Differences in the Components and Relations of a Multidimensional Model of Reading Comprehension in Low and Average 8- to 11-Year-Old French Readers.

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Introduction

If the simple view of reading (Hoover and Gough, 1990; Gough, Hoover and Peterson, 1996) earlier characterised reading comprehension as a product of decoding and linguistic comprehension, research has evolved to a more complex simple view including speed or fluency as a major factor of reading comprehension (Malatesha, Joshi and Aaron, 2000). Through this complex simple view approach, multidimensional models of reading comprehension emerged, which, in addition to the components included in the simple view model (decoding and listening comprehension), proposed the implication of other cognitive skills: verbal reasoning or verbal proficiency (Tilstra, McMaster, Van den Broeck, Kendeou and Rapp, 2009); working memory (Cain, Oakhill and Bryant, 2006); background knowledge and vocabulary (Cromley and Azevedo, 2007); fluency (Adolf, Cats and Little, 2006; Geva and Farnia, 2012) and; phonological awareness (Vellutino, Tunmer, Jaccard and Chen, 2007). The structure of these multidimensional models shows, in general, two main categories of skills: one related to decoding processes and the other related to language processing and listening comprehension, whilst some general cognitive abilities like working memory could play a role in both categories. The only reading ability that is not clearly linked to only one of these two categories is text reading fluency. Whilst connected to decoding and word fluency, text reading fluency is seen as an independent construct that integrates comprehension skills over and above identification skills as children are becoming expert readers (Tilstra et al., 2009). If some results show that text reading fluency influences reading comprehension at the end of primary school (Bianco, Joet, Lima, Nardy, Rémond, Colé and Megherbi, 2013), the impact of text reading fluency and the processes underlying text reading fluency are not yet clear for younger readers (i.e., second grade readers in Geva and Farnia (2012) or first grade readers in Kim, Wagner and Lopez (2012) or adult readers (Sabatini, Sawaki, Shore and Scarborough, 2010)).

Some research on multidimensional models of reading comprehension has focused on a developmental perspective (Vellutino, Tunmer, Jaccard and Chen, 2007; Tilstra et al., 2009). Tilstra et al. (2009) examine the influence of decoding, listening comprehension, verbal proficiency and reading fluency to reading comprehension for fourth, seventh and ninth-grade readers who had shown a decrease in the influence of decoding as they progressed through school and a decrease in the influence of listening comprehension after middle school but a steady influence of verbal proficiency and reading fluency from primary to secondary school grades. In the research on multidimensional models of reading that adopt a developmental perspective based on age or grade differences, few took into account readers' achievements (Cromley and Azevedo, 2007) and fewer had tested to see if the components and the relations between the components of the models were the same for low achievers and for average and high achievers, though sources of comprehension difficulties have been widely explored (Perfetti, Marron and Folz, 1996; Nation, 2005).

Purpose

The purpose of our study is threefold. Firstly, as we hypothesised a structural theoretical model of the relationships between oral language skills, decoding and word fluency, oral text comprehension, reading fluency and reading comprehension (Figure 1), we want to test if this model fits the data obtained from 8 to 11-year-old French students and to identify the contribution and relations of each skill to reading comprehension. Secondly, we want to explore the relations of text fluency with other components of the model and with reading comprehension. Thirdly, we try to identify variations of the relations between these components according to the average or low level of reading achievement of pupils.

