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SEÇÃO TEMÁTICA | *THEMATIC SECTION*
APRENDIZAGEM DA LEITURA, ESCRITA E MATEMÁTICA: CORRELATOS COGNITIVOS |
READING, WRITING AND MATH LEARNING: *COGNITIVE CORRELATES*

Letter-name knowledge: Predicting reading and writing difficulties

Conhecimento do nome das letras: predizendo dificuldades de leitura e de escrita

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Abstract

This study evaluated the precision of a Letter-Name Knowledge task in predicting children at risk/non-risk of reading and writing difficulties in Brazil. A second goal was to compare the precision of classification of two versions of this task: a 26 letter-task and a 15 letter-task. A total of 213 Brazilian children performed the 26 letter-task when they were in kindergarten. Of those children, 176 performed a writing task and 174 performed a reading task in 1st grade Elementary School. The choice of letters for the 15 letter-task was based on the Item Response Theory and on neural network simulation. The results based on the Receiver Operating Characteristic curve analysis, showed that both tasks could be used for screening children with reading and writing difficulties (areas under the curve of 0.83 and 0.80).

Keywords: Letter-name knowledge; Reading and writing difficulties; Screening.

Resumo

Este estudo avaliou a precisão de classificação do risco de dificuldade de leitura e escrita, a partir do conhecimento do nome das letras. Foram aplicadas duas versões da tarefa de reconhecimento das letras, a primeira com todas as 26 letras do alfabeto, e a outra com apenas 15. A tarefa foi aplicada a 213 crianças brasileiras, matriculadas no último ano da Educação Infantil, sendo que, no primeiro ano do Ensino Fundamental, 176 delas realizaram a tarefa de escrita, e

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174 a de leitura. Utilizaram-se a Teoria da Resposta ao Item e a simulação de rede neural para a escolha das 15 letras da versão reduzida da tarefa, e a análise da curva de Características Operacionais do Recebedor para avaliar a precisão de classificação das duas versões da tarefa. Os resultados indicaram que ambas as versões podem ser utilizadas para rastrear crianças com dificuldades de leitura e de escrita, áreas sob curvas de 0,83 e 0,80.

Palavras-chave: *Conhecimento do nome das letras; Dificuldades de leitura e de escrita, Rastreamento.*

The identification of children at risk of reading and/or writing difficulties has become fundamental, as it allows a preventive intervention and increases the chance of success (Jenkins, Hudson, & Johnson, 2007). According to Ozernov-Palchik and Graab (2016) early intervention studies for reading difficulties (for children in kindergarten and 1st grade) present larger effect sizes than later intervention studies (for children in 2nd and 3rd grades), yet, dyslexia is typically not diagnosed until a child has failed to learn to read as expected (usually in second grade or later). Thus research about predictors of reading and writing development are essential for screening purposes (Jenkins et al., 2007; Ritchey & Speece, 2004).

A variable that has been pointed out as a strong predictor of reading and writing acquisition is the Letter-Name Knowledge (LNK) (Barbosa, Medeiros, & Vale, 2016; Ferroni, Diuk, & Mena, 2016; Guo, Sun, Puranik, & Breit-Smith, 2018; Ozernov-Palchik et al., 2017; Petscher & Kim, 2011; Puranik, Petscher, & Lonigan, 2014). Leppänen, Aunola, Niemi, and Nurmi (2008) conducted a study with 158 Finnish children to analyze if the LNK and other cognitive variables predicted reading development. LNK was evaluated when children were in the beginning of pre-school; reading skills were measured in pre-school, and in the 1st and 4th grades of Elementary School. Compared to other variables, like phonological awareness and listening/comprehension, LNK was the strongest predictor of performance in reading tasks. Similar results have been found in many languages, such as English (Paige, Rupley, Smith, Olinger, & Leslie, 2018), Brazilian Portuguese (Barbosa, Medeiros & Vale, 2016), Spanish (Kim & Pallante, 2013), Korean (Kim, 2015), and even in Chinese (Zhang, 2018). In addition, the same factors appear to influence LNK in students with and without disabilities (Greer & Erickson, 2018).

Treiman, Tincoff, and Richmond-Welty (1996) presented a possible explanation for the relation between LNK and reading and writing acquisition. According to these researchers, when children learn the names of the letters, it helps them to connect written language with speech, because it is usual to hear the letter names in the pronunciation of words (e.g., in Brazilian Portuguese, the name of the letter “z”, /ze/, can be heard when pronouncing the word “zebra”, / zebra/). Following this reasoning, Cardoso-Martins and Batista (2005) carried out a study with 25 Brazilian pre-school children. The study asked the children to write pairs of words that started with the same letter and consonant sound. For each pair, the name of the first letter could be heard in the pronunciation of one of the words (e.g., the name of the letter “t”, /te/, in “telefone”, /tele’fõni/), but not in the other (e.g., the name of the letter “t”, /te/, in “tartaruga”, /tahta’ruga/). The results showed that the number of initial consonants written correctly was higher for words whose letter name was clearly heard when pronounced (“telefone”); suggesting that children use LNK to connect writing and speech. Similar results were found by Barrera and Santos (2016) and also in hard-of-hearing preschoolers (Goldberg & Lederberg, 2015). In addition, the name of the letter would offer clues to the sound of the letter because the name of some letters contains a phoneme that the letter usually represents. For example, in Brazilian Portuguese, the name of the letter “v” (/ve/) contains the phoneme /v/, and it is more probable that a child who knows the name of the letter ‘v’ also knows that the sound of that letter is /v/. Huang, Tortorelli, and Invernizzi’s (2014) results are consistent with this hypothesis. In the Huang et al. (2014) study, English-speaking children knew more the sounds of letters in which the first sound of their names corresponds to the sound they represent (e.g., the English name of the letters: ‘v’, ‘z’, ‘t’, ‘p’), rather than the letters whose sounds are represented at the end of their name (e.g., the English name of the letters: ‘l’, ‘r’, ’s’, ‘m’) or letters in which names and sounds are not associated (e.g., the English name of the letters: ‘w’, ‘h’).

