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SEÇÃO: ARTIGO

Identification of signs of dyslexia test: comparison of performance between children with dyslexia and other development disorders

Teste para identificação de sinais de dislexia: comparação de desempenhos entre crianças com dislexia e outros transtornos do desenvolvimento

Test para identificación de señales de dislexia: comparación del desempeño entre niños con dislexia y otros trastornos del desarrollo

Rauni Jandé Roama-Alves[1]
orcid.org/0000-0002-1982-1488
rauniroama@gmail.com

Ricardo Franco de Lima[2]
orcid.org/0000-0003-1022-2849
ricardolima01@yahoo.com.br

Tatiana de Cássia Nakano[3]
orcid.org/0000-0002-5720-8940
tatiananakano@hotmail.com

Sylvia Maria Ciasca[4]
orcid.org/0000-0002-8841-1319
sciasca2015@gmail.com

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Abstract: Screening instruments can help to characterize the academic and neuropsychological difficulties of individuals with Dyslexia. The aim of this study was to verify whether there would be differences in performance in the Identification of Signs of Dyslexia Test (TISD) when a group of children with Dyslexia was compared other diagnostic groups of children with level 1 Autism Spectrum Disorder (ASD), Intellectual Disability (ID), Attention Deficit/Hyperactivity Disorder, Borderline Intellectual Functioning and Academic Difficulties. Participants were 172 children that had been diagnosed by interdisciplinary teams and average age ranging from 8.75 (SD = 2.21) to 10.14 (SD = 2.36) year-old. Comparison and association analyzes were performed using Univariate Analysis of Variance and Multinomial Logistic Regression, respectively. The results indicated that the ID and ASD groups presented more impaired performances. Additionally, the TISD was sensitive enough to identify differences between the Dyslexia and ASD groups, with the latter presenting worse performance. However, with the other groups, such differences were not observed. Complementary studies, with larger samples, are necessary, considering the effects of other variables associated with the disorders studied.

Keywords: dyslexia, psychological test, neurodevelopmental disorders

Resumo: Instrumentos de triagem podem auxiliar na caracterização das dificuldades acadêmicas e neuropsicológicas de indivíduos com Dislexia. O objetivo do estudo foi de verificar se haveria diferenças de desempenho no Teste para Identificação de Sinais de Dislexia (TISD) quando um grupo de crianças com Dislexia fosse comparado a outros grupos diagnósticos de crianças com Transtorno do Espectro Autista, nível 1 (TEA), Deficiência Intelectual (DI), Transtorno de Déficit de Atenção/Hiperatividade, Funcionamento Intelectual Limítrofe e Dificuldade Escolar. Participaram 172 crianças, com diagnóstico provindos de equipes interdisciplinares e médias de idade que variaram entre 8.75 (DP = 2.21) e 10,14 (DP = 2.36) anos. Foram realizadas análises de comparação e associação por meio da Análise Univariada da Variância e da Regressão Logística Multinomial, respectivamente. Os resultados indicaram que os grupos DI e TEA apresentaram desempenhos mais prejudicados. Adicionalmente, o TISD foi sensível para identificar diferenças entre os grupos Dislexia e TEA, com pior desempenho desse último. Entretanto, com os outros grupos, tais diferenças não foram observadas. Estudos complementares são necessários considerando maior casuística e efeitos de outras variáveis associadas aos transtornos estudados.

Palavras-chave: dislexia, teste psicológico, transtornos do neurodesenvolvimento

[1] Universidade Federal de Rondonópolis (UFR), Rondonópolis, MT, Brasil.
[2] Universidade São Francisco (USF), Campinas, SP, Brasil.
[3] Pontifícia Universidade Católica de Campinas (PUC-Campinas), Campinas, SP, Brasil.
[4] Universidade Estadual de Campinas (UNICAMP), Campinas, SP, Brasil.

Resumen: Los instrumentos de clasificación pueden auxiliar en la caracterización de las dificultades académicas y neuropsicológicas de individuos con Dislexia del Desarrollo (DD). El objetivo de este estudio fue verificar si habría diferencias de desempeño en el Test para Identificación de Señales de Dislexia (TISD) cuando se comparó un grupo de niños con dislexia con otros grupos de diagnóstico de niños con Espectro Autista, nivel 1 (TEA), Deficiencia Intelectual (DI), Trastorno de Déficit de Atención/Hiperactividad, Funcionamiento Intelectual Limítrofe y Dificultad Escolar. Participaron 172 niños con diagnósticos provenientes de equipos interdisciplinares y con medias de edad que oscilaron entre 8,75 (SD = 2,21) y 10,14 (SD = 2,36) años. Los análisis de comparación y asociación se realizaron mediante Análisis Univariado de Varianza y Regresión Logística Multinomial, respectivamente. Los resultados indicaron que los grupos DI y TEA presentaron desempeños más perjudicados. Adicionalmente, el TISD fue sensible para identificar diferencias entre los grupos Dislexia y TEA; el peor desempeño fue presentado por el TEA. Entre tanto, con los otros grupos, esas diferencias no fueron observadas. Si consideramos la mayor casuística y efectos de otras variables asociadas a los trastornos estudiados, es necesario realizar estudios complementarios.