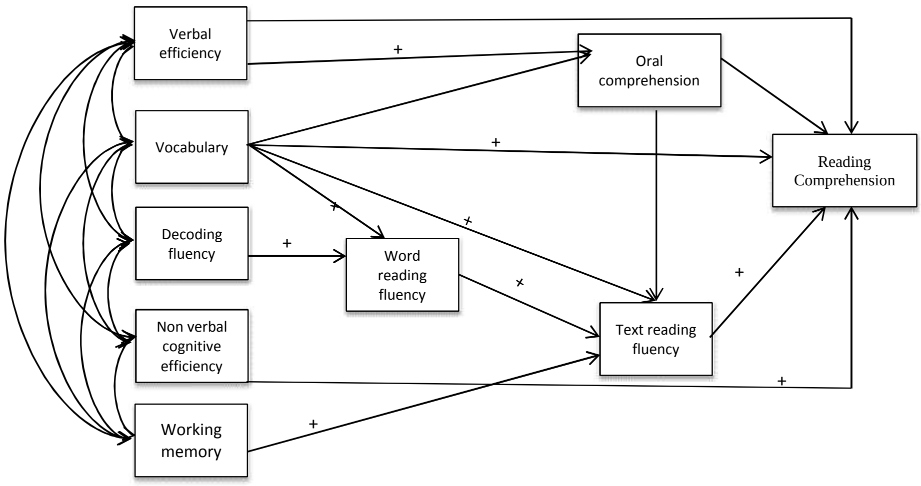

Figure 1: Structural theoretical model of reading comprehension

Method

Participants

The sample included 298 children aged 8 to 12 years old (mean = 9;7, sdt = 0;9). One hundred and nineteen attended grade three classrooms, 94 grade four and 85 grade five (see Table 1). Of the sample, 88.2% followed their age appropriate grade, 3.7% skipped a grade and 8.1% repeated a grade. Boys (N=148) and girls (N=150) were equally represented. Of the sample, 85% were French-only-speaking children, 13% were bilingual with French as the dominant language and 2% had another language as their first language. Regarding socioeconomic status (SES), 49.47% of the children came from middle- to high-status homes and 50.53% came from low-status homes.

Comprehension scores for five texts were subjected to a K-means cluster analysis to assign participants to groups according to their reading comprehension levels (Seifert and Bulcock, 1996). A two-cluster solution was retained as it seems theoretically adapted, statistically consistent (cubic clustering criterion) and it allows the study to have a sufficient number of participants in each group in order to identify statistical differences between groups. The first group comprised 189 average readers (AVG) and the second group comprised 109 low readers (LR). Children from each grade level were represented in each group. However, there were more fifth graders (73) than either fourth graders (63) or third graders (53) in the AVG group, whilst the reverse was true for the LR group (66 third graders, 31 fourth graders and 12 fifth graders). But, with respect to reading comprehension performance, there was no effect of grade level for the LR group ($F(2,106) = 0.65$, ns) and the difference did not reach significance in the AVG group ($F(2,186) = 2.81$, $p=0.06$).

Materials

Reading comprehension (RC) was assessed using five experimental narrative texts that were followed by a set a questions. The texts ranged from 324 to 431 words in length (mean number = 391). After silently reading each text, children answered 12 to 15 questions. In all, children answered 66 questions that mixed open-ended and multiple choice question formats. Internal consistency was excellent, with a Cronbach's alpha of .93.

A standardised narrative comprehension test ("Sacré Nestor") composed of 462 words and 12 questions (Cronbach's alpha = .76) was used to assess listening comprehension (Crunelle, Taillant and Tiberghien, 2000).

Different aspects of reading fluency were assessed through three different tests:

- a decoding fluency test in which participants had to correctly read pseudo-words in one minute, in a list of 40 one-to-three syllables long pseudo-words;
- a word reading fluency test in which participants had to correctly read words in one minute, in a list of 50 one-to-three syllables long regular (30) and irregular (20) words;
- a text reading fluency (TRF) test, inspired by DIBELS (Good and Kaminsky, 2002), in which participants read aloud three connected texts for one minute each. TRF was defined as the mean number of words correctly read in one minute across the texts. Internal consistency amongst the three texts was excellent (Cronbach's alpha = .97).

Receptive vocabulary was assessed with a French shortened version of the Peabody Picture Vocabulary Test (EVIP, Dunn, Theriault-Whalen and Dunn, 1993).

The ability to draw relationships between concepts (verbal efficiency) was assessed with the similarities sub-test of the WISC IV (Wechsler, 2005).

The WISC IV digit span sub-tests (reserve ordered digit span) were used to assess working memory.

Nonverbal cognitive efficiency was assessed using the progressive matrix test (Raven, 1998).

Procedure

Pupils participated during school time in two 30-minute individual test sessions and three 50-minute collective test sessions from January to April 2012.

Results

After a descriptive and psychometric analysis of the scores of the variables of interest (see Table 1), these scores were standardised (mean = 0, sd = 1).

