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The role of word recognition, oral reading fluency and listening comprehension in the simple view of reading: a study in an intermediate depth orthography

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Abstract Empirical research has provided evidence for the simple view of reading across a variety of orthographies, but the role of oral reading fluency in the model is unclear. Moreover, the relative weight of listening comprehension, oral reading fluency and word recognition in reading comprehension seems to vary across orthographies and schooling years. This study aims to examine the direct effects of these three variables on reading comprehension and to test for the existence of indirect effects of word recognition and listening comprehension on reading comprehension via oral reading fluency in European Portuguese, an orthography of intermediate depth. A sample of 264 students was assessed at the end of grades 2 and 4. Structural equation modeling analyses indicated that listening comprehension, word recognition and oral reading fluency predicted reading comprehension in both grade 2 and grade 4. Moreover, the three variables measured in grade 2 predicted later reading comprehension in grade 4. Listening comprehension was always the strongest predictor. Oral reading fluency mediated the relationship between word recognition and reading comprehension, but it was not a mediator variable in the relationship between listening comprehension and reading comprehension. These findings indicate that, similarly to what has been found for other orthographies, the simple view of reading is a valid framework to account for reading comprehension variability in European Portuguese and that interventions to increase reading comprehension levels should focus on word recognition, fluency, and, especially, listening comprehension.

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Introduction

Reading comprehension is a complex ability that involves integrating information, making inferences and constructing meaning through contact and involvement with written language (Cain & Oakhill, 2006; RAND Reading Study Group, 2002). The simple view of reading (SVR; Hoover & Gough, 1990) is one of the most influential frameworks of reading comprehension. According to this framework, reading comprehension depends on two skill components: word recognition and listening comprehension. Word recognition can be broadly defined as the ability to read isolated words (Adlof, Catts, & Little, 2006). Although this ability involves reading words fast and accurately, most of the research has focused mainly on the accuracy dimension (Florit & Cain, 2011), and the term word recognition has generally been associated with tasks in which the number of words read correctly is measured. Some authors use a different term—word reading fluency—when assessing not only the accuracy, but also the speed of reading isolated words (e.g., Kim & Wagner, 2015). Listening comprehension refers to an active process in which individuals concentrate on spoken language, construct meaning from passages, and associate what they hear with their previous knowledge (Gilakjani & Ahmadi, 2011).

The SVR model has received extensive support from the research. The contribution of word recognition and listening comprehension to reading comprehension has been shown in studies across a wide range of education levels, e.g., grades one through nine (Catts, Hogan, & Adlof, 2005; Joshi & Aaron, 2000; Tilstra, McMaster, Van den Broek, Kendeou, & Rapp, 2009; Verhoeven & van Leeuwe, 2008). Although the majority of the research in this field has been conducted with English readers, similar results have also been obtained for other languages, such as Spanish and Chinese (Joshi, Tao, Aaron, & Quiroz, 2012). Moreover, results from longitudinal studies indicate that, at least during primary school years, word recognition and listening comprehension seem to be able to predict reading comprehension at least up to 2 years later (Adlof et al., 2006; Kendeou, van den Broek, White, & Lynch, 2009).

Although the SVR is a useful framework to understand the determinants of reading comprehension, some discussion has arisen regarding whether a third component—oral reading fluency (ORF)—should be added to the SVR framework to better understand the complexity of reading comprehension because strong correlations between ORF and reading comprehension have been observed (Berninger, Abbott, Vermeulen, & Fulton, 2006; Jenkins, Fuchs, Broek, Espin, & Deno, 2003). ORF is the ability to read a text aloud quickly and accurately with the appropriate expression (National Institute of Child Health & Human Development, 2000) and is usually measured by computing the number of words read correctly per minute when reading connected text (Valencia et al., 2010).

The results of the studies conducted with English readers on the question of whether ORF should be added to the SVR, in the sense that reading speed explains variance above and beyond the two original components of the SVR, seem to be mixed: Some studies have found a significant effect of reading speed on reading

comprehension (e.g., Cutting & Scarborough, 2006), but others have not (e.g., Adlof et al., 2006). Studies conducted with readers of more transparent orthographies seem to be more consistent, providing some evidence of a unique contribution of ORF to reading comprehension. For example, Padeliadu and Antoniou (2014) analyzed the relationship among word recognition, reading comprehension and ORF in Greek, a highly transparent orthography. In grades 1–4, the correlations between fluency and reading comprehension were of medium size (ranging between .36 and .47), and ORF was a unique predictor of reading comprehension in grades 2–4. Significant correlations between ORF and reading comprehension were also found in a cross-sectional study (Ribeiro, Cadime, Freitas, & Viana, 2016) conducted with Portuguese children attending grades 2 ($r = .67$) and 4 ($r = .26$). Additionally, fluency was a unique predictor of reading comprehension in grade 2, even after accounting for the effect of other linguistic (e.g., vocabulary) and demographic variables (e.g., gender).

The mediating effect of oral reading fluency

ORF has frequently been viewed as a point of connection between word recognition and reading comprehension, in the sense that it builds on efficient decoding skills (Pikulski & Chard, 2005). Therefore, some studies have investigated the possible mediation effects of ORF on the relationship between the two variables. Kim (2011) examined the influence of word recognition and ORF in reading comprehension using a sample of 79 five-year-old Korean children who had received reading instruction at least for a year. Two models were tested. In the first model, ORF was hypothesized to fully mediate the relationship between word recognition and reading comprehension, i.e., word recognition was only indirectly related to reading comprehension via ORF. In the second model, ORF was hypothesized to partially mediate the relationship between word recognition and reading comprehension, i.e., word recognition had both direct and indirect effects on reading comprehension via ORF. The results indicated that ORF was not uniquely related to reading comprehension, whereas word recognition had a significant direct influence on reading comprehension. This finding suggests that very beginning readers depend considerably on word reading accuracy and that ORF can only later have a mediation effect on the relationship between word recognition and reading comprehension, even for a transparent orthography such as Korean. This claim seems to be supported by the results of studies with older students, such as the one by Silverman, Speece, Harring, and Ritchey (2013), in which the relationship between the components of the SVR, including ORF, was studied using a sample of English-speaking fourth grade students. They found that ORF fully mediated the relationship between word recognition and reading comprehension, and the addition of fluency to the model rendered non-significant the direct effect of word recognition on reading comprehension.

