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Play-Based Assessment: Psychometric Properties of an Early Childhood Learning and Development Assessment Battery

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Abstract: This study aims to explore the reliability, construct validity, and content validity of the *Child Learning and Developmental Playful Assessment Battery* (*Batería de Evaluación Lúdica del Aprendizaje y Desarrollo Infantil;* BELADI), a quantitative instrument based on the authentic assessment and playful learning principles, the purpose of which is to assess infant learning and development through motor and competitive games as well as storytelling. The sample was composed of 113 children from Albacete (Spain) between 58 and 72 months of chronological age (M = 64.72; SD = 3.671). To explore the content validity, an expert judgement was carried out and the Content Validity Coefficient (CVC) was calculated. The reliability was analysed using the Cronbach's alpha and McDonald's Ω, and an exploratory factor analysis (EFA) was conducted. The results revealed high reliability indexes in each of the developmental domains, and the EFA included 11 items distributed in two factors for the psychomotor domain, 27 items grouped in three factors for the cognitive domain, and 20 items divided into four factors for the socioemotional domain. In conclusion, the study verifies the validity and reliability of the BELADI for the assessment of the infant learning and development through play, which may be used in research, education, and psychopedagogy.

Keywords: play; authentic assessment; learning; development; early childhood education; exploratory factor analysis; psychometric properties

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1. Introduction

Play has become a controversial element in the various fields related to education [1]. On the one hand, theoretical approaches such as playful learning places play as a key component for children's development and learning in the early childhood stage [2]. On the other hand, the reality in the early childhood education classrooms reveals a lack of pedagogical intentionality from the teacher when it comes to planning the spaces and moments for play [3]. Furthermore, there is a decreasing amount of time devoted to play due to the curricular requirements and the increasing emphasis on child development and learning assessment processes [3].

Play and assessment in early childhood education seem to be historically antagonistic elements, as enemies whose destiny is to prevail one against the other [4]. However, beyond traditional understandings, authentic assessment holds up as an approach capable of unifying both concepts, emerging as the play-based assessment: an alternative assessment approach which entails a concrete expression of the authentic assessment, based on the systematic observation of children's behaviour and skills in a flexible environment during a period of play [5–8]. Likewise, it could be referred to as playful assessment when the games implemented during the assessment fulfil the principles of playful learning [9], which state that the experience must be lived from enjoyment and social interaction, helping children to find meaning in what they are learning, involving an iterative thought process that is actively engaging and requires concentration [10]. Therefore, the reasoning behind this approach is that, while play is one of the best means for learning and development, it may also be one of the best means for assessment [11].

Moreover, the central role of play in the assessment process makes play-based assessment directly connected to the developmentally appropriate practices (DAP) principles, a method which uses an approach based on strengths and play as components to promote optimal development and learning [8,12]. In the same way, play-based assessment is linked to the early childhood learning trajectories (ECLT), which explain how children develop and state that play constitutes a key factor in the observation of children's learning and development [13].

Although a growing volume of research has shown interest in the role of play as a basis for assessment in early childhood education during the last decade [14,15], there is still a lack of updated research on this topic [16]. Authors such as Barcenilla and Levratto [4] highlight the difficulty for play-based assessment instruments to achieve adequate levels of validity and reliability. In contrast, research such as that conducted by Duncan and colleagues [14], who developed the *Early Language in Play Settings* (eLIPS) for the assessment of expressive and receptive language in early childhood education, reported high reliability and good validity—as did the study by Kaugars and Russ [17], who developed *Affect in Play Scale-Preschool* (APS-P) for the assessment of aspects related to children's socioemotional and cognitive development, with high validity and reliability indices.

On this matter, a previous study based on a systematic review of 55 studies and 41 developmental assessment instruments revealed few instruments that assess specific aspects of learning and development—understood as psychomotor, cognitive and socioemotional—through play, with there being no evidence that play-based assessment tools are capable of comprehensively and efficiently assessing child learning and development [18]. In fact, only one instrument was found for this purpose, namely the Transdisciplinary Play-Based Assessment 2 (TPBA-2) [19], which had several limitations pointed out by Bolton [20], such as a small sample size, lack of information about validity and reliability, as well as the requirement to have several people trained to administer and interpret the test, which may require information about the deviations of the evaluators over time. It should be noted that the results of this study were consistent with those of previous research, such as that of Barcenilla and Levratto [4].

Furthermore, in this previous study, the systematic review of the 41 instruments enabled the identification of the dimensions that showed the greatest coincidence in order to comprehensively assess children's learning and development when aged 2–7 years [18]. These dimensions were categorised on the basis of the definitions and theoretical approaches that the authors used to describe each dimension in their instruments, making it possible to classify them on the basis of frequency of agreement between these definitions. Therefore, of the total number of instruments assessing the psychomotor domain, 62.5% agreed in assessing the *gross motor skills of locomotion*, 43.75% in *gross motor skills of object control*, and 18.75% in *fine motor skills*. As for the instruments assessing the cognitive domain, 96.43% coincided in assessing *emergent literacy skills*, while 60.71% coincided in assessing both *logical-mathematical skills* and *executive functions*. Finally, in the socioemotional domain, 50% of the instruments agreed in assessing *social skills*, 21.43% did the same for *aggression*, *disconnection,* and *emotional recognition*; and 14.23% coincided in assessing *anxiety* and *external influences on emotions* [18].

Thus, the definitions of the dimensions identified in that previous study, which constitute the key and starting point of this research, will be evinced and expanded upon below. It should be noted that, although development has been widely defined in the scientific literature on the basis of three distinct domains –cognitive, socioemotional, and psychomotor– [21,22] these should not be understood as the isolated parts of the same construct, but as interrelated and interdependent elements [22,23].