Table 1: Means (and s.d.) of raw scores for average readers, low readers and all readers

	N	Reading Compr	Oral Compr	Word reading fluency	Text reading fluency	Non verbal cognitive efficiency	Vocabulary	Verbal efficiency	Decoding fluency	Working memory
All readers	298	43.8 (12.8)	5.2 (2.9)	38.7 (10.8)	115.6 (34.0)	29.8 (4.8)	27.5 (4.8)	21.3 (4.5)	28.3 (7.0)	6.4 (1.5)
Average Readers	189	52.0 (5.9)	6.3 (2.7)	42.8 (8.4)	130.4 (29.8)	31.4 (3.6)	29.1 (3.9)	23.0 (4.0)	30.2 (6.0)	6.6 (1.5)
Low Readers	109	29.6 (8.3)	3.4 (2.2)	31.6 (10.9)	89.9 (24.2)	27.0 (5.3)	24.6 (4.9)	18.3 (3.9)	25.0 (7.3)	5.9 (1.3)

After a correlation analysis (see Table 2), a structural equation modelling approach (Kline, 2005) with proc calis of SAS software was used to test our theoretical model for all pupils (Figure 2) and for sub-groups (Figures 3 and 4).

Table 2: Correlations between variables

Variable (N=298)	1	2	3	4	5	6	7	8	9
1. Reading comprehension	1								
2. Oral comprehension	.58***	1							
3. Word reading fluency	.53***	.27***	1						
4. Text reading fluency	.63***	.35***	.84***	1					
5. Nonverbal cognitive efficiency	.52***	.30***	.23***	.32***	1				
6. Vocabulary	.52***	.53***	.32***	.36***	.32***	1			
7. Verbal efficiency	.56***	.57***	.33***	.35***	.37***	.53***	1		
8. Decoding fluency	.42***	.10	.74***	.73***	.19**	.13*	.19**	1	
9. Working memory	.31***	.20**	.23***	.28***	.25***	.20**	.28***	.22***	1

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

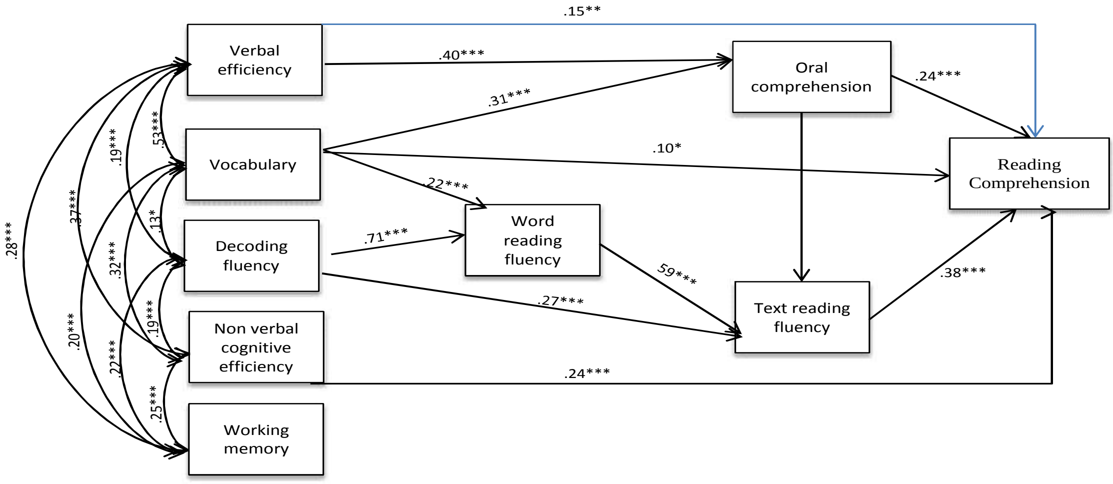

Figure 2: Fitted structural equation model of reading comprehension for the full sample (n=298)

The fitted structural equation model for the full sample (Figure 2) gives the following information:

On TRF: Word reading fluency and decoding fluency are the only direct contributors to TRF, whilst word reading fluency partially mediates the influence of decoding fluency. The influence of vocabulary on TRF is fully mediated by word identification skills. Oral comprehension is not a contributor to TRF as was hypothesised in our theoretical model. Working memory was not found to be a direct predictor of TRF nor nonverbal cognitive efficiency.

