

# Identifying Signs of Dyslexia Test: The construction process

## *Teste para Identificação de Sinais de Dislexia: processo de construção*

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### Abstract

This article aims to present the process of construction of a screening test to assess signs of dyslexia. Two phases were performed: (a) identifying scientific productions and national and international instruments on the assessment of dyslexia and selection of the most frequently evaluated cognitive-linguistic skills; (b) construction of a draft and analysis by specialist judges. From these phases the "Identifying Signs of Dyslexia Test" instrument was prepared, designed for children aged 8-11 years, and composed of the assessment of eight skills: reading, writing, visual attention, calculation, motor skills, phonological awareness, rapid naming, and immediate memory. Future studies are needed to verify the validity and reliability evidence of the instrument.

**Keywords:** Dyslexia; Neuropsychology; Psychological assessment.

### Resumo

*Este estudo objetivou apresentar os processos de construção de um teste de triagem para avaliar sinais de dislexia. O procedimento foi realizado em duas fases: (a) identificação de produções científicas e instrumentos nacionais e internacionais sobre a avaliação da dislexia e seleção das habilidades cognitivo-linguísticas mais frequentemente avaliadas; (b) construção da versão preliminar e análise por juízes especialistas. A partir dessas fases foi elaborado o Teste para Identificação de Sinais de Dislexia, destinado a crianças na faixa etária de 8 a 11 anos. O teste é composto pela avaliação de oito habilidades: leitura, escrita, atenção visual, cálculo, habilidades motoras, consciência fonológica, nomeação rápida e memória imediata. Estudos futuros são necessários a fim de que sejam verificadas evidências de validade e confiabilidade do instrumento.*

**Palavras-chave:** Dislexia; Neuropsicologia; Avaliação psicológica.

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Developmental dyslexia is a specific learning disorder and is characterized by difficulties in the acquisition and development of reading skills. It affects children with normal intelligence levels, absence of sensory deficits and adequate academic instruction (American Psychiatric Association [APA], 2002; Lyon, S.E. Shaywitz, & Shaywitz, 2003; Pestun, Ciasca, & Gonçalves, 2002).

The diagnostic guidelines for dyslexia are: lower performance in reading accuracy, speed and comprehension, as measured by standardized tests, compared to that expected for the chronological age and intelligence; reading/writing characterized by mainly phonological errors; and the late development of oral language can also be observed (APA, 2002; Organização Mundial da Saúde, 2008).

Studies show that children with dyslexia present changes in different cognitive functions, such as: visual attention (Franceschini, Gori, Ruffino, Pedrolli, & Facoetti, 2012), phonological processing (Lima, Salgado, & Ciasca, 2008; Swanson, Xinhua, & Jerman, 2009), motor skills (Nicolson & Fawcett, 2011), and executive functioning (Lima, Azoni, & Ciasca, 2012; Reiter, Tucha, & Lange, 2005).

National and international studies have been conducted aiming to assess cognitive and linguistic skills that could be compromised from the beginning of schooling and that are signs indicative of a learning disorder (Capellini et al., 2009; F.C. Capovilla & Capovilla, 2002; A.G.S. Capovilla, Gütschow, & Capovilla, 2004; A.G.S. Capovilla, Smythe, Capovilla, & Everatt, 2001; Carvalhais, 2010; Nicolson & Fawcett, 2003).

Cox (2002) conducted a study with the aim of developing an instrument - Test of Dyslexia and Dysgraphia (TODD) -, which would help in the diagnosis of dyslexia and dysgraphia. It was composed of memory of symbols, memory of words, phonological skills, visual processing, and rapid naming of symbols. The author found that children with dyslexia or dysgraphia showed impairments in all assessed skills when compared to children without these diagnoses, with the worst performance in phonological and memory skills.

