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Psychological Assessment

Perceptual-motor ability assessment in people with atypical development

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Abstract

The assessment of perceptual-motor maturity has been investigated, and evidence indicates its relevance in the prediction of academic performance, which justifies the relevance of its investigation. This study investigated the psychometric qualities of a screening version of the Bender-Gradual Scoring System (B-SPG in Portuguese) in 273 individuals aged between six and 24 (M = 13.27, SD = 3.63), 166 (60, 8%) males, who were diagnosed with intellectual disabilities. The results of the exploratory factor analysis and regression analysis were satisfactory and demonstrated that it is possible to use only three figures to carry out the evaluation, which facilitates the psychologist's work. The accuracy of the instrument was also estimated, and the results showed adequate indexes. It is concluded that the screening version of the B-SPG proves to be an adequate measure for children with atypical development. However, other studies should be performed.

Keywords: psychological assessment; Bender test; psychometry; perceptual-motor ability; psychoeducational assessment.

AVALIAÇÃO DA MATURIDADE PERCEPTOMOTORA EM PESSOAS COM DESENVOLVIMENTO ATÍPICO

Resumo

A avaliação da maturidade perceptomotora tem sido investigada, e evidências indicam sua relevância na predição do desempenho acadêmico, o que justifica a pertinência de sua investigação. O presente estudo investigou as qualidades psicométricas de uma versão de rastreio do Bender-Sistema de Pontuação Gradual (B-SPG) em 273 indivíduos com idades variando de 6 a 24 anos (M = 13,27, DP = 3,63), sendo 166 (60,8%) do sexo masculino, que tinham o diagnóstico de deficiência intelectual. Os resultados da análise fatorial exploratória e da análise de regressão foram satisfatórios e revelaram que é possível utilizar apenas três figuras para realizar a avaliação, o que facilita o trabalho do psicólogo. A precisão também foi estimada, e os resultados mostraram índices adequados. Conclui-se que a versão de rastreio do B-SPG se mostra uma medida adequada para crianças com desenvolvimento atípico, no entanto outros estudos devem ser realizados.

Palavras-chave: avalição psicológica; teste de Bender; psicometria; habilidade perceptomotora; avaliação psicoeducacional.

EVALUACIÓN DE LA MADUREZ PERCEPTO-MOTRIZ EN PERSONAS CON DESARROLLO ATÍPICO

Resumen

La evaluación del desarrollo percepto-motriz ha sido investigada y existen evidencias de su relevancia para predecir el desempeño académico, lo cual justifica la realización del trabajo. Este estudio investigó las cualidades psicométricas de una versión de sondeo del *Bender-Sistema de Pontuação Gradual* (B-SPG) en 273 individuos con edades entre 6 y 24 años (M = 13,27, DT = 3,63), siendo 166 (60,8%) del sexo masculino, que poseían diagnóstico de deficiencia intelectual. Los resultados del análisis factorial exploratorio y del análisis de regresión fueron satisfactorios, revelando que es posible utilizar apenas tres figuras para realizar la evaluación, lo cual facilitaría el trabajo del psicólogo. La confiabilidad también fue verificada y los resultados mostraron índices adecuados. Se concluye que la versión de sondeo del B-SPG parece ser una medida adecuada para niños con deficiencia intelectual, pero pese a eso, otros estudios deben ser realizados.

Palabras clave: evaluación psicológica; prueba de Bender; psicometría; desarrollo percepto-motriz; evaluación psicoeducacional.

1. Introduction

Perceptual-motor maturity has been extensively investigated, particularly in the international context, and has been associated with important human phenomena due to its strong relationship with cognitive development (Matarma, Lagström, Löyttyniemi, & Koski, 2020; Valderas et al., 2017). Geertsen et al. (2016) verified the association between the development of perceptual-motor skills and academic skills. In their study, Botha and Africa (2020) found a moderate correlation (r = 0.46) between perceptual-motor maturity and motor proficiency, for example. However, investigations in the field of psychological assessment with people with atypical development are still incipient, especially in Brazil (Teixeira & Bosa, 2019).

