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Sources of validity evidence in the assessment of perceived motor competence in Brazilian schoolchildren

Wivianne Abreu Cavalcante[1], Bartira Pereira Palma[2], Anderson Henry Pereira Feitoza[2], Evandro Morais Peixoto[3], Maria Teresa Cattuzzo[2]

[1]Centro Universitário dos Guararapes (UNIFG) – Recife (PE), Brazil
[2]Escola Superior de Educação Física, Universidade de Pernambuco (UPE) - Recife (PE), Brazil
[3]Programa de Pós-Graduação em Psicologia, Universidade São Francisco (USF) - Campinas (SP), Brazil

ABSTRACT

Introduction: The judgment a child makes about his/her competence in the motor domain is known as perceived motor competence, a key element in building the child's healthy behavior; a Pictorial Scale of Perceived Movement Skill Competence (PMSC) seems to be a suitable perceived motor competence's assessment, but its validity needs to be evaluated. **Objective:** To examine the internal structure, the convergent validity, and the reproducibility of the PMSC. **Methods:** The sample comprised 187 Brazilian healthy schoolchildren (9.6 years ± 0.8); it was applied to the questionnaires PMSC and the Self-Perception Profile for Children scale. **Results:** PMSC's confirmatory factor analyses indicated adjustment indexes classified as adequate for a two-factor model; there were satisfactory reliability indices (Cronbach's alpha: 0.654 and 0.652 for locomotion and object control sub domains, respectively); convergent validity (r=0.41 and r=0.56, p<0.001, for locomotion and object control sub domains, respectively). **Conclusion:** These results contribute to the accumulation of sources of evidence for the PMSC as a valid tool for perceived motor competence assessment in a local and global context.

Keywords: evaluation study; validation study; surveys and questionnaires; child health.

INTRODUCTION

In an approach based on developmental psychological theories, the need for autonomy, competence, and connection are known as innate elements to every human being[1,2]. Especially in childhood, which is a critical period for human development, meeting these needs is key to healthy development and well-being. For this purpose, the child must be satisfied with his or herself and skills in different life domains[3]. Indeed, typical behavior of children is that they appear to be constantly testing their skills, a condition in which they can perceive their successes/failures in the different domains of life and develop the capacity to judge their competence in each of them; this capacity for self-judgment can be called perceived competence[3,4].

Considering the physical domain, the judgment a child makes about his/her competence in performing motor skills and physical-sporting activities is known as perceived motor competence (PMC)[4,5]. One of the first instruments to assess children's PMC was the subdomain of athletic competence from the Self-Perception Profile for Children

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Corresponding Author: Maria Teresa Cattuzzo – Escola Superior de Educação Física, Universidade de Pernambuco - Rua Arnóbio Marques, 310 - Santo Amaro – CEP: 50100-130 – Recife (PE), Brazil - Email: mtcattuzzo@hotmail.com

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scale (SPPC)[5]. This instrument consists of six items presented to the children, and they respond on a four-point scale on how much they agree or disagree with statements about PMC. The Pictorial Scale of Perceived Movement Skill Competence (PMSC) was developed[6,7], and it brings some very advantageous characteristics to investigate PMC. The first advantage is its unprecedented proposal to evaluate PMC in the same motor skills used by one of the most used children's motor performance tests[8], making PMSC an instrument more aligned with actual motor performance measures. Such a proposal looks more convenient for the child since she/he can get to know what motor action is under testing; also, it is very suitable for the research of the match between PMC and the motor competence phenomena, as it is called the proficiency in motor skills alongside coordination and control[9,10]. The second advantage is that the PMSC, unlike the SPPC, has a pictorial structure; that is, it uses figures to represent the skills, making the instrument more attractive and clearer to the child, and this structure has already been proven as good[11]. Another noteworthy characteristic, which is not present in SPPC, is that the PMSC evaluates children in 12 gross motor skills grouped in locomotion or object control skills; this number of skills becomes the PMSC more comprehensive about how the child judges himself/herself in ordinary motor skills. Recent studies show that PMSC has been used in countries such as Italy[12] and China[13], which confirms the relevance and scope of this tool in research on children's motor behavior and health.

