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VALIDATION OF AN INSTRUMENT FOR THE QUANTITATIVE ASSESSMENT OF FUNCTIONAL PSYCHOMOTOR SKILLS IN EDUCATIONAL SETTINGS: EXPLORATORY FACTOR ANALYSIS

VALIDAÇÃO DE UM INSTRUMENTO PARA A AVALIAÇÃO QUANTITATIVA DE HABILIDADES PSICOMOTORAS FUNCIONAIS EM CONTEXTOS EDUCACIONAIS: ANÁLISE FATORIAL EXPLORATÓRIA

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ABSTRACT

Psychomotor skills are a fundamental area for holistic development in childhood, but there is a lack of practical and validated assessment instruments for the educational context. The aim of this study was to validate the Venâncio Psychomotor Battery, an instrument for the quantitative assessment of functional psychomotor skills. The research was conducted with preschool children (mean age 5.79 ± 2.02 years). Through exploratory factor analysis, the psychometric properties of the battery were investigated. The results indicated high suitability of the data for factorization (KMO=0.733; Bartlett's test $p<0.001$). A two-factor structure was extracted, explaining 53.4% of the total variance, with excellent model fit indices (RMSEA = 0.00; TLI = 1.02). Factor 1 grouped items related to spatial structuring, coordination, laterality, and body schema, while Factor 2 emphasized the centrality of body schema and laterality. It is concluded that the Venâncio Psychomotor Battery presents strong evidence of validity, constituting a reliable and objective tool to assist educators and psychomotor therapists in the assessment and intervention in child development.

Keywords: Children, assessment, psychomotor performance.

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RESUMO

As habilidades psicomotoras são uma área fundamental para o desenvolvimento holístico na infância, mas há uma carência de instrumentos de avaliação práticos e validados para o contexto educacional. O objetivo deste estudo foi validar a Bateria Psicomotora Venâncio, um instrumento para a avaliação quantitativa de habilidades psicomotoras funcionais. A pesquisa foi realizada com crianças em idade pré-escolar (média de idade 5,79 ± 2,02 anos). Por meio de análise fatorial exploratória, as propriedades psicométricas da bateria foram investigadas. Os resultados indicaram alta adequação dos dados para a fatoração (KMO = 0,733; teste de Bartlett $p < 0,001$). Uma estrutura de dois fatores foi extraída, explicando 53,4% da variância total, com excelentes índices de ajuste do modelo (RMSEA = 0,00; TLI = 1,02). O Fator 1 agrupou itens relacionados à estruturação espacial, coordenação, lateralidade e esquema corporal, enquanto o Fator 2 enfatizou a centralidade do esquema corporal e da lateralidade. Conclui-se que a Bateria Psicomotora de Venâncio apresenta fortes evidências de validade, constituindo uma ferramenta confiável e objetiva para auxiliar educadores e terapeutas psicomotores na avaliação e intervenção no desenvolvimento infantil.

Palavras-chave: Crianças, avaliação, desempenho psicomotor.

INTRODUCTION

Psychomotor development, understood as the science that studies human beings through their bodies in motion and in relation to their internal and external worlds, plays a prominent role in child development. The integration of motor, cognitive, and socio-emotional functions is a cornerstone for the construction of knowledge and for the child's full expression within their surrounding environment. Recent studies reinforce the premise that psychomotor development not only precedes but also underpins more complex academic learning, such as reading and writing [1, 2]. Exploring the world through the body and movement allows children to organize their thinking, structure their body schema, and develop spatial and temporal concepts that are essential for their academic and social progress [3].

In this context, psychomotor assessment emerges as an invaluable diagnostic tool, enabling the early identification of potential developmental deviations or delays that may constitute barriers to learning [4]. A thorough assessment provides educators and health professionals with the basis for planning individualized and effective interventions, promoting the child's holistic development [5.] However, the effective implementation of assessment

processes in the Brazilian school context faces a significant challenge, which constitutes the central issue of this study.