Taking all the above-mentioned into account, the psychomotor domain includes the *fine motor skills*, the *gross motor skills* of *locomotion*, and the *gross motor skills of object control*.

Some authors [24,25] define the constructs of the mentioned dimensions, with *fine motor skills* being those that use small body segments and that are associated to manual dexterity activities. The *gross motor skills of locomotion* are based on moving, jumping, turning, and balance, whereas the *gross motor skills of object control* refer to throwing, catching, and hitting [26].

In the cognitive domain, there are the *emergent literacy skills*, the *logical-mathematical skills,* and the *executive functions*. On the one hand, the emergent literacy skills are defined as an ensemble of knowledges and skills that precede reading and writing development [27], in which there are *phonological awareness*, *alphabet knowledge*, the *understanding of texts structure*, *expressive language*, and *receptive language* [28,29]. Breaking down each of these skills, *phonological awareness* is defined as the metalinguistic ability that allows one to acquire a conscious sensitivity about the spoken language structure and its phonological segments, as it includes processes of identification, segmentation, or intentional combination of sub-lexical unities of words [30–32]. Moreover, the *alphabet knowledge* means the understanding of letters, its forms, and the sounds attributed to them [33]—while the *understanding of texts structure* is the capability of identifying the characters, places, events, and parts (beginning, development, and ending) in a story [34]. In order to conclude with the *emergent literacy skills*, *expressive language* refers to the capability to use verbal and nonverbal language to express and relate using semantic, morphological, and syntactic skills; while receptive language is the capability of understanding, processing, and responding to verbal and nonverbal language through semantic, morphological, and syntactic skills [35,36].

On the other hand, the *logical-mathematical skills* include the *geometry and patterns* as well as the *number* and *arithmetic* subdimensions. The *geometry and patterns* subdimension is defined as the recognition of forms and spatial images and their characteristics, as well as the copy, extension, and interpolation of patterns [37]. The *number* subdimension refers to counting and number sequences, the understanding of the importance of number 10, subitisation, cardinality understanding, and comparing numerical magnitude [37,38]. Regarding arithmetic, it assesses the ability to add and subtract with different assumptions [39].

The last dimension in the cognitive domain refers to the *executive functions*, which are an ensemble of complex cognitive skills that are fundamental for the individual to adapt the behaviours and direct them towards the achievement of an objective [40]. Among these skills is the *working memory*, defined as the ability through which the brain temporarily stores a limited amount of information and manipulates it, remembering or ignoring what is relevant for the resolution of a problem [41,42]. *Inhibitory control* is the capability of confronting an inner predisposition or external impulse, automatically inhibiting and controlling the attention, behaviour, thoughts and/or emotions that are happening, favouring selective and sustained attention [42]. Ending with this dimension, *cognitive flexibility* involves processes related with working memory and inhibitory control and is the ability to shift between task or responses with fluency, being able to adapt to the changes or needs of the environment, to think differently, to change perspective, to recognise mistakes and to learn from them [42,43].

Lastly, in the socioemotional domain, the dimensions can be separated into *emotion recognition*, *external influences on emotions*, *social skills*, *aggressiveness*, *disconnection,* and *anxiety*. *Emotion recognition* is the ability to identify and label emotions associated with facial expressions [44]. The dimension *external influences on emotions* is defined as the understanding about how certain situations can influence the emotional state [45]. Regarding *social skills*, they can be defined as the learning and socially accepted behaviours that allow us to have a positive interaction with others, appropriate to the social expectations and rules [46]. Quite the opposite, the dimension *aggressiveness* makes reference to those antisocial behaviours that involve provocation and/or participation in fighting games –understood as games that use feigned forms of physical and/or verbal violence, which can lead either to unintentional aggression at the aim of the play or to an actual fight, as well as to verbal and/or physical aggression to others [47,48]. In the same way, *disconnection* is the state of solitude and isolation in which the child shows unwillingness to participate in play [49]. Finally, the dimension *anxiety* indicates behaviours wherein the child feels distressed, depressed, preoccupied, and insecure [50].

Therefore, taking into consideration the previously defined dimensions, the *Child Learning and Developmental Playful Assessment Battery (Batería de Evaluación Lúdica del Aprendizaje y Desarrollo Infantil*; BELADI) was created, whose design is based on the playful learning principles, the DAP, and the ECLT [8,10,12,13], as it fosters the ecological validity of the battery [51,52]. This instrument is meant to be a tool for the observation and initial assessment of children's learning and development for any professional working in early childhood education contexts, especially for teachers, as they are key agents in the detection of learning and developmental disorders in children [53–55]. In short, the present research aims to explore the reliability, the construct validity, and the content validity of the BELADI.

2. Materials and Methods

2.1. Sample

A total of 113 children (*n* = 65, 57.5% boys, *n* = 48, 42.5% girls) aged between 58 and 72 months of chronological age (*M* = 64.72; *SD* = 3.671) from the city of Albacete (Spain) participated in the study. Non-probabilistic sampling by convenience was used, under the criterion of including children in the 5-year-old early childhood education classrooms, with the autonomy to carry out the activities in the test battery. Students with special educational needs who require significant support—such as motor disorders, autism spectrum disorder, etc.—and who find it difficult to carry out the proposed activities independently were excluded.