On RC: As predicted in the theoretical model, listening comprehension and text reading fluency are the two main direct predictors of RC. The influences of verbal efficiency and vocabulary on RC are partially mediated by listening comprehension. Nonverbal cognitive skills are another unique predictor of RC.

This model is not far from the simple view of reading, showing two different, almost unlinked, pathways; one for oral language skills (OLS) and the other for written language skills (WLS), even though vocabulary seems to play a direct and indirect role in the OLS pathway to reading comprehension but also an indirect role in the WLS pathway through its influence on word reading fluency.

The fitted model for the AVG group (Figure 3) gives the following information:

On TRF: As anticipated, word reading fluency and decoding fluency are a strong part of TRF, whilst word reading fluency mediates the influence of decoding fluency but only partially. The influence of vocabulary on TRF is fully mediated by word identification skills. Oral comprehension is also a direct, small but significant, contributor to TRF. Working memory was not found to be a direct predictor of TRF but nonverbal cognitive efficiency is.

On RC: As predicted, listening comprehension and TRF are the two main direct predictors of reading comprehension. The influence of verbal efficiency on RC is fully mediated by listening comprehension and the influence of vocabulary is partially mediated both by word fluency and listening comprehension. Nonverbal cognitive skills are a further unique predictor to RC.

Except for the direct link from nonverbal cognitive efficiency to TRF and the absence of direct link from working memory to TRF, the adjusted structural equation model for the average readers group fully corresponds to our theoretical model, drawing a more complex picture than in the simple view of reading by predicting that OLS and WLS pathways should be linked through TRF.

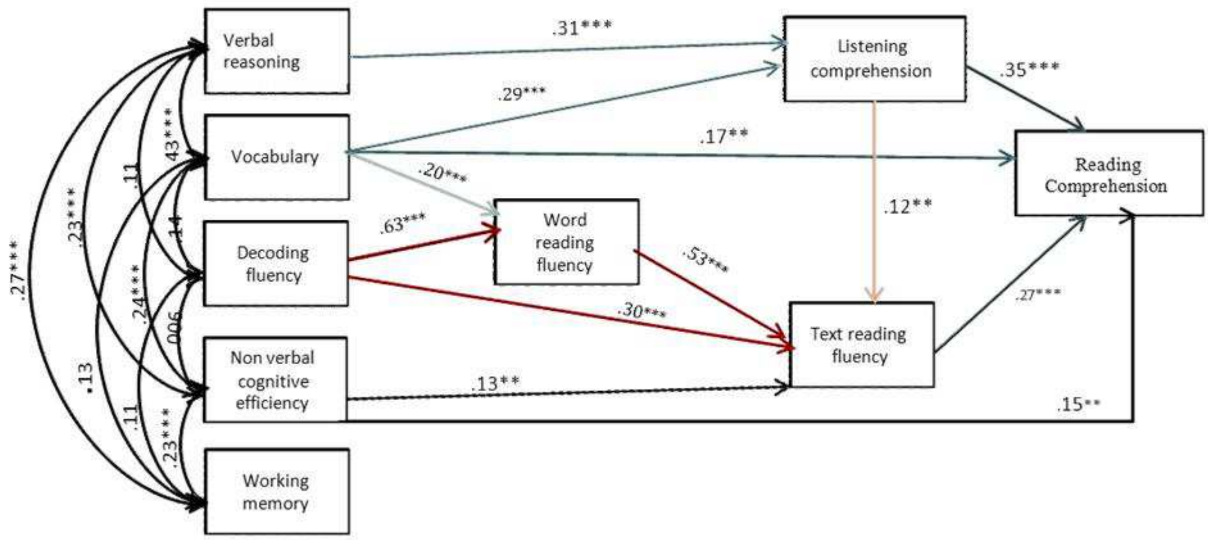

Figure 3: Adjusted structural equation model of reading comprehension for average readers group (N=189)

The resulting structural equation model for the LR group is somewhat different.

As found for average readers, word reading fluency and decoding fluency are a strong part of TRF and word reading fluency mediates the influence of decoding fluency. However, no oral language skill (or any other variable) is linked to TRF.