An important issue investigated by Phillips, Piasta, Anthony, Lonigan, and Francis (2012), is if LNK represents a one-dimensional construct or not. Those investigators carried out a study with 1,074 English-speaking children between two and five years of age. An exploratory factor analysis was performed and the results indicated that LNK represents a one-dimensional construct. After such outcome, the investigators used the Item Response Theory to investigate if certain letters are more likely to be recognized than others. The results showed that a two parameter model (which considered both the difficulty and the discriminative power of the items) was more consistent with the data. An analysis of the parameters assessed revealed that the letters 'o', 'b' and 'a' were the easiest ones and were acquired earlier in development while the letters 'v' and 'u' were the most difficult. It was also shown that some letters are redundant when referring to difficulty and power of discrimination. This result points to the possibility of constructing instruments with less items in order to evaluate the LNK. Phillips et al. (2012) also showed that although children tend to first learn the initial letter of his/her name, results indicated that including this variable in the models did not significantly alter the general pattern of results. It is important to notice that LNK represents a one-dimensional construct even when considering upper and lower case letters (Bowles, Pentimonti, Gerde, & Montroy, 2014).

Just as Phillips et al. (2012), Petscher and Kim (2011) focus was to investigate if a test that requires children to name a reduced number of letters would be as precise at identifying children at risk/non-risk of reading difficulty as compared to a test which requires children to name all the letters of the alphabet. This information is important because if the tests are equally precise, thus, for screening purposes, the test with less items is preferable. The Petscher and Kim (2011) study was carried out with 613 American children enrolled in pre-school. The results showed that considering the power to predict reading difficulty, a LNK test with 15 letters was not different from a LNK test with all the 26 letters of the alphabet.

Considering the learning of reading and writing, screening consists of a brief evaluation focused on variables that are highly predictive of these abilities. Screening is the main way of identifying students that can have future learning difficulties and consequently require a preventive intervention (Jenkins et al., 2007). Researchers have been working to identify screening methods that are valid, efficient, and effective. Ritchey and Speece (2004) and Jenkins et al. (2007) suggest reviewing the test's classification precision. In other words, the precision at which a test classifies students as being at risk or not at risk of presenting reading or writing difficulties. A test's precision of classification can be evaluated based on the *Receiver Operating Characteristic* (ROC) curve, considering the Area Under the Curve (AUC) (Swets, 1988). The AUC indexes the test's overall accuracy and varies from 0.5 (chance level) to 1.0 (perfect discrimination) (Swets, 1988). Compton, Fuchs, Fuchs, and Bryant (2006) suggest that AUC values below 0.7 should be considered poor, between 0.7 and 0.8 fair, between 0.8 and 0.9 good, and above 0.9 excellent.

The AUC has the advantage of being independent of the decision criterion (e.g., liberal or strict) chosen by the evaluator (Swets, 1988). However, other measures that depend on the decision criterion are still useful, such as the sensitivity and specificity indexes. Considering reading and writing difficulties as an example, sensitivity describes the proportion of people with reading or writing difficulties who were identified as being at risk according to a cut point on a screening test (Petscher & Kim, 2011). Specificity describes the proportion of people without reading or writing difficulties who were identified as not being at risk according to a cut point on a screening test (Petscher & Kim, 2011). Jenkins et al. (2007) recommends that in order for a screening test to be considered effective, it should have a sensitivity value of 0.90 or more, while keeping specificity values at an acceptable range (e.g., equal to or greater than 0.50 according to Catts, Petscher, Schatschneider, Bridges, & Mendoza, 2009; or equal to or greater than 0.80 according to Compton et al., 2010). In spite of Jenkins et al. (2007) recommendations, screening tests for reading and writing difficulties developed until today have failed to fully satisfy these standards (Compton et al., 2006; MacGlinchey & Hixson, 2004; Speece, Mills, Ritchey, & Hillman, 2003). For example, Speece et al. (2003) analyzed the precision of a letter-name fluency task at identifying children at risk/non-risk of reading difficulty. Forty children were evaluated on the letter-name fluency task when in pre-school and 39 children were evaluated on the reading task while in the first grade elementary school. The results indicated that the letter-name fluency task presented a sensitivity index of 0.57 and a specificity index of 0.72. Another example is the previously cited, Petscher and Kim (2011) study, in which the LNK test with 26 letters presented a 0.90 sensitivity, and a 0.43 specificity.