2.2. Instrument

The instrument designed is titled *Child Learning and Developmental Playful Assessment Battery* (*Batería de Evaluación Lúdica del Aprendizaje y Desarrollo Infantil;* BELADI). Its aim is to assess the child learning and development process through four sessions of playful strategies based on motor and competitive games and storytelling. The test battery is applied using various groupings in four different moments, the time of application being flexible and versatile according to the characteristics and necessities of the group to be evaluated. It is designed so that it can be applied by anyone with training as a teacher, in psychology, in psychopedagogy, as an occupational therapist, or by educational researchers. The construction of its dimensional structure was based on a systematic review of 41 child learning and developmental assessment instruments [18]. In addition, for the constitution of items suitable for children aged between 4 and 6 years, the structure, procedures, and correction criteria of 21 instruments (see Appendix A) and five additional scientific articles were reviewed [30,41–43,56]. It should be noted that this process of item construction is aligned with research procedures such as the OECD [57] in the design of the Survey on Social and Emotional Skills (SSES). Thus, the battery is divided into three domains as follows:

The psychomotor domain contains three dimensions: *fine motor skills* (8 items), the *gross motor skills* of *locomotion* (11 items), and the *gross motor skills of object control* (5 items). Some examples of these items can be seen in Table 1.

The cognitive domain is made up of three dimensions: *emergent literacy skills*, encompassing *phonological awareness* (7 items), *alphabet knowledge* (2 items), *understanding of texts structure* (2 items), *expressive language* (6 items), and *receptive language* (5 items); the *logical–mathematical skills*, encompassing *geometry and patterns* (13 items), *number* (6 items), and *arithmetic* (2 items); and the *executive functions* (8 items), encompassing *working memory* (3 items), *inhibitory control* (2 items), and *cognitive flexibility* (3 items). Some examples of these items can be seen in Table 2.

Table 1. Examples of psychomotor domain items.

Code	Item
FMS2	Draws an asterisk
FMS3	Draws a circle
FMS6	Buttons
GMSL2	Moves laterally with fluidity
GMSL5	Jumps with feet together over a rope 15 cm above the ground
GMSL6	Jumps on one foot with the left foot at least three times in a row
GMSOC1	Throws ball in direction of target with dominant hand
GMSOC4	Kicks a static ball in the direction of a target

Table 2. Examples of cognitive domain items.

Code	Item
PA1	Constructs meaningful sentences from one word
PA2	Recognises the number of words in a sentence
EL1	Can make simple nouns
EL6	Expresses adverbs appropriately
RL5	Recognises sets of words
WM1	Remembers specific instructions and puts them into practice
IC2	Names the opposite element
CF3	Handles two instructions at the same time
GP2	Identifies the shape and characteristics of a square
GP6	Identifies the shape and characteristics of a rhombus
GP12	Identifies the missing pattern of a series
N2	Counts between two numbers and writes them
N3	Identifies which numbers are larger or smaller than others

The socioemotional domain includes six dimensions: *emotion recognition* (5 items), *external influences on emotions* (3 items), *social skills* (9 items), *aggressiveness* (6 items), *disconnection* (4 items), and *anxiety* (4 items). Examples of these items can be seen in Table 3.

Table 3. Examples of socioemotional domain items.

Code	Item
ER2	Identifies who is happy
ER5	Identifies who is surprised
EI2	Recognises situations likely to provoke sadness or anger
SS1	Cooperates with peers
SS3	Listens to others when it is his/her turn
SS8	Respects turns without needing to be told
AG6	Physically assaults others during play
D3	Places him/herself as a spectator of the game

In the cognitive and psychomotor domains, and in the dimensions *emotion recognition* and *external influence on emotions* in the socioemotional domain, each item is assessed by a rating scale of 0 (not achieved) or 1 (achieved). In specific cases, items can reach 2 points depending on the student's level of achievement. The items of the remaining dimensions in the socioemotional domain are rated by a 5-points Likert scale, comprising 1 (never) and 5 (always). It should be noted that two items in the dimension *executive functions* (cognitive domain) have a response range between 0 and 10 points, depending on the number of correct actions performed. The result of each dimension is extracted adding the points obtained on each of its items, and a score of each domain can be calculated totalling the points of each dimension. In addition, an overall development score can be obtained by adding the scores of the three domains.

2.3. Procedure

Authorisation was obtained from the institution's Social Studies Ethics Committee, and informed consent was sought from all participants. The instruments validation was conducted in two stages. Firstly, an expert judgement was carried out in September and October 2023 composed of three experts: a graduate in psychopedagogy and early childhood and primary education teacher, a school counsellor, and a researcher in the area of specific didactics and research methods. The experts rated each of the scale items according to the criteria: (1) relevance of the item to the dimension content; (2) appropriateness of the item to the dimension content; (3) clarity of item wording; and (4) appropriateness of the correction criteria for each item. Since the experts were informed that the instrument was intended to be applied on a sample of children aged 4–6 years, the assessment of the relevance of the items for this age group was in the evaluated criteria. The criteria were rated quantitatively using a 4-point Likert scale between 1 (none) and 4 (excellent). Compiling the expert's opinions, modifications were made to the wording and correction criteria in nine items, without restructuring the established dimensions. After this process, a content validity analysis was conducted using the Content Validity Coefficient (CVC) [58].

Concurrently, a pilot-test was conducted in October in order to verify that the instructions and activities were understandable for the children. Likewise, the applicability of the instrument was tested in terms of duration, groupings and feasibility. This procedure was performed in a school of Albacete, with a classroom of 13 children that were 5 years old. Feedback from the pilot-test showed the need to distribute the items and actions more evenly across the sessions.

After that, the data collection period began. The application of the battery was based on four play sessions of motor and competitive games as well as storytelling. In all of them, the evaluator was a facilitator of the implemented games, being part of the play experience together with the children. The data were therefore collected through the direct and systematic observation of the children's behaviour and responses. The first play session was a motor story based on the Disney movie *Tarzan*. The children had to complete different motor challenges that occurred throughout the activity, executing diverse skills of moving, jumping, balancing, throwing, catching, and hitting objects to overcome the obstacles they encountered. These challenges were set in the development of the story and involved the assessment of *fine and gross motor skills*, as well as others related to *executive functions*, *expressive language,* and *geometry and patterns*. It should be noted that this play session was videotaped by means of two cameras that allowed us to observe a complete view of the room, in order to be able to watch a posteriori the motor skills that each of the children were executing in order to evaluate them, given the complexity of observing these skills simultaneously in situ in the children in the participating group.

