

## From Bibliophile to Sesquipedalian: Modeling the Role of Reading Experience in Vocabulary and Reading Comprehension

Sanne W. van der Kleij, Adrian P. Burgess, Jessie Ricketts & Laura R. Shapiro

To cite this article: Sanne W. van der Kleij, Adrian P. Burgess, Jessie Ricketts & Laura R. Shapiro (2022): From Bibliophile to Sesquipedalian: Modeling the Role of Reading Experience in Vocabulary and Reading Comprehension, *Scientific Studies of Reading*, DOI: [10.1080/10888438.2022.2068418](https://doi.org/10.1080/10888438.2022.2068418)

To link to this article: <https://doi.org/10.1080/10888438.2022.2068418>



© 2022 The Author(s). Published with license by Taylor & Francis Group, LLC.



Published online: 26 Apr 2022.



Submit your article to this journal [↗](#)



Article views: 499







View related articles [↗](#)



View Crossmark data [↗](#)

# From Bibliophile to Sesquipedalian: Modeling the Role of Reading Experience in Vocabulary and Reading Comprehension

Sanne W. van der Kleij <sup>a,b</sup>, Adrian P. Burgess <sup>a</sup>, Jessie Ricketts <sup>c\*</sup>,  
and Laura R. Shapiro <sup>a\*</sup>

<sup>a</sup>School of Life and Health Sciences, Psychology, Aston University, Birmingham, UK; <sup>b</sup>School of Psychology, University of Birmingham, Birmingham, UK; <sup>c</sup>Department of Psychology, Royal Holloway, University of London, Egham, UK

## ABSTRACT

**Purpose:** We investigated the roles of leisure reading and word reading ability in vocabulary and reading comprehension development in 598 adolescents at ages 10, 11, and 12 (285 girls, 313 boys).

**Method:** Structural equation modeling was used to test whether word reading was associated with vocabulary and reading comprehension: a) directly; b) indirectly via leisure reading; or c) both.

**Results:** We found both direct and indirect effects of word reading on vocabulary: word reading ability directly predicted outcomes, and also predicted the amount of leisure reading, which in turn predicted vocabulary. For reading comprehension we observed direct but not indirect effects of word reading. As expected, vocabulary and reading comprehension outcomes were strongly correlated.

**Conclusion:** Our findings demonstrate the direct effect of word reading ability in predicting vocabulary and reading comprehension, and reveal a crucial mediating role of leisure reading in the development of vocabulary.

“A mind needs books like a sword needs a whetstone, if it is to keep its edge. That is why I read so much.” (Tyrion Lannister from Game of Thrones). Our intellectual heroes are often depicted as bibliophiles and sesquipedalian (avid readers who use unusual words), underlining how fundamental reading is to modern society and inextricably linked to education and learning. After a few years of formal reading instruction, children are expected to be able to learn independently from reading, and from this point onwards, reading becomes a key mechanism for learning new words (Nagy et al., 1985). Fiction book reading is thought to play a particularly important role in vocabulary growth (Pfost et al., 2013). Compared to spoken language, fiction texts typically contain a greater number of word types, which appear in more diverse, meaningful contexts (Castles et al., 2018). In order to benefit from these kinds of texts, children must have sufficient word reading levels. Indeed, children with better word reading ability tend to have greater vocabulary knowledge than children with poorer word reading skills (Mol & Bus, 2011). However, it is not currently clear what drives this association. One possibility is that word reading ability directly predicts the extent to which children can learn from reading: once word reading is sufficiently fluent, it enables them to refine existing knowledge and can free up cognitive resources to comprehend and learn from the text. Alternatively, the relation between word reading ability and learning may be mediated by children’s reading experience, such that more able readers read more and therefore encounter more novel words, and in more diverse

**CONTACT** Sanne W. van der Kleij  s.w.vanderkleij@bham.ac.uk  School of Psychology, University of Birmingham, Birmingham B15 2TT, UK

\*Joint senior authors

© 2022 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

contexts (Nation, 2017). This study tests models that distinguish between the following hypotheses: a) word reading ability directly predicts vocabulary and reading comprehension, b) this relation is mediated by children's leisure reading, or c) both.