As far as we know, no study analyzed the precision of an LNK task at identifying children at risk/non-risk of reading difficulty in Brazil. Studies with this purpose are vital because this information is essential for reading and writing difficulties screening. As pointed out before, a trustworthy screening test can help preventive interventions to begin as soon as possible. Thus, the present study's main goal was to evaluate the precision of a LNK task in predicting children at risk/non-risk of reading and writing difficulties in Brazil. A second goal was to compare the precision of classification of two versions of this task: a 26 letter-task (LNK-26) and a 15 letter-task (LNK-15). Based on Petscher and Kim's (2011) results, we hypothesize that the 15 letter-task will be as good as the 26 letter-task in predicting children at risk/non-risk of reading and writing difficulties.

Method

Participants

This correlational study with a longitudinal design initially included an urban sample of 213 children (110 female) enrolled in kindergarten. Out of the 213 children, 99 were enrolled in private schools and 114 in public schools. The LNK task was applied when children were in kindergarten and the reading and writing tasks were applied when children were in the first grade Elementary School (about 8 months after the LNK Task). One hundred and seventy-four of these children carried out the reading task and 176 children carried out the writing task. The average age of the children at the beginning of the study was about 6 years with a standard deviation of 3.7 months.

This study is part of a broad longitudinal research investigating reading and writing predictors from kindergarten through the first four years of elementary school. This article reports data concerning the first wave of the longitudinal study, related to the psychometric study of the LNK. This study was approved by the Ethics Research Committee of the *Universidade Federal de Juiz de Fora*, and only children whose parents/guardians signed the Informed Consent Form participated in this study.

Instruments

LNK-26 Task: In this task, children were asked to name aloud all of the 26 capital letters of the alphabet. The letters (printed in black Arial font, #36) were shown in two columns on a white card the size of a sheet of paper. The order of the letters was randomized, but was the same for every child. In this task, the child received one point for each letter stated correctly.

Reading Precision Test 1st grade (RPT1): This task was developed by the Cognition and Language Research Group (CogLin). It has 80 words, half of high frequency of occurrence and half of low frequency according to Pinheiro's (1996) word list. Considering consistency in grapheme-phoneme mapping, there is an equal number of regular and irregular words between the two frequency categories. In this task, all of the words were printed in black Times New Roman font, size 12 font on a white card the size of a sheet of paper. The 80 words were presented in eight columns with 10 words per column. Children were guided to read the word aloud as precisely as possible. The child's score was the number of words read correctly. This task has a reliability of 0.99 (Kuder-Richarson internal consistency index).

Writing Precision Test 1st grade (WPT1): This task was developed by the Cognition and Language Research Group (CogLin) based on the Writing Experimental Task, developed in the Autism and Development Study Lab at *Universidade Federal de Minas Gerais*. One hundred and twenty words were selected from Pinheiro's (1996) word list. These words corresponded to four word groups. Group 1 includes regular words (words with a consistent phoneme-grapheme mapping, e.g., the word "*bola*"). Group 2 includes words with contextual rules (words in which a phoneme is represented differently according to its position in the word, e.g., the sound /h/ in the words "*regador*" and "*carro*", which is represented by the letter "r" at the beginning and by the letters "rr" in the middle). The group 3 includes words with morphological/syntactic rules (words in which a phoneme is represented differently according to the grammatical class of the word, e.g., the sounds /iw/ are represented by the letters "iu" in verbs like "*abriu*", but these same sounds are represented by the letters "il" in nouns like "*abril*"). The group 4 includes irregular words (words with an arbitrary phoneme-grapheme mapping, e.g., the word "*boxe*"). The target words were dictated by the evaluator, once alone, once in a sentence, and alone again. Only after this, the children had to write the target word on their answer sheets. The respondents received one point for each word correctly written. Strict correction criteria were applied and anything diverging from the correct spelling of the word was considered an error. This task has a reliability of 0.90 (Kuder-Richarson internal consistency index).

Procedures

The children were evaluated in two individual sessions and three joint sessions by trained researchers in a reserved place inside their schools. The LNK task was applied individually when children were in kindergarten. The application lasted about 2 minutes. The reading and writing tasks were applied about 8 months after the LNK task when children were in the first grade elementary school. The reading task (RPT1) was applied individually and lasted about 20 minutes. The writing task (WPT1) was applied in groups of children in three different days (40 words per day), during the same week of the reading task.

Results

Information related to the highest possible score, the highest-achieved score, the lowest achieved score, the standard deviation, Skewness and Kurtosis of the tasks employed in the present investigation can be seen in Table 1. The mean in the "LNK-26 letters" task was equal to 19.38. In the RPT1 and in the WPT1 the mean was equal to 29.22 and 29.88, respectively. Considering that these tasks were applied when children were beginning reading and writing in the first semester of the first year of formal schooling, low scores in these tasks are expected.

Table 1
Descriptive statistics for letter-name knowledge, reading and writing tasks

Tasks	n	Maximum Score	Highest Score	Lowest Score	*M*	*SD*	Skewness	Kurtosis
LNK-26	213	26	26	0	19.38	(7.52)	-0.99	-0.32
RPT1	174	80	75	0	29.22	(27.15)	0.22	-1.53
WPT1	176	120	96	0	29.88	(28.49)	0.48	-1.08

Note: LNK: Letter Name Knowledge task – 26 letters; M: Mean; RPT1: Reading Precision Task/1st year Elementary School; *SD*: Standard Deviation; WPT1: Writing Precision Task/1st year Elementary School.