Another international instrument is the Dyslexia Early Screening Test (DEST-2), developed by Nicolson and Fawcett (2003). The DEST-2 provides a profile based on the evaluation of some competences, such as: rapid naming, phonemic discrimination, postural stability, rhyme, digits, digit naming, letter naming, order of sounds, form copying, attention, vocabulary, and visual-motor coordination. It is able to indicate a possible reading disorder "risk". According to the authors, children with dyslexia often tend to present low performance in phonemic discrimination, rapid naming, rhyme, and visual-motor coordination.

In the Brazilian context, Capovilla et al. (2001) conducted a preliminary adaptation study for Brazilian Portuguese of the International Dyslexia Test (IDT). This test consists of subtests that assess reading, writing, math skills, phonological awareness, auditory processing, phonological discrimination, short-term memory, auditory sequential memory, visual processing, visual discrimination and perception, short-term visual memory, sequential visual memory, processing speed, sequencing, motor skills, and reasoning. This study showed that the IDT was sensitive in detecting altered skills in Brazilian children with difficulties in writing, especially difficulties related to phonological processing (composed of the reading, writing, phonological awareness, auditory processing, sequencing, and processing speed subtests).

Capellini et al. (2009) developed a protocol for the early identification of reading problems, composed of seven subtests: alphabet knowledge, phonological awareness, working memory, speed of access to phonological information, visual attention, reading of words and non-words and comprehension of phrases from figures presented. The authors stressed the importance of evaluating these skills in elementary education, so that the student at risk for difficulties in reading and writing can be identified. They also stated that, although there are numerous national studies on the relationship between phonological skills and reading acquisition, studies on protocols that can identify impairments in these skills are scarce.

Thus, this study aimed to present the construction process of a screening instrument to assess for signs of dyslexia, called the Identifying Signs of Dyslexia Test (ISDT). It is emphasized that this instrument was proposed in order to facilitate the referral of children at risk for dyslexia for a more comprehensive evaluation, not in itself providing the diagnosis of this disorder. Accordingly, the initial development of this test is presented, and numerous studies are still needed for it to be considered a valid and reliable instrument.

## Method

This study was approved by the Research Ethics Committee of the *Universidade Estadual de*

*Campinas* (Process nº 946/2011). The study consisted of two phases, as described below (Figure 1).

### Phase 1. Theoretical aspects

Initially a review of national and international literature specializing in neuropsychology was conducted to identify evaluation instruments and studies on impaired cognitive-linguistic skills in children with dyslexia. The skills most often evaluated by the instruments and the impaired skills most often studied in this disorder were selected. Next, the activities used to evaluate all the selected skills were described. For this the protocol presented in Table 1 was used.

