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Articles

Content validity of the Virtual Neurocognitive Tracking Test for child population

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Abstract

Objective: This research aims to validate the content of the Screening Test (PRANI) for children, focusing on the development of cognitive tests tailored to the Spanish-speaking population in Latin America.

Method: In this non-experimental, instrumental study, the psychometric properties of a new cognitive test were analyzed, focusing on theoretical validation rather than direct child population application. A panel of nine Child Neuropsychology experts assessed 149 items of a virtual neuropsychological test across five cognitive processes. They used a Likert-type scale for evaluation, focusing on criteria like relevance and writing quality. Content validity was established using the Aiken V coefficient and confidence intervals, emphasizing expert consensus in test development and refinement.

Results: The study resulted in the consolidation of an instrument, reducing the test length from 149 to 119 items by eliminating 30 elements. Significant variations were observed between the initial version of the instrument and the refined version after the expert ratings analysis, which evaluated cognitive processes such as attention, memory, language, visuoconstructive skills, executive functions, and academic skills. A comprehensive assessment of the instrument's content validity was obtained before and after the judges' analysis. Notably, the initial mean values of the Aiken V coefficients were high, both globally and by process and component.

Conclusions: This study highlights the importance and efficacy of developing culturally adapted cognitive assessment tools for children in Latin America, particularly in the Colombian child population. The findings emphasize the necessity for specific cognitive tests for this demographic, providing a reliable and validated framework for their implementation.

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1. Introduction

Access to tests that allow early detection of cognitive development in early childhood is limited. Many of these tests are adapted and adjusted from other countries, so it is necessary to create child cognitive tracking tests from a psychometric perspective in Latin America. This is why the need for cognitive tests adapted to the Spanish-speaking population arises. (Medina et al., 2015)

The Neurocognitive Screening Test (PRANI) is designed to identify and provide a general overview of the weaknesses and strengths that are found in the results of its application (Groppell et al., 2019). In the case of child neuropsychological assessment, there are only broad batteries of tests that extend over the evaluation time (Aygun et al., 2011). This poses a difficulty in applying instruments in this population due to the fact that attentional processes in childhood are reduced over time and can generate interferences in the application results. At this point, the need arises to have a general tracking of cognitive functions in order to determine what will be evaluated later in the final neuropsychological assessment and to have more accurate neuropsychological tests that will be applied to each patient. What has been identified is that tracking tests allow for a decrease in the application times of tests focused on the child population and to be more precise when evaluating cognitive indicators due to the decrease in neuropsychological application times (Medina et al., 2015).

To predict cognitive skills in children, it is necessary to understand the neurodevelopmental process, which is key to establish whether the age is in line with the acquisition of cognitive skills in childhood and to be able to establish whether they are developing according to the expected age (Mas Salguero, 2019). In this understanding, it is important to consider external factors that influence the development of cognitive processes, such as the family nucleus, academic access opportunities, nutrition, among others, which can be decisive in the results obtained in the measurement (Gómez, 2004)

1.1 Development of cognitive processes

The domains that make up the construction of this PRANI test are based on the development of cognitive domains, which refer to the growth of the structure and function of the brain and nervous system in relation to cognition and behavior, involving an interaction between genetically inherited and environmental experience (Woodburn et al., 2021)

1.2 The maturation of the cerebral cortex in childhood

The process of formation and consolidation of brain structures is characterized by dendritic developments, and the myelination of nerve pathways facilitate the rapid development of the brain after birth. The complexification of the cerebral cortex is correlated with the development of more cognitively elaborated behaviors (Rosselli & Ardila, 2016).

The beginning of early childhood and its relationship with cognitive development

This stage is between the second month and the sixth year of life, and is characterized by a greater elaboration of sensory, perceptual, and motor behaviors. At the first two years of life, as cited by Rosselli Cock and Ardila (2016), the child's brain presents an important development of cortical association pathways that coincides with a broad sensorimotor development and with the establishment of bases for the acquisition of more complex cognitive abilities (Alcauter et al., 2014)

Faced with this development of cognitive and structural maturation between 3 and 6 years, children are more skilled at cognitive processes, having a development in speech and language, and having a greater capacity for acquiring new knowledge and learning tools (Eslinger et al., 2022). These cognitive skills are expected to develop adequately between the ages of 6 to 7 years, and these processes are composed of attention, memory, language, visuoconstructive skills, and executive functions (Alex et al., 2023).

1.3 The development of the attentional process in childhood

One of the first cognitive processes that develops in childhood is attention, which is understood as a complex system of information processing and that allows learning the aspects of the environment that are vital for the learning of new skills and controlling other stimuli (distracting factors) (Casarin et al., 2012). This process is related to different neuronal areas, which would be involved in the reticular activating system, the thalamus, the limbic system, and the basal ganglia (Mesulam, 2000). As the child grows, he or she specializes in his or her cognitive attentional ability. According to Tipper et al. (1989), the attentional circuits are strengthened between the ages of 6 to 12, a stage in which they are potentiated in conjunction with processing speed, which has a positive influence on the elaboration and execution of the tasks of this process.

1.4 The development of memory in childhood

Another cognitive process that develops in parallel from childhood is the cognitive process of memory, which is characterized by taking information from a context or situation, recording it, encoding it, storing it and retrieving it when required; a fundamental process not only for learning new information but also for adaptation (Qin et al., 2014). There are three stages in the temporal process of memory: encoding, which is recognized as the ability to record information so that it can subsequently be stored and consolidated, which is recognized as the ability of the subject to store information with strategies, passing from a temporary memory store to a long-term memory store, and lastly, long-term evocation where the information that is recorded and encoded is evoked (Rosselli & Ardila, 2016). After 4 years, the hippocampus structure develops twice and continues its formation until the end of adulthood, this indicates that explicit or declarative memory, depends on other cognitive components such as attention and emotional elements such as motivation, because the creation of a memory is influenced by environmental factors and by the meaning that it has (Riggins et al., 2018). During childhood, and simultaneously, other processes such as language develop, which is vital for the adaptation, learning and communication of the child (Silva et al., 1987).