Palabras clave: dislexia, prueba psicológica, trastornos del neurodesarrollo

According to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) (American Psychological Association (APA), 2013), Neurodevelopmental Disorders are characterized as a group of conditions with symptomatic onset verified in the early years of life. It is common for behavioral impairments to be identified and impact on a personal and social level prior to entering school, and subsequently on the academic and professional levels. The changes may be specifically in learning, in the control of executive functions or even more globally in social skills or intelligence (APA, 2013).

Among these disorders are: Dyslexia (among the Specific Learning Disorders), Intellectual Disability, Attention Deficit/Hyperactivity Disorder (ADHD), Autistic Spectrum Disorder (ASD), Communication Disorders and Motor Disorders. Specifically, the first four were the focus of this investigation, but it should be noted that in the ASD the level of required support was controlled, with only those classed as "Level 1" being included, which covers milder cases. Therefore, when the acronym "ASD" is used throughout the article, this will refer to this diagnostic level.

In addition, two other conditions that compromise school learning and that are frequent in childhood care services (Carvalho *et al*., 2016; Roama-Alves *et al*., 2020) were included in this study: Borderline Intellectual Functioning (BIF) and Academic Difficulties (Peltopuro *et al*., 2014). The first is characterized as a diagnostic group, mainly adopted in psychometric contexts, in which the criterion for its establishment is basically the value of the Intellectual Quotient (IQ), which should be between 70 and 79 (Figueiredo, 2002). This condition usually involves maladaptive behavior in the academic, social and professional areas, being more mild than in Intellectual Disability (Esposito & Carotenuto, 2014).

The Academic Difficulties conditions are those in which there are complaints of learning difficulties, however, after an intensive diagnostic process, it appears that the explanatory variables in the cases are due to emotional changes, inadequate teaching methodologies and poor school adaptation, among others. Unlike Specific Learning Disorders, the subjects do not present neurological changes that explain the complaints (Carvalho *et al*., 2016; Roama-Alves *et al*., 2020).

Studies have been carried out in order to identify neuropsychological and academic performance profiles that can differentiate between some of these conditions, especially the Neurodevelopmental Disorders. For example, in an investigation carried out by Moura *et al*. (2017) better performances in phonological awareness and rapid naming were identified in children with ADHD, when compared to children with Dyslexia. Rumsey and Hamburger (1990), in turn, identified better performances in people with Dyslexia, compared to those with ASD, in long-term visual memory, verbal comprehension, visual perception, solving everyday problems and flexibility.

Dyslexia is described in the DSM-5 (APA, 2013) as a Specific Learning Disorder and affects between 5% of school-age children. It is composed by difficulties in the accurate and fluent reading of words, as well as in spelling, despite preserved intellectual and sensory abilities and the provision of adequate teaching (APA, 2013; Moura *et al*., 2018). The neuropsychological and explanatory

models of Dyslexia emphasize changes in phonological processing, visual processing, auditory processing, attention and motor skills (McGrath *et al*., 2019; Peterson & Pennington, 2015).

0]The Identification of Signs of Dyslexia Test (*Teste para Identificação de Sinais de Dislexia* - TISD) aims to screen these skills. It's stands out in the Brazilian context, being classified as a "screening instrument" elaborated from national and international studies (Alves *et al*., 2015). Other instruments with the same objective have been built internationally. Examples include, the Adult Reading History Questionnaire (ARHQ) (Bjornsdottir *et al*., 2014), the Alouette Reading Test (Cavalli *et al*., 2018) and the Dyslexia Early Screening Test (DEST-2) (Fawcett *et al*., 2014).

Specifically, the TISD consists of eight subtests that assess academic abilities as well as neuropsychological abilities related to written language. The subtests are: (1) Reading; (2) Writing; (3) Visual Attention; (4) Calculation; (5) Motor Skills; (6) Phonological Awareness; (7) Rapid Naming; and (8) Short-Term Memory. However, evidence of validity studies for the TISD are still in the process of being carried out.