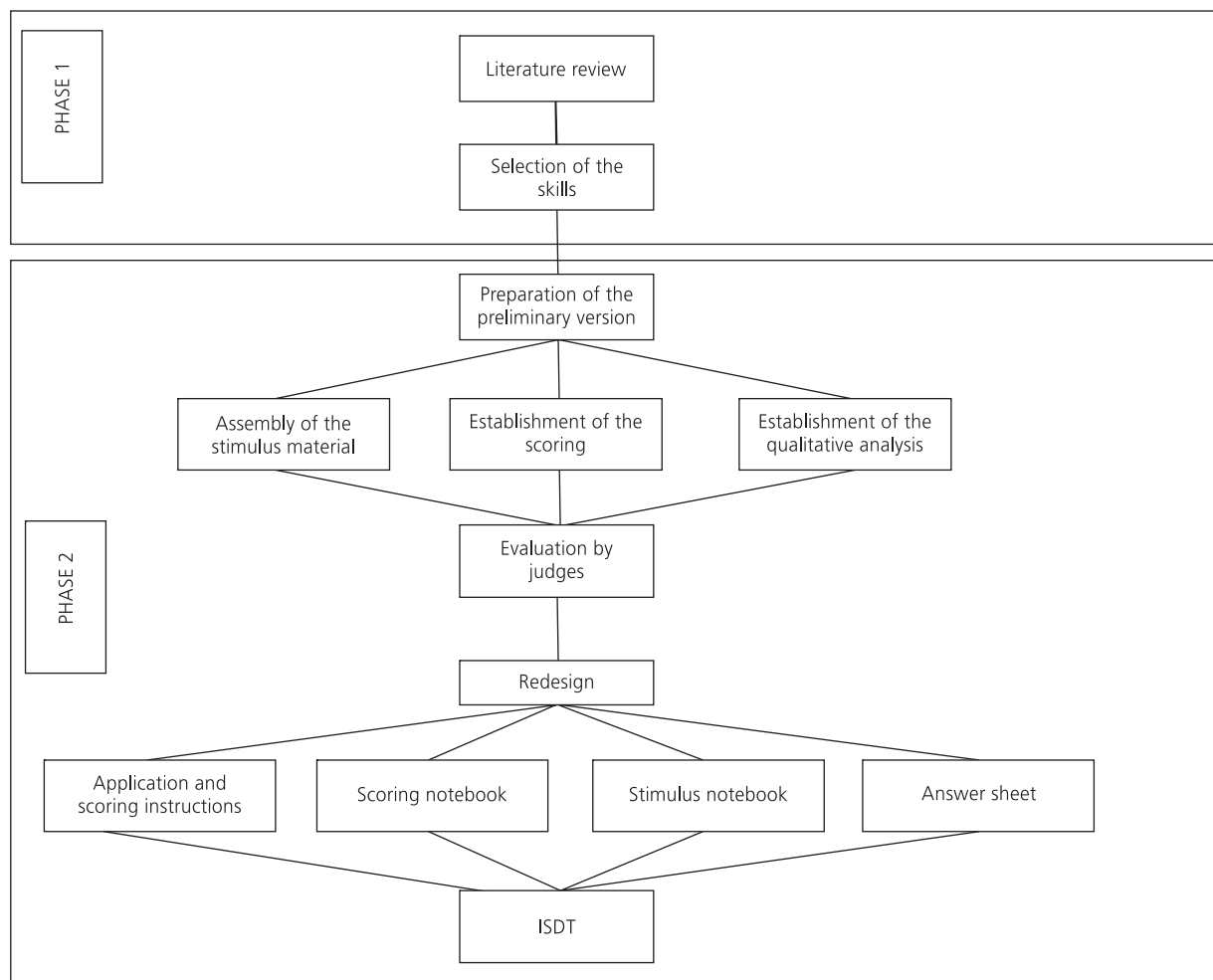


Figure 1. Phases of construction of the instrument.

Note: ISDT: Identifying Signs of Dyslexia Test.

Table 1

Model of table used for the establishment of the skills

Title of the article/book/test/thesis	
Type of production:	
Author(s):	
Year of publication:	
Place of publication:	
Aim:	
Age group:	
Skills evaluated	Description of tasks used for the establishment of the skills

From this theoretical analysis, the skills to compose the ISDT were selected.

## Phase 2. Construction of the instrument

With theoretical and technical assistance from neuropsychology and phonoaudiology specialists, activities based on those described in Phase 1 were developed for each of the selected skills. Next, a preliminary version of the ISDT was constructed, and its scores, its qualitative analysis, and the materials for its application and correction were established.

This version was then evaluated by four specialist judges, one from psychology, one from neuropsychology and two from phonoaudiology. The aim of this evaluation was to carry out judgments regarding the content of the test, verifying whether the selected skills associated with dyslexia were considered and whether the tasks elaborated were suitable for their evaluations. This type of evaluation can be defined as a study of validity evidence based on test content, which aims to determine whether the items comprising the instrument refer or not to the construct evaluated (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999).

All the judges were given a table that contained the definition of the eight cognitive-linguistic skills selected, the activities elaborated for

their evaluations, and a space to mark whether it would be relevant or not to include each one, and possible changes to the way they were being evaluated. The skills and the items that comprised their evaluation were modified, accepted or excluded using a rate of 75% agreement among the judges. The materials prepared were also evaluated by the judges, and the same rate of agreement was adopted for the evaluation of the maintenance and/or exclusion of any of them.