Initially proposed by Lauretta Bender, in 1938, to assess perceptual development based on the Gestalt theory, the Bender test has been widely studied worldwide (Brannigan, 2010; Otoni & Rueda, 2019a; Sisto, Noronha, & Santos, 2005). Among the studies, many of them aimed to create different correction and interpretation systems. However, the most researched system has been the Developmental Bender Scoring System, proposed by Koppitz in 1963 (Noronha, Rueda, & Santos, 2015). Unlike Bender, whose proposal was based on analysis and clinical evaluations, Koppitz (1963) was the first author to introduce measurable analyses from a quantitative perspective for the test. The evaluation considered four aspects to analyze the drawings (distortion of the shape, rotation, integration, and perseveration), with a dichotomous score, in which a point is attributed for each mistake made.

Concerning the proposed correction systems, in Brazil, the Bender-Gradual Scoring System (*Bender-Sistema de Pontuação Gradual* – B-SPG) (Sisto et al., 2005) is currently the only one that has obtained a favorable appraisal by the Psychological Testing Assessment System (Satepsi) of the Federal Council of Psychology, which allows its use for diagnostic purposes. The authors' proposal was based on the interpretation of the test by Koppitz, but taking into account only the distortion of the shape so that a gradual score is attributed to the errors made in the performance of the test. Greater distortions of the shape give higher scores attributed to the protocol evaluated.

Since its proposal, in 2005, the B-SPG has been extensively studied in children with typical intellectual development (Bartholomeu & Sisto, 2008; Carvalho & Noronha, 2009; Noronha, Santos, & Sisto, 2007; Noronha et al., 2015; Sisto, Bartholomeu, Rueda, Santos, & Noronha, 2008; Suehiro & Santos, 2006; Suehiro, Santos, & Rueda, 2015; Valderas et al., 2017). The B-SPG has also been studied using samples with development considered atypical (Noronha, Santos, & Rueda, 2013; Pacanaro, Santos, & Suehiro, 2008; Santos & Jorge, 2007; Vendemiatto, Santos, & Suehiro, 2008), although in smaller numbers, as previously stated.

When perceptual-motor maturity is investigated in people with atypical development, the findings reveal difficulty in carrying out the test, in relation to tiredness, difficulty maintaining the focus of attention, and difficulties in motor coordination (Noronha et al., 2013). Accordingly, it is possible that screening tests could provide useful results similar to the total version of the instrument and with evidence of validity and estimation of reliability (Miranda, Silva, Mendonça, & Bandeira, 2020).

In the international context, reduced versions of the Bender test, prior to the B-SPG in Brazil, were proposed by Santucci and Pêcheux (1981) and Brannigan and Brunner (2002). The first authors proposed applying figures (A, 2, 4, 3, and 7), defining the angulation, spatial concept, the number of elements, and relationship between the parts as criteria for evaluation. Subsequently, Brannigan and Brunner

(2002) established the application of six figures (A, 1, 2, 4, 6, and 8) with a score ranging from zero to five points. Although proposed and used in several studies, both systems did not present psychometric information for the choice of figures.

In Brazil, Rueda, Sousa, Santos, and Noronha (2016) proposed a reduced version for the B-SPG based on Kacero's (2005) proposal, which classified the figures of the Bender tests into three large sets: figures consisting of straight lines and angles (A, 7A, 7B, and 8), points or loops (figures 1, 2, 3, and 5) and curved lines (4 and 6). It should be noted that, unlike other correction systems, in the B-SPG, each part (diamond) of figure 7 is evaluated and scored. Based on this classification, Rueda et al. (2016) carried out an exploratory factor analysis (EFA) to verify which figures have the highest factor loadings in each of these three categories. Subsequently, they performed the regression analysis, showing that figures 3, 4, 7A, and 7B explained 80% of the total test score. Based on this, they concluded that using only three figures could provide information equivalent to the application of all nine, which would provide benefits for the evaluation. In particular, the following can be highlighted: 1. reduction of application time, which would avoid 2. tiredness of individuals.