The previous studies have, therefore, provided some empirical evidence for a mediating role of ORF in the relationship between word recognition and reading comprehension. However, when considering the reading of connected text, some processes of meaning construction take place during the reading activity, which explains why reading words in context is faster than in a list format (Jenkins et al.,

2003). For this reason, Kim and Wagner (2015) asserted that it is possible that ORF captures to some extent some of the abilities involved not only in word recognition but also in oral language comprehension skills. Therefore, these authors tested the hypothesis that oral text reading fluency mediates the relationships not only between word reading fluency and reading comprehension but also between listening and reading comprehension. They also based this premise on the results of previous research (Kim, Wagner, & Foster, 2011; Kim, Wagner, & Lopez, 2012) that showed that listening comprehension was a significant predictor of ORF, opening the way for a possible mediation effect of ORF on the relationship between listening and reading comprehension. To test this hypothesis, Kim and Wagner (2015) used a sample composed of 316 English-speakers that were assessed longitudinally from grades 1–4, using measures of word reading fluency (number of isolated words read correctly in 45 s), text reading fluency (number of words from a text read correctly in 1 min), listening and reading comprehension. Text reading fluency was a moderate direct predictor of reading comprehension in grades 2–4 and completely mediated the relationship between word reading fluency and reading comprehension, but the mediation effect was only partial for listening comprehension, suggesting that not all linguistic skills captured by listening comprehension are also involved in ORF and in reading comprehension (Kim & Wagner, 2015). This mediation effect had not been observed, for example, in the study by Silverman et al. (2013), in which listening comprehension was not a significant predictor of ORF.

In summary, some studies have collected evidence of an indirect effect of word recognition on reading comprehension via ORF, but this mediation effect seems not to occur in the initial phases of reading development. The studies that have tested the existence of an indirect effect of listening comprehension on reading comprehension via ORF have obtained mixed results, observing only a partial mediating effect (Kim & Wagner, 2015) or being unable even to verify the predictive power of listening comprehension on ORF (Silverman et al., 2013), which is one of the premises for the existence of mediation. Furthermore, most of these studies have been conducted with readers of a deep orthography, and it is possible that their results cannot be generalizable to more transparent ones.

Orthographic depth, developmental effects and the simple view of reading

The relative weight of each component of the SVR in reading comprehension, whether including a fluency component or not, seems to depend on the years of schooling of the children but also seems to vary across orthographies. According to the SVR, word recognition should have a stronger effect on reading comprehension than listening comprehension in beginner readers because the students are still trying to master accuracy in word reading (Gough, Hoover, & Peterson, 1996). However, the opposite should be found for readers with more years of instruction, with a reading comprehension level depending more on their linguistic abilities (Gough et al., 1996). This pattern has indeed been observed in studies conducted with English speakers (Adlof et al., 2006; Catts et al., 2005; Francis, Fletcher, Catts, & Tomblin, 2005) but does not seem to be generalizable to orthographies with more

regular and consistent grapheme-phoneme correspondences. A meta-analysis conducted by Florit and Cain (2011) analyzed 33 studies performed with readers from one deep orthography (English) or from one of eight other more transparent orthographies (Dutch, Finnish, French, German, Greek, Italian, Norwegian and Spanish) and who had 1–2 or 3–5 years of schooling. They included studies that used three types of measures for word recognition: pseudo-word reading accuracy, word reading accuracy and word reading fluency. Their results confirmed the SVR prediction for the English orthography: In the early years of schooling (1–2 years), pseudo-word and word reading accuracy were more important than listening comprehension for reading comprehension; for the children with 3–5 years of reading instruction, listening comprehension made a stronger contribution but only when compared to pseudo-word reading. In this second group, word reading accuracy and word reading fluency had a stronger effect on reading comprehension than listening comprehension. However, different results were observed for the transparent orthographies: Listening comprehension had a stronger role in reading comprehension than word reading accuracy, regardless of the years of instruction. Nonetheless, for children with 1–2 years of instruction, word reading fluency made an even stronger contribution to reading comprehension than listening comprehension (Florit & Cain, 2011).

A more recent study (Tobia & Bonifacci, 2015), conducted with 1895 students from grades 1 to 5, explored the relationships among the components of the SVR framework—reading accuracy, speed, listening and reading comprehension—in Italian, a transparent orthography. They used measures of word reading, pseudo-word reading, text reading fluency, listening comprehension of a narrative text and reading comprehension of descriptive and narrative texts. The reading speed latent variable was obtained considering the speed (syllables per second) of reading words, pseudo-words and texts. The accuracy latent variable was measured considering the errors for the same tasks. The results indicated that listening comprehension was the strongest predictor of reading comprehension (standardized coefficients ranging between .60 and .72). Reading accuracy was a significant predictor of reading comprehension but had a lower effect than listening comprehension in all grades, with the exception of grade 2, in which the two variables had similar standardized coefficients (.60 vs. .58). Reading speed was highly correlated with accuracy (ranging between .63 and .69) but was not a significant reading comprehension predictor in any grade. The models for each grade accounted for 77–82 % of the variance in reading comprehension (Tobia & Bonifacci, 2015).

In sum, the relative contributions of word recognition, fluency and listening comprehension to reading comprehension seem to be influenced not only by the phase of reading development but also by the deepness of the orthographies in particular. In general, word recognition seems to be the main determinant of reading comprehension in deep orthographies, particularly in the early phase of reading development, but listening comprehension seems to be a stronger predictor of reading comprehension in more transparent orthographies across a wide range of phases of reading development.

The present study

Most of the studies that have tested the effects of word recognition, ORF and listening comprehension on reading comprehension have used cross-sectional designs, and therefore, the results obtained can be affected to some degree by cohort effects. Additionally, to our knowledge, the relationships among these three variables and reading comprehension have not been studied in European Portuguese, an orthography of intermediate depth (Seymour, Aro, & Erskine, 2003; Sucena, Castro, & Seymour, 2009).