## Results

The Identifying Signs of Dyslexia Test is an instrument designed to evaluate signals indicative of dyslexia, aimed at children aged between eight and 11 years and of individual application. It can be classified as a brief neuropsychological instrument, as it provides screening of cognitive-language skills most commonly evaluated in individuals at risk for this specific learning disability.

### Phase 1

From the literature review conducted in Phase 1 the following productions were identified: (a) "An interpretative model of early indicators of specific developmental dyslexia in preschool age: A comparative presentation of three studies in Greece" (Zakopoulou et al., 2011); (b) "Assessing college-level learning difficulties and "at riskness"

for learning disabilities and ADHD: Development and validation of the learning difficulties assessment" (Kane, Walker, & Schmidt, 2011); (c) "Development of pedagogic tools to identify students at risk for dyslexia" (Andrade, Prado, & Capellini, 2011); (d) "Learning disabilities checklist" (National Center for Learning Disabilities, 2007); (e) "Protocol for the early identification of reading problems: Preliminary study of schoolchildren from the 1<sup>st</sup> school year" (Capellini et al., 2009); (f) "Learning Disability Evaluation Scale - Renormed Second Edition" (LDES-R2) (McCarney & Bauer, 2007); (g) "Neuropsychological functions in children with reading and writing difficulties" (Salles & Parente, 2006); (h) "DEST-2" (Nicolson & Fawcett, 2003); (i) "An evaluation of the psychometric properties of the test of dyslexia and dysgraphia" (Cox, 2002); (j) "Brazilian adaptation of the IDT" (Capovilla et al., 2001); (k) "Exploratory testing of specific dyslexia" (Condemarin & Blomquist, 1989).

There were eight cognitive-linguistic skills most frequently evaluated in all the tests and researched scientific productions: reading, writing, visual attention, calculation, motor skills, phonological awareness, rapid naming, and immediate memory. These were selected to compose the ISDT.

## Phase 2

With the help of a neuropsychologist and a phonoaudiologist, a preliminary version of the ISDT was constructed, with an activity for each of the eight selected skills. It was organized as four materials, the "Application and scoring instructions notebook", "Answer sheet", "Application notebook" and "Stimuli notebook".

Next, the agreement of the four specialist judges was obtained for the maintenance of these eight skills/constructs. Based on the suggestions presented, changes were only made in the way the words and pseudowords of the reading and writing tasks were evaluated. Many polysyllabic words had been adopted, and the inclusion of words with a

maximum of three syllables was suggested, which was accepted considering it is a screening instrument. The judges unanimously decided to maintain the four materials.

Table 2 presents the subtests and their respective activities that were constructed for the composition of the ISDT. The descriptions, form of administration by the evaluator (visual, oral), form of answer presentation by the child (oral, motor), need for recording the time, and total points that can be obtained are also presented. The average time estimated for the individual application of the ISDT is 30-40 minutes.

The test score was organized so that every error made by the child was considered to be one point. Thus, the more points the child gets in the test the worst the performance.

In three subtests the scoring system was different, considering the characteristics of the activity, as described below:

- In the "Visual attention" subtest the errors by omission (target letters that the child did not mark) and by addition (non-target letters marked) are considered. Thus, the score refers to the sum of the two errors types, with the possibility of a total of 195 points;

- In the "Motor skills" subtest each figure is analyzed individually so that each may receive scores of zero (with details and without tremors in the stroke), one (strokes with tremors, without changing the overall structure) and two (strokes with tremors, alterations in the angles and omissions of parts of the figure);

- The subtest "Rapid naming" is composed of two separate boards, one of letters and one of numbers, with each incorrectly named stimulus scoring one point. In addition, the child also receives one point for every five seconds performing of the task. The scores related to errors are added to those obtained for the time taken. Example: if a child performed the task in 18 seconds ( $18/5 = 3.6$ ; with this value rounded up to four, thus providing four points) and committed one naming error, the final score would be five points.

