Word Reading Accuracy as a Mediator for Fluency

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Abstract: This paper aims to test the predictive role of nonword reading abilities (accuracy and fluency) and rapid naming (RAN) over word reading fluency. Letter knowledge (LK) and phonological awareness (PA) for literacy were accounted for as control factors due to their ceiling effects. We test the direct impact of the main predictors and their indirect outcomes by controlling for word reading accuracy. To this end, 206 children participated and completed measures for nonword reading abilities, rapid naming, word reading accuracy, fluency, and letter knowledge, and phonological awareness. The results show that RAN and nonword reading accuracy are direct predictors of word reading accuracy. Word reading fluency is significantly associated with rapid naming. The effect of RAN, nonword reading accuracy, nonword reading fluency on word reading fluency is partially mediated by word reading accuracy. We discuss the practical implications.

Keywords: *nonword reading accuracy, word nonword reading fluency, rapid naming (RAN), word reading accuracy, word reading fluency.*

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Introduction

Reading is a critical skill that all children need to acquire (Taub & Szente, 2012) and leads to the educational and professional success of people (Eloranta et al., 2019).

The main concern of researchers and teachers is to find a method that can help as many children as possible to read. Dyslexia is a disorder that prevents children from reaching the level of extracting meaning from the text. If all the effort is focused on decoding, comprehension will no longer take place. Our goal was to see the components on which we should intervene and better understand the reading process.

The written word is a symbolic representation of the spoken word (Ehri, 2014), and its acquisition is influenced by various factors. Those factors can be internal or external. External factors are the home literacy environment, the family socioeconomic status (Snowling & Hulme, 2020), and the orthographic depth of the language, through which the child gains the reading ability (Landerl et al., 2019).

For decades, researchers have noted that the ease of literacy varies with orthographic depth (Layes et al., 2015; Mann & Wimmer, 2002; Sunde et al., 2020; Ziegler et al., 2010). Most studies have focused on comparing English, considered a language with deep orthography with different languages, some being transparent with consistency in phoneme-grapheme correspondence (Frost et al., 1987; Landerl & Wimmer, 2000; Seymour et al., 2003). Even when Wimmer and Goswami (1994) tested 72 English and 81 Austrian children, they already noticed that the consistency of the orthography could be affecting the reading development indirectly via teaching methods. The turning point was when Ziegler and Goswami developed a theory called PGST, called the Psycholinguistic Grain Size Theory (PGST). The PGST had concluded that the differences observed in reading accuracy and fluency in different spellings are due to differences in phonological recoding and reading strategies, which develop according to these orthographies. In irregular orthographies, children must learn to use flexible unit size recoding strategies, such as grapheme-phoneme correspondence, morphological units, analogy, and recognizing whole words (Georgiou et al., 2008). It is more difficult for a beginner reader to identify and apply those orthographic units and consistently rely on the phonemic level (Ziegler & Goswami, 2005). Georgiou et al. (2008) tested 161 English-speaking Canadian children and 92 Greek-speaking Cypriot children. They concluded that both phonological and orthographic processing predicted reading ability. But the importance of these abilities differed from Greek to

English (Georgiou et al., 2008). Landerl et al. (2019) tested 120 children across grades 1 and 2, gaining one of five alphabetic orthographies that have different orthographic complexities (English, French, German, Dutch, and Greek). They concluded that orthographic transparency *changes* the predictors' contribution; still, this transparency does not *modify* the pattern (Ziegler et al., 2010). The more transparent a language is, the easier and faster children develop the learning ability; thus, at the end of grade one, children become accurate and fluent in foundation-level reading (Seymour et al., 2003).

The Romanian language is a Romance language, with a structure specific to Romance languages, and can be considered high regularity spelling (David et al., 2018). Syllables in Romanian have a vocalic character, with a predominance of consonant-vowel or consonant-vowel-consonant syllable structures, with few initial or final consonant clusters (Dragomirescu, 2012). Represents exception to the phonological principle the letters c and g. For example, c can be read as [k] in clear, but as [ç] when followed by i or e. Another exception is h, which reads as h in hilar, but in the group of letters che, chi, ghe, ghi, it has diacritical value (zero phonological value) (Dragomirescu, 2012).

Romanian children start school at the age of six in Preparatory Grade. At Preparatory Grade, they get familiar with capital letters and digits. They start learning to read in the 1 Grade when they get acquainted with the lowercase letters.

