * Working mem.	–	–	–	–	–	–	0.02	0.35
	Exp. * Processing sp.	–	–	–	–	–	–	−0.12	−1.97 *
	R^2		0.00		0.22		0.24		0.25
	R^2 change		0.00		0.22 **		0.01		0.01

* = $p < 0.05$; ** = $p < 0.01$.
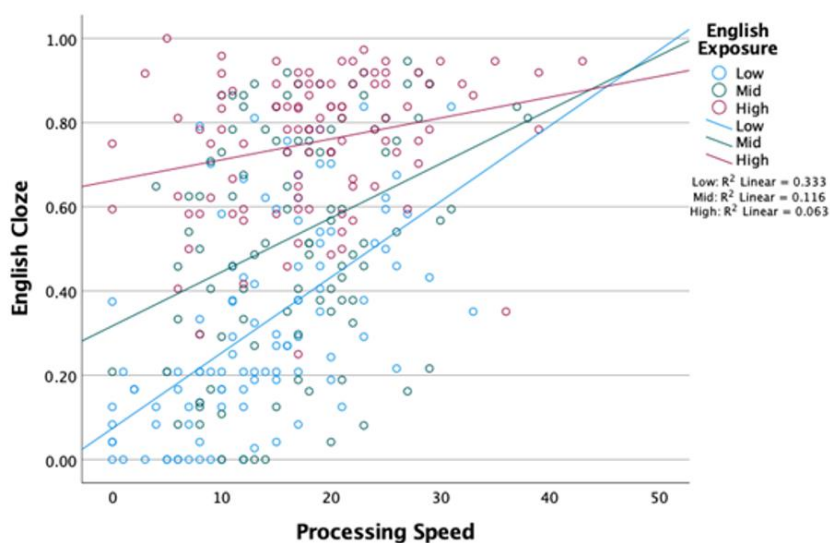
Figure 1. Scatterplot of interaction between English exposure (divided into three levels) and processing speed on English cloze performance.

Spanish cloze results are shown in the bottom half of Table 4. In contrast to English cloze results, only the addition of English exposure at block 2 explained significant variability. At block one, age accounted for just 0.2% of variability, $F (1, 269) = 0.412$, $p = 0.521$. At block two, English exposure accounted for 22% of variability (adjusted $R^2 = 0.22$), $F (1, 268) = 77.02$, $p < 0.01$. At block three, the addition of working memory and processing speed did not significantly improve variance accounted for, $F (2, 266) = 2.08$, $p = 0.127$. Part correlations for working memory and processing speed, respectively, totaled 0.10 and 0.01, indicating that less than 1% of variance in Spanish cloze scores was uniquely explained by cognition. At block four, the addition of the interaction terms between exposure and cognition was not significant, $F (2, 264) = 2.10$, $p = 0.124$. The resulting model accounted for approximately 25% of variability in children's English SR scores (adjusted $R^2 = 0.23$), with English exposure as the only significant predictor.

3.3. Predicting Performance on Narrative Tasks in English and Spanish

Next, we explored the contribution of exposure and cognition on morphosyntactic scores collected using a more naturalistic narrative language task. Table 5 features English narrative results. As with the English cloze task, the addition of age, exposure, and the two cognitive variables explained significant variance. At block one, age accounted for 29% (adjusted $R^2 = 0.28$) of the variation in children's English cloze, $F_{(1, 302)} = 120.57$, $p < 0.01$. At block two, English exposure significantly improved the overall variance and accounted for 9% additional variance (adjusted $R^2 = 0.37$), $F_{(1, 301)} = 41.71$, $p < 0.01$. At block three, working memory and processing accounted for 3% of additional variance (adjusted $R^2 = 0.56$), $F_{(2, 299)} = 8.32$, $p < 0.01$. However, only processing speed retained univariate significance, $t_{(1, 299)} = 3.02$, $p = 0.003$. At block four, the interaction terms of exposure-by-working memory and exposure-by-processing speed were not significant. The resulting model accounted for approximately 40% of variability in children's English cloze scores, with age, exposure, and processing speed retaining individual significance.

Table 5. Model summaries of regressions predicting morphosyntax using narrative tasks.