The most widely disseminated and used psychomotor assessment instruments in research in Brazil, such as the Rosa Neto Motor Development Scale and the Vitor da Fonseca Psychomotor Battery, although robust in their theoretical design, present considerable limitations when applied to the reality of daily pedagogical practice. The application of these instruments often requires a significant amount of time—generally more than 40 minutes per child—and in-depth technical knowledge on the part of the evaluator for the correct administration and interpretation of the results [6]. The complexity of the scoring systems and the technical language used ultimately distance the teacher from this practice, making psychomotor assessment a sporadic event rather than a procedural tool integrated into pedagogical practice.

Additionally, the situation is exacerbated by the fact that many of these instruments, although widely used, lack validation and standardization studies for the Brazilian child population [7]. The use of unvalidated tools can lead to misinterpretations and inappropriate interventions, compromising the reliability of the diagnosis. The scarcity of validated and standardized national instruments represents a critical gap in the field, as pointed out by several researchers [8, 9].

The rationale for the present study therefore lies in the urgent need to address this gap. It is imperative to provide education professionals with a psychomotor assessment tool that is both psychometrically sound and feasible within the school routine. Venâncio's psychomotor battery was designed to meet this need. Developed as part of a master's thesis, its creation stemmed from a critical analysis of existing instruments, seeking to synthesize the most relevant items from the batteries by Fonseca[10], Rosa Neto[11], and Oliveira[12] into a new model, with a focus on optimizing administration time and simplifying the scoring and interpretation system.

Venâncio's battery proposal aligns with international trends aimed at developing assessment instruments with high clinical and educational utility that can be easily integrated

into professional practice[13]. By reducing administration time and simplifying the analysis of results, the aim is to democratize access to psychomotor assessment, allowing a larger number of children to be systematically monitored and enabling teachers to feel more confident and capable of using assessment data in their pedagogical planning.

In light of the above, the objective of this article is to validate Venâncio's psychomotor battery, establishing its psychometric properties.

By subjecting this new instrument to a rigorous validation process, we aim to offer the scientific community—and, in particular, professionals working on the front lines of early childhood education—a reliable, valid, and, above all, tool adapted to the real conditions of the Brazilian school environment, contributing to the promotion of psychomotor development and the prevention of learning difficulties.

METHODOLOGY

This study is a psychometric instrument validation study focused on the exploratory factor analysis of Venâncio's psychomotor battery.

Participants

The sample consisted of 245 children of both sexes, with a mean age of 5.79 ± 2.02 years, regularly enrolled in four municipal educational institutions, including two early childhood education schools and two Municipal Early Childhood Education Centers (CEMEIs). Of the total participants, 120 were male and 125 were female. The selection of this age group is justified because it corresponds to a critical period of child development, during which the acquisition and consolidation of essential psychomotor skills occur, skills that directly influence the literacy process and early academic performance.

Instruments

Three psychomotor assessment batteries were used:

1. Venâncio Psychomotor Battery: The instrument is currently undergoing validation and was designed to be a tool for simplified and rapid application.
2. Gislene de Campos Oliveira Psychomotor Assessment: Used as a comparison instrument for criterion validity, due to its greater structural and classification similarity to the Venâncio battery.
3. Francisco Rosa Neto Motor Development Scale: Used for comparative analysis regarding construct validity.
4. Vitor da Fonseca's Psychomotor Observation Battery: Used as a comparison instrument for criterion validity.

Rationale for the Structure of the Venâncio Battery

The creation of the Venâncio Battery was motivated by the need for an instrument that would overcome certain limitations observed in the original models, particularly regarding test overlap, administration time, and clarity of assessment. The following details the rationale for the modifications implemented.

The batteries that served as the basis for this study are recognized for their robustness and detail in the assessment of psychomotor development. However, a common characteristic among them is their extensive duration, which often results in a long and tiring administration process, both for the assessing professional and for the child. Fatigue can influence the child's performance, introducing a bias in the results and making it difficult to maintain engagement throughout the assessment. Given this scenario, the main objective in creating the new instrument was to develop a more concise and rapidly administered psychomotor assessment battery, without, however, compromising the ability to assess essential psychomotor elements.