1.5 The development of language in childhood

The development of language is one of the communication processes that allows interaction with the environment (Rasgado-Toledo et al., 2021). It is defined as a specialized communication system that includes a series of elements such as oral and written signs, which have meaning at a social and cultural level. These elements allow us to abstract, conceptualize, categorize, associate, retain, remember, organize, control, learn, and communicate (Wolf & Pfeiffer, 2014)

Language acquisition is a slow process that begins from the moment the child interacts with their mother or caregiver. It goes hand in hand with motor development, although many authors maintain that the two are completely independent (Onnis, 2017). From the moment of birth to three months old, the child can only communicate by crying, as a way of expressing discomfort. From 3 to 12 months, the child enters the babbling stage, which is characterized by the appearance of sounds that the child repeats and reviews. Towards the age of one, the first word with communicative intent appears and the child is able to repeat simple words. In this period, the real verbal stage begins (Butterworth, 2014).

From 4 to 5 years old, the child begins to use communication effectively as a socialization tool. At this age, the structure and form of language are much more complete, since in this stage the maturation of verbal language is completed, allowing it to build symbols and other abstract constructions of language (Medina et al., 2015). Until the age of 6, the phonological system must be complete, including all phonemes in verbal expression and in syllable combinations (Rosselli & Ardila, 2016). At this point of evolution, the child needs other processes to be able to understand written language, and that is why they require another process known as visuoconstructional skills.

These skills are known as a complex and multi-component representational cognitive domain, independent of basic sensory and motor abilities (Rosselli, 2015). Within the components of these skills are: the praxic level, related to the execution of the complex motor action where a reproduction of steps or movements is carried out; the visual level, better defined as the representation of the visual characteristics and details of the object to be represented and of the reproduction; and the spatial level, which is the representation of the spatial (topographical) relations between the components of the model, which involve reproduction and semantic-conceptual memory, for example, in tasks that involve visual imagery of objects or figures (Lipsitt & Lewis, 2019), and for which structures such as cortical and subcortical systems are required, these are responsible for unifying and integrating the information from each sensory and semantic processing system.

In the face of these praxic processes, it is important to analyze that, from the first year, the child is progressively more skilled to perform motor acts with one hand. At three years of age, this manual asymmetry is clearly observed for constructional and graphic tasks, failing in its precision, since, at this age, children do not yet understand the parts of a visual pattern and fail to organize them within a whole, the spatial analysis that allows to understand each part and its relationship to form the figure is successfully reached between 6 and 7 years (Rosselli, 2015).

Finally, in the development of cognitive processes, there is the development of executive functions, which are understood as the skills that are developed with greater specialization for what corresponds to the adaptation of the human being in various contexts. This has a series of subcomponents that are understood by planning, abstraction, inhibitory control, among others. It should be noted that this starts from motor control, such as the inhibition of behaviors incompatible with the goal to be achieved and its maintenance in the action that it performs until its completion, until it reaches the regulation of the most complex cognitive processes such as the capacity for abstraction, planning or cognitive organization (Romero-Ayuso et al., 2020).

The development of executive functions is part of its anatomical relationship with the prefrontal cortex, where authors such as García Molina et al (2009), argued that they reach a significant development until the age of 12 and even until early adulthood, however, this has changed the way we look at it with evidence in preschool children, where some of their behaviors show a development of cognitive abilities that integrate executive functions (Shaw et al., 2020). This process works together with other cognitive processes, including language, as it allows to regulate and control behavior through verbal comprehension and inhibition. Therefore, the development and appropriation of the executive processes of inhibition, self-control, working memory and self-regulation through its verbal mediation, allow the acquisition of new executive skills, such as planning and achievement, which, in turn, makes it possible to appropriate new behaviors. Thus, the continuous execution of these five skills allows the solution of simple problems around the age of six (Diniz et al., 2011).

1.6 Assessment tools for cognitive processes in childhood: neurocognitive tracking test

Based on the above and understanding the importance of the development of the cognitive processes mentioned above, namely attention, memory, language, executive functions, and visuoconstructive skills in this life stage between 6 and 7 years, a deepening is carried out on the neuropsychological tests that currently exist in Colombian population: Executive Functions and Frontal Lobes Neuropsychological Battery (BANFE), Pediatric Neuropsychological Assessment 2 (ENI), Wechsler Intelligence Scale (WISC IV) observing that there is a wide range of assessment and standardization batteries, and that in most cases they have a very long application time, in addition, they are adaptations from other countries, not necessarily Spanish-speaking. Likewise, it is evident that there are few scales, especially, neuropsychological tracking tests for the rapid and specific identification of the development of cognitive processes (Peralta-Cuji et al., 2021). In Colombia, there are no neuropsychological tracking tests for children in the beginning of the school stage between 6 and 7 years in virtual and/or standardized format, which is an opportunity to strengthen and provide short-term detection strategies for professionals in the field of psychology and neuropsychology.

It is worth noting that there are currently no easy-to-apply tests for children, and there are only cognitive test batteries that are extensive in application (Peralta-Cuji et al., 2021). In Ecuador, a systematic literature review was conducted with the objective of identifying the cognitive processes that are evaluated in childhood and the tests available for this purpose, by analyzing the databases Pubmed, Scopus, ScienceDirect, Redalyc, Scielo and APA Psycnet between the years 2014 and 2019. The results conclude that the cognitive processes that are usually measured at these ages are language, memory, visual perception, attention, executive functions and academic skills, the most used test batteries for cognitive performance profiles are the Wechsler scales, Kaufman Batteries and the Pediatric Neuropsychological Assessment (ENI). It is concluded that in Ecuador, no neurocognitive tracking or screening tests have been developed, which is a relevant problem when evaluating these conditions in this population.

It is important to note that the concept of neurocognitive tracking test, screening test or cognitive screening, is defined as a brief, easy-to-apply and short-term instrument; its main utility is the discrimination between a normal execution and a performance with difficulties. This type of tests does not fulfill the diagnostic function, but they offer an approach from the neuropsychological functions and their relationship with the adequate development at the level of brain maturation (Espino et al., 2019).