The second play session was based on a storytelling of the Disney movie *Lilo and Stitch*. This involved different activities such as handicrafts, riddle games, counting, and arithmetic dynamics for problem solving, etc., in which the characters in the story needed the help of the participating children to solve the situations that arose and to be able to move forward until they reached the outcome of the story. In this play session, *logical-mathematical skills*, *executive functions*, *emotion recognition*, and *external influences on emotions* were evaluated.

The third and fourth play sessions were related and were based on a gymkhana entitled *The Word Contest*. The children were divided into teams of a maximum of five participants, who had to compete individually in each session over five bases using a format similar to a television quiz show, in which the children had to solve riddles, offer quick answers to situations or problems posed, inhibit behaviours according to the instructions given, use elements of verbal expression to be able to pass a challenge, etc. The aim of the contest was to achieve the highest possible "score" for the team. *Emergent literacy skills* and *executive functions* were assessed in these play sessions.

The number of children included in the groupings for the play sessions was flexible, depending on the size of the group to be evaluated. In the first and second play sessions, the group was divided into 2 halves of maximum 13 participants each, while in the third and fourth play sessions, the children were divided into groups of a maximum of 5.

The measures were recorded in situ by a single researcher, except for those relating to motor skills which, as mentioned above, were recorded a posteriori once the videotape had been viewed. It should be noted that the assessment of the dimensions of *social skills*, *aggressiveness*, *disconnection*, and *anxiety* were carried out by the person responsible for the group being assessed, given the deeper and more significant knowledge they had of the children's behaviours, which are difficult to appreciate by direct observation at a certain moment in time [59,60].

After data collection, the second phase of the study was carried out, in which a reliability and construct validity analysis through an exploratory factor analysis (EFA) was conducted.

2.4. Data Analysis

The data processing performed using Microsoft Excel and the statistical software Jamovi 2.5.1. To calculate the content validity, the content validity coefficient (CVC) [58] was used, which is appropriate for use with a minimum of three experts [61]. The CVC is first calculated for each item, represented by j, according to the formula $CVC_j = \overline{x}_j / V_{max}$, where $\overline{x}$ is the experts' average score for each item, and V_{max} the maximum score that each item can reach. This method takes into account the possibility of bias by experts, with it being calculated that $Pe_j = (1/k)^k$, where k is the number of experts. Finally, $CVC = CVC_j - Pe_j$. Furthermore, the total CVC was calculated for each developmental domain by averaging the coefficients of each of its items.

Regarding the analysis of the reliability and the construct validity, previously, negative formulated items were recoded, as well as those items for which the rating scales were not dichotomous. Items that were scored on a scale of 0 (not achieved), 1 (in progress), and 2 (achieved) were recoded, with 0 and 1 being scored as 0 (since an item in progress is an item not achieved at the time it is assessed), while the score of 2 was scored as 1. Typed scores (or z-scores) were taken into consideration to dichotomise items whose scale was based on a range of achieved responses between 0 and 10, as well as those based on a 5-point Likert scale. Scores equal to or below 0 were scored as 0, while all scores above 0 were scored as 1. The decision to use z-scores to dichotomise items is motivated by their proven potential to form dimensionless units that do not depend on the unit system of the variables, favouring the comparability of scores, as well as constituting part of the linear transformation process that allows the equating of scores with different response ranges [61].

Afterwards, an analysis of the reliability of each of the battery domains was carried out. Before the calculation, the Homogeneity's Index Corrected (IHc) was extracted in order to remove those items that could diminish the reliability of the scale. Then, internal consistency was calculated through Cronbach's Alpha and McDonald's Ω reliability coefficients.

Finally, an EFA considering the Bartlett's sphericity test and the Kaiser–Meyer–Olkin test was conducted. The EFA was performed using the extraction method of *minimum residual* or *unweighted least squares*, due to the fact it is a highly recommended method when there are small samples and an elevated number of variables, as it prevents the occurrence of cases with saturations greater than the unity and negative error variances [62,63]. Likewise, an oblique rotation (*promax*) was used, specially recommended as it supposes a realistic approach to factoring a solution in the social sciences that assume correlations between factors [64]. The advantages of *promax* can be explained by the fact it allows such correlations between factors, it is simpler to calculate, and it is more useful in large data sets [65,66].

3. Results

3.1. Content Validity

In order to verify content validity, CVC was calculated for each of the three developmental domains—psychomotor, cognitive, and socioemotional—that compose the battery (see Table 4). Results showed high coefficients of validity and concordance, which are good in the psychomotor and developmental domains (0.88–0.89) and excellent in the socioemotional domain (0.92) [58].

Table 4. Content validity coefficient for each domain.

Domain *	CVC
PSY	0.89
COG	0.88
SE	0.92

* Note: PSY—Psychomotor; COG—Cognitive; SE—Socioemotional.

3.2. Reliability

Subsequently, a reliability analysis was conducted for each of the three domains that constitute the battery. Based on the IHc and considering 0.15 as the criterial value for item exclusion [67], 18 items were removed. Five of these items belonged to the psychomotor domain, of which three referred to *fine motor skills* (manual dexterity), one to *gross motor skills of locomotion* (movement), and one to *gross motor skills of object control* (kicking); seven items in the cognitive domain, of which two pertained to *executive functions* (*working memory*), one to *logical-mathematical skills* (*number*), and four to *emergent literacy skills* (one to *understanding of texts structure*, two to *receptive language,* and one to *expressive language*); as well as six items in the socioemotional domain, three pertaining to *emotion recognition* and three to *external influences on emotions*.

