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The Role of Phonological Awareness and Rapid Automatized Naming in the Prediction of Reading Difficulties in Portuguese

O Papel da Consciência Fonológica e da Nomeação Automatizada Rápida na Predição de Dificuldades de Leitura em Português

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Abstract

This study investigated the contribution of phonological awareness (PA) and rapid automatized naming (RAN) to the persistence of beginning reading difficulties in Portuguese. The study was longitudinal and involved 13 children who had shown little progress in learning to read during their 1st school year, and 13 children with typical reading development. At the beginning of the study, when participants were, on average, six years and nine months of age, their ability to read and spell words, and their PA and RAN skills were assessed. One year later, the children who had shown difficulties in learning to read were divided into two groups, based on their progress in learning to read during the course of the study: a group with persistent reading difficulties and a group whose difficulties had been overcome. Results showed that both groups performed equally poorly and below controls on the PA tasks at the beginning of the study. In contrast, only the children with persistent reading difficulties performed more poorly than controls on the RAN tasks at that time.

Keywords: Predictors of reading ability, phonological awareness, rapid automatized naming.

Resumo

Este estudo investigou a contribuição da consciência fonológica (CF) e da nomeação automatizada rápida (RAN) para a persistência de dificuldades na aprendizagem inicial da leitura em português. O estudo foi longitudinal e envolveu 13 crianças que haviam apresentado dificuldades na aprendizagem da leitura durante o ano da alfabetização e 13 crianças com desenvolvimento típico da leitura. A habilidade de ler e escrever palavras, a CF e a RAN foram avaliadas no final do ano de alfabetização, quando as crianças tinham, em média, seis anos e nove meses de idade. Um ano mais tarde, as crianças que haviam apresentado dificuldades na alfabetização foram divididas em dois grupos, com base em seu progresso na habilidade de ler palavras ao longo do estudo: um grupo de crianças com dificuldades persistentes e um grupo cujas dificuldades iniciais haviam sido superadas. Os resultados mostraram que ambos os grupos apresentaram déficits na CF no início do estudo. Por outro lado, apenas as crianças com dificuldades persistentes de leitura manifestaram déficits na RAN naquela ocasião.

Palavras-chave: Preditores da habilidade de leitura, consciência fonológica, nomeação automatizada rápida.

Developmental dyslexia is a neurodevelopmental learning disorder characterized by difficulties in the ability to read words with accuracy and/or fluency, despite appropriate literacy instruction and normal or above normal intelligence. It is one of the most frequent developmental learning disorders, affecting approximately 9% of the school age population (e.g., Pennington, 2009).

According to the phonological deficit model (Pennington, 2009), developmental dyslexia results from deficits

in phonological processing, most notably in phonological awareness, that is, the ability to pay conscious attention to the sounds that comprise the words we hear and speak. These deficits compromise the ability to recode letters or letter sequences into the sounds they typically represent in words, an ability that is fundamental for success in learning to read (Cardoso-Martins & Ehri, 2014). In support of this hypothesis, there is evidence that children with dyslexia find it particularly difficult to read pseudowords, that is, words that do not exist in their language and therefore can only be read by phonological recoding.

Despite its prominent position in the literature, the phonological deficit model has recently become the subject of increasing scrutiny (Snowling, 2008). In particular, it

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has been suggested that phonological processing deficits are not sufficient (e.g., Pennington, 2006; Snowling, 2008) or even necessary (e.g., Pennington, 2006; Wolf & Bowers, 1999) for difficulties in learning to read to occur. For example, Snowling, Gallagher and Frith (2003) have noted that, notwithstanding their difficulties in phonological awareness tasks, not all children at high familial risk of developmental dyslexia present with difficulties in learning to read. The same is also true of children with phonological deficit disorder, a condition frequently associated with deficits in phonological awareness (Pennington & Bishop, 2009), suggesting that difficulties in phonological processing can be mitigated or compensated by other processes. One moderating factor that seems particularly important, and the one that is the focus of the present study, is rapid (or automatized) naming of series of familiar stimuli such as letters, colors or pictures of objects (e.g., Peterson & Pennington, 2012).