This evidence allows the verification of "the degree to which evidence and theory support the interpretations of the test scores linked to the proposed uses", according to the American Educational Research Association (AERA), the APA, and the National Council on Measurement in Education (NCME) (AERA *et al*., 2014, p.78). The finding that the performance of children with dyslexia in TISD differs from other Neurodevelopmental Disorders can be considered evidence of validity, called criterion validity. Often, the differential diagnosis between these conditions becomes complex, as they share certain cognitive and behavioral variability.

To date, studies have been provided evidence of validity for the TISD based on content and the relationship with external variables. For the first evidence, an agreement greater than 75% was verified regarding the adequacy and maintenance of the items, according to the evaluation of expert judges (Alves *et al*., 2015). For the second, it was found that the performance in the TISD, in practically all the subtests, differentiated a group without learning difficulties (n = 9) from another with these difficulties (n = 11). Statistically significant, moderate and high correlations between the TISD and the "Test for School Achievement" subtests (Stein, 1994) were also observed (Alves *et al*., 2013). It was also found that the performance in the TISD differentiated a sample of children diagnosed with Dyslexia (n = 15) from another of children without complaints of difficulties in reading and writing (n = 146). There was a difference in all the subtests and in the test total (Alves *et al*., 2018).

In order to identify the evidence based on the relationships with external variables in more depth, an investigation was carried out regarding the effects of variables linked to human development, such as age and school year, on TISD performance (Roama-Alves *et al*., 2019). Through Univariate Analysis of Variance (ANOVA) it was observed that the TISD was able to differentiate groups of six, seven and eight years and also the school years from the first to the fourth year (Roama-Alves *et al*., 2019).

Thus, the aim of this study was to verify whether there would be a difference in performance in the TISD, or specifically in some of its subtests, when a group of children with Dyslexia was compared to other diagnostic groups of children with ASD, Intellectual Disability, ADHD, and also individuals with BIF and Academic Difficulties. It should be noted that this study contributes to the diagnostic criterion validity, by verifying the sensitivity of the test in differentiating Dyslexia from other diagnoses.

Regarding the hypotheses that were raised for the results, we expected to find no differences, despite the instrument in question having demonstrated its ability to differentiate children with Dyslexia from those without learning difficulties (Alves *et al*., 2018). The TISD is characterized as a screening tool, with simplified and brief items, therefore, we hypothesized that it would not be sensitive enough to detect the complexity of neuropsychological and academic changes in each of the disorders investigated.

Method

Participants

Participants were 172 children, of both sexes, from the "Learning Neuro-Difficulties Outpatient Clinic (DISAPRE)", located in the *Hospital de Clínicas* of the State University of Campinas, and from the extension project "Neuropsychological Assessment for children and adolescents: diagnoses and actions (NEUROPSI-i)", of the Federal University of Rondonópolis. The distributions of diagnoses, sex, mean age and mean IQ are presented in Table 1. It should be highlighted that all children with ASD had a "Level 1" degree and did not have hyperlexia and/or hypercalculia comorbidities.

Table 1 – Sample characterization

Diagnosis	f (%)	Sex		Age	TIQ
		Ml (f (%))	Fl (f (%))	M (SD)	M (SD)
Dyslexia	13 (7.6)	7 (4.0)	6 (3.4)	9.69 (0.75)	101.38 (10.09)
ADHD	20 (11.6)	8 (4.6)	3 (1.7)	9.00 (1.73)	96.91 (11.58)
AD	22 (12.8)	15 (8.7)	6 (3.4)	9.85 (2.00)	103.57 (14.86)
ID	63 (36.6)	22 (12.7)	11 (6.3)	9.94 (2.13)	62.96 (6.46)
BIF	46 (26.7)	18 (10.4)	10 (5.8)	10.14 (2.36)	74.07 (2.68)
ASD	8 (4.7)	3 (1.7)	1 (0.5)	8.75 (2.21)	90.50 (2.12)
Total	172 (100)	73 (42.4)	37 (21.5)		

Note. ADHD: Attention Deficit/Hyperactivity Disorder; AD: Academic Difficulties; ID: Intellectual Disability; BIF: Borderline Intellectual Functioning; ASD: Autistic Spectrum Disorder; Ml: Male; Fl: Female; f: frequency; M: Mean; TIQ: Total Intelligence Quotient; SD: Standard deviation.

It is important to emphasize that it was not possible to identify the sex of 62 children (36.1%), due to an error in the spreadsheet system. This was probably because old spreadsheets with virus were converted to newer spreadsheets in the Excel ® program. The available data for this variable were compared between groups and no differences were identified between them (Fisher's Exact; p = 0.92; Cramer's V = 0.11, df = 5, moderate effect size). Intergroup mean ages were also compared and no differences were found, with Tukey's *post-hoc* identifying no specific differences between groups when compared two by two (ANOVA; Mean square = 3.116; F = 0.754; p = 0.585; large effect size, $_p^2$ = 0.188).