Following the deletion of the above-mentioned items, a reliability calculation was made using Cronbach's alpha and McDonald's Ω (see Table 5), obtaining an acceptable internal consistency (above 0.70) in the psychomotor domain and excellent internal consistency (0.88–0.90) in the cognitive and socioemotional domains.

Table 5. Reliability indexes.

Domain *	Cronbach's Alpha	McDonald's Ω
PSY	0.73	0.78
COG	0.88	0.89
SE	0.89	0.90

* Note: PSY—Psychomotor; COG—Cognitive; SE—Socioemotional

3.3. Construct Validity

Finally, an EFA was conducted to verify the construct validity. The results of Bartlett's sphericity test (PSY: χ^2 = 300; p > 0.001/COG: χ^2 = 918; p > 0.001/SE: χ^2 = 1548; p > 0.001) and the Kaiser–Meyer–Olkin test (PSY: KMO = 0.772/COG: KMO = 0.729/SE: KMO = 0.840) allowed us to rule out that the correlations between items constituted an identity matrix. Four items were removed from the cognitive domain based on the KMO test, with values below 0.50 [68], two of which belonged to the *executive functions* dimension (*working memory* and *cognitive flexibility*), one to *emergent literacy skills* (*understanding of texts structure*), and one to *logical-mathematical skills* (*number*). Analysing the structure extracted from the EFA, there were 26 items removed with factor loadings that were negative or below 0.30 [69].

Of the items removed, eight belonged to the psychomotor domain, counting three relating to *fine motor skills* (manual dexterity), three relating to *gross motor skills of locomotion* (movement and balance), and two relating to *gross motor skills of object control* (catching and kicking). Likewise, in the cognitive domain, thirteen items were removed, with six relating to *logical-mathematical skills* (five of *geometry and patterns* and one of *number*), four from the dimension of *emergent literacy skills* (two of *phonological awareness* and two of *expressive language*), and three referring to *executive functions* (two of *inhibitory control*, and one of *cognitive flexibility*). Finally, in the socioemotional domain, five items were removed, comprising three relating to *social skills* and two from the *emotion recognition* dimension.

All in all, in the psychomotor domain, a two-factor solution was obtained (see Table 6). Factor 1 grouped two items related to manual dexterity abilities, with four items related to jumping abilities (two of which combine balance), and one item is related to balance. Factor 2 grouped two items related to throwing abilities and two items associated with moving skills.

Table 6. EFA results in the psychomotor domain.

Dimension	Ability	Item	Factor	
			1	2
Fine motor skills	Manual dexterity	PS_HMF6 PS_HMF7	0.597 0.356	
Gross motor skills of locomotion	Jumping Jumping Jumping and balance Jumping and balance Balance	PS_HMGL4 PS_HMGL5 PS_HMGL6 PS_HMGL7 PS_HMGL11	0.639 0.399 0.383 0.863 0.457	
Gross motor skills of object control	Throwing	PS_HMGCO1 PS_HMGCO2		0.762 0.411
Gross motor skills of locomotion	Moving Moving	PS_HMGL1 PS_HMGL3		0.644 0.512

Regarding the cognitive domain, a three-factor solution was obtained (see Table 7). Factor 1 grouped seven items of *emergent literacy skills* (four of *phonological awareness*, two of *alphabet knowledge* and one of *expressive language*), three items of *logical–mathematical skills* (two of *geometry and patterns*, and one of *arithmetic*), and one item of *executive functions* (*cognitive flexibility*). Factor 2 grouped five items of *logical–mathematical skills* (two of *number*, two of *geometry and patterns*, and one of *arithmetic*), and one of *emergent literacy skills* (*expressive language*). Factor 3 was composed of five items of *logical–mathematical skills* (four of *geometry and patterns*, and one of *number*) and five items of *emergent literacy skills* (three of *receptive language*, one of *expressive language*, and one of *phonological awareness*).

Table 7. EFA results in the cognitive domain.

Dimension	Subdimension	Items		Factor		
				1	2	3
Emergent literacy skills	Phonological awareness	Isolate phonemes	COG_CF3	0.328		
		Omission of syllables	COG_CF4	0.613		
		Counting syllables	COG_CF5	0.309		
		Words construction	COG_CF6	0.816		
	Alphabet knowledge	Letter dictation	COG_ABC1	0.759		
		Letter writing	COG_ABC2	0.471		
	Expressive language	Adverbs	COG_LE6	0.358		
Logical–mathematical skills	Geometry and patterns	Oval	COG_GP5	0.551		
		Rhombus	COG_GP6	0.375		
	Arithmetic	Subtraction	COG_AR2	0.358		
Executive functions	Cognitive flexibility	Mistake recognition	COG_FC1	0.484		

Table 7. *Cont.*

Dimension	Subdimension	Items		Factor		
				1	2	3
Logical–mathematical skills	Number	Counting	COG_N1		0.507	
		Comparing numerical magnitudes	COG_N3		0.628	
	Geometry and patterns	Seriation	COG_GP11		0.697	
			COG_GP13		0.946	
	Arithmetic	Adding	COG_AR1		0.315	
Emergent literacy skills	Expressive language	Utility of objects	COG_LE4		0.685	
Logical–mathematical skills	Geometry and patterns	Triangle	COG_GP1			0.439
		Square	COG_GP2			0.503
		Circle	COG_GP3			0.473
		Interpolation	COG_GP12			0.384
	Number	Separation by halves	COG_N5			0.503
Emergent literacy skills	Receptive language	Chronological events	COG_LR1			0.526
		Prepositions	COG_LR3			0.373
		Sets	COG_LR5			0.589
	Expressive language	Verbs	COG_LE3			0.580
	Phonological awareness	Construction of sentences	COG_CF1			0.582

Finally, in the socioemotional domain, a four-factor solution was obtained (see Table 8). The groupings of the items were consistent with the previously established dimensions of *social skills* (factor 1), *aggressiveness* (factor 2), *disconnection* (factor 3), and *anxiety* (factor 4). It should be noted that the EFA removed the dimensions of *emotion recognition* and *external influences on emotions*.