The reliability of the LNK-26 task was calculated using the Kuder-Richardson statistic. The LNK-26 task presented a very good internal consistency index, KR20 = 0.95. The accuracy for each letter was calculated with the "mirt" package from the R *software* (Chalmers, 2012), and can be seen in Table 2. The letters that presented the highest accuracy were the letters 'A', 'X', 'U', 'O', 'I', 'L' and 'E', and the letters that presented the lowest accuracy were the letters 'N', 'Z', 'Y', 'Q', 'D', 'W' and 'K'. Based on Pinheiro (1996) word list, we calculated the token frequency for each letter. The correlation between token frequency and accuracy was statistically significant ($r = 0.59$, $p = 0.002$), reflecting better performance for more frequent letters.

To verify the dimensionality of the LNK-26 task, the biserial correlation was analyzed using the "mirt" (Chalmers, 2012) statistic package previously mentioned. The biserial correlation is a statistic method that measures the correlation of one particular task item with the total task score. No item showed a low biserial correlation (all the correlations were greater than 0.60). In addition, an item factor analysis which uses as data the frequencies of all separate item response vectors was applied. A Full Information Factor Analysis (FIFA) was carried out, and resulted in a predominantly one-dimensional structure in the data: the first factor explaining 79.6% of variance and the second factor explaining only 7.4%.

The IRT-Pro (Paek & Han, 2013) program was used to check for local independence (LD χ^2). Local independence occurs when the answer given to an item does not influence the answer given to other items.

Table 2
Accuracy for each letter in the LNK-26 task

Letter	Accuracy (%)
A	93.0
B	76.1
C	74.6
D	59.2
E	81.2
F	71.8
G	77.0
H	76.5
I	90.6
J	77.9
K	56.8
L	83.6
M	73.2
N	65.3
O	91.1
P	70.0
Q	62.0
R	72.8
S	72.3
T	72.3
U	92.0
V	73.7
W	59.2
X	92.5
Y	62.9
Z	65.3

Thus, the performance in one item depends only on the respondent's latent trait size and the item does not provide tips for the answers in other items (Sartes & Formigoni, 2013). After inspecting the values in the IRT-Pro analysis, the highest value found was 2.8 (relation between the item 'Q' and 'W'). Since, only values above 10 indicate local dependence in IRT-Pro, the local independence of the items was assumed.

After the assumptions of one-dimension and local independence had been fulfilled, scale construction could start. In order for this to happen, the Item Response Theory (IR models of three, two, and one parameter were applied and a graphic analysis of the adjusted models was performed). The one-parameter model takes into consideration only the difficulty of the items (parameter b). The two-parameter model evaluates the difficulty (parameter b) and the item discrimination capacity (parameter a). The three-parameter model measures the difficulty (parameter b), the discrimination (parameter a) and the probability of a hit by chance in the item (parameter c). The graphic inspection of the models revealed that the one and two parameter models were the ones which presented the best adjustments. In addition to the graphic inspection, it is important to mention that the correlation between the scores (theta) of two-parameter models and three-parameter models and the one-parameter model was 0.98. Thus, since the correlations and the adjustment of the one and two parameter models were very close, the one-parameter model was chosen for being more parsimonious. Another advantage of the one-parameter model (Rasch model) is that it allows the construction of a correction table based on the hits, which is not feasible in the other models. An analysis of the items difficulty (parameter b) of the LNK-26 task revealed that this task can be considered easy, as the most difficult item (letter K) presented a difficulty index equal to -0.165. The easiest items were letters A (-1.833), X (-1.833) and U (-1.707).

The present study's main goal is to evaluate precision of the LNK task in predicting children at risk/non-risk of reading and writing difficulties in Brazil. Thus, an important step in this direction is to determine the reading and the writing difficulty in the present study sample. Since there is not a standardized test with norms for children in the first year of Elementary School (about 7 years old) in Brazil, we decided to classify children as having reading or writing difficulties based on their scores on the Reading Precision Test (RPT1) and Writing Precision Test (WPT1) used in the present study. Therefore, every child who scored one standard deviation below the group mean in each test, was classified as having reading and/or writing difficulty. Out of the 174 children who completed the RPT1, 63 (36.8%) of them were classified as having reading difficulties. Out of the 176 children who completed the WPT1, 55 (31.3%) of them were classified as having writing difficulty.

Another objective of the present study is to compare the precision of classification of two versions of the LNK task: a 26 letter-task (LNK-26) and a 15 letter-task (LNK-15). For the construction of the LNK-15 task, it was decided to check the Differential Item Functioning (DIF) using the two-parameter model. An item has a differential functioning when subjects with the same level of latent skill have different probabilities of getting the item correct because of the simple fact that they belong to different groups (Andriola, 2001). This analysis was done using the simultaneous multifactorial detection model and the differential functioning of the item (Gonçalves, Gamerman, & Soares, 2013). The results showed that the letters 'A', 'X' and 'Y' presented DIF and, therefore, they were excluded from the pool of letters considered in the construction of the LNK-15 task. To select the best letters to include in the LNK-15 task a neural network simulation was carried out. Based on the standard score results of the Rasch model, the participants' scores on the 26 letter task were included as factors and the variable "reading difficulty" was included as the dependent variable. The items shown by the neural network simulation as being the most important for this classification were selected to make up the LNK-15 task. The 15 items selected for the LNK-15 task were the letters F, E, I, P, S, Z, Q, N, H, G, C, K, U, W and J.