The IQ means were also compared and differences were found among the groups (ANOVA; Mean square = 5361.400; F = 62.235; p < 0.001; large effect size, $_p^2$ = 0.881). Tukey's *post-hoc* differentiate the Dyslexia, ADHD, Academic Difficulties groups between the Intellectual Disability and BIF groups (p <0.001). The Intellectual Disability group differed from all the others (p <0.001). The only group that the BIF did not differ from was the ASD group (p = 0.162), with the latter only differing from the Intellectual Disability group (p <0.001).

Instruments

Wechsler Intelligence Scale for Children (WISC-III; Figueiredo, 2002): assesses the intellectual performance of individuals aged 6 to 16 years and 11 months. It is composed of 12 subtests organized in two groups: (a) Verbal: Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span; (b) Performance: Picture Completion, Coding, Picture Arrangement, Blocks Design, Object Assembly, Symbol Search. Test performance results in three composite measures: Verbal IQ (sum of the points of the verbal subtests), Performance IQ (sum of the points of the Performance subtests) and Total IQ (sum of the points obtained in the Verbal and Performance subtests). From the

performance in all subtests, four factor indices can also be obtained: 1. Verbal Comprehension (composed by the subtests Information, Similarities, Vocabulary and Comprehension), 2. Perceptual Organization (composed of the subtests Picture Completion, Picture Arrangement, Blocks Design and Object Assembly), 3. Freedom from Distractibility (composed by the Arithmetic and Digit Span subtests) and 4. Processing Speed (composed of the Coding and Symbol Search subtests). These factor scales, like the IQ scales, have a mean value of 100 and a standard deviation of 15 points. The test offers the following interpretations of intellectual performance: "mental retardation", "borderline mental functioning", "low average", "average", "bright normal", "very high" and "gifted".

The numerous psychometric studies carried out on this instrument have produced results related to: convergent validity with the Raven Color Progressive Matrices test, with a value of 0.77, and with school grades, with a value of 0.47; reliability, temporal stability was verified through the test-retest procedure, specifically with the subtests "Coding" and "Symbol Search", with correlations of 0.70 and 0.63, respectively; and standardization, with differences found between the means of three age groups, through the ANOVA procedure, presenting significant values (p <0.05), which justified the development of standards of correction for the age criterion.

Identification of Signs of Dyslexia Test (TISD) (Alves *et al.*, 2015): Consists of a screening instrument that aims to evaluate signs indicative of Dyslexia. It is intended for students from the first to the fourth year, is applied individually and has an average duration of 25 minutes. It consists of 8 subtests that evaluate both academic/school abilities (Reading, Writing, Calculation) and cognitive abilities related to written language (Visual Attention, Motor Skills, Phonological Awareness, Rapid Naming and Working Memory). The score is calculated based on the mistakes made, so that the higher the child's score, the worse their performance. Some evidence of validity already identified includes: content validity, with calculated agreement greater than 75% among expert judges; criterion validity, indicating differences in practically all subtests when comparisons are made between children without learning difficulties and children with dyslexia and with learning difficulties (Alves *et al.*, 2013; Alves *et al.*, 2018); convergent validity with the Test for School Achievement (*Teste de Desempenho Escolar* - TDE), in which statistically significant strong correlations were verified between the TISD Reading and TDE Reading (-0.70), the TISD Writing and TDE Writing (-0.88) and the TISD Calculation and TDE arithmetic (-0.73) (Alves *et al.*, 2013).

Procedures

The study was approved by the Research Ethics Committee of the Federal University of Rondonópolis (CAAE: 63121916.4.0000.8088) and of the State University of Campinas (FCM / UNICAMP, Authorization No. 946/2011). The children's performance data were obtained from DISAPRE and NEUROPSI-i. The TISD was already part of the standard evaluation battery in these two places. In this way, their databases were accessed and children were selected that had already had their diagnosis finalized by the professional teams that worked there.

These sites conduct interdisciplinary evaluations, including the neuropsychological evaluation, which includes the evaluation of cognitive and academic abilities from a standardized protocol. Evaluations are conducted individually, in prepared, lighted and ventilated rooms, on the outpatient clinic, by qualified professionals (research team members). The children evaluated are, as a rule, referred by public health and education services to investigate complaints related to learning difficulties. Specifically, for this study, the survey and selection of all diagnoses was a period of seven years, between 2011 to 2018.