Table 8. EFA results in the socioemotional domain.

Dimension	Item		Factor			
			1	2	3	4
Social skills	Cooperate	HS1	0.783			
	Share	HS2	0.875			
	Help	HS4	0.867			
	Integrate	HS5	0.914			
	Participate in group play	HS6	0.646			
	Complies with rules	HS9	0.672			
Aggressiveness	Gets involved in fighting games	AG1		0.816		
	Starts fighting games	AG2		0.923		
	Discuss	AG3		0.612		
	Teases	AG4		0.774		
	Verbally assaults	AG5		0.747		
	Physically assaults	AG6		0.829		
Disconnection	Isolation	D1			0.752	
	Wandering	D2			0.895	
	Play spectator	D3			0.726	
	Without interest	D4			0.737	
Anxiety	Worried	ANS1				0.761
	Frightened	ANS2				0.764
	Cries easily	ANS3				0.793
	Seeks approval	ANS4				0.494

After the EFA, a new reliability analysis was carried out to verify the extent to which each of the factor solutions affected its internal consistency. An increase in reliability was obtained in the psychomotor domain with respect to the pre-AFE analysis, and a decrease in the cognitive and socioemotional domains (Table 9). This did not noticeably affect the reliability of the instrument, as the differences were barely between one and three hundredths of a point, while the indices continue to show a high rate of internal consistency.

Table 9. Reliability indexes post EFA.

Domain *	Cronbach's Alpha	McDonald's Ω
PSY	0.76	0.80
COG	0.85	0.86
SE	0.89	0.89

* Note: PSY—Psychomotor; COG—Cognitive; SE—Socioemotional.

4. Discussion

Based on the above-mentioned results, it is possible to evince the achievement of the proposed objective, making it possible to address the main gap in the field of research, namely the lack of instruments for comprehensively and efficiently assessing children's learning and development through play [4,18]. The BELADI aims to overcome the limitations outlined by Bolton [20] about one of the precursor instruments using the play-based assessment approach, the TPBA 2 [19], creating an efficient instrument for multiple contexts and professionals, which does not require more than one evaluator to apply. In addition, the sample size is sufficient to be able to carry out this EFA [61,70], as will be explained in detail in the limitations section. Likewise, authors have pointed out the lack of the empirically demonstrable reliability and validity of play-based assessment instruments [4]. In this sense, the BELADI solves this limitation by obtaining high content validity coefficients and internal consistency indexes by means of the CVC, the Cronbach's alpha, and McDonald's Ω. In summary, the BELADI offers a significant contribution to the field of study, demonstrating that an assessment of learning and development in early childhood education, conducted in a natural play context, is possible by means of a practical and efficient approach which does not detract from the guarantee of adequate psychometric properties.

Likewise, the exploration of the factors has allowed us to delimit the composition of each BELADI domain. Based on the factorial solution extracted from the EFA, it can be seen how the dimensions in the psychomotor and cognitive domains differ from those previously constituted on the basis of the systematic review carried out in a previous study [18], whereas in the socioemotional domain, groupings are maintained, except for the elimination of the dimensions of *emotion recognition* and *external influences on emotions*.

4.1. Psychomotor Domain

In the psychomotor domain, 11 items of the 24 proposed remained. As authors such as Carvajal and colleagues [71] point out, the validation of an instrument is a continuous and dynamic process, so that changes in the configuration of the items are part of the natural process of validation [72]. In this case, the elimination of the items in this domain was coherent, given that they repeatedly assessed the same skills as those items that remained in the factorial solution, showing an excess of indicators referring to the same constructs. Proof of this is that there were eight items that assessed *fine motor skills* through manual dexterity. Of these, only two items remained (PS_HMGL6 and PS_HMGL7) that already assumed a functional assessment of this construct, as the rest of the measures did not provide an assessment of aspects that could be complementary. The same was the case for balance within the *gross motor skills of locomotion*. A total of six items were proposed to assess this skill, of which three items remained as they were more complex to perform correctly by the children.

Taking into account the above, the EFA shows two clearly differentiated factors. On the one hand, both factors have tended to group items on the basis of the particular skills with which they are associated. On the other hand, although it is a clear differentiation between the motor skills, the first factor groups the *fine motor skills* (manual dexterity) with the *gross motor skills of locomotion*, specifically with jumping and balancing. However, this grouping is aligned with the findings of several studies [73,74] that highlights the existence of an interdependent functional relationship between the postural stability (inherent to the abilities of jumping and balancing) and manual dexterity. Therefore, this factor could be referred to as the *jumping, balancing, and manual dexterity skills* dimension.

Regarding the second factor, it unites the *gross motor skills of locomotion* with the *gross motor skills of object control*. Likewise, it is coherent due to these skills that can be categorised according to a broader construct, that is, the *gross motor skills* [26]. Thus, given its composition, this factor would constitute the dimension entitled *locomotion and throwing skills*.

4.2. Cognitive Domain

In the cognitive domain, the EFA offers three factors which group the items of the dimensions: *emergent literacy skills*, *logical–mathematical skills*, and *executive functions*. Of the latter dimension, only one of the items remains, referred to as *cognitive flexibility*. The factorial solution of this domain shows groupings no longer based on the type of ability but based on the acquisition of processes in accordance with the child's development. Thus, factor 2 groups the most elementary abilities, followed by factor 3, whereas in factor 1, the most complex abilities converge.