Considering the information of each of the cognitive processes and the research objective, it is important to highlight the importance of these short screening instruments in the orientation of a neuropsychological assessment. The novel component of the virtual format is also highlighted, since the tools that are developed in these media enjoy visual appeal, allow the incorporation of striking, versatile, and interactive stimuli and support to maintain higher levels of attention and motivation in their users, especially in young people (Benítez et al., 2018).

1.7 Content validity evidence based on test content.

Psychological attributes cannot be measured directly (like weight or height), so they are defined as constructs and their measurement requires instruments that have psychometric properties of reliability and validity. Specifically, following the Standards for Educational and Psychological Testing of the *American Educational Research Association* (AERA), the *American Psychological Association* (APA) and the *National Council on Measurement in Education* (NCME), "validity refers to the extent to which evidence and theory support the interpretations of test scores for the proposed uses of tests" (2018, p. 11). In accordance with the above, validation processes involve the collection of solid and relevant scientific evidence, which can come from different sources, one of which is based on the content of the test.

Sireci and Faulkner-Bond (2014) define content validity as "the degree to which the test content is congruent with the assessment purposes" (p. 101), which implies defining specifications where the cognitive processes to be sampled through the performance of the evaluated are established, as well as their weight or relative importance in the test, as a basis to support the proposed interpretation of the test scores. It is worth remembering that the purpose of the instrument object of this study seeks to fulfill a screening function for a future diagnosis, in a neuropsychological assessment context. In this sense, for Urbina (2014), the content of neuropsychological tests should be based on accumulated scientific and clinical evidence on brain-behavior relationships. According to the above, the evidence of content validity requires logical and empirical analysis of the test items in terms of their representativeness (adequacy with respect to the test specifications) and relevance (importance for the evaluation of the domain).

Although there are different methods to estimate content validity, they can be grouped into two: expert judgment-based or statistics-based. Expert judgment-based methods, such as the one used in this study, involve a group of experts in the field issuing a series of judgments on the congruency between the items and the domain to be evaluated (e.g., on a Likert scale). The procedures employed require specifying how the experts were selected, their credentials, how their ratings were obtained, and their degree of agreement on the validity of the test items (Urbina, 2014). Likewise, there are different indexes to quantify the degree of agreement between experts, such as the Content Validity Index (Lawshe, 1975), the Congruency Index (Hambleton, 1980) or the V-coefficient (Aiken, 1980; 1985). The V-coefficient has the advantage that inferential statistical procedures can be applied in terms of significance and confidence intervals, and that its calculation takes into account the number of rating categories, as well as the number of judges, allowing to estimate the inter-judge agreement more precisely, reasons why it was chosen for the validation process that is presented in this article.

2. Materials and Methods

2.1 Design

A non-experimental, instrumental study was conducted, since it aimed to analyze the psychometric properties of a new test (Ato et al., 2013), taking into account the latest edition of the Standards for Educational and Psychological Testing (AERA, APA, & NCME, 2014).

2.2 Instruments

The measurement instrument that was subjected to the content validity process is a neuropsychological screening test consisting of 149 items distributed in different components, related to five cognitive processes: attention (30 items), memory (34 items), language (37 items), visuoconstructional skills (16 items) and executive functions (32 items). This test is designed in a virtual format and contains instructions, exercises, scoring buttons and examples. A detailed description of the instrument and its design and construction process can be found in Rico et al. (2021).

Additionally, a format in Microsoft Excel® was developed, in which a group of expert judges rated each of the 149 items of the instrument on the criteria of relevance (the task measures the cognitive process for which it was created), relevance (the task is important within the instrument), sufficiency (the activity is sufficient to measure the process) and writing (the grammatical construction of the activity is logical and coherent). The rating of each item in each criterion was made using a Likert-type scale with response options from 1 to 4, with 1 being the minimum score and 4 being the maximum score.

2.3 Procedure

A group of nine expert judges in the field of Child Neuropsychology independently rated each of the items on the established criteria (relevance, relevance, sufficiency, and writing), using a Likert scale with values between 1 and 4, with 4 being the best possible rating. According to Lynn (1986, cited by Delgado-Rico et al., 2012), at least three judges per item should be considered. The criteria used for the selection of the judges were: undergraduate degree in psychology and postgraduate degree in neuropsychological evaluation and diagnosis and master's degree in neurosciences and/or clinical neuropsychology, with at least 4 years of experience in the application of neuropsychological tests in child population.

Based on these ratings, the Aiken coefficient (1980; 1985) was calculated for each item in each criterion. This coefficient constitutes a point estimate of the mean ratings of the judges for an item, which assumes values between 0 and 1. Thus, as the degree of consensus among judges increases, the value of this coefficient approaches 1 (if the agreement is perfect, its value will be 1), which means that its content validity increases. As a sample estimator, this coefficient can be treated inferentially to establish how close it is to the population mean of expert judges. However, this procedure must consider the small sample sizes that are usually used in content validity studies (e.g., less than 10 judges), as well as the truncated nature of the rating scale (e.g., from 1 to 4), properties that lead to the violation of the normality assumptions, so Penfield and Giacobbi (2004) propose a methodology for the calculation of asymmetric confidence intervals (CI) that takes into account these restrictions. The CIs provide the limits within which the population value of V is found with a certain level of confidence and constitute a reference for testing a null hypothesis about the value of V. The calculation of V is carried out using the following

$$V = \frac{\underline{X}-l}{k} \quad (1)$$

where $\underline{X}$ is the sample mean rating of the judges, l is the minimum possible rating (in this case 1), and k is the maximum possible rating minus the minimum possible rating. The CI is then calculated from this value as

$$L = \frac{2nkV+z^2-z\sqrt{4nkV(1-V)+z^2}}{2(nk+z^2)} \quad (2)$$

$$U = \frac{2nkV+z^2+z\sqrt{4nkV(1-V)+z^2}}{2(nk+z^2)} \quad (3)$$

where L is the lower bound, U is the upper bound, z is the value in the standard normal distribution for a given confidence level, V is the Aiken coefficient, k is the maximum possible score minus the minimum possible score, and n is the number of judges.