RC is predicted by listening comprehension, TRF and nonverbal cognitive skills. Compared to average readers, listening comprehension contributes less to RC and nonverbal skills contribute more. The influences of verbal efficiency and vocabulary on RC were found to be fully mediated by listening comprehension.

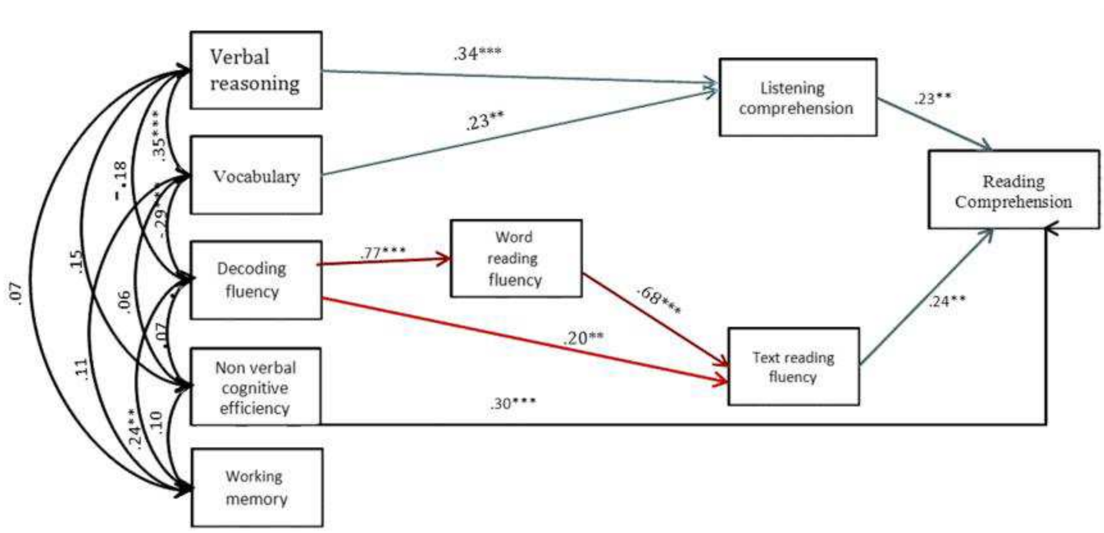

Figure 4: Fitted model for low readers group (N=109)

Conclusion

The results obtained by studying differences in the relationships between multiple predictors of reading comprehension for low and average primary school readers seem to indicate that proficiency in reading is acquired by passing from an independent participation of the OLS and WLS to reading comprehension, as stated by the simple view of reading, to a more integrated functioning with some links between these two groups of skills, which calls for more complex views of reading. Differences in text reading fluency seem to be a key point to understanding reading comprehension progress. In our study, in the LR model, there is no link between listening comprehension (or other language precursors of listening comprehension) and TRF, as if low readers were on the second stage of Samuel's model of fluency, the accurate but not automatic stage associated with "a slow and laborious rate of reading" and with "limited understanding and recall of what has been read" (Samuels, 2002, p. 171). On the contrary, this link between listening comprehension and text reading fluency exists in the AVG model. It could indicate that average eight to 11-year-old readers are on the accurate and automatic stage or fluent stage where students can "decode and comprehend simultaneously" (Samuels, 2002, p. 172). Teachers should therefore try to develop fluency in terms of automaticity and accuracy of oral and silent text reading to allow their students to establish links between their OLS and their WLS to obtain a higher level of reading comprehension.

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fitted model for average readers			
Index		**Index**	
x^2(df)	23.04*(14)	CFI	.98
x^2/df	1.64	NNFI	.95
SRMR	.03	NFI	.96
RMSEA (90% CI)	.05 (.00, 10)	AIC	85.04
AGFI	.91		

Table 3: Indices of fit for the adjusted model for average readers

fitted model for low readers			
Index		**Index**	
x^2(df)	15.61*(18)	CFI	1
x^2/df	.86	NNFI	1
SRMR	.04	NFI	.95
RMSEA (90% CI)	.00 (.00, 07)	AIC	69.61
AGFI	.92		

Table 4: Indices of fit for the adjusted model for low readers