		Block 1		Block 2		Block 3		Block 4	
		β	t	β	t	β	t	β	t
	English narrative								
1.	Age	0.53	10.90 **	0.42	8.51 **	0.25	3.92 **	0.25	3.96 **
2.	Exposure to English	–	–	0.31	6.42 **	0.31	6.57 **	0.31	6.17 **
3.	Working memory	–	–	–	–	0.11	1.95	0.11	1.95
	Processing speed	–	–	–	–	0.18	3.12 **	0.18	3.12 **
4.	Exp. * Working mem.	–	–	–	–	–	–	−0.01	−0.14
	Exp. * Processing sp.	–	–	–	–	–	–	−0.04	−0.84
	R^2	0.29		0.37		0.41		0.41	
	R^2 change	0.29 **		0.09 **		0.04 **		0.00	
	Spanish narrative								
1.	Age	0.39	6.71 **	0.55	8.32 **	0.52	6.15 **	0.54	6.37 **
2.	Exposure to English	–	–	−0.30	−4.56 **	−0.30	−4.52 **	−0.32	−4.71 **
3.	Working memory	–	–	–	–	0.06	0.90	0.03	0.36
	Processing speed	–	–	–	–	0.00	0.02	−0.03	−0.40
4.	Exp. * Working mem.	–	–	–	–	–	–	−0.10	−1.51
	Exp. * Processing sp.	–	–	–	–	–	–	−0.06	−0.80
	R^2	0.15		0.22		0.22		0.23	
	R^2 change	0.15 **		0.07 **		0.00		0.02	

* = $p < 0.05$; ** = $p < 0.01$.

Spanish narrative results are shown in the bottom half of Table 5. As with English narrative results, age and exposure explained significant variability. At block one, age accounted for 15% of variability, $F_{(1, 248)} = 45.51$, $p < 0.01$ and at block two, English exposure accounted for 6% of additional variance (adjusted $R^2 = 0.21$), $F_{(1, 268)} = 77.02$, $p < 0.01$. At block three, the addition of working memory and processing speed did not significantly improve variance accounted for, $F_{(2, 245)} = 0.38$, $p = 0.69$, nor did the addition of interaction terms at block four, $F_{(2, 243)} = 2.343$, $p = 0.09$. After four blocks, the resulting model accounted for approximately 24% of variability in children's Spanish narrative scores (adjusted $R^2 = 0.21$), with age and English exposure the only significant predictors. For the sake of thoroughness, interaction terms with age were also tested and entered into all models. None of the interactions were significant and, for parsimony, we excluded them from all models.

3.4. Predicting Performance on Cloze Tasks Based on Language Dominance

Given the differential predictors of morphosyntactic performance across English and Spanish, we further explored the role of input and cognition on morphosyntax using children's scores from their stronger vs. weaker language performance. Stronger language performance was determined by taking the higher of the two cloze scores across both languages, whereas weaker language performance was determined by taking the lower of

the cloze two scores. Only children with complete testing data in both languages for the cloze task ($n = 270$) and the narrative task ($n = 249$) were included in follow-up language dominance analyses. Table 6 reports the number and percentage of children who scored better in English or Spanish on cloze and narrative tasks, among those without any missing data. Note that a majority of children (65%) were dominant in the same language on both tasks; however, 35% of children showed mixed dominance across tasks, scoring better in one language for one task and the other language on the other task.

Table 6. Cross-tabulation of "stronger language" frequency counts across morphosyntax tasks.

		Narrative: Stronger Language		
		English:	Spanish:	Total:
Cloze: Stronger language	English:	$n = 51$	74	125 (50%)
	Spanish:	13	112	125 (50%)
	Total:	64 (26%)	186 (74%)	250

Results for weaker and stronger cloze performance are displayed in the upper and lower halves of Table 7, respectively. We consider the weaker language performance first. After controlling for age at block one $F(1, 268) = 60.47$, $p < 0.001$, English exposure explained 6% additional variance at block two, $F(1, 267) = 20.97$, $p < 0.001$. The β coefficient was negative, indicating, with higher exposure to English, that the cloze scores in their weaker language were lower (recall that for half of participants the weaker cloze performance occurred in English and for the other half of participants the weaker cloze performance occurred in Spanish). At block three, working memory and processing speed explained 4% additional variance (adjusted $R^2 = 0.27$), $F(2, 265) = 6.63$, $p = 0.002$; yet, only working memory retained univariate significance. At block four, interaction terms explained an additional 5% of variability, $F(2, 263) = 10.18$, $p < 0.001$; and only exposure-by-processing speed retained univariate significance. Again, the β coefficient was negative, meaning that processing speed was more strongly associated with cloze performance in the weaker language among children with low exposure to English. The resulting model accounted for approximately 33% of variability in children's cloze scores in their weaker language, with age, exposure, working memory, and exposure-by-processing speed all retaining individual significance.