Using a longitudinal design, the present study aims to examine the direct effects of listening comprehension, word recognition and ORF on reading comprehension and the indirect effects of word recognition and listening comprehension on reading comprehension via ORF in European Portuguese. Specifically, this study aims to explore the following research questions: (a) Are word recognition, ORF and listening comprehension equal predictors of reading comprehension, in both the early (grade 2) and more advanced years (grade 4) of reading instruction? (b) Are word recognition, ORF and listening comprehension measured in the initial levels of schooling predictors of later reading comprehension levels? (c) Is ORF a mediating variable in the relationships between word recognition and reading comprehension and between listening comprehension and reading comprehension?

We expect our results to have some similarities with the ones obtained for orthographies more transparent than English (Florit & Cain, 2011; Tobia & Bonifacci, 2015). Therefore, the first hypothesis of this study is that word recognition, ORF and listening comprehension are all direct predictors of reading comprehension, but listening comprehension is the strongest predictor not only for beginner readers (grade 2) but also for readers with more years of reading instruction (grade 4). The second hypothesis is that word recognition, ORF and listening comprehension in grade 2 predict reading comprehension in grade 4. The third hypothesis is that ORF is not only a direct predictor but also a mediator of the effect of word recognition and listening comprehension on reading comprehension in both grades. Each hypothesis was tested in a separated model by means of structural equation modeling.

Method

Participants

The initial sample was composed of 325 students who were assessed when they attended grade 2 and again when they attended grade 4. Thirty-five students were not in the same classes or schools in grade 4 and therefore were not assessed at the second time point; thus, they were excluded from the study. Twenty-six students did not complete at least three out of the four measures used in this study in, at least, one of the grades and were also excluded from the sample. Therefore, the final sample was comprised of 264 students assessed at the two time points. The mean age was 7.38 years (SD = 0.494, range 7–9) when the children were in grade 2 and

9.46 years (SD = 0.507, range 9–11) when they were in grade 4. The students attended public (n = 228, 86.4 %) and private schools (n = 36, 13.6 %) in northern Portugal. More than half of the students were boys (n = 136, 51.5 %). A convenience sampling method was used, given that participants were recruited in schools that had a collaboration protocol with the university with which the researchers were affiliated. However, the proportions of students from public schools and from both genders were representative of the distribution of the students in the population; according to data from the National Council for Education and the National Office of Education and Science Statistics for the academic year 2012/2013, 88.3 % of children from first to fourth grade attended public schools, and 51.5 % of these children were boys. Regarding socio-economic status, because of the low income of their families, approximately 37 % of the sample qualified for reduced-price meals at school, for access to a loan service for books and for support for the acquisition of school supplies. Moreover, of the students' mothers, 21.2 % had completed a university degree, 19.3 % had completed high school, and 58.8 % had a lower educational degree (no information was collected for 0.7 % of the mothers). Students with severe special educational needs who qualified for special education were not included in the sample, but children with mild emotional, behavioral or language problems who did not qualify for special education were included in the sample. All students were native speakers of European Portuguese.

Instruments

Test of word reading [*TLP—Teste de Leitura de Palavras*] (Chaves-Sousa et al., 2015). This test assesses the reading of single words. The TLP includes four vertically scaled forms for students attending grades one to four. In this study, the test forms for the second (TLP-2) and fourth grades (TLP-4) were administered. Each test form includes 30 items (real words) that are presented in isolation through a computer application. The student is asked to read each word aloud, without time limits. The responses are scored as 0 (incorrect) and 1 (correct). The raw score for each test form is computed by adding up the number of words correctly read and is then converted to a standardized score that places scores from the different test forms in a same metric ($M_{Grade2} = 109$, $SD_{Grade2} = 10$; $M_{Grade4} = 126$, $SD_{Grade4} = 10$). The reliability coefficients (PSR—Person Separation Reliability, KR20—Kuder–Richardson 20 and ISR—Item Separation Reliability) ranged between .88 and .99 for TLP-2 and between .74 and .97 for TLP-4. Regarding validity evidence, the scores of TLP-2 and TLP-4 were significantly correlated with the results in other tests of word recognition, tests of reading comprehension, working memory, vocabulary, ORF and teachers' assessment of reading skills (Chaves-Sousa et al., 2015).

Reading Fluency Assessment Test (Carvalho, 2010). This test assesses ORF in students in grades 2–6 and is composed of a single text that the child must read aloud. The text is composed of 281 words, and it is an adapted version of the tale "The Emperor's New Clothes" by Hans Christian Andersen. The administration of the test is individual and has a time limit of 3 min. The mean number of correct words read per minute is computed. Regarding reliability evidence, the test–retest

correlation coefficient was .94. Regarding validity evidence, statistically significant correlation coefficients were reported between the results in this test and teachers' assessment of ORF.

Test of Listening Comprehension of Narrative Texts [*TCTMO-n—Teste de Compreensão de Textos na Modalidade Oral—Narrativo*] and Test of Listening Comprehension of Informative Texts [*TCTMO-i—Teste de Compreensão de Textos na Modalidade Oral-Informativo*] (Santos et al., 2015; Viana et al., 2015). The tests assess listening comprehension of narrative (TCTMO-n) and informative texts (TCTMO-i), and each test is composed of four vertically scaled forms for students in grades one to four. In this study, the test forms for students in grades two (TCTMO-n-2 and TCTMO-i-2) and four (TCTMO-n-4 and TCTMO-i-4) were administered. Each test form is composed of four texts and 30 items. Texts are presented in short passages whose excerpts range from 40 to 195 words and the correspondent items are presented after each passage. TCTMO-n and TCTMO-i are presented in a digital format. The student listens to the text passages and to the multiple-choice questions (three options) that are presented orally and marks the chosen option on the computer screen. The responses are scored as 0 (incorrect) and 1 (correct). The raw score for each test form is computed by adding up the number of correct responses and is then converted to a standardized score that places the scores obtained in the different test forms in a same metric scale (TCTMO-n: $M_{Grade2} = 106$, $SD_{Grade2} = 10$, $M_{Grade4} = 122$, $SD_{Grade4} = 10$; TCTMO-i: $M_{Grade2} = 107$, $SD_{Grade2} = 10$, $M_{Grade4} = 117$, $SD_{Grade4} = 10$). The reliability coefficients ranged between .73 and .96 for TCTMO-n-2 and between .70 and .98 for TCTMO-n-4; for TCTMO-i-2, the coefficients ranged from .74 to .95; for TCTMO-i-4, they ranged from .72 to .94. Statistically significant correlation coefficients were obtained with the results in other tests of listening comprehension and tests of reading comprehension.