Despite these advantages offered by PMSC, the researchers need to be aware of the tool's psychometric quality before choosing to use it, especially if it was built in another place. Initially developed and validated for four to five years old Australian children[6], and then for five to eight years old ones[7], the PMSC had its structure investigated for content and construct validity in Portugal[14] (five to 10 years old children), Spain[15] (five to 11 years old children), and Brazil[16] (five to 10 years old children). These results confirm the universal character of the PMC phenomenon and such a tool is worthy.

Thus, it is admissible that the PMSC reliably measures children's perception in performing motor skills activities. However, the process of validation is a cumulative one, so a set of scientific evidence (i.e., sources of validity evidence) must endorse the instrument validity[17]. From those differences between the PMSC and SPPC, one can question whether such instruments equivalently measure the phenomenon of PMC, i.e., if the scales are convergent. Conceptual convergence is present if high correlations between the focal instrument and another instrument evaluate a similar construct[18,19].

It seems plausible to assume that, although the scales may have different approaches, both assess the same phenomenon, but this must be confirmed by examining their convergence. Furthermore, confirming the factorial structure should mean one more step towards accumulating pieces of evidence of the PMSC validity.

The present study's objectives were to estimate the internal structure, the convergent validity, and the reproducibility of the PMSC.

METHODS

Participants

The sample comprised healthy children (8 to 10 years old). All the students from a public school in Recife, Brazil, were invited to join, and those who volunteered to participate and had the parental consent form signed and who did not present physical or cognitive impairment were included (n=187). This research was conducted in the school facilities, during the class period, with schoolteachers' and principals' support. The local Ethics Committee approved this study (protocol no. 1.853.815).

Instruments and procedures

Sample characterization considered anthropometric evaluation, calculation of body mass index (BMI), and socio-demographic evaluation. The stature measure used a portable stadiometer (GIMI) with an accuracy of 0.1 millimeters; the body mass was measured with a portable digital scale (Glicomed) with an accuracy of 0.1 grams; BMI calculation used the formula[20]: BMI= body mass/height^2. The socio-demographic data were estimated through the children's home zip codes.

The perception of motor competence (PMC) was evaluated by the Pictorial Scale of Perceived Movement Skill Competence (PMSC)[6,7] and by the athletic competence sub-domain of the Self-Perception Profile for Children (SPPC) scale[5].

The PMSC uses figures to assess how much the child perceives her/himself to be competent to perform six locomotion skills (run, gallop, hop, leap, horizontal jump, slide), and six object-control skills, in this case, balls (striking a stationary ball, stationary dribble, kick, catch, overhand throw, and underhand roll). Initially, an "ice breaker" activity was conducted when the researcher explained to the child what research is and asked her/himself to give examples. The example item was applied so that the child becomes familiar with the procedures and the scale. Next, the PSMC was presented as a game with figures, and an example skill (jumping jacks) was used to familiarize the child; it was asked if she/he knew the skills because some nomenclatures could be unknown. In this case, there was a demonstration of these skills; the complete test lasts 5-8 min.

The SPPC has six independent sub-domains (school competence, social acceptance, athletic competence, physical appearance, behavioral behavior, and global self-esteem). Each sub-domain consists of six questions, which describe a competent child and a not competent one in some activities. For example, in the athletic sub-domain, "some children do all kinds

of sports well, but others do not feel they are good at sports". The researcher asks the participant which child/picture he or she looks more like, and if she/he perceives herself partially or totally like that child/picture; the Likert scale ranging from one to four points, where "one" represented the lower PMC and "four" the higher PMC. Then, the SPPC athletic competence sub-domain was applied, and it took 5-8 min. One evaluator, experienced in this type of data collection, conducted all interviews. For the test-retest reliability assessment, both instruments were reapplied after an interval of seven to fifteen days, in 55 participants (29.4%).

Data analysis

Data normality was verified by employing the Kolmogorov-Smirnov test and scatter histograms. The socio-economic classification was done according to the national standards[21], using the average income of the children living place.