Table 7. Model summaries of regressions predicting morphosyntax using cloze tasks in children's weaker and stronger languages.

		Block 1		Block 2		Block 3		Block 4	
		β	t	β	t	β	t	β	t
Child's weaker language									
1.	Age	0.43	7.78 **	0.54	9.24 **	0.38	5.04 **	0.39	5.28 **
2.	Exposure to English	–	–	−0.27	−4.58 **	−0.26	−4.45 **	−0.27	−4.56 **
3.	Working memory	–	–	–	–	0.20	3.03 **	0.19	2.90 **
	Processing speed	–	–	–	–	0.13	1.16	0.06	0.86
4.	Exp. * Working mem.	–	–	–	–	–	–	0.02	0.32
	Exp. * Processing sp.	–	–	–	–	–	–	−0.24	−4.06 **
	R^2	0.18		0.24		0.28		0.33	
	R^2 change	0.18 **		0.06 **		0.04 **		0.05 **	
Child's stronger language									
1.	Age	0.32	5.52 **	0.22	3.49	0.09	1.16	0.10	1.17
2.	Exposure to English	–	–	0.24	3.89 **	0.25	3.96 **	0.25	−3.70 **
3.	Working memory	–	–	–	–	0.13	1.79	0.13	1.73
	Processing speed	–	–	–	–	0.08	1.14	0.08	1.06
4.	Exp. * Working mem.	–	–	–	–	–	–	0.01	0.10
	Exp. * Processing sp.	–	–	–	–	–	–	−0.05	−0.77
	R^2	0.10		0.15		0.17		0.17	
	R^2 change	0.10 **		0.05 **		0.02		0.00	

* = $p < 0.05$; ** = $p < 0.01$.

In contrast, exposure was the only predictor that significantly explained children's morphosyntactic scores in their stronger language. At block one, age accounted for 10% of variance in scores. At block two, English exposure significantly improved the variance accounted for to 15%, F (1, 267) = 15.13, $p < 0.001$. The addition of cognitive variables and interaction terms were not significantly related to morphosyntactic outcomes at blocks three and four.

3.5. Predicting Performance on Narrative Tasks Based on Language Dominance

Table 8 depicts children's narrative scores in their weaker and stronger language. In the weaker language, only the addition of age at block one yielded significant change in variance accounted for, F (1, 247) = 108.91, $p < 0.001$, explaining 31% of variability. An analysis of all predictors present in the model at block four revealed that the interaction of exposure-by-processing speed was also significant ($t = -2.13$, $p = 0.026$). The part correlation of the interaction was weak ($r = -0.11$), explaining 1.25% of unique variability in the final model.

Table 8. Model summaries of regressions predicting morphosyntax performance using narrative tasks in children's weaker and stronger languages.

		Block 1		Block 2		Block 3		Block 4	
		β	t	β	t	β	t	β	t
Child's weaker language									
1.	Age	0.55	10.44 **	0.58	9.21 **	0.49	6.17 **	0.50	6.32 **
2.	Exposure to English	–	–	−0.05	−0.83	−0.06	−0.92	−0.06	−0.88
3.	Working memory	–	–	–	–	0.06	0.85	0.05	0.73
	Processing speed	–	–	–	–	0.10	1.52	0.05	0.65
4.	Exp. * Working mem.	–	–	–	–	–	–	0.01	0.13
	Exp. * Processing sp.	–	–	–	–	–	–	−0.14	−2.13 *
	R^2		0.31		0.31		0.32		0.33
	R^2 change		0.31 **		0.00		0.01		0.02
Child's stronger language									
1.	Age	0.56	10.64 **	0.56	8.91 **	0.44	5.59 **	0.46	5.86 **
2.	Exposure to English	–	–	0.00	0.01	0.00	0.06	−0.03	−0.46
3.	Working memory	–	–	–	–	0.11	1.62	0.06	0.88
	Processing speed	–	–	–	–	0.10	1.52	0.10	1.45
4.	Exp. * Working mem.	–	–	–	–	–	–	−0.15	−2.33 *
	Exp. * Processing sp.	–	–	–	–	–	–	0.03	0.47
	R^2		0.31		0.31		0.33		0.35
	R^2 change		0.31 **		0.00		0.02 *		0.02 [†]

* = $p < 0.05$; ** = $p < 0.01$, [†] = $p = 0.056$.