Regarding the critical value of V, it is possible to evaluate its statistical significance from a discrete probability distribution (Aiken, 1985). In this way, Aiken establishes that with 4 rating categories and 9 expert judges, minimum values of .74 are required for a significance of 5% ($p = .036$) and of .81 for a significance of 1% ($p = .007$). For their part, Merino-Soto and Livia-Segovia (2009) indicate that a liberal cut-off point for the null hypothesis would be just above random variation (V0 = .50), while a more conservative level of validity would require at least a V0 = .70. In any case, according to Penfield and Giacobbi (2004), the values for the null hypothesis of V and its confidence interval are relative; for example, in the early stages of test development, less restrictive values can be taken (such as V0 = .40 with a 90% confidence), especially if there is a small number of expert judges. The decision to reject the null hypothesis about the population value of V ($H0: V \leq V0$) implies that the lower bound of the confidence interval exceeds the value set for V0. Considering these considerations, for the present study, an intermediate scenario between a liberal and a conservative criterion was proposed, setting a cut-off point for Aiken's V of .65, with a 95% confidence; that is, if confidence intervals are obtained whose lower bound is less than this value, it is concluded that the item does not have sufficient content validity.

3. Results

The composition of the screening instrument was defined based on the judges' ratings. In this way, the decision to keep or remove an item was based on the criteria of relevance and pertinence: if an item violated any of these criteria, it was removed from the test, as it lacked representativeness or importance according to the judgment of the experts (Sireci & Faulkner-Bond, 2014; Urbina, 2014). The assessment of the sufficiency and writing criteria was taken into account to generate content recommendations. According to this, the V coefficients for the items by cognitive process in the qualified criteria are presented below. The tables that are presented below contain the items organized by process and component. The items and the lower limits of their CIs (95%) are underlined and italicized, from which an item was considered to have insufficient content validity according to the judgment of experts, in terms of relevance or pertinence.

Table 1. Content validity for the items of the cognitive process of Attention

Ítem	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
Sustained auditory																				
18	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	4.00	.00	1.00	.88	1.00	3.78	.44	.93	.77	.98
19	3.67	.50	.89	.72	.96	3.56	.73	.85	.68	.94	3.78	.44	.93	.77	.98	3.44	1.01	.81	***.63***	.92
20	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.11	1.05	.70	***.52***	.84
21	3.44	.88	.81	***.63***	.92	3.44	.88	.81	***.63***	.92	3.56	.88	.85	.68	.94	3.11	1.05	.70	***.52***	.84
22	3.56	.73	.85	.68	.94	3.44	.73	.81	***.63***	.92	3.56	.73	.85	.68	.94	2.89	1.05	.63	***.44***	.78
23	3.67	.71	.89	.72	.96	3.22	1.09	.74	***.55***	.87	3.67	.71	.89	.72	.96	2.89	1.05	.63	***.44***	.78
24	3.22	1.09	.74	***.55***	.87	3.11	1.05	.70	***.52***	.84	3.56	.73	.85	.68	.94	2.89	1.05	.63	***.44***	.78
Selective auditory																				
25	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.56	.88	.85	.68	.94	3.33	.87	.78	***.59***	.89
26	3.67	.50	.89	.72	.96	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.33	.87	.78	***.59***	.89
27	3.67	.50	.89	.72	.96	3.44	.73	.81	***.63***	.92	3.44	.73	.81	***.63***	.92	3.33	.71	.78	***.59***	.89
28	3.56	.53	.85	.68	.94	3.44	.73	.81	***.63***	.92	3.44	.73	.81	***.63***	.92	3.22	.83	.74	***.55***	.87
29	3.67	.50	.89	.72	.96	3.44	.73	.81	***.63***	.92	3.56	.73	.85	.68	.94	3.22	.67	.74	***.55***	.87
30	3.22	.97	.74	***.55***	.87	3.44	.73	.81	***.63***	.92	3.44	.73	.81	***.63***	.92	3.11	.78	.70	***.52***	.84
Visual sustained																				
1	3.89	.33	.96	.82	.99	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	4.00	.00	1.00	.88	1.00
2	3.33	.87	.78	***.59***	.89	3.67	.71	.89	.72	.96	3.33	.87	.78	***.59***	.89	3.89	.33	.96	.82	.99
3	3.33	.87	.78	***.59***	.89	3.67	.71	.89	.72	.96	3.33	.87	.78	***.59***	.89	3.89	.33	.96	.82	.99
4	3.56	.73	.85	.68	.94	3.78	.44	.93	.77	.98	3.44	.73	.81	***.63***	.92	3.78	.44	.93	.77	.98
5	3.56	.73	.85	.68	.94	3.78	.44	.93	.77	.98	3.44	.73	.81	***.63***	.92	3.78	.44	.93	.77	.98
6	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
7	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
Selective visual																				
8	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
9	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.44	.73	.81	***.63***	.92	3.56	.88	.85	.68	.94
10	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.44	.73	.81	***.63***	.92	3.56	.88	.85	.68	.94
11	3.44	.88	.81	***.63***	.92	3.67	.71	.89	.72	.96	3.22	.83	.74	***.55***	.87	3.33	1.00	.78	***.59***	.89
12	3.44	1.01	.81	***.63***	.92	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	3.67	.71	.89	.72	.96
13	3.44	1.01	.81	***.63***	.92	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92
14	3.22	1.09	.74	***.55***	.87	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94	3.22	.97	.74	***.55***	.87
15	3.22	1.09	.74	***.55***	.87	3.78	.44	.93	.77	.98	3.44	.73	.81	***.63***	.92	3.22	.97	.74	***.55***	.87
16	3.22	1.09	.74	***.55***	.87	3.67	.71	.89	.72	.96	3.44	.73	.81	***.63***	.92	3.11	1.05	.70	***.52***	.84
17	3.22	1.09	.74	***.55***	.87	3.67	.71	.89	.72	.96	3.33	.87	.78	***.59***	.89	3.11	1.05	.70	***.52***	.84

M: Mean expert rating; SD: Standard deviation of expert ratings; L: Lower limit of 95% confidence interval; U: Upper limit of 95% confidence interval

For the cognitive process of Attention (Table 1), the items that did not obtain significant results (L < 0.65; p > 0.05) in relevance or pertinence were 17 out of 30 (4 of sustained auditory attention, 4 of selective auditory attention, 2 of sustained visual attention, and 7 of selective visual attention). In this process, more than 50% of the original items would be eliminated, although the V coefficients ranged from 0.70 to 1.00 considering the criteria of pertinence and relevance. Likewise, there is a significant number of items that require reviews of sufficiency or writing. For these reasons, it was the component most affected by the experts' rating.