Although it is a recent proposal, studies have sought validity for the B-SPG screening version. In a study conducted by Otoni and Rueda (2019a), in which they used figures 3, 4, and 7, through the analysis of differences in means, it was found that the participants with a low academic performance presented significantly higher means in the B-SPG (screening version) than groups with medium and high performance. In addition, the authors correlated the means of participants in school subjects (Portuguese, mathematics, science, geography, history, and arts) with the mean in the screening version. Pearson's correlation coefficients ranged from $r = -0.50$ (Portuguese) to $r = -0.20$ (arts).

In turn, Otoni and Rueda (2019b), when analyzing the internal structure of the screening version using the Rasch model, identified that figure 3 presented a higher level of difficulty, requiring greater perceptual-motor maturity for its correct execution. Based on the results of both studies, they concluded that the screening version of the B-SPG could be a promising tool in the assessment of perceptual-motor maturity. Within this context, and in an attempt to expand the studies with the screening version of the B-SPG, this study aimed to analyze figures 3, 4, and 7, this time, in children with atypical development.

2. Method

2.1 Participants

Study participants were 273 individuals aged between 6 and 24 (*M* = 13.27, *SD* = 3.63), 166 (60.8%) of whom were male. They came from 11 institutions, classified as 'special education' institutions according to the Law of Guidelines and Bases of National Education (*Lei de Diretrizes e Bases da Educação Nacional* – Brazil, 1996). They had a diagnosis of intellectual disability performed by a multidisciplinary team from each institution. More specifically, the diagnoses were: Down syndrome, mild cerebral palsy, among others. Although 273 people composed the sample, the collection was carried out with 324 individuals. However, with 51 of them, it was not possible to identify any of the figures drawn, and, as suggested by the authors of the scoring system, these tests were considered 'non-interpretable', since their correction and analysis were impossible. Regarding the inclusion criteria, all tests suitable for correction were considered valid.

2.2 Instrument

- Bender Visual-Motor Gestalt Test – Gradual Scoring System (B-SPG) (Sisto et al., 2005): the instrument consists of nine figures (A, 1, 2, 3, 4, 5, 6, 7, and 8; in figure 7, two hexagons are analyzed – 7A and 7B), which are presented sequentially to be copied 'as best as possible' on a blank sheet without any mechanical help or the use of an eraser. The difference in the B-SPG is the possibility of its collective application through the projection of the figures using a screen projector. However, since this sample was composed of people with disabilities, the application was individual, using the cards. The score attributed to the drawings is gradual, with only the distortion of the shape being evaluated, with greater distortion equating to higher scores attributed in the evaluation. These scores vary from zero (figure without error related to shape distortion) to two, except for figure 6, in which the score can vary from zero to three. The overall score of the B-SPG varies from zero to 21.

Studies have verified validity evidence for the B-SPG (internal structure, criterion, concurrent, and convergent), as well as reliability (interrater, split-half, and through the Rasch model). The test standards were developed based on a sample of more than 1,000 children between 6 and 10 years of age.

2.3 Procedures

Initially, contact was made with the institutions, and meetings were scheduled with the management to explain the objectives of the study and verify the possibility of carrying out the project. After authorization, the project was submitted for analysis by the Research Ethics Committee of the São Francisco University and, after approval (Certificate of Presentation for Ethical Appreciation – *Certificado de Apresentação para Apreciação Ética* – CAAE nº 20460113.6.0000.5514), contacts were initiated with the subjects' parents or legal guardians.