Nonword reading accuracy and nonword reading fluency determining word reading accuracy and fluency

The purpose of the reading is to convey printed information. Reading development begins with mapping grapheme to phoneme, then progresses to word nonword reading, fluency, and reading comprehension (Taub & Szente, 2012). Nonword reading is the process defined by the learning of how letters and groups of letters map onto their corresponding sounds (Ehri, 1995). Nonwords are unfamiliar words, so they cannot be recognized as spelling units (Moll et al., 2009; Wimmer & Schurz, 2010). Their reading is based on phonological processing, involving the nonword reading of new, unfamiliar letter sequences (Ehri, 2014). Even hardly decoded words can be recognized once they have been read several times (Ehri, 1995).

Word reading accuracy is the ability to accurately identify single words from print (Pasquarella et al., 2015). That ability enables comprehension. It is assessed by asking children to read aloud (Pasquarella

et al., 2015). In languages with regular spelling, the transition from nonword reading to fluent reading takes place after a few months of training (Kuhn & Stahl, 2003; Puolakanaho et al., 2008).

Fluent reading is characterized by accuracy in nonword reading, automaticity in recognizing words, and appropriate prosody (Hudson et al., 2005). In regular orthographies, reading deficits are characterized by a slower speed than by inaccurate reading (Wimmer & Schurz, 2010). That is why in transparent orthographies, reading accuracy seems to be a less important factor than fluency (Serrano & Defior, 2008). However, David et al. (2018) observed difficulties in both accuracy and fluency of the Romanian children.

Rapid Automatic Naming and word reading accuracy and fluency

The use of RAN evaluates the speed of obtaining phonologically encoded information from long-term memory (Logan et al., 2011). The assessment is easy. It takes place by presenting a series of visual stimuli, familiar to the subject, placed horizontally from left to right, in random order, which students must name as quickly as possible (Norton & Wolf, 2012; Taub & Szente, 2012). The stimuli are alphanumeric (letters, numbers) or non-alphanumeric (objects, colours). The alphanumeric ones generally have a stronger correlation with the reading skills than the non-alphanumeric ones (Scarborough, 1998). RAN is a predictor of reading abilities thanks to its linguistic and perceptual elements and connections (Norton & Wolf, 2012). RAN an implicit process of phonological processing (Melby-Lervag et al., 2012) and is independent of PA (Layes et al., 2015; Wolf et al., 2000).

It is a universal predictor of reading fluency in all orthographies (Georgiou et al., 2008; Landerl et al., 2019).

Control Factors

PA is the ability to identify, manipulate, or analyse parts of spoken words (Taub & Szente, 2012). It is an explicit phonological processing ability (Tilanus et al., 2013) required for reading (Goswami, 2015). Upon entering school, children have a slightly developed PA, but by age 9, they reach the ceiling level (Landerl et al., 1996; Vaessen et al., 2010). PA can be considered a universal predictor (Katzir et al., 2004) because it explains literacy in general, regardless of the phase of development of the child. Still, the influence of PA on reading skills depends on linguistic transparency, and the relationship is more robust in irregular orthographies than in regular ones (Georgiou et al., 2008; Landerl & Wimmer, 2000). Moreover, in transparent

orthographies, PA is a better predictor of reading accuracy than fluency (Wimmer & Mayringer, 2002).

In alphabetical systems, letter knowledge plays a fundamental role; without it, the principles of literacy (accuracy and fluency) cannot be acquired (Stuart & Coltheart, 1988). The results generally come from the positive longitudinal correlations in which upper case letters were used at the end of the kindergarten. Then, the reading skills were tested in the first class (Caravolas et al., 2001; Catts et al., 2001). Results showed that the more letters children recognize, the better they read. Letter knowledge is a relevant predictor for literacy until children finish first grade because, after this moment, they manage to identify the letters by sound or by name (Foulin, 2005). Still, letter knowledge is a universal predictor, independent of the spelling transparency of the language (Georgiou et al., 2008).

The present study supports the understanding of literacy (i.e., word reading accuracy and fluency) of children in grade one by highlighting the predictive role of the following factors: nonword reading abilities (nonword reading accuracy and nonword reading fluency, rapid naming (RAN), in context of skills development for reading in the Romanian language. This information is essential for Romanian education, being very little research in the literacy of Romanian children because there was no standardized test for the Romanian population to evaluate the reading of the list of words and nonwords. The study also comes with information about the literacy process in regular spelling, indicating how the shift from the nonword reading process to fluent reading occurs.

We designed the **specific hypotheses** of the present research by considering the general theoretical guidelines. We assume: *rapid naming (RAN) is negatively associated with reading accuracy and positively with fluency, meaning that an increase in the speed of rapid naming leads to a reduction in the number of errors in reading and addition in reading speed* b) *high nonword reading capabilities lead to high accuracy and fluency*, c) *RAN has a mediator effect of on nonword reading abilities over word reading fluency (RF) when controlling for word reading accuracy*.