Similarly, the model predicting narrative scores in the stronger language also showed a significant change in variance accounted for at block one (adjusted $R^2 = 0.31$) with the addition of age, F (1, 247) = 113.10, $p < 0.001$. As with the weaker language, exposure accounted for no additional significant variability at block two, F (1, 246) = 0.00, $p = 0.993$. At block three, working memory and processing accounted for 2% of additional variance (adjusted $R^2 = 0.32$), F (2, 244) = 3.28, $p = 0.039$. However, only age reached univariate significance. At block four, the interaction terms of exposure-by-working memory and exposure-by-processing speed were not significant, F (2, 242) = 2.91, $p = 0.056$. After four blocks, the final model accounted for approximately 35% of variability in children's stronger narrative, with age and exposure-by-working memory retaining individual significance.

4. Discussion

The purpose of this paper was to examine potential differential contributions of nonverbal cognitive processing to morphosyntactic task performance. We found that nonverbal cognitive skills predicted children's performance differently on grammatical

cloze versus narrative tasks. In children's L1 (Spanish), cognition was not significantly related to performance on either grammatical cloze or narrative tasks. Performance on narrative tasks in children's L2 (English) was significantly predicted by processing speed, after controlling for age and exposure. Grammatical cloze tasks in children's L2 (English) posed an additional cognitive demand on working memory, as well as processing speed. Overall findings suggest the cognitive demands of assessment vary for bilinguals based upon the language and type of assessment.

In order to approach morphosyntactic tasks in a broadly informative way, we used language tasks that target sentence-level (grammatical cloze tasks) and discourse-level (narrative tasks) language. We temper this by being very clear that a grammatical cloze task may, in some ways, prime children to complete the task (Shin and Kiel 2009). This is due to the nature of grammatical cloze tasks, which elicit a target word that is very similar to words embedded earlier in the test item. For example, a grammatical cloze item may read: "The boys swim every day. Yesterday they _____". Because the word "swim" appears within the test item, the child may be cognitively primed to choose the word "swam". The narrative tasks on the TNL asked children to both recount stories from their own experience and to retell stories they had heard. These grammatical cloze and narrative tasks can be conceptualized as being on opposite ends of a continuum, in regard to both their contextual support and formality. The grammatical cloze tasks were closed-ended, more formal in nature, and lower in contextualization when compared to narrative tasks. Thus, during cloze tasks, children are not asked to use language in a naturalistic way, as one would when recounting an experience. In contrast, the narrative tasks were open-ended, less formal, and featured images for contextualization. Given these differences, we hypothesized that the distinct morphosyntactic tasks may tap different cognitive processing capacities. We also hypothesized that, for our sample of children, who represent a bilingual population, tasks in English and Spanish may tap cognitive skills differently.

We found a differential contribution of nonverbal cognitive skills on children's performance on grammatical cloze versus narrative tasks in English, suggesting that, for bilingual students, domain general nonverbal cognitive skills are tapped differently across distinct tasks. Specifically, an additional 3% of variability in cloze performance in English was explained by the addition of working memory and processing speed (after controlling for age and exposure). An additional 4% of variability in narrative performance in English was explained by the addition of working memory and processing speed, although only processing speed retained univariate significance ($p < 0.05$). These results may reflect the priming effect that exists in grammatical cloze tasks (Bock 1986; Shin and Kiel 2009; Shin and Kiel 2012) but is less apparent in narrative tasks. Priming and automaticity may go hand in hand with the automaticity of cloze responses, particularly as children become more familiar with their second language and are able to process the task more quickly (for example, as seen in gating tasks) (Marshall and van der Lely 2008).