After the authorizations, through the signature of the consent form, the data were all collected individually. The application took place in rooms and spaces provided by the institutions, under suitable conditions for the application. The collection was carried out by a team of psychologists, master's and doctoral students in Psychology, who had been previously trained to standardize the procedure. To answer the B-SPG, all individuals received a pencil and an A4 sheet of paper. The instructions were given according to the instructions in the test manual.

The average response time of the test was around 30 minutes. Sisto et al. (2005) reported that the approximate application time was approximately 10 minutes in the data collection for the construction of the gradual scoring system.

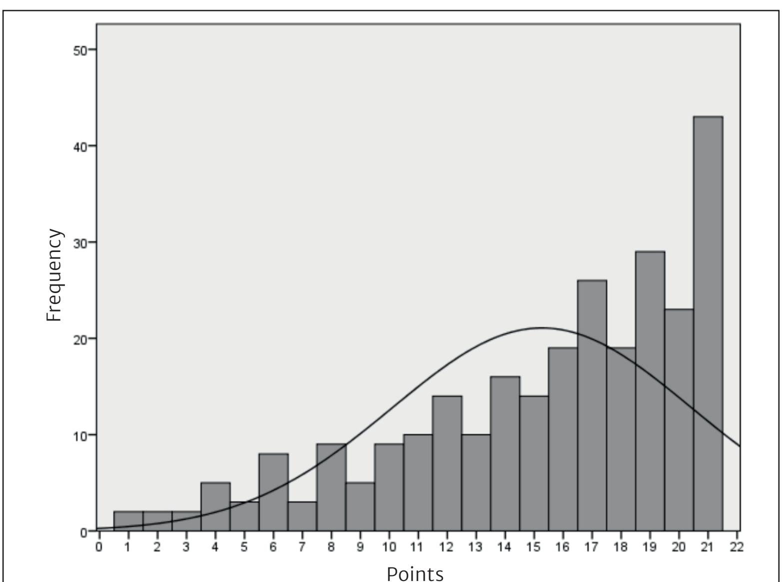
2.4 Data analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20.0 software. Initially, the descriptive statistics of the scores in the B-SPG were calculated. Then, the EFA was performed using the Principal Axis Factoring extraction method. According to Costello and Osborne (2005), this is the appropriate method when working with samples that do not present a normal distribution. It is important to highlight that, initially, the Kaiser-Meyer-Olkin index (KMO = .92) and the Bartlett's Sphericity Test (χ_2 (45) = 1218.82, p <.001) were used to verify the possibility of factorization of the correlation matrix. Following the same procedure adopted by Rueda et al. (2016), the rotation method and the number of factors to be extracted were not fixed. The EFA was performed to verify which figures had the highest factor loadings, considering the groups of drawings established by Kacero (2005) to classify the figures that compose the Bender Test. After this analysis, and considering the results, the selected figures were submitted to a regression analysis, considering the independent variables. The dependent variable was the total score of the B-SPG. The Enter method was used. Finally, the alpha coefficient for the selected figures was verified. It is important to highlight that all analysis procedures were performed in line with the study by Rueda et al. (2016).

3. Results

Initially, to verify the descriptive statistics of the B-SPG, a histogram was created (Figure 3.1). As it can be seen, the highest score concentration was 21 points (43 subjects, representing 15.8% of the sample). Considering that the test scores errors, it is evident that a high number of subjects presented very low performance in the B-SPG. More than 75% of the sample had more than ten errors in the distortion of the shape. In turn, no participant performed the B-SPG without presenting any distortion of the shape (zero points). The mean score was 15.26 (*SD* = 5.17).

Figure 3.1. Frequency histogram of scores on the B-SPG.



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Following the proposed analyses, it was verified whether the data were subject to factoring. The Kaiser-Meyer-Olkin index (KMO = .92) and the Bartlett's Sphericity Test (χ_2 (45) = 1218.82, p <.001) were used to verify the possibility of factorization of the correlation matrix. Unlike the study by Rueda et al. (2016), which verified an initial structure of two factors, in the analysis of the present study, a single factor structure was observed, with an eigenvalue of 5.09, which explained 50.87% of the variance. The factor loadings and the grouped results, considering each type of layout, are presented in Figure 3.2.