The process of learning new words from written text involves storing information about pronunciation (phonology), meaning (semantics) and spelling (orthography). This information is progressively refined to increase the depth of word knowledge, within a network of multiple high-quality lexical representations. A word with a high-quality lexical representation is one that can be recognized accurately and efficiently from orthography (during reading), or phonology (during listening; Perfetti & Hart, 2002), providing access to rich word knowledge. Once children have sufficient reading skills to acquire new word meanings from text, it is estimated that they learn about a third of their new vocabulary through independent reading (agy et al., 1987; Nagy et al., 1985). Experimental studies demonstrate that children are able to infer word meanings from reading and that this process is more effective for children with better reading accuracy and efficiency, greater word knowledge and more reading experience (Cain et al., 2004; Joseph & Nation, 2019; Nagy & Anderson, 1984; Ricketts et al., 2011).

Knowing many words that can be read efficiently, and with meaning, facilitates integration across a text so that a mental model can be built to support comprehension (Perfetti & Stafura, 2014). Better accuracy and comprehension whilst reading a text will in turn help the reader to infer the meaning of any unfamiliar words that are encountered, thus supporting vocabulary growth (Cain et al., 2004; Ricketts et al., 2011). Existing evidence supports this interplay between word knowledge, vocabulary and reading comprehension. Better word reading accuracy and efficiency and vocabulary knowledge are associated with faster growth in subsequent reading comprehension (Duff et al., 2015; Quinn et al., 2015; Verhoeven et al., 2011), although the importance of word reading ability for reading comprehension is argued to decrease over reading development (Foorman et al., 2015; Language and Reading Research Consortium, 2015; Lervåg et al., 2018). Reading comprehension also supports vocabulary development (Verhoeven et al., 2011; Wagner & Meros, 2010). It follows that children with poor reading ability face barriers to word learning and comprehension. These difficulties are likely to be compounded by a reluctance to read: poor readers are typically less motivated to read for pleasure, reducing their reading activity and therefore their experience with text (McGeown et al., 2012; Van Bergen et al., 2019). Therefore, a child's reading ability may not only influence the *quality* of the input (and therefore the ability to learn from text), but also the *quantity* of input (Cain & Oakhill, 2011).

Amount of reading experience is widely viewed as important for the continuing development of language and literacy skills (Cunningham & Stanovich, 1998), but its role has not been clearly defined within influential theories aimed at understanding reading processes, such as the Simple View of Reading (Gough & Tunmer, 1986) or the Reading Systems Framework (Perfetti & Stafura, 2014). There are a number of ways in which reading experience could exert an influence on word reading and comprehension processes. Nation (2017) has emphasized the importance of encountering words across diverse, meaningful written contexts. Children who regularly read for pleasure will encounter more novel words than children who seldom read for pleasure. This will enable them to learn new orthographic forms that can be stored for later reading. In addition, their reading experience provides practice in reading familiar words, improving word reading ability (Nation, 2017; Share, 1995). Reading experience also exposes the reader to different types of texts and provides opportunities to improve reading strategies. Overall, increasing word reading ability, and fostering exposure to orthography, text conventions and reading strategies, will all come together to support reading comprehension (Perfetti & Stafura, 2014).

Above, we argued that reading ability may influence the amount that children read, and vice versa. Previous correlational studies have found a stronger relation from reading ability to children's reading amount, than from reading amount to reading ability (Harlaar et al., 2011; Leppänen et al., 2005). However, these studies did not separate word reading ability and reading comprehension. More recent studies that have modeled word reading and reading comprehension separately found different relations for each aspect of reading. Word reading efficiency predicts the amount of