For this process, the component of selective visual attention was the one with the highest number of items that did not reach the limits of content validity (items 11 to 17), being the criteria of wording and Pertinence the ones that had the lowest evaluation by the judges. The Sustained auditory and selective auditory components had 4 items each that did not reach minimum thresholds, with very low scores in wording and relevance, while the sustained visual attention component had only two items that were not accepted with low scores in importance and sufficiency.

In relation to the items included in the final scale, it can be observed that this component obtained a mean rating by the judges of 3.71 (SD = .56) in the Pertinence criterion, 3.74 (SD = .50) in the Relevance criterion, 3.63 (SD = .61) in Sufficiency and 3.62 (SD = .64) in Writing.

Table 2. Content validity for the items of the cognitive process of Memory

Ítem	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
Immediate auditory memory																				
31	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	3.78	.44	.93	.77	.98
32	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.78	.67	.93	.77	.98	3.78	.44	.93	.77	.98
33	3.33	1.00	.78	***.59***	.89	3.22	1.09	.74	***.55***	.87	3.00	1.12	.67	***.48***	.81	2.78	1.30	.59	***.41***	.75
34	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.44	.88	.81	***.63***	.92	3.44	.73	.81	***.63***	.92
35	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
36	3.00	1.12	.67	***.48***	.81	2.89	1.17	.63	***.44***	.78	2.67	1.12	.56	***.37***	.72	2.89	1.36	.63	***.44***	.78
37	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.44	.88	.81	***.63***	.92	3.56	.73	.85	.68	.94
38	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.44	.88	.81	***.63***	.92	3.67	.71	.89	.72	.96
39	3.00	1.12	.67	***.48***	.81	2.89	1.17	.63	***.44***	.78	2.78	1.20	.59	***.41***	.75	2.78	1.30	.59	***.41***	.75
Auditory recall																				
60	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.33	.87	.78	***.59***	.89	3.67	.71	.89	.72	.96
Immediate visual memory																				
40	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.78	.44	.93	.77	.98
41	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.44	.93	.77	.98

Ítem	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
42	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.78	.44	.93	.77	.98
43	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.67	.50	.89	.72	.96
44	3.78	.67	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96
45	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.44	.93	.77	.98
46	3.78	.67	.93	.77	.98	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.67	.50	.89	.72	.96
47	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
48	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
49	3.56	.88	.85	.68	.94	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.78	.44	.93	.77	.98
50	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	3.78	.44	.93	.77	.98
51	3.56	.88	.85	.68	.94	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.78	.44	.93	.77	.98
52	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00
53	3.33	1.00	.78	***.59***	.89	3.67	.50	.89	.72	.96	3.33	.87	.78	***.59***	.89	3.56	.73	.85	.68	.94
54	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	3.78	.44	.93	.77	.98
55	3.33	1.00	.78	***.59***	.89	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.78	.44	.93	.77	.98
56	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
57	3.33	.87	.78	***.59***	.89	3.67	.50	.89	.72	.96	3.44	.73	.81	***.63***	.92	3.56	.73	.85	.68	.94
58	3.89	.33	.96	.82	.99	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99
59	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
Visual recall																				
61	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.44	.88	.81	***.63***	.92
62	3.22	.97	.74	***.55***	.87	3.22	.97	.74	***.55***	.87	3.11	.93	.70	***.52***	.84	3.44	.88	.81	***.63***	.92
63	3.67	.71	.89	.72	.96	3.56	.73	.85	.68	.94	3.44	.88	.81	***.63***	.92	3.33	.87	.78	***.59***	.89
64	3.44	.88	.81	***.63***	.92	3.56	.73	.85	.68	.94	3.44	.88	.81	***.63***	.92	3.33	.87	.78	***.59***	.89

M: Mean expert rating; SD: Standard deviation of expert ratings; L: Lower limit of 95% confidence interval; U: Upper limit of 95% confidence interval

The results for the cognitive process of Memory are presented in Table 2. In this process, the items with L < 0.65 and p > 0.05 were 8 out of 34 (3 of auditory immediate, 3 of visual immediate and 2 of visual recovery). For the items of this process, taking into account the criteria of relevance and, the V values were in a range of 0.63 to 1.00. It is noteworthy that the component of immediate visual memory was almost entirely preserved, despite having a significant number of items. On the other hand, content reviews for sufficiency or wording are required in all components, although in a lower proportion than what was observed in the attention process.

In this process it is also observed that the criterion that grouped the highest number of items with low scores was the sufficiency criterion in the Immediate auditory memory component and the writing criterion in the Visual recall component.

For this component, the items included in the final scale obtained an average rating from the judges of 3.85 (SD = .37) for the relevance criterion, 3.87 (SD = .29) for the relevance criterion, 3.77 (SD = .45) for the sufficiency criterion, and 3.74 (SD = .48) for the wording criterion.

Table 3. Content validity for the items of the cognitive process of Language

Item	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
Comprehension – Following directions																				
65	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00
66	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	4.00	.00	1.00	.88	1.00
67	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	4.00	.00	1.00	.88	1.00
68	3.89	.33	.96	.82	.99	3.78	.44	.93	.77	.98	3.56	.88	.85	.68	.94	3.78	.67	.93	.77	.98
69	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99
70	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.56	.88	.85	.68	.94	3.78	.44	.93	.77	.98
Reading comprehension																				
71	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00
72	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99
73	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.89	.33	.96	.82	.99
74	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.89	.33	.96	.82	.99
75	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.89	.33	.96	.82	.99
76	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.89	.33	.96	.82	.99
77	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
78	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.78	.67	.93	.77	.98	3.78	.44	.93	.77	.98
79	3.67	.50	.89	.72	.96	3.67	.50	.89	.72	.96	3.56	.73	.85	.68	.94	3.78	.44	.93	.77	.98
80	3.44	1.01	.81	***.63***	.92	3.44	1.01	.81	***.63***	.92	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
81	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
82	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.71	.89	.72	.96	3.89	.33	.96	.82	.99
Expression – Naming																				
83	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
84	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.89	.33	.96	.82	.99
85	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.89	.33	.96	.82	.99
86	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.89	.33	.96	.82	.99