Figure 3.2. Factorial structure by type of layout in the B-SPG.

Figures	Factorial load
Points and loops	
Figure 1	0.55
Figure 2	0.59
Figure 3	0.70
Figure 5	0.65
Straight lines and angles	
Figure A	0.59
Figure 7A	0.83
Figure 7B	0.83
Figure 8	0.82
Curved lines	
Figure 4	0.70
Figure 6	0.80

The observed results are in agreement with the findings of Rueda et al. (2016) when verifying that figures 3 and 7A and 7B presented the highest factor loadings of the 'points and loops' and 'straight lines and angles' drawings, respectively. In turn, in the 'curved lines', the highest factor loading was also observed in figure 6, corroborating the study by Rueda et al. (2016). However, in the aforementioned study, the factor loadings of figures 4 and 6 were very close (0.47 and 0.49 respectively), which led the authors to choose the use of figure 4, since figure 6 is the only one that has a score ranging from zero to three points. The decision was also based on the study by Sisto et al. (2010), which, through Differential Item

Functioning, found that figure 6 presented greater difficulty for girls. In the case of this study, a difference of 0.10 was observed in the factor loadings of these figures, with figure 6 being the one with the highest value (0.080).

As a result, it was decided to carry out the subsequent analyses considering two blocks of figures in order to verify which would be the most appropriate option. Therefore, an analysis was performed with figures 3, 7A, 7B, and 4 analyzes and another with figures 3, 7A, 7B, and 6. To verify the predictive value, the regression analysis was performed using the Enter method, taking the selected figures as the independent variables and the total score of the B-SPG as the dependent variable. It was observed that the first set of figures predicted 86% (adjusted R^2) of the total test variance, while the second set explained 87% of it. Based on this result and considering the justifications presented by Rueda et al. (2016), the option was to consider a possible reduced version of the B-SPG with figures 3, 4, 7A, and 7B. The results of this analysis are presented in Figure 3.3.

Figure 3.3. Multiple regression with the selected B-SPG figures.

Figure	B	Standard error	Beta	*t*	*p*
Figure 3	2.44	0.26	0.27	9.58	< 0.001
Figure 4	2.00	0.22	0.26	9.07	< 0.001
Figure 7A	2.56	0.28	0.32	9.14	< 0.001
Figure 7B	2.41	0.28	0.30	8.66	< 0.001

We can observe that all the results were statistically significant in predicting the total score of the B-SPG. In addition, Cronbach's alpha was calculated, obtaining a value of .82. When considering figure 6 instead of figure 4, the alpha value was .84. This reinforced the decision taken to consider figure 4 in the reduced version of the B-SPG since the values were very close, and, as already shown by Otoni and Rueda (2019a), figure 4 would be more appropriate since its score range is the same as the other figures (from 0 to 2), as well as it being a figure that is less difficult to reproduce.

4. Discussion

Constructing measurement instruments and conducting studies that seek evidence of validity for these tests that can be used with people with disabilities is fundamental and must be part of public policies (American Psychological Association, 2011), as professionals use their results to provide reliable psychological assessments. Despite the fact that the evaluation area has reached a high level of development over the last two decades in Brazil (Reppold & Noronha, 2018), the steps have been slower with regard to the construction of instruments for atypical populations (Noronha et al., 2013; Oliveira & Nunes, 2018).

In the present study, the evaluation of perceptual-motor maturity was investigated in a sample of people diagnosed with intellectual disabilities, using a reduced version of the B-SPG (Rueda et al., 2016). The B-SPG is considered an important screening tool, since its results maintain significant correlations with the results of intelligence measures (Pacanaro et al., 2008; Sisto et al., 2008, among others), as well as being a predictor of academic performance (Suehiro et al., 2015). Matarma et al. (2020), Botha and Africa (2020), and Geertsen et al. (2016) have emphasized the relevance of assessing perceptual-motor skills due to their association with academic skills.