Since the seminal work of Denckla and Rudel (1976), a large body of research has demonstrated a strong relationship between rapid automatized naming (RAN) and both concurrent and future literacy skills (see Kirby, Georgiou, Martinussen, & Parrila, 2010, and Norton & Wolf, 2012, for reviews). This relationship has been shown in practically every language in which it has been tested, including Portuguese (e.g., Albuquerque, 2012; Justi & Roazzi, 2012), and regardless of variations in other predictors of literacy ability, such as verbal and non-verbal skills, general processing speed, and phonological awareness (Kirby et al., 2010). Nonetheless, there has been much disagreement regarding the explanation underlying this relationship. According to one theoretical standpoint (e.g., Wagner & Torgesen, 1987), RAN predicts reading ability because, comparable to phonological awareness (PA), it is an index of phonological processing ability. On the other hand, Wolf and her colleagues (e.g., Bowers & Wolf, 1993; Wolf & Bowers 1999) have suggested that RAN indexes processes that are, at least in part, independent of phonology, including attention, visual discrimination, integration of visual information with stored phonological and semantic representations, and access and retrieval of phonological labels. In support of their view, they have shown that deficits in RAN and PA often dissociate, and that deficits in RAN can predict literacy difficulties even in the absence of deficits in PA. Perhaps more importantly for the purpose of the present study, there is evidence that deficits in both RAN and PA are often associated with more severe and persistent literacy difficulties than isolated deficits in RAN or PA (Kirby et al., 2010). This may be particularly true of orthographies more consistent than the English orthography. Indeed, given the claim that PA plays a relatively modest role in the prediction of later literacy skills in more consistent orthographies (e.g., de Jong & van der Leij, 1999; Papadopoulos, Georgiou, & Kendeou, 2009; Wimmer, Mayringer, & Landerl, 2000), it is unlikely

that isolated deficits in PA predict severe and persistent reading difficulties in these orthographies.

The findings reviewed above suggest that, when used in conjunction with PA, RAN may be a particularly useful tool in the prognosis of children who experience difficulties in the beginning phases of reading acquisition. In the present study we investigated this hypothesis in a group of children who were learning to read in a relatively consistent orthography – Brazilian Portuguese – and who had demonstrated difficulties in learning to read during their first school year. Children's reading and spelling ability was evaluated twice, at the end of their first and second school years. Both PA and RAN were assessed at the beginning of the study, that is, at the end of children's first school year. Based on the evidence reviewed above, we predicted that skills in both RAN and PA would better distinguish the children who overcame their reading difficulties over the course of the study from those who did not than skills in PA alone.

Method

Participants

The sample was initially comprised of two groups of 6- to 7-year old children ($M = 7$ years and 1 month; $SD = 3.65$ months) enrolled in the former “*pré-primário*” (kindergarten) of private schools in a large Brazilian city: 13 children with beginning reading difficulties and 13 children without reading difficulties, individually matched for age, gender and kindergarten class. They all had normal or above normal intelligence as assessed by the Brazilian version of the Wechsler Intelligence Scales for Children-III (WISC-III; see below). To be assigned to one of the two groups, children had to meet two criteria. First, they had to be nominated by their teachers as having or having not manifested difficulties in learning to read throughout the school year. In all cases, teachers' indication occurred towards the end of the school year, approximately 5 to 6 months after the beginning of reading instruction. In addition, the children had to have scored in the middle-inferior to inferior range, in the case of the children with reading difficulties, or in the middle-superior to superior range, in the case of the children without reading difficulties, on the reading subtest of a Brazilian test of academic performance – TDE (see below) – that was administered at the end of their kindergarten year. Among the children indicated by the teachers, only one did not meet both criteria and could not be included in the study. As illustrated in Table 1, the children assigned to the group with beginning reading difficulties performed significantly worse than the children assigned to the group of children without reading difficulties (henceforth the control group) on that subtest. They also performed significantly below the control group on the spelling subtest of the same test and on an experimental pseudoword reading task that were also administered at the end of kindergarten.

Table 1

Mean Age and Mean Scores (and Standard Deviations) on the Literacy Tests, as a Function of Group

Measures	Group	
	Reading Difficulty <i>n</i> = 13	Controls <i>n</i> = 13
Time 1		
TDE: Reading (max. = 70)	18.38 (10.83)*	50.85 (6.56)
TDE: Spelling (max. = 35)	6.08 (3.30)*	15.08 (5.30)
Pseudoword Reading (max. = 20)	2.77 (2.92)*	13.00 (3.56)

Note. TDE = Test of Academic Performance.