In order to compare the classification precision of at risk/non-risk of reading/writing difficulty of both LNK tasks, ROC curves were constructed based on the classifications obtained from the RPT1 and WPT1 test scores. Three cut-off points for each LNK test were chosen. One with sensitivity greater or equal to 90%; one with specificity equal to or greater than 50%; and one with specificity equal to or greater than 80%. Table 3 shows the values of the Area Under the Curve (AUC), as well as the sensitivity and specificity for each cut-off point.

Considering the screening of reading difficulty, both LNK-26 and LNK-15 tests exhibit appropriate AUC values (0.83) (Table 3). AUC values close to 0.5 indicate that the test does not classify well the individuals in the two groups, while the values above 0.80 indicate that the test is fit for classifying individuals in the two groups. Another important point is that when comparing the sensitivity and specificity indexes of both tests, these indexes were very close. It should be noticed that changing the reading difficulty classification criterion to below the 25th percentile in the RPT1 did not change in a statistically significant way the AUC values of the LNK-26 and LNK-15 tests (AUC values of 0.83 and 0.84, respectively). The same pattern was observed when the AUC was calculated considering only children from public schools (AUC values of 0.81 and 0.84 for the LNK-26 and LNK-15, respectively) or private schools (AUC values of 0.89 and 0.87 for the LNK-26 and LNK-15, respectively).

When considering the screening of writing difficulty, the same pattern was observed. In other words, both LNK-26 and LNK-15 tests present appropriate AUC values (0.80) and the sensitivity and specificity indexes of both tests were very close. It is important to notice that changing the writing difficulty classification criterion to below the 25th percentile in the WPT1 did not change in a statistically significant way the AUC values of the LNK-26 and LNK-15 tests (AUC values of 0.78 and 0.79, respectively). The same pattern was observed when the AUC was calculated considering only children from public schools (AUC values of 0.78 and 0.79 for the LNK-26 and LNK-15, respectively). However, the AUCs were better for children from private schools (AUC values of 0.93 and 0.90 for LNK-26 and LNK-15, respectively).

The last comparison considering the LNK-26 and the LNK-15 tasks deals with their reliability. The reliability of the LNK-15 task was calculated using the Kuder-Richardson statistics. The LNK-15 task presented a very good internal consistency index, KR20 = 0.93, being very close to the 0.95 value for the LNK-26 task. In short, both tasks exhibited very good internal consistency indexes.

Table3
Area under the curve, sensitivity and specificity of LNK-26 and LNK-15 tasks

Letter-Name Knowledge Task	Reading (RPT1)			
	AUC (95% CI)	Letter Cut Points	Sensitivity	Specificity
LNK-26	0.83 (0.76 – 0.89)	25	0.95	0.32
		24	0.86	0.54
		20	0.77	0.83
LNK-15	0.83 (0.77 – 0.90)	14	0.94	0.39
		13	0.86	0.65
		11	0.77	0.82
	Writing (WPT1)			
LNK-26	0.80 (0.72 – 0.87)	25	0.94	0.30
		24	0.82	0.50
		18	0.73	0.81
LNK-15	0.80 (0.73 – 0.87)	14	0.93	0.36
		13	0.82	0.60
		11	0.73	0.80

Note: AUC: Area Under the Curve; C.I.: Confidence Interval; LNK-26: Letter Name Knowledge task –26 letters; LNK-15: Letter Name Knowledge task – 15 letters; RPT1: Reading Precision Task/1st year Elementary School; WPT1: Writing Precision Task/1st year Elementary School.

Discussion

The present study's main goal was to evaluate the precision of the LNK-26 task in predicting children at risk/non-risk of reading and writing difficulties in Brazil. Considering the LNK-26 task it should be noticed that this task exhibited a high reliability (0.95) and good AUCs for reading (0.83) and for writing 0.80. Another important point about the task concerns the information about the participants' accuracy in each letter. Results indicated that the five vowels were among the most accurate items, and the letters with worst accuracy were: 'N', 'Z', 'Y', 'Q', 'D', 'W' e 'K'. These results seem to reflect the fact that vowels are taught earlier to children whether being through informal family games or formally in schools. In addition, generally speaking, these results also seem to reflect the frequency in which the letters appear in Brazilian Portuguese words, since among the letters with lower accuracy were infrequent letters like 'Y', 'W' e 'K', for example. This hypothesis was corroborated by a statistically significant correlation between letter frequency (token) and accuracy in the present study: $r = 0.59$, $p = 0.002$.

The results obtained from the biserial correlation and the Full Information Factor Analysis provided evidence that the LNK-26 task evaluates a predominantly one-dimensional construct. This result is consistent with the results found by Petscher and Kim (2011) and Phillips et al. (2012). The adjustments of the three, two, and one parameter models were very close in the present study. Thus, the one-parameter model was chosen, considering both the model adjustments themselves, and the fact that the one-parameter model is more parsimonious than the other models. The adoption of the one-parameter model is in line with the Petscher and Kim (2011) study which also used the one-parameter model. On the other hand, Phillips et al. (2012) results indicated that a two-parameter model would provide a better adjustment for their data. It is important to remember that in the present study, the two-parameter model also presented a good adjustment to the data. However, since in the present study the one-parameter model also presented a good adjustment to the data, and the correlation between the one-parameter model and the two-parameter scores (theta) is almost perfect, it seems more reasonable to choose the one-parameter model due to its parsimony and for pragmatic reasons. After all, one advantage of the one-parameter model (Rasch model) is that it allows the construction of a correction table based on the hits, which is not possible in the other models.