Item	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
87	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.89	.33	.96	.82	.99
88	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.89	.33	.96	.82	.99
Expression – Writing																				
89	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
90	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.56	.73	.85	.68	.94
91	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
92	3.67	.50	.89	.72	.96	3.67	.50	.89	.72	.96	3.67	.50	.89	.72	.96	3.56	.73	.85	.68	.94
93	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.44	.73	.81	***.63***	.92
94	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94	3.67	.50	.89	.72	.96	3.11	.93	.70	***.52***	.84
95	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94	3.78	.44	.93	.77	.98	3.33	.87	.78	***.59***	.89
96	3.67	.50	.89	.72	.96	3.44	.73	.81	***.63***	.92	3.67	.50	.89	.72	.96	3.33	.87	.78	***.59***	.89
97	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94	3.67	.50	.89	.72	.96	3.33	.87	.78	***.59***	.89
Expression – Reading																				
98	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.44	.73	.81	***.63***	.92
99	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.67	.50	.89	.72	.96
100	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.67	.50	.89	.72	.96
101	3.67	.50	.89	.72	.96	3.78	.44	.93	.77	.98	3.56	.53	.85	.68	.94	3.67	.50	.89	.72	.96

M: Mean expert rating; SD: Standard deviation of expert ratings; L: Lower limit of 95% confidence interval; U: Upper limit of 95% confidence interval

In order to the cognitive process of Language (Table 3), it had very favorable results, since due to statistical significance ($L < 0.65$; $p > 0.05$) only 2 out of 37 items were eliminated (1 of text comprehension and 1 of the expressive components in reading). For this process, the V coefficients ranged from 0.81 to 1.00. In addition, in the components of Comprehension - Following instructions and Expression - Naming all the items were well evaluated in the criteria of sufficiency and wording.

Regarding the criteria of pertinence, relevance, sufficiency, and wording, the mean scores of the items included in the final scale were 3.82 (SD = .36), 3.81 (SD = .39), 3.71 (SD = .53), and 3.76 (SD = .43), respectively.

Table 4. Content validity for the items of the cognitive process of Visual-Constructional Skills

Ítem	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
Praxia																				
102	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96
103	3.44	.88	.81	***.63***	.92	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.56	.73	.85	.68	.94
104	3.44	.88	.81	***.63***	.92	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92	3.56	.73	.85	.68	.94
105	3.44	.88	.81	***.63***	.92	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96
106	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.56	.88	.85	.68	.94	3.22	.83	.74	***.55***	.87
107	3.56	.73	.85	.68	.94	3.89	.33	.96	.82	.99	3.56	.73	.85	.68	.94	3.44	.88	.81	***.63***	.92
108	3.56	.73	.85	.68	.94	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94	3.44	.88	.81	***.63***	.92
109	3.56	.73	.85	.68	.94	3.67	.50	.89	.72	.96	3.56	.73	.85	.68	.94	3.44	.88	.81	***.63***	.92
Visuospatial ability																				
110	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.44	.73	.81	***.63***	.92	3.11	.93	.70	***.52***	.84
111	3.22	.83	.74	***.55***	.87	3.33	.87	.78	***.59***	.89	3.33	.87	.78	***.59***	.89	3.22	.97	.74	***.55***	.87
112	3.22	.83	.74	***.55***	.87	3.33	.87	.78	***.59***	.89	3.33	.87	.78	***.59***	.89	3.22	.97	.74	***.55***	.87
113	3.22	.83	.74	***.55***	.87	3.33	.87	.78	***.59***	.89	3.33	.87	.78	***.59***	.89	3.11	.93	.70	***.52***	.84
114	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.33	.87	.78	***.59***	.89
115	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.88	.81	***.63***	.92
116	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.33	.87	.78	***.59***	.89
117	3.67	.50	.89	.72	.96	3.78	.44	.93	.77	.98	3.67	.50	.89	.72	.96	3.22	.83	.74	***.55***	.87

M: Mean expert rating; SD: Standard deviation of expert ratings; L: Lower limit of 95% confidence interval; U: Upper limit of 95% confidence interval

For the process of Visual-Spatial Skills (Table 4), which is the smallest of the test, the V values ranged from 0.74 to 0.96. Based on the defined criterion, 6 out of 16 items were eliminated for their non-significant values ($L < 0.65$; $p > 0.05$), 3 of them in the praxic component and 3 in the visual component.

For the four criteria considered, the mean scores of the judges for the items that were not eliminated were 3.68 (SD = .61), 3.78 (SD = .44), 3.64 (SD = .63), and 3.36 (SD = .86) for the criteria of relevance, pertinence, sufficiency, and wording, respectively.

Table 5. Content validity for the items of the cognitive process of Executive Functions