Test of Reading Comprehension of Narrative Texts [*TCTML-n—Teste de Compreensão de Textos na Modalidade de Leitura-Narrativo*] and Test of Reading Comprehension of Informative Texts [*TCTML-i—Teste de Compreensão de Textos na Modalidade de Leitura-Informativo*] (Santos et al., 2016). These tests assess students' reading comprehension of narrative (TCTML-n) and informative texts (TCTML-i), and each includes three vertically scaled forms for students in grades two to four. The test forms for the second (TCTML-n-2 and TCTML-i-2) and fourth grades (TCTML-n-4 and TCTML-i-4) were used in this study. The tests are presented in a pencil-and-paper format. The student reads silently the text passages that are followed by multiple-choice questions (three options) and marks the chosen option on the answer sheet. Each test form of the TCTML-n is composed of 27 items, and each test form of the TCTML-i includes 33 items. The responses are scored as 0 (incorrect) and 1 (correct), and the total raw score obtained in each test form can be converted to a standardized score (TCTML-n: $M_{Grade2} = 100$, $SD_{Grade2} = 10$; $M_{Grade4} = 108$, $SD_{Grade4} = 10$; TCTML-i: $M_{Grade2} = 100$, $SD_{Grade2} = 10$; $M_{Grade4} = 108$, $SD_{Grade4} = 10$) that is placed in a common scale for TCTML-n or TCTML-i test forms, thus allowing the direct comparison of the scores. The reliability coefficients ranged between .70 and .96 for TCTML-n-2 and between .72 and .94 for TCTML-n-4; in the TCTML-i-2, these coefficients ranged

from .72 to .95; and in the TCTML-i-4, they ranged from .78 to .95. Regarding validity evidence, significant correlations between the scores on these test forms and the results on other tests of reading comprehension, word recognition, working memory, vocabulary, ORF and teachers' assessment of reading skills were obtained.

Procedure

Data collection was performed in the last 2 months of the academic year (May–June) in both grades. Legal authorizations for data collection were solicited from the Portuguese Ministry of Education and the respective school boards. The anonymity and confidentiality of the data were assured. Each parent or legal tutor was informed about the study aims and signed an informed consent to allow the participation of the students in this study. The administration of the tests was performed by trained psychologists who followed the instructions presented in the tests' technical manuals. TCTMO-n, TCTMO-i, TCTML-n and TCTML-i were administered collectively in the students' classroom, and the remaining tests were administered individually. In each classroom group, the assessment was performed on two consecutive days. In the morning on the first day, children completed TCTML-n and TCTMO-i; in the morning on the second day, children completed TCTML-i and TCTMO-n. Completion of each of these tests lasted approximately 1 h and a half. In the afternoon, children completed individually the TLP, followed by the Reading Fluency Assessment Test. The administration of the two individual tests lasted approximately 10–15 min per student.

Data analysis

Descriptive statistics (frequencies, mean scores and standard deviations) were calculated. Pearson correlations (r) were computed to analyze the relationships among all measured variables. The correlations' magnitude was evaluated using the criteria proposed by Cohen (1992): .10 indicates a small effect, .30 a medium effect, and .50 a large effect.

Structural equation modeling (SEM), as implemented by Mplus (Version 7; Muthén & Muthén, 2012), was used to test three models. In model 1, the direct effects of word recognition, ORF and listening comprehension on reading comprehension measured at each grade level were tested. In model 2, word recognition, ORF and listening comprehension measured in grade 2 were tested as direct predictors of reading comprehension in grade 4. In model 3, the indirect effects of word recognition and listening comprehension on reading comprehension via ORF, all measured in the same grade level, were added to model 1. Latent variables were created for reading comprehension and listening comprehension in each grade level, given that two measures were used to assess each one. Word recognition and ORF scores were treated as observed variables, given that only one measure was used to represent each construct.

The maximum likelihood estimator (ML) was used in the computation for the analyses. The full information maximum likelihood (FIML) method was used to address missing cases, given that the pattern of missingness was completely

random, as indicated by Little's MCAR test, $\chi^2(82) = 67.304$, $p = .879$. FIML uses the maximum information available for the computation of the analyses without imputing values or excluding cases (Peeters, Zondervan-Zwijnenburg, Vink, & van de Schoot, 2015). However, even when using FIML, in Mplus, cases with missing values in any observed variable are automatically dropped from the analysis. In this study, three subjects had missing values for two observed predictors (word recognition and ORF in grade 2) because they did not complete the tests. Therefore, only 261 cases were considered in the SEM analysis.

To assess the model fit, the Chi square (χ^2) value, the ratio between the Chi square and the degrees of freedom (χ^2/df), the Akaike information criterion (AIC), the Bayesian information criterion (BIC), the comparative fit index (CFI), the Tucker-Lewis Index (TLI) and the root mean square error of approximation (RMSEA) were considered. Values less than 3.00 for the χ^2/df ratio are generally considered indicators of an acceptable fit, and values less than 2.00 indicate a good model fit (Bollen, 1989). Model fit is also considered acceptable when CFI and TLI values are higher than .90 (Hoyle & Panter, 1995) and the RMSEA value is lower than .08 (Browne & Cudeck, 1993). The significance level was 5 % for all analyses.

Results

Table 1 provides the descriptive statistics (number of valid cases, means and standard deviations) for the scores of each measured variable and the correlations among all variables.

All correlation coefficients were statistically significant. Medium-sized correlation coefficients were found between reading comprehension and all other variables not only in grade 2 but also in grade 4. In general, the correlation coefficients between reading comprehension and the other three variables seemed to be very similar in the two grades. ORF had large correlations with word recognition and low correlations with listening comprehension in both grades.