Based on the analysis of the item difficulty (parameter b) of the LNK-26 task, the results show that this is an easy task, an indication that the task is more appropriate to evaluate children with little ability. Considering that the task purpose is to screen children with reading and/or writing difficulties, this result proves its appropriateness.

A second goal of the present study was to compare the classification precision of LNK-26 and LNK-15 tasks. In the selection of the items that would make up the LNK-15 task, the letters that presented DIF were excluded, and a neural network simulation was carried out to select the 15 most important letters to distinguish children who were classified as having difficulty from those classified as having no difficulty.

A comparison of the LNK-26 and LNK-15 tasks reveal that both tasks exhibit the same AUCs values for reading (0.83) and for writing (0.80). It is important to notice that the AUC indexes the test's overall accuracy and according to Compton et al. (2006) AUC values between 0.8 and 0.9 are good. Thus, both tasks are good at identifying children at risk/non-risk of reading and/or writing difficulty. It is important to consider that both tasks presented statistically equivalent AUCs despite changes in the classification criterion for reading or writing difficulties or for specific samples of children from public or private schools. Another important point is that the sensitivity and specificity values of both tasks were very close considering the different cut-offs. In addition, both tasks presented very good internal consistency indexes: 0.95 for the LNK-26 and 0.93 for the LNK-15. Therefore, considering the use of the tasks for screening purposes, the LNK-15 task is the best choice because it has the same overall accuracy, very good reliability and is faster to apply.

Petscher and Kim's (2011)'s study is the most similar to the present study for comparison purposes because those authors also compared two LNK tasks and reported AUCs and sensitivity and specificity values considering the screening of reading difficulty. Petscher and Kim determined the best cut-off point in their study aiming at the best balance between sensitivity and specificity. In the present study, we followed Jenkins et al. (2007) recommendations and presented three cut-off points for each task: one considering sensitivity close to 0.90, one considering the sensitivity related to a specificity of 0.50, and the last considering the sensitivity related to a specificity of 0.80. For the LNK-26 task, Petscher and Kim found a sensitivity of 0.90 associated with a specificity of 0.43, with an average between the two values equal to 0.66. In the present LNK-26 task, if we adopt the same criteria as those of Petscher and Kim, we would have a cut-off point (24) with a sensitivity of 0.86 and a specificity of 0.54, as being the best balance between sensitivity and specificity for screening purposes (see Table 3). In this case, the average is equal to 0.70, which indicates a slightly greater balance between sensitivity and specificity than that found by Petscher and Kim. For the LNK-15 task, the best balance between sensitivity and specificity was also found in the present study, since the average in Petscher and Kim's study is 0.71 and in the present study the average between sensitivity and specificity is 0.75.

The small outcome difference between the present study and Petscher and Kim's (2011) study reflects the fact that the AUC values found by Petscher and Kim for reading difficulty classification (AUC = 0.79 for LNK-26 task and 0.77 for the LNK-15 task) are slightly lower than those found in the present study (0.83 for both LNK tasks). One possible explanation for this accuracy difference favoring the present study can be found in the Pollo, Kesler, and Treiman (2005) study. The investigators reviewed the relationship between the letters names and the letter sounds of English and Brazilian Portuguese. According to Pollo et al. (2005) letter names are more clearly pronounced in a larger number of Portuguese words than in English, thus making it easier for Brazilian children to realize that the written form is a representation of the speaking sounds. Considering that Petscher and Kim's study was carried out with English speaking children, this could explain why the LNK task exhibits a lower accuracy in their study.

One advantage of the present study compared to other studies that evaluated the classification precision of LNK tasks or phonological awareness tasks (e.g., Bridges & Catts, 2011, Clemens, Shapiro, & Thoemmes, 2011; Petscher & Kim, 2011; Speece et al., 2003) is that the present study also evaluated the precision of the LNK task in predicting children at risk/non-risk of writing difficulties. Considering the AUCs for reading and for writing, the AUC was slightly better for reading (0.83) than for writing (0.80). However, taking into account the AUCs confidence interval it cannot be concluded that these AUCs are statistically different. In addition, both AUC values are considered good according to Johnson, Jenkins, and Petscher (2010) criterion. It is important that future studies in other languages also evaluate the classification precision of the LNK task for reading difficulty and for writing difficulty, so it will be possible to know if the LNK task is better at predicting one or another.

One limitation of the present study is the lack of a "gold standard" to determine the existence of reading and writing difficulties in Brazilian children in the first year of elementary school. As, in the beginning of the present investigation, the standardized reading and writing test available in Brazil (e.g., Stein, 1994; Lúcio & Pinheiro, 2014) was developed for children starting from the second year elementary school (the former first grade), it was necessary to develop reading (RPT1) and writing (WPT1) measures appropriate for first year school children. However, it is important to notice that these tasks were constructed considering word frequency appropriate for the children's grade (Pinheiro, 1996) and that both tasks exhibited very good reliability indexes based on the Kuder-Richarson statistic: KR20 = 0.99 for the RPT1 and KR20 = 0.90 for the WPT1.