**p* < .001.

One year later, at the end of 1st grade, the children were re-tested on the reading and spelling subtests of the TDE. Results showed that the children in the group with beginning reading difficulties varied largely with regard to their ability to read words. In view of this, they were divided into two groups: the group with persistent reading difficulties, that is, the 6 children whose scores on the reading test were at least one *SD* below the mean score of

the control group, and the group of children with transient reading difficulties (*N* = 7), whose scores on the reading test were above that cut-off point. As illustrated in Table 2, the children with persistent reading difficulties performed significantly worse than the children with transient reading difficulties and controls on both the reading and the spelling subtests of TDE at the end of 1st grade. No differences were found between the latter two groups at this occasion.

Table 2

Mean Age and Mean Scores (and Standard Deviations) on the Literacy and Intelligence Tests, as a Function of Group and Time

Measures	Group		
	Persistent Reading Difficulty <i>n</i> = 6	Transient Reading Difficulty <i>n</i> = 7	Controls <i>n</i> = 13
Time 1			
WISC-III: Full IQ	103.17 (15.30)	108.43 (13.05)	117.23 (7.47)
WISC-III: Verbal IQ	104.17 (15.10) ^{a, b}	107.43 (11.04) ^a	117.77 (8.50) ^b
WISC-III: Performance IQ	101.83 (15.92)	108.71 (14.36)	113.85 (12.67)
TDE: Reading (max. = 70)	12.83 (10.07) ^a	23.14 (9.63) ^a	50.85 (6.56) ^b
TDE: Spelling (max. = 35)	3.83 (1.72) ^a	8.00 (3.16) ^b	15.08 (5.30) ^c
Pseudoword Reading (max. = 20)	2.67 (2.42) ^a	2.86 (3.48) ^a	13.00 (3.56) ^b
PA*	-.77 (.88) ^a	-.46 (.39) ^a	.60 (.62) ^b
RAN*	.83 (1.10) ^a	-.35 (.39) ^b	-.19 (.69) ^b
Time 2			
TDE: Reading (max. = 70)	41.83 (11.05) ^a	57.86 (3.58) ^b	58.15 (5.64) ^b
TDE: Spelling (max. = 35)	12.50 (3.56) ^a	19.86 (3.81) ^b	20.38 (3.62) ^b

Note. WISC-III = Wechsler Intelligence Scales for Children-III; TDE = Test of Academic Performance; PA = Phoneme awareness; RAN = Rapid automatized naming; *composite *z* scores.

^acell differs significantly from cells with superscripts b or c; ^bcell differs significantly from cells with superscripts a or c; ^ccell differs significantly from cells with superscripts a or b.

Procedure

Participants were evaluated at two different times with an interval of approximately 12 months: Time 1 occurred towards the end of kindergarten, and Time 2 at the end of 1st grade. At both Time 1 and Time 2, children were administered the reading and spelling subtests of the TDE (Stein, 1994). At Time 1, they were also administered the WISC-III (Wechsler, 2002), and tests of PA, RAN and pseudoword reading ability. Except for the WISC-III, which was administered at a private clinic or at the child's home, all tests were administered in a quiet place at the children's schools. The study was approved by the Ethics Committee of the *Universidade Federal de Minas Gerais* and, in all cases, the children's parents signed a written consent form allowing their children to participate in the study.

Instruments

Word Reading and Spelling. The ability to read and spell words was assessed with the corresponding subtests of TDE (Stein, 1994). The reading subtest comprises 70 words printed in lower case letters in a card, in order of increasing difficulty. Children are asked to read aloud the words at their own pace. Thirty-five words are included in the spelling subtest. The words are dictated in order of increasing difficulty, and the test is discontinued after 10 incorrect responses in a row (or after completion of the subtest). Reliability (alpha) is reported to be .86 and .90, for the reading and spelling subtests, respectively. At the end of kindergarten, children were also asked to read a set of 20 pseudowords (e.g. *bude*, *calvilho*, etc.) printed in capital letters at the center of individual cards.

Phonemic Awareness. Two experimental tasks were used. In the phoneme detection task, children were asked to identify among three different words, the two that started with the same sound. The task is divided into two parts, each one of which is comprised of two or three training trials, followed by 10 test trials. In the first part, all words begin with a CV or CVC syllable (e.g., *sorvete* 'ice-cream' – *machado* 'axe' – *cigarro* 'cigarette'); in the second part, two of the words in a trial begin with a consonant cluster (e.g., *praça* 'square' – *coroa* 'crown' – *criança* 'child'). For each trial, the examiner showed a card with drawings of the words' referents, and pronounced the words out loud. The number of correct responses was scored.