The goal was to reduce the total assessment time, making it a more dynamic and less exhausting experience for those involved.

Criteria for Test Selection and Exclusion

The development of the new battery involved a systematic process of reviewing and selecting tests, based on the following criteria:

1. Consensus Among Reference Instruments: Priority was given to retaining activities and tests that demonstrate consistency and relevance by being present in all three reference batteries. The presence of a test in multiple established instruments was interpreted as an indicator of its fundamental importance for psychomotor assessment.

- Gross Motor Skills / Gross Coordination: Walking in a straight line, Jumping in the air, Foot/hand dissociation, Sitting still on a bench
- Fine Motor Skills / Fine Coordination: Building a tower, Maze.
- Body Schema: Drawing the human figure, Knowledge of body parts.
- Lateralization: Checking dominance (eye, hand, and foot), Self-recognition, Recognition in others, Reproduction of movement in schematic figures, Recognition of object positions
- Spatial Structuring: Knowledge of spatial terms, Spatial adaptation and organization, Visual memorization—mental representation of gestures, Reproduction of spatial structures.
- Temporal Structuring: Logical sequence of time (story), Walking to the rhythm of clapping, Reproduction of rhythmic structures.

2. Elimination of Redundancies: A functional analysis of each test was conducted to identify overlaps in the assessment of psychomotor elements. Tests that assessed the same psychomotor component already covered by another activity retained in the battery were removed. This approach allowed for streamlining the instrument, eliminating redundancies

and focusing on a more direct and objective assessment of each skill. Some tests were removed from each battery, such as:

> From the Rosa Neto battery:

- Fine Motor Skills: Threading a needle, tying a knot, paper balls, thumb tip, circle with the thumb. **Justification:** these tests are variations of the same psychomotor element, and Venâncio's battery retains the most representative tests
- Gross Motor Skills (Balance): Balance on one knee, Balance with trunk flexed, Squatting balance, Static one-legged stance—eyes closed. **Rationale:** Many of these tests are variations of the same psychomotor element (static balance). The Venâncio battery retains the most representative tests (immobility on a bench with eyes closed, immobility on tiptoes with eyes open, dynamic one-legged stance) which already adequately assess balance without the need for multiple repetitions.

> From the Oliveira battery:

- Fine Motor Skills: Cutting, Dynamic hand coordination, Air circles, Pencil grip. **Justification:** These tests assess aspects of visual-manual coordination and manual dexterity that are already covered by the body schema and spatial structuring assessments included in the Venâncio battery.
- Gross Motor Skills: Walking, Running, Asymmetry (with eyes open and closed), Posture when sitting to write, draw, or cut out. **Rationale:** Many of these tests are variations or redundancies of tests already included. Movement dissociation is already represented by the hand dissociation and foot/hand dissociation tests included in the Venâncio battery.
- Balance: Hopping on one foot with eyes open, hopping while clapping. **Justification:** These tests assess dynamic balance, but are already covered by the jumping in the air and dynamic one-legged stance tests retained in Venâncio.

> From the Fonseca battery:

- Tone (Extensibility, Passivity, Paratonia, Syndactyly, Synkinesis). All tone tests have been removed. **Justification**: Although important, tone tests are more specific to

detailed neurological assessment and require specialized clinical observation. The Venâncio battery maintains a focus on functional psychomotor assessment, which is more appropriate for the school and screening context. Tone elements are indirectly assessed through the retained balance and coordination tests.

- Global Praxia: Agility (hopping with legs apart and together), various complex dissociation tests. **Justification:** Many of these tests are complex variations of movements already assessed in a simpler and more direct manner in the retained tests. Oculomotor coordination is assessed through the global coordination tests.
- Fine Motor Skills: Dynamic Manual Coordination (putting on and taking off a bracelet), Drumming, Speed and Accuracy (drawing dots and crosses). **Rationale:** Although these tests assess fine motor coordination, they require a significant amount of time to administer. Furthermore, they are not the focus of the Venâncio Battery, since speed and agility, despite being important components of motor ability, do not represent the central objective of this battery. And these elements are already covered in other tests included in the Venâncio Battery.