Finally, the recommendation that the screening methods should show a high sensitivity (at least 0.90 for Jenkins et al., 2007), is justified by the fact that the objective of the screening is to identify at-risk children in a way that they can participate in early prevention programs. However, according to Nelson (2008), it is questionable to allow an unreasonable amount of false positives; therefore, reasonable specificity values are also important (at least 0.50 according to Catts et al., 2009). A screening tool that yields many false positives causes a waste in resources since the intervention will be performed on individuals that actually do not need intervention; it could also create anxiety in teachers, children, and children's guardians. Thus, considering all aspects, it seems that the LNK-15 task developed in the present study would fit reasonably, considering a cut-off of 13 points in this task; the LNK-15 presents a sensitivity of 0.86 and a specificity of 0.65 for the screening of reading difficulties, and a sensitivity of 0.82 and a specificity of 0.60 for the screening of writing difficulties. The present results for the LNK-15 task are promising, especially considering that it has been difficult to fully satisfy the standards for sensitivity and specificity in the literature (e.g., the letter-name fluency task developed by Speece et al. in 2003, presented a sensitivity of 0.57 and a specificity of 0.72; on the other hand, the LNK task developed by Petscher and Kim in 2011, presented a 0.90 sensitivity, and a 0.43 specificity). It should be emphasized that although the search for tasks with better sensitivity and specificity indexes should continue, the LNK-15 task developed in the present study can be used, with due care, to guide future preventive interventions.

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Contributors

C.N.G. JUSTI contributed in the study design and in the discussion of the results and contributed in data analysis and interpretation; and in the review and approval of the final version of the article. F.R.R. JUSTI contributed in data analysis and interpretation; and in the review and approval of the final version of the article. N. CUNHA contributed in data collection and discussion.

References

Andriola, W. B. (2001). Descrição dos principais métodos para detectar o Funcionamento Diferencial dos Itens (DIF). *Psicologia, Reflexão e Crítica, 14*(3), 643-652.

Barbosa, M. R., Medeiros, L. B. O., & Vale, A. P. S. (2016). Relação entre os níveis de escrita, consciência fonológica e conhecimento de letras. *Estudos de Psicologia, 33*, 667-676.

Barrera, S. D., & Santos, M. J. (2016). Conhecimento do nome das letras e habilidades iniciais em escrita. *Boletim Academia Paulista de Psicologia, 36*, 1-15.

Bowles, R., Pentimonti, J., Gerde, H., & Montroy, J. (2014). Item response analysis of uppercase and lowercase letter name knowledge. *Journal of Psychoeducational Assessment, 32*, 146-156.

Bridges, M. S., & Catts, H. W. (2011). The use of a dynamic screening of phonological awareness to predict risk for reading disabilities in kindergarten children. *Journal of Learning Disabilities, 44*(4), 330-338.

Cardoso-Martins, C., & Batista, A. (2005). O conhecimento do nome das letras e o desenvolvimento da escrita: evidências em crianças falantes do português. *Psicologia Reflexão e Crítica, 18*(3), 330-336.

Catts, H. W., Petscher, Y., Schatschneider, C., Bridges, M., & Mendoza, K. (2009). Floor effects associated with universal screening and their impact on the early identification of reading disabilities. *Journal of Learning Disabilities, 42*(2), 163-176.

Chalmers, R., P. (2012). MIRT: A multidimensional item response theory Package for the R Environment. *Journal of Statistical Software, 48*(6), 1-29. http://dx.doi.org/10.18637/jss.v048.i06

Clemens, N. H., Shapiro, E. S., & Thoemmes, F. (2011). Improving the efficacy of first grade reading screening: An investigation of word identification fluency with other early literacy indicators. *School Psychology Quarterly, 26*(3), 231-244.

Compton, D. L., Fuchs, D., Fuchs, L. S., & Bryant, J. D. (2006). Selecting at-risk readers in first grade for early intervention: A two-year longitudinal study of decision rules and procedures. *Journal of Educational Psychology, 98*, 394-409.

Compton, D. L., Fuchs, D., Fuchs, L. S., Bouton, B., Gilbert, J. K., Barquero, L. A., ... Crouch, R. C. (2010). Selecting at-risk first-grade readers for early intervention: Eliminating false positives and exploring the promise of a two-stage gated screening process. *Journal of Educational Psychology, 102*, 327-340.

Ferroni, M., Diuk, B., & Mena, M. (2016). Desenvolvimento da leitura e a escritura de palavras com ortografia complexa: seus preditores. *Avances em Psicología Latinoamericana, 34*, 253-271. http://dx.doi.org/10.12804/apl34.2.2016.04

Goldberg, H., & Lederberg, A. (2015). Acquisition of the alphabetic principle in deaf and hard-of-hearing preschoolers: The role of phonology in letter-sound learning. *Reading and Writing, 28,* 509-525.

Gonçalves, F., Gamerman, D., & Soares, T. (2013). Simultaneous multifactor DIF analysis and detection in Item Response Theory. *Computational Statistics and Data Analysis, 59*, 144-160.

Guo, Y., Sun, S., Puranil, C., & Breit-Smith, A. (2018). Profiles of emergent writing skills among preschool children. *Child Youth Care Forum, 47*, 421-442. http://dx.doi.org/10.1007/s10566-018-9438-1

Greer, C., & Erickson, K. (2018). A preliminary exploration of uppercase letter-name knowledge among students with significant cognitive disabilities. *Reading and Writing, 31*, 173-183. http://dx.doi.org/10.1007/s11145-017-9780-y

Huang, F., Tortorelli, L., & Invernizzi, M. (2014). An investigation of factors associated with letter-sound knowledge at kindergarten entry. *Early Childhood Research Quarterly, 29*, 182-192.