Model 1 presented a good fit, $\chi^2(44) = 95.53$, $p < .001$; $\chi^2/df = 2.17$; CFI = .95; TLI = .94; RMSEA = .07 (90 % CI [.05–.09]); AIC = 14,562.71; BIC = 14,676.78. The model explained 79.7 % of the variance in reading comprehension measured in grade 2 and 88.2 % of the variance in grade 4. Table 2 presents the unstandardized and standardized coefficients, and Fig. 1 depicts the standardized regression paths for model 1. Word recognition, ORF and listening comprehension significantly predicted reading comprehension measured at the same grade level. Listening comprehension was the strongest direct predictor of reading comprehension both in grade 2 and grade 4. ORF and particularly word recognition made a smaller contribution to reading comprehension in both grades.

Regarding model 2, the fit indices were as follows: $\chi^2(7) = 26.20$, $p < .001$; $\chi^2/df = 3.74$; CFI = .96; TLI = .91; RMSEA = .10 (90 % CI [.06–.14]); AIC = 7494.84; BIC = 7548.31. CFI and TLI values were inside the cutoff values, but the χ^2/df and the RMSEA values slightly exceeded the reference values. We retained the model given that some authors suggest a less strict criterion for χ^2/df, indicating as acceptable values lower than 5 (Westland, 2015), and values for RMSEA between .08 and .10 have been considered indicators of a mediocre fit

Table 1 Descriptive statistics and correlations between the scores in word recognition, listening comprehension, fluency and reading comprehension measures in grades 2 and 4

Measure	*N*	M	SD	RFAT-2	TCTMO-n-2	TCTMO-i-2	TCTML-n-2	TCTML-i-2	TLP-4	RFAT-4	TCTMO-n-4	TCTMO-i-4	TCTML-n-4	TCTML-i-4
TLP-2	261	112.08	7.04	.630***	.241***	.227***	.456***	.419***	.638***	.579***	.209**	.202**	.467***	.496***
RFAT-2	261	64.95	23.57	–	.164**	.148*	.450***	.450***	.581***	.830***	.198**	.165**	.460***	.551***
TCTMO-n-2	254	108.93	9.82		–	.504***	.462***	.484***	.237***	.193**	.473***	.464***	.377***	.451***
TCTMO-i-2	256	111.88	10.84			–	.460***	.499***	.119	.187**	.409***	.464***	.452***	.420***
TCTML-n-2	258	100.83	10.07				–	.651***	.438***	.448***	.424***	.401***	.558***	.597***
TCTML-i-2	259	99.81	10.07					–	.339***	.432***	.419***	.448***	.524***	.563***
TLP-4	264	124.17	7.93						–	.555***	.318***	.246***	.471***	.449***
RFAT-4	264	112.54	26.53							–	.150*	.148*	.500***	.543***
TCTMO-n-4	264	123.48	9.02								–	.587***	.481***	.522***
TCTMO-i-4	263	119.47	10.77									–	.484***	.491***
TCTML-n-4	263	111.63	11.36										–	.656***
TCTML-i-4	264	112.40	13.44											–

The number at the end of the name of the test corresponds to the version for grade 2 or grade 4. The number of valid cases (N) varies across measures due to the existence of missing values, i.e., children who did not complete all tests. Word recognition, listening comprehension and reading comprehension scores are standardized (see measures' descriptions)

TLP Test of Word Reading, *RFAT* Reading Fluency Assessment Test, *TCTMO-n* Test of Listening Comprehension of Narrative Texts, *TCTMO-i* Test of Listening Comprehension of Informative Texts, *TCTML-n* Test of Reading Comprehension of Narrative Texts, *TCTML-i* Test of Reading Comprehension of Informative Texts

*** $p < .001$; ** $p < .01$; * $p < .05$

Table 2 Direct effects of word recognition, oral reading fluency and listening comprehension on reading comprehension (models 1 and 2)

Paths	Unstandardized			Standardized estimate
	Estimate	SE	*p*	
Model 1				
$WR_{G2} \rightarrow RC_{G2}$	0.156	0.071	.028	.146
$ORF_{G2} \rightarrow RC_{G2}$	0.114	0.021	<.001	.358
$LC_{G2} \rightarrow RC_{G2}$	0.754	0.085	<.001	.763
$WR_{G4} \rightarrow RC_{G4}$	0.139	0.059	.018	.135
$ORF_{G4} \rightarrow RC_{G4}$	0.151	0.018	<.001	.489
$LC_{G4} \rightarrow RC_{G4}$	0.887	0.091	<.001	.742
Model 2				
$WR_{G2} \rightarrow RC_{G4}$	0.252	0.080	.002	.215
$ORF_{G2} \rightarrow RC_{G4}$	0.156	0.024	<.001	.447
$LC_{G2} \rightarrow RC_{G4}$	0.654	0.099	<.001	.616

LC and RC are latent variables; ORF and WR are observed variables

WR word recognition, *ORF* oral reading fluency, *LC* listening comprehension, *RC* reading comprehension, *G2* grade 2, *G4* grade 4

(Browne & Cudeck, 1993) but only values higher than .10 have been deemed unacceptable (Maccallum, Widaman, Preacher, & Hong, 2001). The three predictors measured in grade 2 explained 74.6 % of the variance in reading comprehension in grade 4. All three were significant predictors, but listening comprehension made the strongest contribution to reading comprehension measured 2 years later (see Table 2; Fig. 2).

Model 3 had a poor fit, $\chi^2(45) = 336.18$, $p < .001$; $\chi^2/df = 7.47$; CFI = .81; TLI = .73; RMSEA = .16 (90 % CI [.14–.17]); AIC = 19,192.87; BIC = 19,335.45. The inspection of the modification indices indicated that adding a regression path from ORF measured in grade 2 to ORF measured in grade 4 would lead to an improvement in the model fit. Given that, theoretically, ORF measured in grade 2 should predict ORF in grade 4, we respecified the model by including this regression path. This revised version of model 3 fit the data well—$\chi^2(44) = 120.69$, $p < .001$; $\chi^2/df = 2.74$; CFI = .95; TLI = .93; RMSEA = .08 (90 % CI [.06–.10]); AIC = 18,979.39; BIC = 19,125.53—and accounted for a high proportion of the variance in reading comprehension (80.0 and 88.0 % for grade 2 and grade 4, respectively) and a moderate proportion of the variance in ORF (39.0 and 68.6 % for grade 2 and grade 4, respectively). Table 3 presents the unstandardized and standardized coefficients, and Fig. 3 depicts the standardized regression paths for the revised model 3. Again, all three predictors had significant direct effects on reading comprehension.