In the phoneme deletion task, the child is asked to repeat a word enunciated by the examiner after deleting its first sound (e.g., *gato* 'cat': *ato*; *flanela* 'flannel': *lane-la*). The task has 10 training trials and 20 tests trials. The number of correct responses to the test trials was scored. Performance on the two phonemic awareness tasks was significantly correlated ($r = .54, p < .01$). A PA composite score consisting of the corresponding summed z -scores divided by two was thus derived and used in the analyses comparing the three groups of participants.

Rapid Serial Naming was measured with a version of the RAN task (Denckla & Rudel, 1976). The participant was asked to name as fast as possible series of repeating familiar stimuli printed on a chart, in the form of a matrix consisting of five rows and 10 columns. There were four different charts, each comprised of a different type of stimulus (letters, digits, objects, and colors). In each chart, five different stimuli were presented 10 times each in a random order. Responses were timed using a stopwatch. The time taken to name all the stimuli was scored. Students' scores on the RAN tasks were significantly correlated (r s ranging from .51 to .77).

In view of this, a composite score consisting of the mean of the summed corresponding z -scores was used in the analyses described below.

Intelligence. Intelligence was measured with the Brazilian version of the WISC-III (Wechsler, 2002). Reliability (alpha) for full IQ is reported to be .93.

Results

The aim of this study was to investigate the role played by PA and RAN in predicting persistent, as opposed to transient, reading difficulties in Brazilian Portuguese. Table 2 lists the mean composite scores for the PA and RAN tasks, along with the mean scores for the other tests that were administered at Time 1, separately for the three groups of children (Given the small number of participants, whenever possible, non-parametric tests were used to test the significance of the differences found between the groups. Specifically, the Kruskal-Wallis test was used to evaluate the significance of the overall group difference, and the Mann-Whitney test was used to evaluate the significance of any pairwise differences).

At Time 1, both groups of children with beginning reading difficulties performed significantly worse than controls on the pseudoword reading task and on both the reading and the spelling subtest of the TDE (*Persistent vs. Controls*: pseudoword reading: $p < .001$, Cohen's $d = 3.34$; TDE reading: $p < .001$, $d = 5.18$; TDE spelling: $p < .001$, $d = 2.62$; *Transient vs. Controls*: pseudoword reading: $p < .001$, $d = 3.03$; TDE reading: $p < .001$, $d = 3.78$; TDE spelling: $p < .01$, $d = 1.59$). As illustrated in Table 2, the group with persistent reading difficulties also performed worse than the group with transient reading difficulties on both the reading and spelling subtests of the TDE at Time 1. The difference between these two groups on the spelling subtest was statistically significant ($p < .05$, $d = 1.74$). These results suggest that the children with persistent reading difficulties were already poorer readers than the children with transient reading difficulties at Time 1, and this might be the reason why their reading difficulties were relatively more persistent. However, it is important to note that, except for two children, the scores of the children with transient difficulties on the reading subtest of the TDE at Time 1 fell well within the range of the scores of

the group of children with persistent reading difficulties. In addition, as illustrated in Table 2, no difference was found between these two groups with regard to the hallmark of alphabetic literacy acquisition, namely, the ability to read by recoding letters or groups of letters into the sounds they represent in words.

The comparisons involving the PA and RAN measures showed a significant effect of group ($p < .001$, for PA and $p < .01$, for RAN). Pairwise comparisons revealed that both the children with transient reading difficulties and the children with persistent reading difficulties performed equally poorly and significantly worse than controls on the PA tasks administered at the beginning of the study (*Persistent vs. Controls*: $p < .001$, $d = 2.04$; *Transient vs. Controls*: $p < .01$, $d = 2.03$). In marked contrast, only the children with persistent reading difficulties performed significantly worse than controls on the RAN measure at that time ($p < .001$, $d = 1.29$). As illustrated in Table 2, their scores were also significantly poorer than those of the group with transient reading difficulties ($p < .01$, $d = 1.62$). Similar results were obtained when the two children in the group of transient reading difficulties who had performed relatively well on the word reading subtest of the TDE at Time 1 (see above) were excluded from these analyses.