Jenkins, J. R., Hudson, R. F., & Johnson, E. S. (2007). Screening for service delivery in an RTI framework: Candidate measures. *School Psychology Review, 36*, 582-599.

Johnson, E. S., Jenkins, J. R., & Petscher, Y. (2010). Improving the accuracy of a direct route screening process. *Assessment for Effective Intervention, 35*(3), 131-140.

Kim, Y. (2015). Developmental, component-based model of reading fluency: An investigation of predictors of word-reading fluency, text-reading fluency, and reading comprehension. *Reading Research Quarterly, 50*, 459-481. http://dx.doi.org/10.1002/rrq.107

Kim, Y. S., & Pallante, D. (2013). Predictors of reading skills for kindergartners and first grade students in Spanish: A longitudinal study. *Reading and Writing, 25*, 1-22.

Leppänen, U., Aunola, K., Niemi, P., & Nurmi, J. E. (2008). Letter knowledge predicts grade 4 reading fluency and reading comprehension. *Learning and Instruction, 18*, 548-564.

Lúcio, P. S., & Pinheiro, A. M. V. (2014). Novos estudos psicométricos para o subteste de leitura do Teste de Desempenho Escolar. *TemasemPsicologia, 22*, 109-119. http://dx.doi.org/10.9788/TP/2014.1-09

MacGlinchey, M., & Hixson, M. (2004). Using curriculum-based measurement to predict performance on state assessments of reading. *School Psychology Review, 33*, 193-203.

Nelson, J. M. (2008). Beyond correlational analysis of the dynamic indicators of basic early literacy skills (DIBELS): A classification validity study. *School Psychology Quarterly, 23*(4), 542-552.

Ozernov-Palchik, O., & Graab, N. (2016). Tackling the 'dyslexia paradox': Reading brain and behavior for early markers of developmental dyslexia. *WyleyInterdisciplynary Reviews*: *Cognitive Science, 7*, 156-176. http://dx.doi.org/10.1002/wcs.1383

Ozernov-Palchik, O., Norton, E., Sideridis, G., Beach, S., Wolf, M., Gabrieli, J., & Gaab, N. (2017). Longitudinal stability of pre-reading skill profiles of kindergarten children: Implications for early screening and theories of reading. *Developmental Science, 20*, 1-18. http://dx.doi.org/10.1111/desc.12471

Paek, I., & Han, K. T. (2013). IRTPRO 2.1 for Windows (item response theory for patient-reported outcomes). *Applied Psychological Measurement, 37*(3), 242-252. http://dx.doi.org/ 10.1177/0146621612468223

Paige, D., Rupley, W., Smith, G., Olinger, C., & Leslie, M. (2018). Acquisition of letter naming knowledge, phonological awareness, and spelling knowledge of kindergarten children at risk for learning to read. *Child Development Research, 2018*, 1-10. http://dx.doi.org/10.1155/2018/2142894

Petscher, Y., & Kim, Y. S. (2011). Efficiency of predicting risk in word reading using fewer, easier letters. *Assessment for Effective Intervention, 37*(1), 17-25.

Phillips, B. M., Piasta, S. B., Anthony, J. L., Loningan, C. J., & Francis, D. J. (2012). IRTs of ABCs: Children's letter name acquisition. *Journal of School Psychology, 50*, 461-481.

Pinheiro, A. M. V. (1996). *Contagem de frequência de ocorrência de palavras expostas a crianças na faixa pré-escolar e séries iniciais do 1° grau*. São Paulo: Associação Brasileira de Dislexia.

Pollo, T., Kessler, B., & Treiman, R. (2005). Vowels, syllables, and letter names: Differences between young children's spelling in English and Portuguese. *Journal of Experimental Child Psychology, 92*, 161-181.

Puranik, C., Petscher, Y., & Lonigan, C. (2014). Learning to write letters: Examination of student and letter factors. *Journal of Experimental Child Psychology, 128*, 152-170.

Ritchey, K., & Speece, D. (2004). Early identification of reading disabilities: Current status and new directions. *Assessment for Effective Intervention, 29*(4), 13-24.

Sartes, L. M. A., & Formigoni, M. L. S. (2013). Avanços na psicometria: da teoria clássica dos testes à teoria de resposta ao item. *Psicologia*: *Reflexão e Crítica, 26*, 241-250.

Speece, D., Mills, C., Ritchey, K., & Hillman, E. (2003). Initial evidence that letter fluency tasks are valid indicators of early reading skill. *Journal of Special Education, 36*, 223-233.

Stein, L. (1994). *Teste de desempenho escolar*. São Paulo: Casa do Psicólogo.

Swets, J. A. (1988). Measuring the accuracy of diagnostic systems. *Science, 240*, 1285-1293. http://dx.doi.org/10.1126/science.3287615

Treiman, R., Tincoff, R., & Richmond-Welty, D. (1996). Letter names help children connect print and speech. *Developmental Psychology, 32*, 505-514.

Zhang, X. (2018). Letter-name knowledge longitudinally predicts young Chinese children's Chinese word reading and number competencies in a multilingual context. *Leraning and Individual Differences, 65*, 176-186.

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