No significant direct effect of listening comprehension on ORF was observed in grade 2 or in grade 4. In the same way, no indirect effect of listening comprehension on reading comprehension via ORF was observed (see Table 3). In contrast, word recognition had not only significant direct effects on ORF but also significant indirect effects on reading comprehension via ORF in both grades.

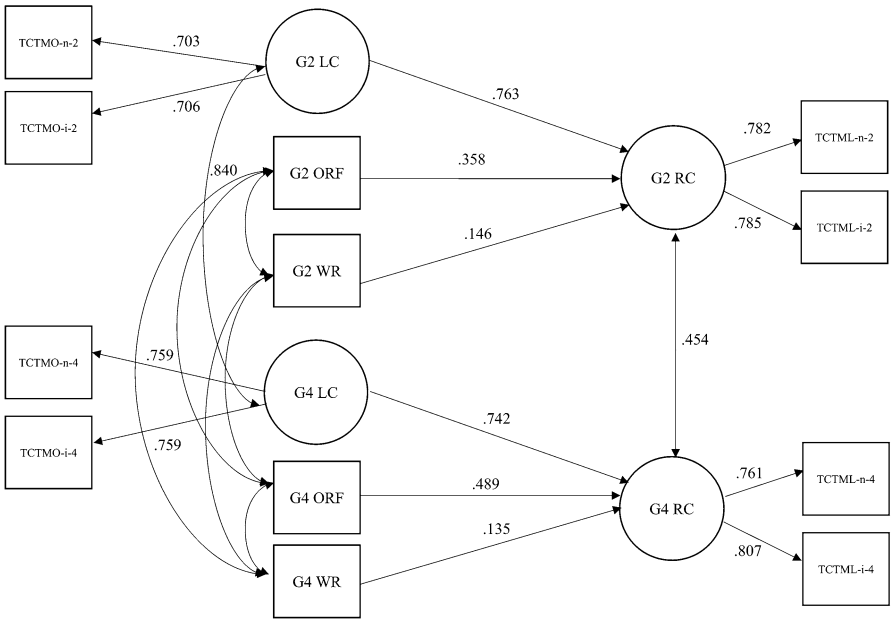

Fig. 1 Model 1: word recognition (WR), listening comprehension (LC) and oral reading fluency (ORF) tested as direct predictors of reading comprehension (RC) in grade 2 (G2) and grade 4 (G4) (n = 261). *Note* Standardized coefficients are depicted. All paths were statistically significant

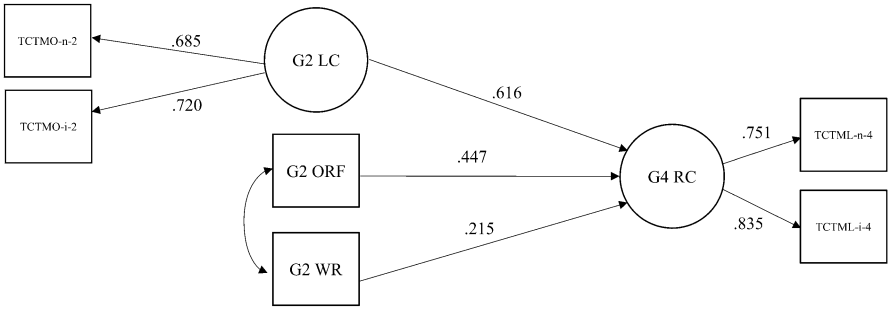

Fig. 2 Model 2: word recognition (WR), listening comprehension (LC) and oral reading fluency (ORF) measured in grade 2 (G2) predicting reading comprehension (RC) in grade 4 (G4) (n = 261). *Note* Standardized coefficients are depicted. All paths were statistically significant

Discussion

This study aimed to investigate whether the components of the SVR, i.e., word recognition and listening comprehension, as well as an ORF dimension were direct predictors of reading comprehension in both the early (grade 2) and more advanced phases (grade 4) of reading development and whether the strength of the relationship between the variables suffered developmental effects. Furthermore, a

Table 3 Direct and indirect effects of word recognition, oral reading fluency and listening comprehension on reading comprehension (model 3)

Paths	Unstandardized			Standardized estimate
	Estimate	SE	*p*	
$WR_{G2} \rightarrow RC_{G2}$	0.163	0.072	.023	.152
$ORF_{G2} \rightarrow RC_{G2}$	0.111	0.022	<.001	.342
$LC_{G2} \rightarrow RC_{G2}$	0.755	0.085	<.001	.758
$WR_{G2} \rightarrow ORF_{G2}$	2.073	0.169	<.001	.624
$LC_{G2} \rightarrow ORF_{G2}$	0.124	0.180	.492	.040
$WR_{G2} \rightarrow ORF_{G2} \rightarrow RC_{G2}$	0.229	0.050	<.001	.213
$LC_{G2} \rightarrow ORF_{G2} \rightarrow RC_{G2}$	0.014	0.019	.481	.014
$WR_{G4} \rightarrow RC_{G4}$	0.138	0.059	.019	.135
$ORF_{G4} \rightarrow RC_{G4}$	0.150	0.018	<.001	.484
$LC_{G4} \rightarrow RC_{G4}$	0.886	0.091	<.001	.749
$WR_{G4} \rightarrow ORF_{G4}$	0.373	0.144	.009	.114
$LC_{G4} \rightarrow ORF_{G4}$	−0.039	0.156	.803	−.010
$WR_{G4} \rightarrow ORF_{G4} \rightarrow RC_{G4}$	0.056	0.023	.014	.055
$LC_{G4} \rightarrow ORF_{G4} \rightarrow RC_{G4}$	−0.006	0.024	.804	−.005
$ORF_{G2} \rightarrow ORF_{G4}$	0.869	0.047	<.001	.777

LC and RC are latent variables; ORF and WR are observed variables

WR word recognition, *ORF* oral reading fluency, *LC* listening comprehension, *RC* reading comprehension, *G2* grade 2, *G4* grade 4

second goal was to investigate whether word recognition, ORF and listening comprehension measured in the initial levels of schooling predicted reading comprehension performance 2 years later. Finally, a third goal was to test whether ORF was also a mediator of the relationship between the components of the original SVR model. Although these questions have been previously studied in a variety of orthographies, this is the first study that investigates them in European Portuguese, an intermediate depth orthography.