3. Addition of test: Temporal structuring of the sentence. Justification: This test was specifically included in the Venâncio battery because: 1. It is present in the Rosa Neto battery as an important element of temporal assessment. 2. It is NOT present in the Oliveira and Fonseca batteries, representing a significant gap. 3. It is of extreme importance for assessing the child's ability to understand and structure temporal sequences through language. 4. It complements the assessment of temporal structuring, which includes storytelling, clapping rhythms, and rhythmic structures. 5. It provides valuable information about the child's cognitive-linguistic development, which is essential for academic learning.

4. Optimization of Administration Time: The final selection of tests was guided by the goal of significantly reducing administration time. Activities were chosen that, when combined,

offer a comprehensive overview of the child's psychomotor development within a shorter time frame compared to the original instruments.

Reducing Redundancy and Optimizing Time

A comparative analysis of the batteries by Rosa Neto, Oliveira, and Fonseca reveals a significant overlap of tests that assess the same psychomotor variables. For example, all three batteries include multiple tests to assess static and dynamic balance. Venâncio's Battery consolidated this assessment into a smaller number of tests, such as "Immobility on the bench" and "Dynamic one-legged stance," which were selected for their ability to cover the essential components of balance, making the application of a long series of similar tests unnecessary.

Similarly, for fine coordination, instead of an extensive list of age-specific tasks (as in Rosa Neto's EDM), the "Tower Building" and "Maze" tests were chosen, as they are considered sufficient for effective screening of visuomanual coordination.

This approach to selection and consolidation aims to drastically reduce the time required to administer the battery, making it more feasible for use in time-constrained settings, such as schools and clinics, without sacrificing the quality of the assessment.

Clarity in Language and Classification

The Venâncio Battery proposes a reorganization of the assessed areas into a clearer and more functional structure. The dimensions have been grouped into five major areas: (I) Coordination/Tone/Balance, (II) Body Schema, (III) Lateralization, (IV) Spatial Organization, and (V) Temporal Organization. This classification seeks to provide a clearer and more easily interpretable psychomotor profile for the evaluator.

In addition, the language used in the instructions and scoring criteria has been refined to be more direct and objective, reducing ambiguity and increasing consistency among

different evaluators. The inclusion of a specific section for assessing the socio-affective aspect, to be completed by the child's teacher, represents an important distinction, recognizing the influence of emotional and behavioral factors on psychomotor performance.

Link to the website for accessing the tool and the application and classification manual: www.nepec.venanciomota.com.br

Validation Procedures

The Venâncio battery was designed to synthesize the most relevant assessment elements from the three most widely used batteries in Brazilian studies—those by Vitor da Fonseca, Francisco Rosa Neto, and Gislene de Campos Oliveira—with the aim of optimizing the assessment process, reducing administration time, and facilitating the interpretation of results, making it more accessible and practical, especially for the school setting.

The decision to use the Oliveira battery as the primary parameter for classification, rather than the batteries by Rosa Neto and Fonseca, is based on significant structural and conceptual differences. The Rosa Neto battery, for example, employs an analytical approach that segments the assessment into distinct scores for fine motor skills, gross motor skills, and balance. Furthermore, it uses a complex calculation equation and does not provide a specific score or classification for laterality, an essential component of psychomotor assessment. Another point of divergence lies in the assessment of the elements of space and time, which are treated jointly in the Rosa Neto battery.

Similarly, Vitor da Fonseca's psychomotor observation battery also adopts a segmented approach, assessing balance, gross coordination (gross praxia), and fine coordination (fine praxia) separately. This fragmentation of psychomotor components contrasts directly with the structure of Venâncio's battery.