Methodology

Participants

In this study, 206 grade 1 students (111 boys and 95 girls) participated voluntarily, and informed consent was obtained from their parents. Participants were students at schools in the North-East part of the Romanian county: 4 schools in urban areas and one school in rural areas. The mean age was: 96.14 months ($SD = 3,996$). The children have the

Romanian language as their native language, have no impaired hearing or sight problems. They were not diagnosed with ADHD, epilepsy, or behavioral issues. They come from various social environments. Initially, we tested 215 children, but those with speech sound disorders were eliminated from the final data analysis.

Procedure and measure

We tested the children at the end of the year in schools in the second half of May 2019. We used The Battery for Assessment of Dyslexia, and Evolutive Dysorthography (Sartori et al., 1995; adapted for the Romanian population by David et al., 2018; David & Roşan & 2017, p. 60) and the Onset Deletion Test from Batteries devaluation du langage écrit et de ses troubles (BELEC), Mousty et al. (1994) adapted for the Romanian population by David & Roşan, 2017, for PA.

The lists were presented in a fixed sequence (letters, familiar words, nonwords, RAN, PA).

We tested the children individually. We started a stopwatch when the list was presented to the child and stopped when they finished the last task. If a child got stuck, we asked them to move on and complete the list.

The DDE 2 test (David & Roşan, 2017, p. 60) generally allows for the evaluation of the reading and word reading accuracy competencies for first to third-grade children. The Battery includes tests that can establish the initial level of the competencies and understand whether their characteristics are not suited. We administered the measurement one at a time for each of the main variables of the study as it follows:

Letter-sound knowledge (LK) was tested using "Test 1" from the DDE-2 Battery of Assessment. We asked the students to recognize 26 capital letters. We recorded the correct answers.

Phonological awareness (PA) was measured with the Syllabic deletion subtest from BELEC, Mousty, et al. (1994). The children heard a pseudonym and had to delete the first syllable. For example, from "bamu" remains "mu."

Rapid naming (RAN) - Rapid naming is defined as the speed of obtaining a phonological code from long-term memory (Denckla & Rudel, 1976). Digit Naming was administered. The children were presented with a 30-digit matrix: 2, 4.5, 7.9 randomly arranged (Tong et al., 2017). They were asked to name them, reading the rows horizontally. We measured the time for calling the numbers.

Nonword reading accuracy and nonword reading fluency - The "Sample 3" of the DDE-2 test was administered. The test includes nonwords organized by columns. We asked them to read the columns one by one. We told them that the items were non-existent words and asked them to read them as they were. For nonword reading accuracy, we recorded: the nonwords read correctly and the time. Nonword reading accuracy: nonword correctly read percentage, nonword reading fluency: the time necessary to read one nonword (time/ nr. items nonword list).

Reading accuracy and reading fluency – We used Test 2 from the DDE-2 test, which measures the correctness of reading the word list. The test contains common words passed on the column. We asked them to read the columns one by one. We recorded the number of words read correctly for reading accuracy (percentage of correctly read words) and time for reading fluency (time/ nr. item word list).

Results

Preliminary analysis

First, we display the average levels of abilities measured in children and the minimum and maximum values in table 1.

Table 1 Means (and standard deviations) of RAN, word reading accuracy, word reading fluency, nonword reading fluency, nonword reading accuracy.

	Minimum	Maximum	Mean	Std. Deviation
RAN	8.75	46.00	18.0143	4.63380
Word reading accuracy	30.36	100.00	93.6720	9.45660
Word reading fluency	.01	.40	.0391	.04135
Nonword reading accuracy	.00	100.00	84.2536	18.26310
Nonword reading accuracy	.01	1.21	.0626	.09586

Further, we display the intercorrelations of the main variables studied in the article. The results are shown in Table 2 and discussed below.

Table 2. Zero-order intercorrelation between main variables

	1.	2.	3.	4.	5.	6.
Nonword reading accuracy	1					
Nonword reading fluency	-.167*	1				
RAN	-.331**	.225**	1			
Letter knowledge	.289**	-.027	-.062	1		
Phonological awareness	.440**	-.129	-.164*	.359**	1	
Reading accuracy	.725**	-.235**	-.443**	.272**	.510**	1
Reading fluency	-.568**	.312**	.692**	-.084	-.321**	-.767**

** $p < .05$, *** $p < .001$

The results show a strong positive relation ($r=.72$) between nonword reading accuracy and reading accuracy. Meanwhile, nonword reading accuracy with reading fluency is a negative mild but significant relation ($r = -.57$). Between nonword reading fluency and reading accuracy is a weak negative significant relation ($r = -.24$), reading fluency and reading accuracy are positive weak significant relation ($r = .31$). As results show, there is a weak to mild significant negative association between word rapid naming and reading accuracy ($r = -.44$) and a strong positive correlation ($r = .69$). Finally, the results indicate a negative significant strong relation between reading accuracy and reading fluency ($r = -.78$).