In this way, early numeracy skills are those basic logical–mathematical concepts, such as number knowledge (counting, comparison, etc.), geometry (triangle, circle, and square) and patterns, among others [75–77].

In accordance with that, factor 2 groups the most elemental cognitive processes related to the seriation skills (*geometry and patterns* items), which serve as a fundamental basis for the development of other early numeracy skills [78]. It also includes two items about number knowledge (counting and comparing numerical magnitudes). Precisely, comparing numerical magnitudes has been related to arithmetic [79,80], also present in this factor with an item which refers to addition. Following Martínez and Sánchez [81], it is a simple process that starts with counting, quickly processed by the brain, since it solves the problem moving forward along the numerical line through different strategies. Lastly, the factor also includes one item about *expressive language* (*emergent literacy skills*), related to the expression of the utility of objects. Gjicali and colleagues [82] affirm that expressive knowledge serves as a proper indicator of number knowledge, and therefore, of the representation of children's mathematical thinking. Therefore, this dimension can be referred to as *basic cognitive skills*.

Factor 3 groups the rest of the early numeracy skills. A *geometry and patterns* item appears related to the identification of a missing pattern (interpolating), which is identified with an increasing level of difficulty with regard to factor 2, since interpolating is a more complex skill than copying a series, which is acquired after the age of 4 years [83]. Basic geometry items include the recognition of triangle, circle, and square shapes and their characteristics. Traditionally, there are four basic geometric figures, adding the rectangle to those mentioned, which, in the present analysis, have been excluded, possibly because the differentiation between square and rectangle shapes occurs around the age of 5 years [84].

One item from the subdimension *number* is also incorporated into this factor, referring to splitting up 10 objects in two halves, which represents a task of greater complexity for the children due to it being based not only on counting abilities, but also the cardinality, classification, abstraction and generalisation, that promote children's reasoning about the numerical relationships between sets [85].

The items related to *emergent literacy skills* included in factor 3 involve all items measuring *receptive language*, one item of *expressive language* (verbal expression), and one item of *phonological awareness* (sentence construction). Language has been broadly linked to the development of the logical–mathematical skills [86,87], with it even being possible to build a specific linguistic construct of these skills, commonly named mathematical language, for which empirical evidence is connected with the acquisition of numerical skills at the early age [88].

Recent research places receptive language as an important predictor of early numeracy skills [89], which are present in this factor through *geometry and patterns*, and *number knowledge*. Likewise, the construction of sentences (*phonological awareness*) is closely related to language through the syntaxis, that is, the use and understanding of word order and word combinations to create meaningful phrases or sentences, and which is more sensitively and accurately related to mathematics performance [86]. Furthermore, for any sentence construction, the existence of a verb is essential [90], which is why it seems logical that this factor groups the expressive language item referring to verbal expression. Taking all of the above-mentioned into account, the dimension represented by factor 3 could be referred to as *cognitive skills in progression*.

Regarding factor 1, it groups the most complex abilities and processes in comparison with the rest of factors. The *logical–mathematical skills* include more complex geometric figures, like the rhombus, a figure that starts from the square and that is considered as unique, owing to it having a wide variety of qualities that allow children to better understand the characteristics of other figures [91,92]; and the oval, whose complexity in defining makes it difficult for children under 6 years of age to differentiate it from the circle [93,94]. This factor also includes subtraction, identified as a more complex process that depends on the acquisition of the addition skills. In early childhood education, "counting forwards is not the same as counting backwards, nor is calculating the transformation of a number when adding to it as when subtracting from it" [81] (p. 237).

The *phonological awareness* and the *alphabet knowledge*, both present in factor 1, are processes that significantly influence the *emergent literacy skills*, a dimension that predominate in this factor [95]. Because of the way in which one of the items related to *alphabet knowledge* is assessed in this battery, it can be assimilated into rapid automatised naming (RAN), defined as a complex process that puts into practice different cognitive capacities referring to the ability of naming letters, numbers, colours, etc., as quick as possible [96]. Despite the lack of strict time control, the stimuli are presented in a fluid manner, encouraging a quick response from the child. Although phonological awareness is related to logical thinking and solving mathematical problems [97], RAN shows a higher correlation with arithmetic, being a predictor, among others, of the subtraction skills, especially in those in single digits [98,99].

Finally, factor 1 includes one item of *cognitive flexibility* (*executive functions*). This ability has been related to alphabet knowledge and phonological awareness development through the linguistic skills of spelling and decoding letters and words [100]. It highlights its predictive capacity about learning to read [101] and its influence on mathematical performance in early childhood education, since it allows for the ability to switch between different strategies that promote an understanding of a concept or problem solving, which is the reason why it is directly linked to arithmetic [102,103].

Lastly, as in all other factors in this domain, one item appears, referred to as *expressive language* regarding the use of adverbs. In this sense, the bibliography centred in the acquisition of the Spanish language mentioned the increasing difficulty that the use of adverbs requires with respect to other grammatical categories, such as verbs [104]. Its justification resides in the adverb function itself, which is based in modifying verbs [105]. Given the theoretical argumentation presented, the dimension represented in this factor 1 could be labelled as *complex cognitive skills*.

4.3. Socioemotional Domain

In the socioemotional domain, the factor solution differentiates four factors that group the items based on the previously established dimensions: *social skills*, *aggressiveness*, *dis-*

connection, and *anxiety*. Different studies pointed out the relationship between social development and the behaviours related to aggressiveness [106], anxiety [107], and social skills [108,109]. The extracted factors required an ensemble of inner and external processes that starts with emotion recognition, and that allows emotions to be efficiently managed in order to respond to a stimulus, which corresponds to the process of emotional regulation [110]. In the same way, evidence has been found for the relationship between emotional regulation and the behaviours explored in the aforementioned dimensions, not only in childhood but also continuing into adulthood [111].