Table 2

Names and descriptions of the subtests that comprise the Identifying Signs of Dyslexia Test

Subtests	Description of the subtests	Score
1. <i>Reading</i>	Recognition of 21 letters of the alphabet presented in random order; reading of nine words and nine pseudowords.	Total = 39
1.1 Letters		
1.2 Words	Application: visual. Response: oral.	
1.3 Pseudowords		
2. <i>Writing</i>	Dictation of letters of the alphabet presented in random order; dictation of nine words and nine pseudowords.	Total = 39
2.1 Letters		
2.2 Words	Application: oral. Response: motor.	
2.3 Pseudowords		
3. <i>Visual attention</i>	Set of 195 randomly distributed letters, in which the child must seek a specific one, in this case "p". Application: visual; recording of time (60 second time limit). Response: motor.	Total = 195
4. <i>Calculation</i>	Four problems to be solved mentally, each corresponding to a mathematical operation. Application: oral. Response: oral.	Total = 4
5. <i>Motor skills</i>	Copying of a figure formed by lines and four geometric figures (circle, triangle, square and rectangle). Application: visual. Response: motor.	Total = 10
6. <i>Phonological awareness</i>	Two tasks: one of rhyme identification (in which the aim was to identify which words rhymed with each other); and another of rhyme production (in which the aim was to say a word that rhymed with another). Had the support of the pictures of the target words. For example, when asked to rhyme the word "giraffe", the figure of a giraffe is presented. Application: visual. Response: oral.	Total = 6
6.1 Rhyme		
6.2 Rhyme production		
7. <i>Rapid naming</i>	Two different boards: one containing a set of 25 letters; and the other a set of 25 numbers; in both the child must name the stimuli as quickly as possible. Application: visual recording of time. Response: oral.	Total = 50 (added to the scores from the time taken in the naming)
7.1 Letters		
7.2 Numbers		
8. <i>Immediate memory</i>	Two tasks: one for the repetition of six increasing sequences of digits; the other for the repetition of six sequences of pseudowords. Application: oral. Response: oral.	Total = 12
8.1 Digits		
8.2 Pseudowords		

The four materials that composed the ISDT can be described as follows:

a) Application and scoring instructions notebook: presents the instructions on how the test should be applied, the materials that should be used, the types of errors possible in each subtest, and how to calculate the score;

b) Answer sheet: in which the answers given by the subject are recorded; and which is divided into two parts: (I) that of the evaluator, in which the evaluator writes down the answers given and the score obtained by the child; and (II) that of the child, composed of the subtests that require making notes for the evaluation ("Writing", "Visual attention" and "Motor skills").

c) Application notebook: used by the evaluator during the test application; presents the application instructions;

d) Stimuli notebook: notebook with the visual stimuli of the "Reading", "Motor skills", "Phonological awareness" and "Rapid naming" subtests.

Some examples of items comprising each subtest can be observed in Figure 2. The majority of what is presented refers to the items of the "Answer Sheet-Evaluator" material. Items that comprise other materials, such as the "Answer sheet-Child" and "Application notebook", are presented only for the "Writing" and "Calculation" subtests, to better understand their contents.