Our results also found that these cognitive processes are differentially taxed across children's first and second language. Cognition was not significantly related to performance in the L1 on any tasks. One explanation for this finding may be that a bilingual performing morphosyntactic tasks in their L2 utilizes nonverbal cognitive skills to a greater degree than a bilingual performing identical tasks in their L1, because verbal abilities are less robust in their L2. Bilinguals may use their nonverbal cognitive skills in a compensatory way when completing language tasks in the L2, to support verbal skills that are still in development.

These findings are consistent with those from previous investigations on cognitive processing among bilinguals, showing a differential taxation of cognitive processes, as indicated by performance on grammatical tasks (Da Fontoura and Siegel 1995; Abu-Rabia and Siegel 2002). The additional processing cost in the L2 may stem from the cognitive demands inherent in cloze tasks: interpreting the cloze sentence's meaning, choosing the missing word, and producing it in its grammatically correct form, all in the L2. We posit that grammar in an L2 may not be as automatic as it is in an L1, in alignment with our hypothesis. Given these findings, students completing the grammatical cloze task in the

L2 must utilize their cognitive skills to a greater extent than they would in their L1, in order to produce language in the L2.

Narrative tasks in the L2 also taxed children's processing speed more than narratives produced in the L1, implicating larger task demands for L2. Importantly, this finding implies that, while bilingual students are often able to complete language-based narrative assessments in their L2, the processing demands required to successfully perform these tasks are differentially impacted according to the language (L1 or L2) of the task. Narrative tasks completed in the L2 may be more difficult for bilingual students than narrative tasks in the L1. The relative difficulty of an assessment task, based upon the test taker's language status, is an important consideration for practitioners and creators of assessments.

4.1. A Balance of Tasks

Given that bilingual children are not two monolinguals in one cognitive system, but rather, bilinguals are learners of multiple languages which develop over time, we wanted to consider whether there were patterns of cognitive contribution which were reflective of the child's weaker or stronger language. Additionally, we wanted to consider weaker versus stronger language and task demands in light of recent findings on how a child's dominant language is not always their first language (Oppenheim et al. 2020). Therefore, language strength is not as simple as "L1" and "L2". Weaker versus stronger may be a more useful conceptualization of bilinguals. For our Texas-based sample, in particular, children do not simply learn another language, such as English, in a formal language class later in schooling. They live in bilingual realities. This balance of languages via exposure in their environments is such that the language that is not their L1 may become more dominant as they are exposed to things such as more formal schooling, older siblings, media, and friends.

Thus, we considered a child's stronger and weaker performance on each of the language tasks (see Table 6). Of children with complete data in both languages, (*n* = 250), we conducted follow-up analyses to look at patterns across the language in which they performed more accurately (i.e., stronger language) vs. less accurately (i.e., weaker). Not surprisingly, children's performance in their weaker language on cloze tasks was associated with a higher processing cost. This was not true for stronger language performance cloze tasks. There was no significant relationship between our study's cognitive factors and performance on narrative tasks in either strong or weaker language. That is, we did not find a significant relationship between morphosyntactic skills when measured by narrative tasks and working memory or processing speed. This null relationship was observed in both the weaker and stronger language. Recall that the narrative language tasks are less structured, more contextualized tasks. In these ways they are a more ecologically valid language task. So, it may be that when completing narrative tasks, children are more relaxed and/or more practiced or habituated to thinking in and talking in the manner of telling narratives. There are also more ways to be correct when telling a narrative versus the relatively narrowly correct way to answer the grammatical cloze task items. These provide a possible explanation for why we did not find a cognitive contribution in either strong or weak language (regardless of the language being English or Spanish) on the grammatical narrative task, though this merits further research.

There were interaction effects when we considered language exposure and performance on tasks in children's weaker or stronger language. There was a negative association between Spanish cloze task performance when effects were interacted with higher English language exposure for children who performed weaker on the cloze task in Spanish. This was logical, given that increased exposure to English will negatively impact grammatical cloze performance in Spanish (See Table 7). This is possibly because of the higher processing demands of having to complete tasks in Spanish when students are being exposed to English at higher rates. As exposure to English increases, children theoretically become further and further away from a "balanced" profile of exposure. In fact, children have been shown to switch in language dominance from their L1 to their L2 (Oppenheim et al. 2020).