Although our three groups of participants did not in general differ significantly with regard to IQ, there was a trend for both groups with beginning reading difficulties to score below controls on the WISC-III. In view of this, two ANCOVAs controlling for individual differences in full IQ were conducted, one for PA and the other for RAN. Similar to the results reported above, the group factor was significant for both dependent variables, $F(2, 22) = 6.57$, $p < .01$, $\eta_p^2 = .37$, for PA and $F(2, 22) = 4.70$, $p < .05$, $\eta_p^2 = .30$, for RAN. Furthermore, contrasts with the control group as the reference category revealed that both the children with persistent difficulties and the children with transient difficulties significantly underperformed controls on the PA measure, both $ps < .01$. On the other hand, similar to what we had found before, while the group with persistent reading difficulties performed significantly below controls on the RAN measure ($p < .05$), the children with transient reading difficulties performed as well as controls.

Discussion

In the present study, we examined the role played by PA and RAN in the prediction of literacy skills of children experiencing difficulties in the beginning of reading acquisition in a relatively consistent orthography – Brazilian Portuguese. We predicted that deficits in both PA and RAN, rather than deficits in PA alone, would be associated with persistent reading difficulties in our sample. As mentioned previously, Pennington (2006) has cogently argued that isolated deficits in PA (or in any other cognitive skill for that matter) may not be sufficient to explain reading difficulties. In addition,

it has been suggested that PA plays a relatively modest role in the prediction of literacy skills in more consistent orthographies (e.g., de Jong & van der Leij, 1999; Papadopoulos et al., 2009; Wimmer et al., 2000; but see Caravolas, Volin, & Hulme, 2005, for a different view). In line with our prediction, although both groups of children with beginning reading difficulties had deficits in PA at the beginning of the study, not all of them showed word reading and spelling difficulties one year later. Our results suggest that, in addition to deficits in PA, children with persistent reading difficulties in Brazilian Portuguese are likely to present deficits in rapid naming at the beginning of literacy acquisition. As described previously, only the children with persistent reading difficulties performed significantly worse than controls on the RAN tasks administered at the end of kindergarten. Indeed, while none of the children with transient reading difficulties scored above the cut-off of one standard deviation above the mean reaction time of the control children on the RAN tasks, as many as four of the six children with persistent reading difficulties did.

It is unlikely that the differences observed between the children with persistent reading difficulties and those whose reading difficulties were transient resulted from differences in their intelligence. In fact, the two groups did not differ significantly on either Verbal or Performance IQ, as measured by the WISC-III (Wechsler, 2002). Nor did they seem to differ with regard to learning ability more generally or to the presence of other developmental disorders (see, e.g., Michalick, 2005, for a detailed description of the present sample).

As noted previously, some researchers have argued that RAN is best viewed as a measure of phonological processing skill (Wagner & Torgesen, 1987). In this case, the presence of RAN deficits in children with persistent reading difficulties could simply be a sign of more severe phonological difficulties which, arguably, would place a greater toll on the ability to learn to read by processing and remembering letter-sound relations in words, a foundational skill in alphabetic reading acquisition (e.g., Cardoso-Martins & Ehri, 2014). In line with this, the children with persistent reading difficulties performed significantly worse than those with transient difficulties on the digit span subtest of the WISC-III (*Mean raw score* = 6.17 and 8.86, respectively, $p < .05$), a task that assesses verbal short-term memory. However, the two groups with beginning reading difficulties performed equally poorly and significantly below controls on measures that clearly rely on phonological processing skills, namely, the PA and the pseudoword reading tasks. Furthermore, similar to the results of other studies (Wolf & Bowers, 1999), the correlation between RAN and PA ($r = .41$, $p < .05$) or between RAN and the digit span subtest of the WISC-III ($r = -.43$, $p < .05$) for the whole group was very modest, suggesting that RAN and PA should not be considered as two measures of the same underlying construct (Wolf & Bowers, 1999). Last but not least, there is evidence that

children with deficits in both PA and RAN show more severe and persistent reading difficulties than children with deficits only in PA, even when the two groups of children are matched for PA (e.g., Kirby, Parrila, & Pfeiffer, 2003; Papadopoulos et al., 2009). This was certainly the case in the present study.

Taken together, our results suggest that deficits in RAN constitute an important risk factor in the development of persistent reading difficulties in Portuguese, at least when associated with deficits in PA. Our results should however be interpreted with caution. This study comprised a small sample of children, all of them coming from high socioeconomic status family. In addition, the children were followed for only one year. Clearly, more studies are necessary to evaluate the generality of the present findings to a more representative sample of children at risk of developing reading disabilities. In case our results are confirmed, it will be important to investigate the cognitive factors behind RAN. As mentioned in the introduction, there is still no consensus regarding the nature of these factors and how they contribute to the development of reading.

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