Data analysis

The data were organized in an Excel® spreadsheet and were later analyzed using the IBM Statistical Package for the Social Sciences (SPSS)

26.0 for Windows® program. In order to homogenize the data obtained from the TISD, children were identified in the database who had not been able to respond to any subtest. In general, for all these unsuccessful subtests, their maximum scores were awarded. Specifically for the Rapid Naming subtest, which has not yet been standardized and in which a no limit score was stipulated during its construction, the highest score obtained in the total sample of the survey (which was 81 points) was identified and awarded for these cases.

The following statistical analyses were then performed: (1) ANOVA for comparison between independent groups; the effect size was verified using the Partial Eta Squared ($_p^2$), with the following reference values: values close to 0.01 as a small effect; close to 0.06 as a medium effect; and values close to or greater than 0.14 as a large effect; in order to identify the significant differences between each of the intergroup means obtained, Tukey's *post-hoc* test was performed; (2) Fisher's exact test for comparison between groups in nominal variables; the effect size was verified using Cramer's V, with the following parameters of interpretation: degrees of freedom (*df*) = 5 (small = 0.05, moderate = 0.13, large = 0.22); (3) Multinomial Logistic Regression analysis to verify the probabilities of higher scores in the test total, according to the diagnostic groups, having Dyslexia as the reference category. Values (*p*) of ≤ 0.05 were considered significant.

Results

Table 2 presents the descriptive statistics (means and standard deviations) obtained in the subtests and in the total of the TISD, according to the clinical groups investigated.

Table 2 – TISD means and standard deviations obtained by clinical group

Subtest	Groups					
	Dyslexia M (SD)	**ADHD M (SD)**	**AD M (SD)**	**ID M (SD)**	**BIF M (SD)**	**ASD M (SD)**
Reading	11.54 (9.78)	10.00 (9.04)	7.27 (10.00)	16.24 (12.68)	13.52 (12.13)	25.25 (16.23)
Writing	16.62 (7.69)	13.00 (8.03)	10.86 (8.92)	19.08 (11.05)	16.00 (10.77)	26.25 (14.74)
VA	19.15 (52.90)	5.50 (3.45)	20.59 (56.50)	30.73 (63.34)	9.52 (28.33)	100.75 (100.80)
Calc.	1.31 (1.31)	1.30 (1.38)	1.32 (1.28)	2.67 (1.25)	2.09 (1.33)	3.38 (1.40)
MS	5.62 (2.36)	3.90 (3.00)	4.45 (3.17)	5.30 (3.29)	4.33 (2.91)	7.50 (3.07)
PA	3.92 (1.70)	2.95 (1.31)	3.73 (1.72)	4.62 (1.37)	3.61 (1.66)	4.63 (1.59)
RN	16.23 (19.98)	11.00 (5.24)	13.95 (22.11)	24.51 (25.25)	18.98 (19.82)	54.29 (34.07)
STM	6.62 (2.18)	5.40 (2.99)	4.91 (2.86)	7.27 (2.31)	6.37 (2.29)	8.88 (3.87)
Total	80.69 (92.59)	52.15 (25.22)	67.00 (99.68)	110.22 (111.16)	74.26 (58.79)	224.13 (174. 97)

Note. ADHD: Attention Deficit/Hyperactivity Disorder; VA: Visual Attention; Calc: Calculation; MS: Motor Skills; PA: Phonological Awareness; RN: Rapid Naming; STM: Short Term Memory; SD: Standard deviation; M: Mean.

Table 3 presents the ANOVA results, in which the objective was to identify the effects of the variable "clinical group" on the performance in the TISD, through intergroup comparisons. It was found that there were significant effects ($p \leq 0.05$) in all subtests and in the total of the test, all with large effect size.

Table 3 – ANOVA for effect of clinical group

ANOVA				
Subtest	**Mean Square**	**F**	**p**	**η_p^2**
Reading	543.57	3.88	0.002	0.32
Writing	426.31	3.94	0.002	0.32
Visual Attention	13383.81	4.86	< 0.001	0.35
Calculation	13.52	7.92	< 0.001	0.43
Motor Skills	22.08	2.33	0.044	0.25
Phonological Awareness	11.61	4.94	< 0.001	0.36
Rapid Naming	2417.64	5.00	< 0.001	0.36
Short Term Memory	32.61	5.04	< 0.001	0.36
Total	44431.79	5.05	< 0.001	0.36

Note. F: Ratio between the model and its error; p: significance; η_p^2: Partial Eta Squared.