Pearson correlation tested the convergence between the instruments, assuming a correlation value equal to or greater than .50 as sufficient to show convergent validity[22]. An intraclass correlation (ICC) was applied for test-retest evaluation, assuming values <.40 as low, .40 to .75 as good, and >.75 an excellent agreement[23]. The dependent t-test estimated the systematic or random changes in the mean score of the instruments in the first and second evaluations. Bivariate correlation evaluated whether there was proportional bias between the difference of the evaluations (AV1-AV2) and the means of the evaluations [(AV1 + AV2) / 2]. Instrument accuracy indicators were checked using the Cronbach Alpha coefficient; values greater than .70 were used as indicators of accuracy[24] and values greater than .60 were considered acceptable[25]. SPSS 21.0 software was used for these analyzes.

The Confirmatory Factor Analysis (CFA) based on polychromatic correlation matrices, using the Weighted least squares with means and variances adjusted (WLSMV) method was used to evaluate the factorial structure of PMSC. The models were tested from the recommended adjustment indices by[26] chi-squared ($\chi 2$), degrees of freedom (df), reason regarding degrees of freedom ($\chi 2/df$), Comparative Fit Index (CFI), and Root-Mean-Square Error of Approximation (RMSEA). As for the reference values, we have adopted those commonly employed in literature: $\chi^2/gl \leq 3$; CFI $\geq .90$; RMSEA $\leq .06$. Mplus 7.3 statistical software was used for these analyzes.

RESULTS

The final sample consisted of 187 children aged 8 to 10 years (9.6 years ± 0.8; 50.7% male). Sampling losses were due to a lack of signature of the informed consent term (14.6%), non-attendance on the day of the evaluation (5.1%), and incomplete data (6.3%). Considering an Effect Size = 0.3, an alpha = 0.01, this sample of 187 children achieved a Power (1- ß err prob) = 0.95 (G*Power software). Regarding the sample's socioeconomic level, 55.5% were classified as low level; 46.8% of participants exhibited normal weight status.

Descriptive analyses of variables

The PMSC score and the SPPC athletic competence sub-domain score presented normal distribution and acceptable values of asymmetry[27] mean scores and standard deviation of these variables are in Table 1.

Correlation between the scales

The Pearson correlation test resulted in a moderate correlation between the locomotion sub-domain (r=0.41, p<0.001), object control (r=0.56, p<0.001), and total score (0.58, p<0.001) of the PMSC with the SPPC athletic competence sub-domain.

Test-retest evaluation

The ICC values resulted in good agreement for the PMSC locomotion, and score athletic competence sub-domain; also, excellent agreement for the PMSC object control score and PMSC total score was found (Table 2).

The results of the dependent test-t showed that the response changes between the evaluations were random in the locomotion score (0.1, p<0.001), object control score (-0.6, p<00.001), the PMSC total scores (-0.5, p<0.001), and in the SPPC athletic competence sub-domain (-0.3, p<0.001) (Table 2).

The results of the bivariate correlation for the differences between the evaluations showed that the SPPC athletic competence

Table 1: Mean and standard deviation (SD) of the age, the score from the sub-domain of athletic competence of the Self-Perception Profile for Children (SPPC), and the score from the Pictorial Scale of Perceived Movement Skill Competence (PMSC) of the 187 children (8 to 10 years). Recife, Brazil.

	Mean	SD
SPPC (score)	17.2	4.0
PMSC (total score)	39.1	5.0
PMSC locomotion (score)	20.1	2.8
PMSC control objects (score)	19.0	3.1

Table 2: Intraclass correlation coefficient (ICC), the difference between means, and relative bias in the test-retest in the items of the sub-domain of self-Perception Profile for Children (SPPC) and Pictorial Scale of Perceived Movement Skill Competence (PMSC) of 55 students. Recife, Brazil.