Building on the first research question, our first hypothesis stated that word recognition, ORF and listening comprehension are all direct predictors of reading comprehension, but listening comprehension is the strongest predictor in both phases of reading development. This hypothesis was fully verified. Our results indicate that word recognition and listening comprehension are significant direct predictors of reading comprehension, similarly to what has been demonstrated in other studies in a variety of orthographies (Cain, Catts, Hogan, & Lomax, 2015; Catts et al., 2005; Joshi et al., 2012). Moreover, no developmental effects on the relationships between each of the three predictors and reading comprehension were found, given that all three predictors contributed similarly to reading comprehension in both grades. Regarding word recognition, our results indicate that in European Portuguese, after 4 years of instruction, word recognition still has an effect on reading comprehension. Moreover, its contribution to reading comprehension does not decrease, but it is low across both phases of primary school.

The results of this study also demonstrated that listening comprehension made the strongest contribution to reading comprehension in both grades, when all variables were measured at the same grade level. Although this result is not completely in line with the original prediction of the SVR, which stated that word recognition should have the greatest effect on beginner readers (Gough et al., 1996), it is congruent with the results of previous studies conducted with readers of transparent orthographies that suggested that linguistic abilities, as measured in listening comprehension, are the most determinant factor of successful reading comprehension, even for beginner readers (Florit & Cain, 2011; Tobia & Bonifacci, 2015). Note, however, that our study used a measure of word reading accuracy and not of word reading fluency. Future studies should assess whether adding a measure of word reading fluency to the models lead to different results, given that evidence collected in the previously described meta-analysis showed that this variable is a stronger predictor than listening comprehension in transparent orthographies (Florit & Cain, 2011).

The results of this study also suggest that ORF is correlated with and has an important effect on reading comprehension in both grade levels. The correlation coefficients between reading comprehension and ORF obtained in our study are very similar to the ones obtained for readers of transparent orthographies at equivalent grade levels (e.g., Padeliadu & Antoniou, 2014). Our results also indicate that ORF has a significant effect on reading comprehension in both grades, providing additional support for the hypothesis that a fluency component should be added to the SVR, as previously suggested in studies in orthographies with more (Cutting & Scarborough, 2006) or less orthographic deepness (Padeliadu & Antoniou, 2014) than European Portuguese. We found one recent study in a transparent orthography (Tobia & Bonifacci, 2015) that did not find a unique effect of fluency on reading comprehension. However, the differences in the findings can be related to the differences in the measures used to assess reading fluency, i.e., a combination of the speed of reading isolated words, pseudo-words and words in text, as used in Tobia and Bonifacci's (2015) study, *versus* only text reading speed, as used in our study.

The second hypothesis of this study was that word recognition, ORF and listening comprehension in an initial level of reading development (grade 2) predict later reading comprehension (grade 4). This hypothesis was also verified given that all three variables measured in grade 2 significantly predicted reading comprehension 2 years later. A similar finding was previously obtained for readers of the English orthography (Adlof et al., 2006), and our results reinforce the predictive power of the three variables in a different orthography. Once again, listening comprehension was the strongest predictor. The procedure that was used in this study for listening comprehension measurement is highly similar to the ones used in other studies that investigated the relationship among the variables involved in the SVR (e.g., Adlof et al., 2006; Kim, Park, & Wagner, 2014; Tobia & Bonifacci, 2015; Verhoeven & van Leeuwe, 2008): narrative and/or informative text passages that students listened to, followed by questions. However, in our study, the listening comprehension tests have a format that is similar to the one of the reading comprehension tests (narrative and informative texts followed by multiple-choice questions with three options),

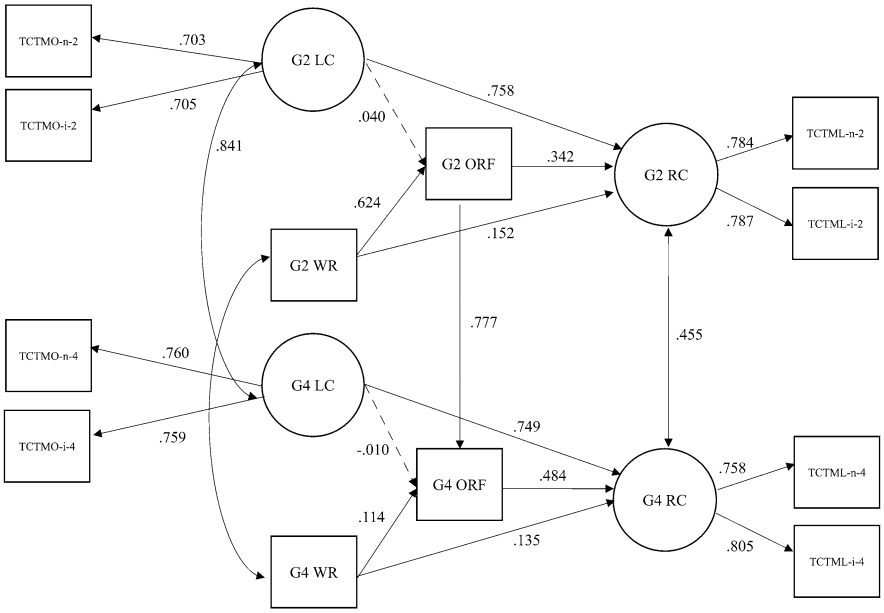

Fig. 3 Model 3 (revised): word recognition (WR), listening comprehension (LC) and oral reading fluency (ORF) tested as direct predictors of reading comprehension (RC), and ORF tested as a mediator of the effect of word recognition and listening comprehension on reading comprehension in grade 2 (G2) and grade 4 (G4) (n = 261). *Note* Standardized coefficients are depicted. *Solid lines* represent statistically significant paths, and *dashed lines* indicate statistically non-significant paths

whereas in some studies more diversified formats of reading and listening comprehension measures were used, such as a combination of cloze tests and tests with open-ended questions (see, for example, Adlof et al., 2006; Kim & Wagner, 2015). Moreover, text comprehension, whether the text is presented orally or written, requires the ability to construct meaning, not only at a local but also at a global level (Kintsch & Rawson, 2005), and entails cognitive and linguistic skills, such as working memory, grammatical knowledge, vocabulary, or the ability to monitor comprehension (Kim, 2016; Perfetti, Landi, & Oakhill, 2005). All these similarities are non-existent among reading comprehension, word recognition and oral reading fluency. Therefore, future studies should explore if the similarity of the measures used contributed to the finding that listening comprehension is the strongest predictor of reading comprehension.