Regarding the findings, the frequency of the scores observed in Figure 3.1 indicates that there was a sharp curve on the right, equating to higher scores, which refers to a greater concentration of errors than of correct responses in the case of the B-SPG (Sisto et al., 2005). Considering this, it should be noted that the psychometric studies of the B-PSG were constructed through the application of figures in samples of children aged 6 to 10 (Sisto et al., 2005), as the perceptual-motor development reaches its peak around this age (Bender, 1955; Koppitz, 1963; Santucci & Pêcheux, 1981). At age 10, therefore, most children should be able to copy the drawings without errors. In this study, individuals aged from 6 to 24 participated, with a mean age of 13 years old, which reiterates the assertion that cognitive deficits have implications for other areas of development.

It is important to note that the analyses performed and the results observed allow us to state that the screening version of the B-SPG proposed by Rueda et al. (2016) can also be used with individuals with atypical development, confirming the research hypothesis. However, the findings only allow us to reach this conclusion, with further studies needed that seek to provide evidence of validity for this version in samples with atypical development, aiming to investigate whether there is a differentiation of the individuals according to different diagnoses and, if so, how this occurs. Studies should also aim to verify differences due to age in subjects with atypical development in order to identify other evidence of validity.

With regard to the subsequent analyses, which dealt with the factorial structure according to the type of drawing, namely, points and loops, straight lines and angles, and curved lines, the findings corroborate those of Rueda et al. (2016). Figures 3, 4, and 7 (with the evaluation of diamonds A and B), as identified by the authors, can be used as a measure of perceptual-motor maturity, explaining approximately 51% of the variance. The proposition of Paim (1992) should be highlighted, which states that, at 6 years of age, the child can draw loops and lines. At the age of 7, the child can draw oblique lines and join the subparts, while at 10 years of age, hexagons are successfully completed. It seems appropriate that items (figures) that evaluate points and loops (figure 3), straight lines and angles (figure 7), and curved lines (figure 4) are included in the reduced version of the instrument (Kacero, 2005).

The Brazilian psychological assessment has achieved good results in the last two decades, the result of joint efforts by scientific associations, research laboratories, and the class council. The scenario of lack of resources with proven evidence of validity and estimates of reliability that guarantees the quality of the diagnoses has passed, and a new moment has commenced, in which the development of psychological tests for use with people with disabilities is still lacking. Accordingly, the Federal Council of Psychology, through various actions, has encouraged researchers to promote progress.

The present study aimed to test the factorial solution found for the reduced version of the Bender-Gradual Score System for a sample of children with typical development, in a sample of people with diagnosed intellectual disability, students of 'special education' institutions. This aim was achieved, although other research agendas must be constructed. Psychological tests of different natures could be applied to people with atypical development, with a view to establishing evidence of validity for the evaluation of this population and also establishing eventual normative distribution.

Some limitations of this study could be the focus of future studies. For example, investigating the level of intellectual disability (mild, moderate, severe, profound) of the individuals in the sample, as this would allow a deeper discussion of the implications of the results regarding the use of the instrument in the clinical practice. In addition to working with children diagnosed with atypical development, it would be interesting to have information about their intellectual development as a way of comparing them. Furthermore, verifying whether the diagnosis obtained was primary or secondary would also enrich the research data, identifying the underlying pathology(s). More detailed information about these diagnoses and the intellectual level of the subjects would allow more robust analyses to be carried out, controlling these effects. It is important to highlight that, with the expansion of research, such as the present study, it is possible to provide psychologists who work with this public with a valuable instrument to both substantiate their diagnostic hypotheses and to provide more reliable clues to develop their intervention programs.

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