An additional explanation for this phenomenon is that, among children who have low cumulative English exposure and whose weaker language is English, high current exposure to English may not necessarily result in immediate increased accuracy on an English grammatical task. It is possible there is U-shaped learning—that is, children who are early learners of English may perform in a less standardized grammatical way before they perform in a more standardized grammatical way (i.e., overgeneralization of rules governing regular and irregular cases) (Kuczaj 1977).

For children who have high English exposure, and whose weaker of two languages is, nonetheless, English, it might be the case that these children represent the bottom 15% of learners, who are low in both English and Spanish, regardless of exposure. This could also be an effect of the nature of the children's English exposure. We only collected data on the quantity of language that children were exposed to via self-report. We do not collect any direct data on the quality/nature of this English exposure. It is possible that this measure is missing some essential aspects of English language exposure that might explain this negative relationship.

4.2. Findings in Light of the Theory of Cognitive Abilities

There are different potential reasons for our various findings that can best be understood via our theoretical framework of the theory of cognitive abilities. Recall that our study and hypotheses were grounded in the theory of cognitive abilities by Cattell–Horn–Carroll (Cattell 1963; Flanagan and McGrew 1998). This framework posits that domain general factors we tested (working memory and processing speed) may support the completion of formal educational assessment tasks. Cattell–Horn–Carroll (Cattell 1963; Flanagan and McGrew 1998) posited that intelligence is made up of abilities at both the domain-general level and at the domain-specific level. It is important to note that domain-specific abilities are often supported by domain-general abilities. An example would be working memory capacity (domain general) supporting the domain-specific abilities of language that are used to manipulate language on an assessment task. We can see this type of functioning in using language to complete a grammatical cloze task. We must bear in mind that as domain-general factors support domain-specific tasks, these mechanisms are not always cleanly delineated. For example, students may use auditory working memory to hold phonological sequence representations in order to complete grammatical cloze tasks (Park et al. 2015). Such complex relationships may explain the joint contributions of cognitive factors on English grammatical cloze tasks.

4.3. Implications

Our study and findings suggest implications for bilingual language assessment best practice. The ways in which nonverbal cognitive skills support language task performance may inform supports for remediating possible linguistic deficits. This is one reason why it is important to test a child in both languages, document their exposure, and understand that up to 10% of children's performance on certain tasks (such as grammatical cloze tasks) may be explained by cognition and not language. While grammatical narrative tasks did not tap cognitive factors in a statistically significant way (for either language, whether weak or strong) it may be that language tasks which are closed-ended and low in contextualization are, by their nature, tapping different skills based upon the child's language status. Additionally, an assessment which does not take into account a child's amount of exposure to the language being measured may lack clarity around the cognitive processes at work behind a bilingual child's performance.

The implicit differential cognitive demands across children's languages and language-based tasks have implications for assessment and clinical practice. First, assessments used to determine eligibility for language services or educational testing should consider both of the child's languages, not only the language that is considered to be dominate. This is consistent with recommendations for clinical practice (Bedore and Peña 2008; Bedore et al. 2012). While this is not always possible as standardized assessment measures

evaluating a child's first language are not always available, our findings support previous positions (i.e., Bedore et al. 2012) describing the importance of information on the child's development in their first language for acquiring the most accurate picture of their linguistic ability. We additionally propose that—beyond the language of the task—examiners should consider the demands of the language task, including the task type and morphosyntactic structures embedded in the task, as this will differentially tax the child's cognitive load. This is particularly important as morphosyntactic forms are considered clinical markers for identifying children with developmental language disorder (Bedore et al. 2018).

Additionally, the ways in which we consider and interpret studies of language proficiency and/or disability versus difference that do not account for nonverbal factors may shift somewhat if our findings are replicated and garner further attention. Additionally, practitioners (including teachers and pediatricians), as well as parents, can be made further aware of the ways in which potential difficulty with language and ultimately literacy (Kim et al. 2015) may be signaled by children's ability or inability to perform certain kinds of tasks, which may include nonverbal tasks.