Overall, our results suggest that for readers of European Portuguese, listening comprehension can be a good indicator not only of the concurrent reading comprehension levels but also of the reading comprehension levels that the students will have at the end of primary school. Furthermore, this finding implies that assessment and intervention to promote reading comprehension should place a special focus on the promotion of linguistic abilities, in addition to promoting the decoding of isolated words and the fast and accurate reading of connected text. The

results from a recent study that assessed Portuguese primary school teachers' planning for literacy instruction indicated that when asked to plan a 2-h instructional block, a high percentage of teachers (more than 75 % of those who taught grades 1–2 and more than 90 % who taught grades 3–4) included comprehension activities in their literacy instruction plan (Spear-Swerling, Lopes, Oliveira, & Zibulsky, 2015). However, the study did not distinguish listening and reading comprehension activities, and therefore, it is not clear whether listening comprehension activities were frequently referred. Nonetheless, the same study found that few teachers included in their planning activities to promote linguistic-related abilities, such as vocabulary, and that in addition to comprehension, they placed a special focus on reading fluency training (Spear-Swerling et al., 2015). This finding may indicate that Portuguese teachers neglect to some extent the promotion of linguistic abilities, but future studies are needed to further clarify their reading instructional practices.

Our third hypothesis stated that ORF is not only a direct predictor but also a mediator of the effects of word recognition and listening comprehension on reading comprehension in both grades. This hypothesis was only partially verified, given that only word recognition suffered a mediation effect from ORF. Additionally, this mediation effect was only partial, given that word recognition was still a direct predictor of reading comprehension. Our finding supports the idea that in European Portuguese, ORF captures some but not all of the abilities involved in the accurate reading of isolated words, not only in the initial phase of reading development but also in a more advanced phase. The full mediation of the relationship between word recognition and reading comprehension after 4 years of reading instruction is a result that has been found previously in studies conducted with English readers (Kim & Wagner, 2015; Silverman et al., 2013). Note, however, that Kim and Wagner (2015) also found a full mediation effect in the second grade, whereas we found only a partial effect, but they used a measure of word reading fluency and not a measure of word reading accuracy, as in our study. Therefore, the slight differences in the results can possibly be due to the use of different measures of word recognition.

Nonetheless, ORF was not a mediator of the relationship between listening and reading comprehension, nor was listening comprehension a direct predictor of ORF in either of the two grade levels. Conflicting results about the existence of this effect in English readers have been previously found (Kim & Wagner, 2015; Silverman et al., 2013), but the results of this study seem to support the inexistence of such an effect. It is possible that at least until grade 4 and in an intermediate-depth orthography, the abilities entailed in ORF involve few meaning-related processes associated with the context and that this is accentuated by the type of tasks typically used to assess ORF: Readers are simply asked to read aloud a text, and it is not stated that the comprehension of that text will be assessed. Therefore, it is possible that, facing this type of instruction, the readers direct a great part of their attentional resources to the basic processes of fast and accurate reading and not to the construction of meaning. However, more research on this effect is needed, particularly in transparent and semi-transparent orthographies.

Limitations and guidelines for future research

Some limitations should be considered in the interpretation of the results obtained in this study. The first limitation is related to the measures used: only one measure for assessing word recognition and ORF was used. A replication of the study using more varied measures for each construct could provide important insights about the possible influence on the results of the measures used. Another limitation is related to the sample. Being a longitudinal study, a large percentage of the students did not complete all measures at both moments or dropped the study in the 2 years that separated the two assessment moments. Therefore, although the sample seems to be representative, its size is relatively small.

A third limitation is related to the results obtained for model 2: although the results of this model were in line with the second hypothesis of our study, some of the fit indices were not inside the adequate cutoff values and therefore the results should be read with some caution. These fit problems contrast with the excellent fit of the other models, in which the reading comprehension is predicted by the other three variables measured at the same grade-level. Given that, in model 2, there is a two-year time interval between the assessment of the predictors and the outcome variable, it is possible that some instability occurs in the individual differences observed in word recognition, fluency, listening and reading comprehension. Besides, it is also possible that the effects of the three predictors in grade 2 on reading comprehension in grade 4 are mediated by the results in the same variables in grade 3. Future studies should explore this hypothesis. Moreover, data from European Portuguese readers have indicated that other variables, such as vocabulary and reasoning, can have an additional effect on reading comprehension, particularly after the initial school grades (Ribeiro et al., 2016). Therefore, other cognitive skills that have an effect on reading comprehension can also be included in the models tested in future studies.

Conclusions

In general, the high percentage of the variance in reading comprehension explained by word recognition, ORF and listening comprehension is similar to the percentage of variance explained in other studies (Catts et al., 2005; Tobia & Bonifacci, 2015). This finding indicates that the SVR, including a fluency component, is a valid and useful framework to account for the reading comprehension differences among readers in an intermediate depth orthography, thus adding to the established and vast body of research conducted with English readers. However, the results obtained for the relative importance of each of the three predictors are highly similar to the findings of other studies of transparent orthographies where listening comprehension was the main predictor (Florit & Cain, 2011; Tobia & Bonifacci, 2015). In addition, ORF seems to assume particular importance due to its mediator effect on the relationship between word recognition and reading comprehension in both grades. Therefore, reading instruction should not only focus on the promotion of

speed and accurate reading but also give particular attention to the capacity to construct meaning through oral language.

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