Path analysis of the role of reading accuracy as a mediator between predictors of reading and fluency

The non-standardized parameters show that nonword reading accuracy and RAN are significant predictors for reading accuracy. Fluency is significantly and positively associated with RAN and important and negatively with nonword reading accuracy. To determine the relations between the factors measured in an explanatory model, we conducted an SEM analysis. Thus, through multiple regressions, we obtained the model (Figure 1).

Figure 1 Mediation effect of reading accuracy on the relation between nonword reading accuracy, nonword reading fluency, RAN and word reading fluency.

The results showed that the model has a good correspondence with the data, for the whole sample $\chi^2 = 4.223$, $df = 3$, $p = .238$, $CFI = 0.99$, $TLI = 0.98$ and $RMSEA = 0.04$, the model explaining 76% of the reading fluency variance. The standardized parameters are exposed in Table 1, and the results of the direct, indirect, and total effect in Table 2.

The specific results are available in Table 2. We display the results below by considering the direct, indirect, and total effects of word reading accuracy as a controlling factor between the main incremental factors for word reading fluency.

Table 3. Main estimates for the direct, indirect, and total effects

<i>Parameter- Mediation effects</i>			
<i>Standardized direct effects</i>	<i>Estimate (S.E.)</i>	<i>Lower</i>	<i>Upper</i>
Nonword reading accuracy < --- Reading fluency	-.04 (.07)	-.192	.059
Nonword reading fluency < --- Reading fluency	.08 (.19)*	.034	.585
RAN < --- Reading fluency	.41 (.11)**	.288	.603

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Reading accuracy < --- Reading fluency	-.57 (.12) **	-.716	-.355
<i>Standardized indirect effects</i>			
Nonword reading accuracy < --- Reading accuracy < --- Reading fluency	-.31 (.08) **	-.431	-.149
Nonword reading fluency < --- Reading accuracy < --- Reading fluency	.04 (.04) *	.012	.142
RAN < --- Reading accuracy < --- Reading fluency	.12 (.06) *	.022	.238
<i>Standardized total effects</i>			
Nonword reading accuracy < --- Reading fluency	-.35 (.11) *	-.522	-.156
Nonword reading fluency < --- Reading fluency	.12 (.22) *	.053	.705
RAN < --- Reading fluency	.54 (.14) **	.415	.715
Reading accuracy < --- Reading fluency	-.57 (.12) **	-.716	-.355

* $p < .05$, ** $p < .001$

Direct effects:

Nonword reading accuracy has a significant and positive association with word reading accuracy ($B = .28$, $SD = .02$, $p < .001$). The more correctly children read the nonwords, the more correctly they will read the words. Nonword reading fluency, on the other hand, does not significantly affect reading accuracy ($B = -.673$, $SD = 4.35$, $p = .12$), but it has a significant effect on reading fluency ($B = .04$, $SD = .02$, $p = .01$). RAN has a significant effect on word reading accuracy ($B = -.43$, $SD = .09$, $p < .001$), and with word reading fluency has a positive, significant association ($B = .004$, $SD = .001$, $p < .001$). Increased naming speed increases reading fluency. Finally, word reading accuracy is negatively and significantly associated with word reading fluency ($B = -.003$, $SD = .001$, $p < .001$), meaning that children who read more correctly will read even faster.

Indirect effect

A significant indirect effect on word reading fluency is observed from RAN, so the faster the child will call the numbers, the more fluent he will read ($B = .004$, $SD = .002$, $p = .048$) when controlling for reading accuracy. Nonword reading abilities – nonword reading accuracy ($B = -.001$, $SD = .001$, $p = .002$) also significantly influence reading fluency when controlling for reading accuracy. Nonword reading fluency also has a significant indirect effect when controlling for reading accuracy, over reading

fluency ($B = .02$, $SD = .04$, $p = .016$). Good decoding skills lead to correct and fast reading.

Total effects.