	ICC	Difference between means	*r*
PMSC	0.78	-0.5*	-0.24
PMSC locomotion	0.68	0.1*	0.00
PMSC control objects	0.82	-0.6*	-0.16
SPPC	0.67	-0.3*	-0.27**

r, the bivariate correlation between the difference between the (AV1 – AV2) and the average of the evaluations [(AV1 + AV2)/2]. * p<0.001. ** p<0.05.

sub-domain (r=-0.27, p<0.05) suffered a proportional bias, and the locomotion score (r=0.00, p<0.05), object control score (r=-0.16, p<0.05), and PMSC total score (r=-0.24, p<0.05) did not suffer proportional bias (Table 2). Cronbach's alpha coefficients demonstrated acceptable levels of reliability for the PMSC (locomotion = 0.654 and object control = 0.652).

Construct validity

Results from the CFA indicated adjustment indexes classified as adequate for the two-factor model for PSMC [WLSMVχ^2= 84.629; df= 53, p=0.004; WLSMV χ^2/gl = 1.59; CFI≥0.91; RMSEA ≤0.056 (IC90%; 0.032-0.078)]. The factorial model is presented in Figure 1.

The proposed PSMC model indicates good factor load levels for the respective factor items between 0.396 and 0.604 for the locomotion factor and between 0.404 and 0.639 for the object contro factor. In addition, a high-magnitude correlation was observed between the factors.

DISCUSSION

This study aimed to examine the convergent validity between the PMSC and SPPC athletic competence sub-domain in healthy schoolchildren. The results allow confirming the convergence between these scales. These findings are similar to that showed of by[28], who evaluated 5 to 9 years old children (N=247) and confirmed convergent validity between PMSC and the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (ICC= 0.26, 95%, p=0.032). Such results suggest that children's PMC may be a comprehensive construct, composed of broad and specific aspects related to motor skills, athletic, and sports activities.

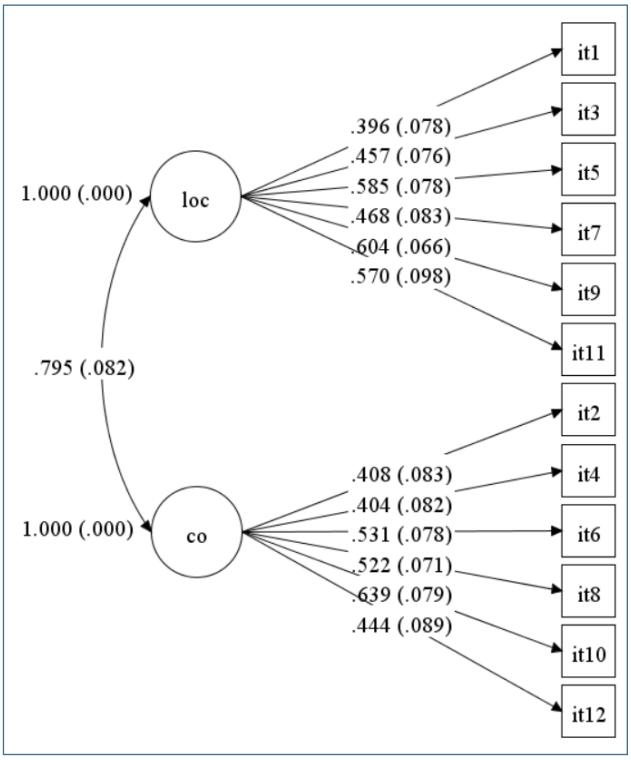

Figure 1: PSMC confirmatory factorial model.

The SPPC athletic competence sub-domain characteristically evaluates the children's perception of his/her competence in a broad-spectrum context, *i.e.*, asking for their self-judgment in sports activities, outdoor games, and demonstration of athletic ability[5]. On the other hand, the PMSC evaluates specifically the child's PMC in twelve gross motor skills (six of locomotion and six of object control)[6,7]. We can suggest that both scales evaluate different variances of the same construct. So, there is the possibility of choosing the appropriate instrument depending on the research question. Besides, by understanding that the scales are complementary, the joint use of them to evaluate the PMC would be a way to better embraces the phenomenon.