<b>1. Reading</b>	<p><b>1. READING</b></p> <p><b>1.1 LETTERS</b></p> <p style="text-align: center;">A-D-V-J-E-I-K-L-B-M-O-T-R-N-C-H-U-P-F-W-Y</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center;">Mistakes made</td> <td style="width: 50%; text-align: center;">Qualitative indicators</td> </tr> <tr> <td style="height: 20px;"></td> <td style="height: 20px;"></td> </tr> </table> <p style="text-align: right;">Total of letters incorrectly read: <input style="width: 50px;" type="text"/> (Maximum=21)</p>	Mistakes made	Qualitative indicators																								
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<b>2. Writing (Child's answer sheet)</b>	<p><b>PSEUDOWORDS</b></p> <table style="width: 100%;"> <tr> <td>1) _____</td> <td>4) _____</td> <td>7) _____</td> </tr> <tr> <td>2) _____</td> <td>5) _____</td> <td>8) _____</td> </tr> <tr> <td>3) _____</td> <td>6) _____</td> <td>9) _____</td> </tr> </table> <p style="text-align: right;">Total: _____</p>	1) _____	4) _____	7) _____	2) _____	5) _____	8) _____	3) _____	6) _____	9) _____																	
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<b>4. Calculation (Application notebook)</b>	<p>Instruction: Say: "Now I want you to answer a few math problems that I read. Do not rush to answer Let's start?".</p> <p>1. "Maria had 2 dolls and her mother gave her 3 more, how many does she have?".</p>																										
<b>5. Motor skills</b>	<p><b>5. MOTOR SKILLS</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 30%;">Figures</th> <th style="width: 50%;">Quantitative and qualitative aspects</th> <th style="width: 20%;">Points</th> </tr> <tr> <td>Circle</td> <td></td> <td></td> </tr> <tr> <td>Rectangle</td> <td></td> <td></td> </tr> <tr> <td>Square</td> <td></td> <td></td> </tr> <tr> <td>Triangle</td> <td></td> <td></td> </tr> <tr> <td>Cross</td> <td></td> <td></td> </tr> </table> <p style="text-align: right;">Total points: (Maximum=10) <input style="width: 50px;" type="text"/></p>	Figures	Quantitative and qualitative aspects	Points	Circle			Rectangle			Square			Triangle			Cross										
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Figure 2. Examples of items comprising each subtest.



## Discussion

The aim of this study was to present the construction process of an instrument, named the ISDT, for identifying signs of dyslexia. When the steps for its construction were completed, it was composed of four application and correction materials for eight skills/subtests.

For the “Reading” and “Writing” subtests, the selection of the words and the balance between degrees of difficulties among regular, irregular and rule words, of low and high frequency (and later reformulated, at the suggestion of the judges, so that they contained a maximum of three syllables) were performed by the phonoaudiology professional that participated in the construction of the entire instrument. Of the nine words that comprised each of both subtests, five were high frequency and four low frequency; among them, three regular, three irregular, and three for the rule.

According to Salles and Parente (2007) when using the dual route model of reading (by phonological and lexical route, firstly the graphophonemic [reading] or phonographemic [written] conversion is encountered and secondly the representation of known words, stored in the lexicon, to recognize words [reading] or produce them [writing]). Accordingly, in the use of the phonological route, the words with regular correspondence between graphemes and phonemes are read/written faster and more accurately than the irregular words, where the equivalences between letter-sound are arbitrary and unexplained by rules. Reading by phonological route tends to regularize the irregular words, which causes incorrect pronunciation and conflicts with the recognition also generated by the lexical route. Children with dyslexia usually experience difficulties in all these types of words (Martins & Michallick-Triginelli, 2009), therefore the balance was made.

The inclusion of pseudowords in these two subtests is justified by the fact that this kind of word is read/written through the phonological route, with no internal representations of the orthographic form in the mental lexicon, thus enabling the evaluation of this route, the most commonly impaired in

relation to the lexical in subjects with dyslexia (Pinheiro & Rothe-Neves, 2001; Ramus & Szenkovits, 2008; Salgado & Capellini, 2008; Salles & Parente, 2007). The pseudowords used were acquired through the study by Pinheiro (1994).

All the letters of the alphabet were used as stimuli for the “visual attention” subtest, as this is considered verbal content. Lima et al. (2012) and Ziegler, Pech-Georgel, Dufau and Grainger (2010), found no significant changes in the performance in attention tests in which the stimuli presented lower verbal demand (symbols) in individuals with dyslexia. Conversely, in tests that had verbal stimuli (letters and digits) low performance was found, probably due to the phonological deficit.