A total significant effect of RAN over word reading fluency was observed ($B = .005$, $SD = .001$, $p = .001$), indicating a partial mediating through word reading accuracy. Similarly, a total significant effect from nonword reading accuracy ($B = -.001$, $SD = .001$, $p = .002$), indicating a partial mediation through word reading accuracy. Finally, a total significant effect was found from nonword reading fluency over word reading fluency ($B = .05$, $SD = .22$, $p = .005$), indicating a partial mediation through word reading accuracy.

Discussions

The main goal of this research was to examine the predictive role of nonword reading abilities (nonword reading accuracy and fluency) and rapid naming (RAN) for literacy (word reading accuracy and fluency; in a Romanian grade one child. The path analysis carried out supports all the hypotheses formulated and the role of the mediator of the accuracy of the reading (word reading accuracy). The fit indicators support the proposed model, and most of the variance of the criterion variable is explained by the proposed predictors.

At first, we wanted to determine if RAN is a predictor for word reading accuracy and word reading fluency when controlling LK and PA in a regular orthography. Our results indicate RAN as a predictor of both aspects of reading, accuracy, and fluency, consistent with those of other studies (Lima et al., 2019; Norton & Wolf, 2012). RAN is a significant predictor especially for languages with high spelling regularity, as is the case with Romanian children (David et al., 2018; Fricke et al., 2016; Georgiou et al., 2008; Kirby et al., 2010; Moura et al., 2015; Norton & Wolf, 2012; Papadopoulos et al., 2016).

Next, we wanted to examine the association between nonword reading skills and word reading abilities. Nonword reading is the process used in learning to read words and nonwords (Ehri, 1995). Results show that the better the child's nonword reading skills are, the higher the reading accuracy is. These are consistent with the literature and demonstrate the significant role of nonword reading skills in reading learning, regardless of the specific conditions of the children (like age, Georgiou et al., 2008, language regularity, Seymour et al., 2003). The indirect effect of nonword reading accuracy on fluency via word reading accuracy is significant,

suggesting that both lexical and sublexical pathways are activated at word reading (Layes et al., 2015). It also shows us that in regular spellings, first-grade children, when reading, are already switching from nonword reading to spelling processing (Ehri, 1995; Schaars et al., 2017). Struggling readers have poor decoding abilities, especially when decoding multisyllabic words (Toste et al., 2017).

Our results agree with Heggie and Wade-Wooley (2017) and highlight the importance of improving decoding skills to increase reading fluency.

The predictive role of PA and RAN has been intensively studied, but to our knowledge, the process of fluency development has not been highlighted so clearly. Of course, we all intuit that increasing accuracy leads to improved fluency, but how exactly this happens has not been shown. We believe that this clarifies the process and can guide interventions for the development of fluency.

Conclusion

Although the literature has highlighted many aspects of the reading process, we do not have much information for Romanian literacy. Very little research has been carried out due to the lack of measuring instruments. Our study had the role in finding out which are the predictors of reading and how literacy for Romanian children takes place. The Romanian language is highly regular, but it still has its particularities (vowel bigram and trigrams, etc., Dragomirescu, 2012) which make it challenging to learn to read. Our results are consistent with the previous research in literacy foundation in regular orthographies (Araújo et al., 2010; Caravolas et al., 2012; Landerl & Wimmer, 2008; Landerl et al., 2019). We believe that the result is significant, which shows us that reading accuracy is a **mediator between RAN and fluency for 1-grade children**. Previous studies showed that phonological awareness and letter knowledge mediated the RAN–reading relationship (Papadopoulos et al., 2016; Poulsen et al., 2015) for preschool children's literacy. Also, RAN was a mediator between PA, WM, attention, orthographic processing, and word reading fluency (Papadopoulos et al., 2016).

We found out that the role of a mediator can be taken over by reading accuracy. The fact that accuracy is a mediator between predictors (nonword reading accuracy, nonword reading fluency, and RAN) and fluency is of practical importance, meaning that, if we want to improve fluency, we must intervene on reading accuracy and rapid naming (Kirby et al., 2010). Interventions to combat dyslexia will consider this aspect.

Limitations

We only had 206 participants from Suceava county. A larger sample nationwide would offer a more accurate image. The study is a cross/sectional one, so the results have theoretical value.

Ethical approval

This article does not include any tests performed on animals by any of the authors.

Following the Romanian research law, before testing, ethical approval was received from the Ethical Commission of the Faculty of Psychology and Educational Sciences of Iasi. We obtained written agreement from the Suceava County School Inspectorate and the school principals

We informed the children's parents regarding the purpose of the study, and we asked for their acceptance by signing the informed consent. Children had given their verbal consent before the test began. We informed them that they could withdraw, with no other consequences on their status.

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