Theoretically, the SPPC athletic competence sub-domain could not represent early childhood very well, since in this developmental phase the children are not deeply involved in athletic and sports activities; this reinforces the need for a PMC's evaluation covering the typical gross motor skills more usually present in the youngest children's motor repertoire. In advancing to second childhood, it is expected the children to engage in sports and athletic activities, and thus, she/he can be able to perceive her/himself in both gross motor skills and sports and athletic activities, interpreting such contexts as similar[29]. Thus, our results seem to corroborate the theoretical proposition from Estevan and Barnett[29], who have shown that second-graders children judge their competence in gross, athletic, and sports motor skills as alike.

In sum, from a developmental perspective, the older child's ability to understand the domain of gross motor skills is inherent to their experience in sports and athletic context[30]. Our results support those found for Portuguese, Spanish, and Greek children[14,15,28] by showing that second-childhood Brazilian children were able to understand and judge their competence over locomotor and object control skills.

Regarding the instrument's accuracy, some studies have found adequate values in the object control skills factor[14,16,28,31] and the locomotion skills factor[15]. In the present investigation, Cronbach's alpha coefficient values demonstrated acceptable levels of accuracy for the two-factor model of the instrument; such results agree with previous ones[32].

When analyzing the reproducibility of the instruments, ICC values showed that the children remained consistent in judging their competence among the evaluations. The reproducibility in the scores from SPPC's athletic competence sub-domain was classified as good and reproducible in the PMSC locomotion skills. The reproducibility in the object control score and the PMSC total score were classified as excellent. The reproducibility results

from the SPPC's athletic competence sub-domain corroborate the previous study[31] that showed a strong correlation (r=0.83) in the test-retest. The results of the reproducibility of the PMSC scale confirm previous results found in Brazil[16] as well as in other countries: Australia[6], Portugal[14], Spain[31,] and in US[32].

The mean score changes from the first to the second evaluation were random, meaning that there was no learning of the instruments. No study performed the such analysis with the SPPC's athletic competence sub-domain. Regarding the PMSC, our results disagree with the results found by Barnett et al.[32], since they have identified boys learned the instrument in the retest. Thus, our results have shown that the interval between evaluations was sufficient and efficient to evaluate the reproducibility of the instruments, ensuring that there was no learning bias.

The results of the bivariate correlation for the differences between the evaluations showed that the SPPC's athletic competence sub-domain suffered a proportional bias, but the PMSC did not. This result suggests that even if the children had performed a motor competence test, this event was not a bias for the PMC assessed by PMSC. These results differ from that found by Barnett et al.[32], which identified proportional bias for all children in the object control PMSC score.

Finally, our results of the factorial analysis indicated adjustments classified as adequate for the two-factor model (object control and locomotion) for PSMC, confirming what was proposed by Barnett et al.[7]. These results are taken together suggesting the two factors model is good behavioral representatives of the phenomena evaluated. Being the first study in Brazil and the second in the world to attribute evidence of external (convergent) validity to PMSC is the strength of this study. However, a limitation of this study is that the sub-domain of active gaming skills of PMSC was not evaluated. Besides, evaluating the relationship between PMSC score and actual motor competence would be essential information for the attribution of criterion validity. We can also point out our non-probabilistic sampling as a limitation. Although the power of the sample was quite acceptable (0.95), the generalizations of our results should be viewed with caution, that is, for healthy schoolchildren who have the same age group as the present study. Although the importance of investigating the sex factor is recognized in studies that deal with developmental variables, the present study did not investigate sex as an analysis variable. We understand that this could be characterized as a limitation, to be overcome in future studies. Thus, subsequent studies should consider moving beyond our limitations to add valid evidence to the PMSC.

Summing up, we can affirm that the PMSC has shown to be a valuable instrument for evaluating children's PMC and an excellent candidate to be a global tool since it has been applied in several countries. Our results showed that the PMSC has convergent validity with the subdomain of SPPC sport competence, fair values of reliability, and reproducibility, and confirmed that Locomotor and Object Control skills are factors that make up the scale for Brazilian children. Future studies should seek to attribute new sources of evidence of validity to qualify the PMSC to assess childhood PMC worldwide.

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