In contrast, both Venâncio's and Oliveira's batteries adopt a more integrated perspective. In both instruments, the elements of fine motor skills, gross motor skills, and balance are consolidated into a single motor coordination factor. Additionally, the concepts of

space and time are assessed as independent constructs, and laterality is a separately scored and classified item. This structural congruence makes the Oliveira battery the most suitable instrument for a validation closer to an adaptation, allowing for a more direct and cohesive analysis of the effectiveness and simplification proposed by the Venâncio battery.

Therefore, the methodology employed sought to validate Venâncio's new instrument by contrasting it with the Oliveira battery due to their conceptual and structural affinity. The Venâncio battery represents an evolution by integrating the main items assessed in the three reference instruments, but with an organization that prioritizes simplicity in application and interpretation, aligning more closely with the Oliveira model. The structure was designed to be clear and easy to apply, maintaining the ability to generate a detailed psychomotor profile of the child, while meeting the need for a more agile instrument adapted to the practical reality of health and education professionals.

Data Analysis

To validate the instrument, an exploratory factor analysis was performed using the maximum likelihood estimation method and varimax rotation. Prior to this, the assumptions of factorability were verified using Bartlett's sphericity test and the Kaiser-Meyer-Olkin (KMO) index. The model fit was assessed using the RMSEA, TLI, and BIC indices.

RESULTS

Table 1 presents the descriptive characteristics of the sample. It can be seen that the participants' mean age was 5.79 years (±2.02), ranging from 4 to 12 years, indicating a sample predominantly composed of children in preschool and early elementary school.

Table 01: Sample Characterization

Variables	**Mean±SD**	**Minimum score**	**Maximum score**
Age	5,79±2,02	4	12
Motor Coordination	17,77±7,97	0	33
Body Schema	14,88±6,40	0	31
Lateralization	11,94±5,23	0	20
Spatial structuring	8,50±4,25	0	20
Temporal structuring	8,39±3,79	0	19

Source: Author's own

Exploratory Factor Analysis identified two main factors, which together explained 53.40% of the total variance in the data. Factor 1 accounted for 30.30% of the variance, while Factor 2 explained 23.10%. In Factor 1, the spatial structuring variable exhibited a very high factor loading (0.977), indicating a strong association with this factor. Body schema (0.456), laterality (0.498), and temporal structuring (0.317) also exhibited loadings on this factor, albeit with moderate or low magnitudes. Factor 2 showed a stronger association with body schema (0.759), laterality (0.530), and motor coordination (0.493), suggesting that this factor may represent a dimension related to motor control and organization.

Table 02: Exploratory Factor Analysis

Factor loadings	**Factor**	
	1	**2**
Spatial structuring	0.977	
Temporal structuring	0.317	
Body schema	0.456	0.759
Lateralization	0.498	0.530
Motor Coordination		0.493
Variance of each factor	30,30	23,10
Total variance	30,30	53,40

Source: Author's own

Table 3 shows that the indicators of sample adequacy and model quality yielded satisfactory results. The KMO index was 0.73, a value considered adequate for conducting factor analysis, indicating good sample fit. Bartlett's Sphericity Test was significant (χ^2 = 336.95; $p < 0.001$), confirming that the correlation matrix is factorable.

Regarding model fit indices, the RMSEA was 0.00 (95% CI: 0.00–0.144), suggesting good fit, although the wide confidence interval calls for caution in interpretation. The TLI was 1.02, a value indicative of excellent model fit to the data. Regarding internal consistency, Cronbach's alpha was 0.71 and McDonald's omega was 0.76, both indicating acceptable to good internal reliability of the instrument.

Table 3: Indicators of fit, quality, and internal consistency of the model.