On the other hand, the EFA has deleted the dimensions of *emotion recognition* and *external influence on emotions*, which could be justified due to their pertinence to a broader construct, the emotional understanding, and fundamental for the socioemotional development in the early childhood stage [44,112]. Cavioni and colleagues [113] concluded that, from the age of 4 years, most children are capable of recognising basic emotions, being that, from the age of 5 years, most children can identify the external causes that influence emotions. Thus, if these processes are already assumed to be acquired at the ages explored, perhaps the assessment of emotional aspects should focus on more complex processes that begin to be present at these ages, such as emotional regulation [114].

All that, in addition to evidence from previous research exploring the relevance of assessing these aspects at the infant stage [18], demonstrates the consistency with which the EFA categorises the factors in this area.

4.4. Limitations

As possible limitations of the present study, it should be noted that both the convenience sampling method and the exclusion of children with special educational needs, which would make it difficult for them to carry out the proposed activities autonomously, could limit the generalisability of the study. Likewise, another possible limitation is related to the item recoding process. The transformation of the scores could affect the sensitivity of the construct being measured, since by using a dichotomous scale, part of the richness provided by having greater variability in the data could be lost.

Another possible limitation could be the sample size. Certainly, there are different positions on what the ideal sample size is for conducting factor analyses. As Pearson and Mundfrom [115] state, some authors defend a position in which a minimum of between 3 and 10 subjects per item is required [116–118]; while other authors defend a minimum sample size of subjects regardless of the number of items contained in the instrument [119–121]. In this sense, for the development of the present factor analysis, on the one hand, we are in a position of agreement with this second group of authors, including the premises of Hair and colleagues [70] and Tourón and colleagues [61], who state that a sample size of more than 100 subjects can be considered adequate in view of the characteristics of the study in question. On the other hand, we take into consideration evidence from authors such as de Winter and colleagues [122], who claim that conducting an EFA should not be rejected solely because of a small sample size, as it can reveal reliable factor solutions and valuable latent patterns, even under restrictive conditions.

Even so, it should be noted that this study is part of broader research. As a prospective work, it would be relevant to implement a confirmatory factor analysis of the battery with a significantly larger sample than the one presented in this study in order to verify the fit of the correlation matrix.

5. Conclusions

In conclusion, the BELADI materialises the definition of playful assessment through the constitution of a versatile and efficient instrument for the observation and initial assessment of children's learning and development in the educational environment for multiple purposes—teaching, psychopedagogical, and research—which overcomes the limitations referred to by Barcenilla and Levratto [4] in terms of psychometric properties, guided under the framework of playful learning, DAP, and ECLT, which confers ecological validity [8,10,12,13,51,52]. In this way, the factor structure of the BELADI supports a multidimensional understanding of children's learning and development, whose approach aligns with a globalised conception of these constructs, allowing for an appreciation of skills that transcend the boundaries of the theoretical categorisations of the initially conceived domains and dimensions [123]. This holistic approach coincides with the way in which the teaching–learning process is conceived in early childhood education to favour development and learning [124], guaranteeing the relevance of BELADI for the different purposes of any professional work at this stage.

The creation of the instrument and the first results of its reliability and validity suggest that a paradigm change is possible, where assessment ceases to be a tedious process for both the child and the teacher; where play is no longer a residual element but has a pedagogical purpose; where both assessment and play share their relevance and spaces that corresponds to them in current early childhood education; and, above all, where assessment and play are no longer antagonistic concepts, but friendly elements that were always destined to understand each other.

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Data Availability Statement: The datasets presented in this article are not readily available because the data belong to a larger study, a doctoral thesis, and its access is also limited by the permissions and procedures followed with the Ethics Committee on Social Research of the University of Castilla-La Mancha.

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Appendix A

Table A1. References of instruments reviewed for the item construction.

Instruments
1. Test of Gross Motor Development version 2 (TGMD-2) [125]
2. Movement Assessment Battery for Children (MABC-2) [126]
3. Escalas McCarthy de aptitudes y psicomotricidad para niños (McCarthy) [127,128]
4. Test de Desarrollo Psicomotor 2–5 años (TEPSI) [128]
5. Merril-Palmer-R [129]
6. Prueba para la Evaluación del Conocimiento Fonológico (PECO) [130]
7. Prueba de Lenguaje Oral Navarra (PLON-R) [131]
8. FACILITO [132]
9. Dynamic Indicators of Basic Early Literacy Skills (DIBELS) [133]
10. Phonological Awareness Literacy Screening for Preschoolers (PALS pre-K) [134]
11. Batería Neuropsicológica de Funciones Ejecutivas y Lóbulos Frontales (BANFE-2) [135]

Table A1. *Cont.*

Instruments
12. Evaluación neuropsicológica de las funciones ejecutivas en niños (ENFEN) [136]
13. Dimensional Change Card Sort (DCCS) [137]
14. Test de Memoria y Aprendizaje (TOMAL) [138]
15. Research-Based Early Maths Assessment Short Form (REMA-SF) [139]
16. Early Mathematics Assessment System (EMAS) [37]
17. Test para el diagnóstico de las competencias básicas en Matemáticas (TEDI-MATH) [140]
18. Emotion Matching Task (EMT) [141]
19. Preschool Play Behaviour Scale (PPBS) [142]
20. Child Behaviour Scale (CBS) [143]
21. Child Behaviour Rating Scale (CBRS) [144]

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