The figures present in the “Motor skills” and “Phonological awareness” subtests were specifically designed for use in the ISDT. There was no reproduction of registered material and figures, respecting the copyrights of other tests and scientific productions.

Specifically for the “Motor skills” subtest, basic geometric shapes and a design formed by lines (which formed an “X”, being one of the curved strokes) were included. The selection and construction of these figures were justified because of a study by Santos and Jorge (2007), in which low performance of Brazilian children with dyslexia was found in the Bender test, which evaluates the perceptual-motor skills, and is based on figures with geometric characteristics.

The rhyme (identification and production) was selected from among the phonological skills to compose the “Phonological awareness” subtest, as studies show that this ability develops early in children with typical development (Cao, Bitan, & Booth, 2008; Pessoa & Paes, 2005), which does not occur in children with dyslexia (Lima et al., 2008; Salgado & Capellini, 2008).

The tasks presented in the “Calculation” subtest were developed to cover the four mathematical operations, following the development from the simplest (addition and subtraction) to the more complex (multiplication and division). The activities were read by the evaluator and needed to be answered orally by the child. This



subtest was included in order to be contrasted with the other subtests, as good performance is expected by children with dyslexia. Frequently children with dyslexia tend to present good arithmetic performance when it does not involve the recognition/reading of algorithms or the reading of the problem itself, probably due to the presence of verbal contents that permeate both these types of reading, which is impaired in this disorder (Caldonazzo, Salgado, Capellini, & Ciasca, 2006).

The development of the "Rapid naming" subtest was based on the test model proposed by Denckla and Rudel (1974). In a national study by Capellini, Ferreira, Salgado, and Ciasca (2007) that used this same model, it was found that the children with dyslexia took less time in the naming with the boards of numbers and letters when compared to a control group without complaints of school difficulties and another with Attention Deficit and Hyperactivity Disorder (ADHD), hence the choice of both boards for the present study.

The composition of the two tasks of the "immediate memory" subtest was decided due to impairments observed both in the repetition of pseudowords (Andrade et al., 2011; Salles & Parente, 2006) and the repetition of digits (Capovilla et al., 2001) in Brazilian subjects with dyslexia.

In the construction process of psychological instruments, as presented by Pasquali (2009a), the first steps consist of the definition of the theoretical aspects involved with the constructs to be evaluated and the operational definition of their items. With the ISDT these steps were carried out.

According to Resolution nº 2/2003 of the *Conselho Federal de Psicologia* (Federal Council of Psychology) (Brasil, 2003) other steps need to be performed so that the construction of the ISDT can be finalized, such as: presentation of empirical evidence of validity and reliability of the interpretations proposed for the test scores, verification of the psychometric properties of the instrument items, organization of a manual covering the practical aspects (in this case, to improve the version already created and to include the technical and scientific aspects already raised and new

elements, such as the correction and interpretation of the test results).

For this, some future procedures are planned, according to the literature (Anastasi & Urbina, 2000; Pasquali, 2001; Pasquali, 2009b), so that the analysis of the psychometric parameters of the ISDT can be carried out and evidence of its reliability and validity obtained, such as: (a) empirical analysis of the items and subtests; (b) comparison between criterion groups, such as between children of different clinical groups (learning difficulties, mixed disorder of scholastic skills, intellectual disabilities, ADHD, and dyslexia itself) and a group of children with no learning difficulty complaints; (c) search for correlations between the subtests that make up the ISDT and other previously validated tests that measure the same skills that comprise it, and also between the subtests and school performance.

With the completion of these procedures, normative groups can be defined based on parameters such as gender, age and education level, so that a standard can be established for the test results, as well as an enhancement of its standardization, which includes improvement in the means of implementation and correction. Therefore, it is expected that in addition to providing an assessment of neuropsychological abilities impaired in children with dyslexia, the ISDT is a tool that will assist in comprehending dyslexia and in the neuropsychological study of the disorder.

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