Table 4 presents the *post-hoc* values for the data that were significant on ANOVA, comparing the clinical groups. It can be seen that the Intellectual Disability group and, mainly, the ASD group were the ones that most differed from the others, presenting higher scores (Table 2) in the TISD, that is, with worse performances. The Academic Difficulties group was the most different from these groups, followed by the ADHD, Dyslexia and BIF groups. It is important to note that in the Motor Skills subtest there were no differences between any groups. The Dyslexia group, in general, performed better than the ASD group, specifically in the subtests of Visual Attention, Calculation, Rapid Naming and in the total of the TISD. In Calculation the Dyslexia group was also differentiated from the group with Intellectual Disability, with better performance. The ASD group performed worse than all the other groups.

Table 4 – Post-Hoc (Tukey) for the comparison of the clinical groups in the TISD

Subtest	**Group**	**Dyslexia**	**ADHD**	**AD**	**ID**	**BIF**
Reading	ID			0.031	-	
	ASD		0.029	0.004		
Writing	ID			0.021	-	
	ASD		0.032	0.006		
Visual Attention	ASD	0.009	< 0.001	0.004	0.006	< 0.001
Calculation	ID	0.010	0.001	0.001	-	
	ASD	0.007	0.003	0.003		
Phonological Awareness	ID		0.001		-	
	BIF				0.011	-
Rapid Naming	ASD	0.004	< 0.001	0.001	0.011	0.002
Short Term Memory	ID			0.003	-	
	ASD		0.016	0.003		
Total	ASD	0.011	< 0.001	0.001	0.018	0.001

Note. ADHD: Attention Deficit/Hyperactivity Disorder; AD: Academic Difficulties; ID: Intellectual Disability; BIF: Borderline Intellectual Functioning; ASD: Autistic Spectrum Disorder.

Finally, Table 5 presents the data obtained in the Multinomial Logistic Regression analysis, which verified the probabilities of higher scores in the TISD total, according to the diagnostic groups, having Dyslexia as the reference category. The only significant value found was related to the ASD group, in this case, it can be said that when the child was closer to the characteristics of this disorder, the likelihood of them scoring more in the TISD increased 1.009 times in relation to the characteristics of Dyslexia. That is, children with ASD were more likely to obtain higher scores in the TISD than children with Dyslexia. Some other parameters of this analysis were evaluated in order to verify whether they were reliable (Bittencourt, 2003), such as: the likelihood ratio test, which was highly significant (Deviance = 410.518; p = 0.001), despite the "Pseudo R-squared", Nagelkerke of 0.115 (low value, not adequate); however, these data should not be an impediment to accepting the data obtained (Bittencourt, 2003).

Table 5 – Multinomial Logistic Regression with the Dyslexia group as the reference category

Parameter estimates									
Group		**B**	**Standard model**	**Wald**	**df**	**p**	**Exp(B)**	**95%CI for Exp(B**	
								LB	**UB**
ADHD	Intercept	1.073	0.585	3.363	1	0.067			
	TISD Total	-0.010	0.008	1.726	1	0.189	0.990	0.975	1.005
AD	Intercept	0.724	0.502	2.077	1	0.150			
	TISD Total	-0.003	0.005	0.307	1	0.579	0.997	0.988	1.007
ID	Intercept	1.293	0.426	9.199	1	0.002			
	TISD Total	0.003	0.004	0.734	1	0.392	1.003	0.996	1.010
BIF	Intercept	1.346	0.442	9.290	1	0.002			
	TISD Total	-0.001	0.004	0.074	1	0.786	0.999	0.991	1.007
ASD	Intercept	-1.685	0.732	5.294	1	0.021			
	TISD Total	0.009	0.004	4.541	1	0.033*	1.009	1.001	1.017

Note. *Significant value; ADHD: Attention Deficit/Hyperactivity Disorder; AD: Academic Difficulties; ID: Intellectual Disability; BIF: Borderline Intellectual Functioning; ASD: Autistic Spectrum Disorder; CI: Confidence Interval; LB: Lower bound; UB: Upper bound.

Discussion

The aim of this study was to verify whether there would be a difference in performance in the TISD, or specifically in some of its subtests, when a group of children with Dyslexia was compared to groups of children with other Neurodevelopmental Disorders (ASD, Intellectual Disability, ADHD) and also individuals with BIF and Academic Difficulties. Among the main results, it is clear that the group with Dyslexia had fewer difficulties in the TISD especially when compared to the ASD group. When compared to the groups with BIF, ADHD and Academic Difficulties, no significant differences were found in any of the subtests. The comparison with the group with Intellectual Disability showed differences only in the Calculation subtest. When regression analysis was performed, children with ASD were more likely to obtain higher scores in the TISD than the children with Dyslexia, reinforcing the result of the analysis of variance.