Many of the current educational practices for bilingual instruction and assessment are not yet evidence based. This is in part because of the ongoing debate about the validity of studying bilingual's cognition and the ways in which the fields of education, linguistics and cognition generally consider the importance of studying bilingual cognition. As mentioned, academic inquiry about bilingual's cognition has generally sought to elucidate some added cognitive benefit of bilingualism versus the elucidation of subtle differences in cognition in a second language. For example, studies have focused on whether or not being bilingual enhances such domain-general cognitive factors as executive function (Crivello et al. 2016; Dick et al. 2019).

4.4. Limitations

We acknowledge that bilingualism as a whole involves languages other than English and Spanish. Additionally, we are reporting on the findings of language use in a particular context and setting which may or may not generalize to other contexts and settings. This includes, but is not limited to, the cultural and policy environments of Texas and its complicated histories and attitudes towards bilingualism, particularly in public school settings.

We acknowledge that our findings may not be fully generalizable to all bilingual testing. Running these analyses with speakers of other languages (and in other areas) might have yielded different results. Our study also examined kindergarteners through fourth graders and these results may vary by age of participants.

4.5. Future Directions

Examining processing speed in typically developing (TD) and developmental language disorder (DLD) populations of mono and bi-lingual students may provide insights into the cross-linguistic differences of TD and DLD manifestations in cognition. These potential differences in processing speeds may vary according to task demands and cognitive domain-general and domain-specific processes. Additionally, implications for the findings of our current study point toward possible ways in which nonverbal and verbal skills are tapped according to child-level language exposure, which could potentially vary by not only the child's language proficiency status but also their typicality or atypicality (disability). In the future, by exploring the ways in which nonverbal cognitive factors function for typical and atypical bilinguals, we may better understand and evaluate students with language difference, language disability, and those with both difference and disability.

Appendix A

Table A1. Morphosyntactic composites in English and Spanish derived from performance on Test of Narrative Language in English and Spanish.

TNL Item Type	English Items	Spanish Items
Temporal relationships—uses one or more adverbial phrases or clauses between actions or events	Task 4, #19 Task 6, #8	Task 4, #20 Task 6, #8
Causal relationships—indicates causal relationships between actions or events; using (because, so that, since, in order to …)	Task 4, #20 Task 6, #9	Task 4, #21 Task 6, #9
Grammaticality—uses grammatically correct sentences without errors	Task 4, #21 Task 6, #15	Task 4, #22 Task 6, #15
Tense—uses the same tense throughout the story	Task 4, #22 Task 6, #14	Task 4, #23 Task 6, #14
Reference—consistent references to characters; appropriate pronoun use	Task 6, #13	Task 6, #13
Total items:	**18**	**18**

Appendix B

Table A2. Morphosyntactic cloze composites [a], derived from Bilingual English Spanish Assessment [b] and Bilingual English Spanish Assessment—Middle Extension [c].

English Forms	Example	# of items on BESA	# of items on BESA-ME
Progressive	They **are** watch**ing**	3	–
Negative	Does**n't** like	3	2
Plural	Apple**s**	3	3
Possessive	Duck**'s** eggs	3	3
Third-person singular	Play**s**	3	4

Table A2. *Cont.*

English Forms	Example	# of items on BESA	# of items on BESA-ME
Copula	Flower **is** pretty	3	2
Passive	Dog **was chased**	3	4
Past	**Walked** the dog	3	4
Irregular past	**Ate** the banana	–	4
Question inversion	**What is** it … ?	–	6
Prepositions	On the plate	–	2
Relative clause	Dog **that has black fur**	–	3
Spanish forms	**Example**	**# of items on BESA**	**# of items on BESA-ME**
Progressive	La niña **está** nad**ando**	3	–
Article	**Unas/las** manzanas	4	3
Direct object clitic	Él **los** abraza	4	3
Subjunctive	Quiere que com**an**	4	6
Irregular past	La niña **fue**	–	4
Prepositions	**Encima de** la mesa	–	2
Negative	**No** tiene	–	3
Relative clause	Niño **que juega con la pelota**	–	4
Adjective	Zapato morad**o**	–	4
Conditional	Ir**ía**	–	5
Imperfect past	Ella nad**aba**	–	4

Note: [a] = scores on items in composites were summed and converted to percentages; [b] = *Bilingual English Spanish Assessment* (BESA; Peña et al. 2018); [c] = *Bilingual English Spanish Assessment—Middle Extension Field Test Version* (BESA-ME; Peña et al. 2016).

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