Ítem	Pertinence					Relevance					Sufficiency					Wording				
	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U	M	SD	V	L	U
Innibitory control																				
118	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.56	1.01	.85	.68	.94
119	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.67	1.00	.89	.72	.96
120	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.67	1.00	.89	.72	.96
121	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	3.67	1.00	.89	.72	.96
122	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.67	1.00	.89	.72	.96
123	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99	3.56	1.01	.85	.68	.94
124	3.78	.67	.93	.77	.98	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.33	1.12	.78	***.59***	.89
125	3.56	.88	.85	.68	.94	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.33	1.12	.78	***.59***	.89
126	3.89	.33	.96	.82	.99	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.67	1.00	.89	.72	.96
127	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.33	1.12	.78	***.59***	.89
128	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.33	1.12	.78	***.59***	.89
129	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.67	.71	.89	.72	.96	3.33	1.12	.78	***.59***	.89
Working memory – phonological loop																				
138	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.67	.71	.89	.72	.96
139	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
140	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
141	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	4.00	.00	1.00	.88	1.00	3.89	.33	.96	.82	.99
Visual-spatial working memory																				
130	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96
131	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
132	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.44	.73	.81	***.63***	.92
133	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.89	.33	.96	.82	.99	3.67	.71	.89	.72	.96
134	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
135	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
136	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
137	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.78	.44	.93	.77	.98	3.56	.73	.85	.68	.94
Cognitive flexibility																				
142	3.67	.71	.89	.72	.96	3.56	.73	.85	.68	.94	3.33	.87	.78	***.59***	.89	2.78	1.09	.59	***.41***	.75
143	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.22	.83	.74	***.55***	.87	2.89	1.05	.63	***.44***	.78
144	3.56	.73	.85	.68	.94	3.56	.73	.85	.68	.94	3.22	.83	.74	***.55***	.87	2.89	.93	.63	***.44***	.78
145	3.56	.73	.85	.68	.94	3.44	.88	.81	***.63***	.92	3.11	.93	.70	***.52***	.84	2.78	1.09	.59	***.41***	.75
146	3.33	.87	.78	***.59***	.89	3.11	1.17	.70	***.52***	.84	3.33	1.12	.78	***.59***	.89	3.00	1.00	.67	***.48***	.81
147	3.00	1.00	.67	***.48***	.81	2.78	1.20	.59	***.41***	.75	3.00	1.22	.67	***.48***	.81	2.89	1.17	.63	***.44***	.78
148	3.00	1.00	.67	***.48***	.81	2.67	1.12	.56	***.37***	.72	2.89	1.17	.63	***.44***	.78	2.89	1.17	.63	***.44***	.78
149	3.00	1.00	.67	***.48***	.81	2.67	1.12	.56	***.37***	.72	2.89	1.17	.63	***.44***	.78	2.89	1.17	.63	***.44***	.78

M: Mean expert rating; SD: Standard deviation of expert ratings; L: Lower limit of 95% confidence interval; U: Upper limit of 95% confidence interval

Finally, in the process of Executive Functions (Table 5), favorable results were also obtained, since out of the 32 initial items only 3 were eliminated from the cognitive flexibility component (L < 0.65; p > 0.05). For this process, the V value was distributed in a range of 0.56 to 1.00. In terms of sufficiency and wording it was important to review especially the cognitive flexibility component and partly the inhibitory control component.

In summary, based on the previous results, the decision was made to eliminate a total of 30 items, thus reducing the length of the test from 149 to 119 items. The variation between the initial version of the instrument and the purged version after analyzing the expert ratings is presented in Table 6, where, as suggested by Pedrosa et al. (2013), a global assessment of the content validity of the instrument is obtained before and after the judges' analysis. It is interesting to note that the initial average values of the Aiken V coefficients are high, both at the global level, as well as by process and by component.

Table 6. Total content validity, by cognitive process and by test component, before and after expert judgment

Process	Component	Initial version			Final versión		
		Items	MP	MR	Items	MP	MR
Attention	Sustained hearing	7	.86	.82	3	.90	.89
	Selective hearing	6	.87	.83	2	.93	.87
	Sustained visual	7	.87	.94	5	.90	.96
	Selective visual	10	.81	.91	3	.89	.89
	Total Attention	**30**	**.85**	**.87**	**13**	**.90**	**.90**
Memoy	Immediate auditory	9	.87	.85	6	.96	.94
	Auditory recall	1	.89	.89	1	.89	.89
	Immediate visual	20	.93	.96	17	.95	.97
	Visual recall	4	.85	.85	2	.93	.91
	Total Memory	**34**	**.88**	**.89**	**26**	**.93**	**.93**
Language	Comprehension – Following directions	6	.97	.96	6	.97	.96
	Reading comprehension	12	.93	.93	11	.94	.94
	Expression – Naming	6	.94	.94	6	.94	.94
	Expression – Reading	9	.93	.89	8	.93	.90
	Expression – Writing	4	.94	.94	4	.94	.94
	Total Lenguage	**37**	**.94**	**.93**	**35**	**.94**	**.94**
Visual-Constructional Skills	Praxia	8	.86	.94	5	.88	.94
	Visuospatial ability	8	.84	.86	5	.90	.91
	Total Visual - constructional Skills	**16**	**.85**	**.90**	**10**	**.89**	**.93**
Executive functions	Innibitory control	12	.95	.96	12	.95	.96
	Working memory – phonological loop	4	1.00	1.00	4	1.00	1.00
	Visual-spatial working memory	8	.94	.94	8	.94	.94
	Cognitive flexibility	8	.78	.72	3	.86	.85
	Total Executive Functions	**32**	**.92**	**.90**	**27**	**.94**	**.94**
	Total General	**149**	**.90**	**.93**	**119**	**.91**	**.94**

MP: Mean V in Pertinence; MR: Mean V in Relevance

4. Discussion

One of the fundamental purposes of reviewing a measurement scale, especially when psychological constructs are measured, is to be able to establish the degree of relationship between the content of the item and the domain that is intended to be evaluated (Penfield & Giacobbi, Jr., 2004). In this research, the Aiken V statistic was used. This statistic has been reviewed in sufficient detail in relation to the confidence interval and the inference regarding the population value. The results of the research show that the instrument has a high degree of reliability, which means that reliable measurements of neurocognitive tracking in the child population can be made.

The Aiken V coefficient (1980; 1985) is a point estimate of the mean ratings of judges for an item. It assumes values between 0 and 1, where 0 indicates that there is no consensus among judges and 1 indicates perfect consensus. As the degree of consensus among judges increases, the value of this coefficient approaches 1, which means that the item has a higher content validity.

In this study, the Aiken V coefficient was used to assess the content validity of each item in each of the criteria. The results showed that the items had a high degree of consensus among judges, suggesting that the items reliably measure the content domain that they are intended to measure. Expert ratings tended to be high, indicating a high degree of content validity. For example, perfect validity coefficients (V = 1) were obtained for several items.

The probability of an item being rejected increased in correlation with the standard deviation of judge ratings. This means that the more scattered the expert opinions were, the more likely the item was to be rejected. According to Penfield & Giacobbi (2004), the values for the null hypothesis of V and its confidence interval are relative; for example, in the initial stages of test development, less restrictive values can be taken. In this study, a cut-off point for Aiken V of 0.65 was set, with a 95% confidence level. This means that if the confidence interval for an item is less than 0.65, the item is concluded to have insufficient content validity.