It is interesting to note that there were no differences between the Dyslexia group and the Academic Difficulties group. That is, children with learning difficulties resulting from neurological changes had similar performances to children with difficulties originating from environmental

and/or emotional variables. In this case, the TISD items were not sensitive enough to differentiate the groups, especially in the neuropsychological abilities, because in the academic area, this result was, in a way, expected, considering that both groups had complaints of similar academic difficulties. The hypothesis raised is that the factors causing the academic problems in the Academic Difficulties group can also affect the neuropsychological performance. Therefore, the TISD was not able to detect more evident differences between the groups and what characterize their diagnoses. According to the literature, environments aversive to learning and emotional changes can interfere in children's neuropsychological and academic development (McCormick *et al*., 2015; Wang & Sheikh-Khalil, 2014).

The TISD was also not able to differentiate the Dyslexia and ADHD groups. However, international studies demonstrate that the cognitive profiles of these groups tend to differ. In an investigation carried out by Moura *et al*. (2017) the following abilities were evaluated and compared between these two groups: intellectual performance, phonological awareness, rapid naming, processing speed, verbal working memory, visuospatial short-term memory, flexibility and verbal fluency. Among the results, they found worse performance by the Dyslexia group in rapid naming and phonological awareness. Gooch *et al*. (2011) found similar results regarding this linguistic performance, however, they also found poor results for the ADHD group in verbal working memory, visuospatial short-term memory and processing speed.

However, some national studies have shown results similar to those found here, with no differences between groups in both neuropsychological and academic abilities (Capellini *et al*., 2011; Oliveira *et al*., 2011). One possible explanation is that the assessment instruments used in these international studies presented greater complexity in their structures. In contrast, like the TISD, the instruments used in national studies presented fewer items and had the purpose of diagnostic screening. Again, due to its evaluative structure, the TISD was not able to detect the most evident differences between the groups or to differentiate their diagnoses.

When the group with Dyslexia was compared to the groups with low intelligence (Intellectual Disability and BIF), there were practically no differences in performance in the TISD. Due to this intellectual cognitive characteristic, these last two groups were expected to present significantly lower performances, especially in the neuropsychological ability subtests. On the other hand, similarity in academic ability subtests would be expected. It should be emphasized that one of the diagnostic criteria for Specific Learning Disorders is that the difficulties resulting from the condition cannot be better explained by intellectual disabilities (APA, 2013). Therefore, it can be inferred that school performances among these diagnostic groups can often be similar. However, also in this comparison, the TISD was not able to detect the most evident differences between the diagnostic groups.

Unlike the Dyslexia group, it was observed that in all school abilities the Academic Difficulties group performed better than the Intellectual Disability group. Among the neuropsychological abilities, there was only better performance in Short-Term Memory. This is an important aspect, since it can be inferred that there may be a certain profile in the results of the TISD for Academic Difficulties when compared to Intellectual Disability, which involves the performance discrepancy between the set of subtests of academic abilities and those of neuropsychological abilities (despite all abilities being reduced in these cases). In Intellectual Disability there would be a discrepancy between these two areas, with academic performances much lower than neuropsychological ones, while in Academic Difficulties theses performances would be similar. In addition to these profiles, an extremely low performance across the TISD could indicate the presence of ASD. Even though this group had no intellectual disabilities, its performance was severely impaired. Of the eight children with ASD assessed, only three were able to perform the instrument

tasks. All of them were already old enough to be literate, according to the mean age of the group.

In a study by Rumsey and Hamburger (1990) different results were found. They sought to compare the neuropsychological profiles of adult individuals with ASD (Level 1) (*n* = 10) and Dyslexia (*n* = 15), with mean ages of 26 and 22 years, respectively. The following abilities were evaluated: intelligence, academic (reading, writing and calculation), verbal fluency, fine motor skills, lateralization, dexterity, auditory and visuospatial working memory, verbal and visuospatial long-term memory, verbal comprehension, visual perception, solving everyday problems, planning and cognitive flexibility.

Similar to the present study, the IQs of the two groups were within the average, with no statistically significant differences between them (ASD = 95.70; Dyslexia = 103.87). However, differences were also found, with the ASD group performing better in auditory and visuospatial working memory and visual perception and the Dyslexia group in long-term visual memory, verbal comprehension, visual perception, solving everyday problems and flexibility. Accordingly, different profiles were found, mainly in certain cognitive/neuropsychological abilities. As some of these abilities are also assessed by the TISD, these data can be transposed for the present investigation, demonstrating that the results were not similar.