Index	Value
Fit	
Total KMO	0,73
Bartlett's test	X^2 =336,95 (p<0,001)
Quality	
RMSEA (IC95%)	0,00 (0,0 a 0,144)
TLI	1,02
Internal consistency	
Cronbach's α	0,71
McDonald's ω	0,76

KMO: *Keiser-Meier-Olkm*; RMSEA: *Root Mean Square Error of Approximation; TLI: Tucker-Lewis Index*

DISCUSSION

The primary objective of this study was to validate the Venâncio Psychomotor Battery, an instrument developed for the quantitative assessment of functional psychomotor skills in children in the context of early childhood education. The need for assessment tools that are

simultaneously objective, easy to administer, and psychometrically robust is a topic of growing interest in the literature, especially in educational settings where early identification of psychomotor difficulties is essential for planning effective interventions[14,15.]

The results of the sample adequacy analysis, using Bartlett's sphericity test (χ^2=337; p<0.001) and the Kaiser-Meyer-Olkin index (KMO=0.733), confirmed the factorability of the data, indicating that the correlations between items were sufficiently strong to justify the application of exploratory factor analysis. This procedure is consistent with best practices for construct validation of new assessment instruments, as demonstrated in validation studies of other psychomotor batteries, such as the Portuguese version of the NPmot[16.]

Exploratory factor analysis with varimax rotation revealed a two-factor structure that, together, explained 53.4% of the total variance in the data. Factor 1, which accounted for 30.3% of the variance, grouped with the highest weight the items on Spatial Organization (0.977), Motor Coordination (0.493), Lateralization (0.498), and Body Schema (0.456). This grouping suggests an underlying construct that can be interpreted as Perceptual-Motor Organization, reflecting the child's ability to perceive and organize themselves in relation to space and objects, a fundamental dimension of psychomotor development[17].

Factor 2, in turn, explained 23.1% of the variance and was predominantly defined by the Body Schema (0.759) and Lateralization (0.530) items, with a lower loading for the Temporal Structuring item (0.317). The high loadings of the same Body Schema and Lateralization items in both factors, albeit with different weights, suggest the centrality and integrative nature of these psychomotor components. They appear to act as a bridge between the organization of the body in space (Factor 1) and its organization in time and rhythm. The lower loading of the Temporal Structuring item may indicate that, in this age group, the notion of time is a more abstract concept still in development, or that the instrument may require refinement in this specific regard to capture this dimension more accurately.

The model fit indices (RMSEA=0.00; TLI=1.02; BIC=5.11) were excellent, and the model's chi-square test (p=0.532) indicated a perfect fit, reinforcing the validity of the two-factor structure found. This means that the proposed theoretical model fits the collected

empirical data very satisfactorily, lending reliability to the Venâncio Psychomotor Battery as an assessment instrument.

The practical implications of this study are significant for physical education and psychomotor professionals. The validation of this instrument provides a quantitative tool that can assist in the detection of deficits, the monitoring of psychomotor development, and the evaluation of the effectiveness of intervention programs, aligning with the need for evidence-based practices in the school setting[18]. The clear factor structure, with an emphasis on perceptual-motor organization, provides educators with a more focused direction for their activities, allowing for the planning of strategies aimed at the integrated development of psychomotor skills.

As limitations, it is acknowledged that the sample, although adequate for factor analysis, was restricted to a specific geographic context, which suggests caution in generalizing the results. Future studies could replicate this validation with more diverse samples and conduct a confirmatory factor analysis to corroborate the structure found here. Furthermore, investigating the predictive validity of the battery in relation to children's future academic performance would represent an important advance for the field.

CONCLUSION

Venâncio's Psychomotor Battery has proven to be a tool with solid evidence of construct validity for assessing functional psychomotor skills in preschool children. The identified two-factor structure, centered on psychomotor organization and the integration of body schema and laterality, is theoretically coherent and offers a clear view of the main dimensions of psychomotor development in this age group. The excellent fit indices of the statistical model confirm the robustness and reliability of the instrument.

It is therefore concluded that the validated battery represents a practical, objective, and reliable tool for physical education professionals and psychomotor specialists. Its application can enhance the assessment process in the school setting, enabling the early diagnosis of

difficulties, the monitoring of children's progress, and the development of more effective pedagogical practices aimed at the student's holistic development.

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