In this sense, it is important to take into account the different models that have been proposed to carry out measurements of cognitive functions in the child population. A relevant starting point for this work was that of (Anderson, 2002), where a model is proposed that involves four executive domains called: attentional control, cognitive flexibility, goal setting, and information processing. One of the lines that are raised in the cited work refers to the need to design analytical studies in which the interrelationship that can be given between the different domains can be analyzed on a large scale, a line of work that is intended to be developed based on the results of the present study.

Other works such as those of Anderson & Burnett (2017) and Takio et al. (2014), propose the study of executive functions in children from asymmetric perceptual processes, attention, language, and motor development. However, these works also mention the inefficiency of instruments such as the Bayley Developmental Test (2019). and the Executive Function Activities Test (EAFT), to predict motor and cognitive disorders, suggesting, in addition, the use of much more complete test batteries that more precisely evidence the relationships between dimensions and activities inherent to each process. This is an aspect that is highlighted in the present study by considering for each of the dimensions, a series of specific activities, which will allow to evaluate in more detail each of the processes that are considered in the PRANI cognitive tracking test.

An important feature of the present research is to be able to make a diagnosis of cognitive functions in the child population without necessarily having to focus on the measurement of these processes in the population with some type of disease or cognitive disorder (Buelow et al., 2012; Daraki et al., 2017; de Mello et al., 2012; Woodward et al., 2017). This has been a relevant factor for the proposal of new rapid and optimal assessment instruments, where it can be highlighted that one of the objectives of the present research is to identify and relate cognitive predictor factors that are key to the identification of anomalies and alterations of the neuropsychological processes of children at an early age.

The process of obtaining evidence of validity and reliability must continue; a first phase consists in analyzing the pilot data, which will allow to refine the item bank based on an empirical criterion. Likewise, new studies with representative samples should be carried out to calculate psychometric indicators and define grading norms.

The global pandemic has renewed the focus on mental health intervention. Virtual reality is a new and promising approach that can be used for early detection, intervention, and evaluation. In this regard, the intervention conducted by (Sorge et al., 2023) in their study on the analysis of prison environments is worth highlighting. The study analyzed physiological reactions and feedback from participating groups. This type of virtual exercise can highlight the relevance of this type of tool, which can not only facilitate detection but also intervention or process evaluation. This is the case with the present research, which is the implementation of a digital tool for early detection in the development of cognitive processes in children.

The purpose of this type of early detection allows for curricular and contextual adaptations in the case of children. This, in turn, can generate implementation and awareness programs for different types of

learning and possible disabilities that are detected through early detection. This is in line with the proposals of (Tomai et al., 2017) in their research on the promotion of the development of children with disabilities through school inclusion: clinical psychology in supporting teachers in Mozambique. The study highlights the need to create favorable environments for children, including those with disabilities.

On the other hand, child neuropsychology requires further advances, as it is a relatively young science that requires more research and new theories to strengthen evaluations, interventions, and awareness programs for neurodevelopmental disorders. One of the greatest challenges is to use, in this case with the present research, the analysis of profiles through programming machines to perform early detections and interventions, as postulated in the research of (Shah et al., 2023) on Neuropsychological detection and prediction using machine learning algorithms: a comprehensive review. This is one of the futures of child neuropsychology and these areas of evaluation and diagnosis, so the path of this research will allow the future of new processes in neuropsychology and neuroscience.

5. Conclusions, limitations and recommendations.

The following conclusions can be drawn from the above results:

1. Statistical Rigor: Using the Aiken V coefficient and confidence intervals for each criterion provided a robust statistical analysis, ensuring the content validity of the test items. This approach allowed for a precise measurement of the consensus among the expert judges.

2. Item Refinement: The decision to eliminate 30 items from the original pool of 149 was a critical step toward optimizing the instrument's efficiency. This refinement reflects the stringent criteria adopted for content validity and the commitment to developing a concise and effective tool.

3. Expert Consensus: High mean values of the Aiken V coefficients across most items indicate a strong expert consensus on content validity, which is essential for the reliability of the cognitive tracking test.

4. Test Development Process: The study's methodology, involving a non-experimental, instrumental design, adhered to rigorous standards for educational and psychological testing,

reflecting the complexity and thoroughness of developing a neuropsychological assessment tool.

5. Implications for Future Research: The findings provide a solid foundation for further research and development of cognitive tests tailored to the Latin American child population. The refined test instrument has the potential to become an important tool for early cognitive development assessment, emphasizing the need for culturally and linguistically appropriate methodologies in psychological testing.

The study's strengths include a comprehensive assessment by neuropsychology experts, rigorous statistical validation using the Aiken V coefficient, a refined virtual assessment tool tailored for Latin American children, and its relevance in addressing a significant gap in neuropsychological resources. Limitations encompass the panel's size which, while adequate, could be expanded for broader validation, the absence of direct testing within the child population that may affect practical applicability, geographical specificity that may limit generalization, potential technological barriers inherent in virtual formats, and the necessity for further validation to confirm reliability across diverse populations.

Ethical approval:

The research is classified as a low-risk study according to Resolution 8430 of 1993 of the Ministry of Health, Article 11, because it is a study that uses retrospective research techniques and methods and does not involve any intentional intervention or modification of biological, physiological, psychological, or social variables in the individuals who participate in the study.

Informed consent statement

Email authorization from expert judges, the instrument was not applied, only the items were validated.

Conflict of interest statement

All authors declare that there is no conflict of interest in this research.

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Authors' contribution

In this research, A.R. led study design, test management, and interpretation of results. A.G. contributed with his expertise in psychometry, especially in content validation and statistical analysis, as well as writing significant sections of the manuscript. J.T. contributed to the overall structure of the instrument and coordinated its technical and technological implementation, as well as the structuring of the results. P. B. coordinated with the evaluating experts and provided valuable insights into the refinement of the PRANI instrument., focused on literary review and manuscript writing, as well as providing a critical perspective for the discussion and conclusions of the study. All authors reviewed and approved the final version of the manuscript.

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