Studies have, however, shown a broad spectrum of impairment in ASD (Level 1) both in neuropsychological functions (Lai *et al*., 2017; Wilson *et al*., 2014) and in academic abilities. Even when hyperlexia and/or hypercalculia are present, there are difficulties in more abstract skills, such as textual comprehension (Kalandadze *et al*., 2018; Wei, Christiano *et al*., 2015). In addition, there is also a clear communication disability that is strongly linked to this condition, even at the mildest levels (APA, 2013). All of these conditions may have led to the performance profile verified by the TISD in the present study, which was the worst compared to the other disorders investigated. The evaluative structure of this instrument was based on impairments commonly found in language abilities related to written language and to Dyslexia. It is possible that these impairments are more evident in ASD than in Dyslexia, at least in the age groups studied here.

It is known that such disorders present variability in the intraindividual neuropsychological profiles (D'Souza & Karmiloff-Smith, 2017; Moll *et al*., 2020) and that establishing a psychometric profile, of criterion, for each of them in an instrument can be an arduous, detailed task. The TISD is characterized as a screening instrument, that is, it was designed for quick application and, for that reason, has few items. Accordingly, it evaluates some academic and neuropsychological abilities briefly. It is probably due to this evaluation structure that few differences were found between the groups. Rather than a battery of instruments (not only involving a cognitive assessment as in the case of the TISD, but also an emotional one, at least) it is necessary to assess these conditions, from a clinical-qualitative perspective, in order to avoid false positives (Pestun *et al*., 2002). Even computational models for assessing Dyslexia, for example, may not present absolute accuracy in their identification (Zavaleta *et al*., 2018).

The data presented here reinforce the use of the TISD as a screening instrument and highlight the precautions that should be taken in its use to raise diagnostic hypotheses of any Neurodevelopmental Disorder, especially regarding higher scores being exclusively indicative of Dyslexia. It is, however, important to consider that previous results demonstrated that the TISD was able to discriminate children without learning difficulties from those with Dyslexia (Alves *et al*., 2018), presenting data indicating that it is sufficient for a basic screening procedure and criterion validity reinforcing its functionality.

Final considerations

The data revealed that the TISD was sensitive in basically differentiating groups of children with Dyslexia and with ASD, the latter presenting a mild level and having no hyperlexia and/or hypercalculia comorbidities. The neuropsychological impairments, especially those related to

language development, were used to explain this result. Regarding the other disorders in which these differences were not seen, it can be hypothesized that the TISD was not sensitive enough to detect them.

The results also reinforce the continuity of studies of this size for the TISD. The present results should not be considered definitive in relation to the functionality of this test for identifying specific differences between some Neurodevelopmental Disorders. There were limitations, such as the control of the age, in which a large effect size was identified in the differences among the groups, which may have incurred a type 2 error. There were also problems in identifying the sexes, due to data loss in the databases.

In the future, with an expansion of the sample, diversifying it by age groups, sex, social class and comorbidities among the disorders, perhaps other data can be found, with the possibility of cut-off scores being generated for the diverse disorders, as well as for Dyslexia. This conclusion also applies to cases of ASD, as the group investigated here had its diagnostic specificities and was very small. Despite having generated interesting results, the instrument does not adequately contemplate the complexity of the disorder. TISD fulfills a Brazilian gap in screening instruments capable of assessing Neurodevelopmental Disorders. Studies like the one carried out here further reinforce the importance of differential diagnosis and the importance of searching for evidence of validity for tests in this category.

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Rauni Jandé Roama-Alves

Doutor em Psicologia pela Pontifícia Universidade Católica de Campinas (PUC-Campinas), em Campinas, SP, Brasil. Professor da Universidade Federal de Rondonópolis, em Rondonópolis, MT, Brasil.

Ricardo Franco de Lima

Doutor em Ciências Médicas pela Universidade Estadual de Campinas (UNICAMP), em Campinas, SP, Brasil. Professor da Universidade São Francisco, em Campinas, SP, Brasil.

Tatiana de Cássia Nakano

Doutora em Psicologia pela Pontifícia Universidade Católica de Campinas (PUC-Campinas), em Campinas, SP, Brasil. Professora da Pontifícia Universidade Católica de Campinas (PUC-Campinas), em Campinas, SP, Brasil.

Sylvia Maria Ciasca

Doutora em Neurociências pela Universidade Estadual de Campinas (UNICAMP), em Campinas, SP, Brasil. Professora da Universidade Estadual de Campinas (UNICAMP), em Campinas, SP, Brasil.

Endereço para correspondência:

Rauni Jandé Roama-Alves

Universidade Federal de Mato Grosso

Campus Universitário de Rondonópolis

Rodovia Rondonópolis-Guiratinga, KM 06, MT 270

Av. dos Estudantes, 5055

78735-901

Rondonópolis, MT, Brasil

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