reading for pleasure but not vice versa (Torppa et al., 2020; Van Bergen et al., 2019). This means that word reading difficulties could act as a constraint on the amount of leisure reading, with children with poorer word reading ability choosing to read less in their own time than better readers. In terms of the relationship with reading comprehension, there is some evidence that reading comprehension ability predicts reading amount (e.g., Erbeli et al., 2019). However, there is a stronger theoretical case for a reciprocal relationship, in which reading experience is crucial for building reading comprehension skills, *and* having better reading comprehension skills predicts more time spent reading (Locher & Pfof, 2020; Pfof et al., 2013; Torppa et al., 2020). Importantly, even after controlling for early word reading accuracy, reading amount still predicts reading comprehension (Sénéchal, 2006). According to Torppa et al. (2020), this could possibly be explained by the fact that reading experience enhances background knowledge and language skills (e.g., vocabulary, syntax) which are needed for effortless reading comprehension. In Torppa et al.'s study, reading comprehension also predicted children's leisure reading, but the effect was less strong and mainly found in earlier stages of reading development. In sum, for word reading efficiency, the relation between reading ability and experience appears to be unidirectional, with word reading efficiency predicting reading amount. In contrast, for reading comprehension, a reciprocal relationship is likely, although the evidence points most strongly toward the importance of reading experience for building reading comprehension skills.

With respect to lexical learning, encountering words across diverse contexts is thought to be important for the quality of lexical representations in (at least) three ways. As described above, reading widely will allow children to encounter words that they might not encounter in everyday language contexts. This will allow them to learn new orthographic forms, but also link these forms to meaning. In addition, repeated encounters with words across diverse contexts promotes co-activation of phonological, orthographic and semantic information, tightening existing links between these aspects of word knowledge (Nation, 2017; Perfetti & Hart, 2002). Finally, experiencing words in different contexts may introduce the reader to new meanings of known words, allowing them to increase the depth of their understanding of these words. For example, they might know that "pride" is something that they can feel and then learn that it has multiple meanings and can also be "a group of lions." Indeed, there is extensive correlational evidence that children who read more in their own time know more about orthography and word meanings than those who read less (Cain & Oakhill, 2011; Mol & Bus, 2011; Schiefele et al., 2012; Spear-Swerling et al., 2010; Van Bergen et al., 2019).

Several studies have demonstrated that reading amount predicts subsequent vocabulary knowledge (Cain & Oakhill, 2011; Echols et al., 1996; Pfof et al., 2013; Sullivan & Brown, 2015), with more leisure reading being associated with greater vocabulary knowledge. This is consistent with theoretical approaches that propose that children who read more, encounter a greater number of novel words and can acquire higher quality lexical representations (Nation, 2017).

Less clear is how the influence of reading experience changes during development. Previous studies have shown that individual differences in word reading, vocabulary knowledge and reading comprehension are highly stable over development (Bornstein et al., 2014; Landerl & Wimmer, 2008; Ricketts et al., 2020; Verhoeven et al., 2011). However, we don't know whether the influence of reading experience on these skills is consistent over time. It is possible that the importance of reading experience for reading comprehension and vocabulary knowledge increases in secondary school, when children are increasingly expected to read on their own in order to learn. Indeed, in a meta-analysis, Mol and Bus (2011) showed that print exposure predicted oral language skills, and the magnitude of this effect increased with age. The influence of print exposure on reading comprehension was smaller, not quite reaching significance. In a recent study, Locher and Pfof (2020) found a significant association between leisure reading and reading comprehension, which was consistent between ages 10 and 14 years.

## Present study

As outlined above, previous research indicates that reading experience plays an important role in the acquisition of high-quality lexical knowledge, and the development of good reading comprehension skills that allow children to learn new word meanings from text. However, previous studies have not modeled these skills together and the theory that reading experience is a key mediating factor between basic reading skills, vocabulary and reading comprehension has not yet been tested. We collected data on word reading efficiency, leisure reading, vocabulary knowledge and reading comprehension in children at ages 10, 11, and 12. We tested whether word reading ability would be associated with vocabulary and reading comprehension: a) directly, b) indirectly via leisure reading (full mediation), or c) both directly and indirectly via leisure reading (partial mediation).

As for the direct effect from word reading to vocabulary and reading comprehension, we expected that poorer word reading efficiency might act as a constraint on vocabulary and reading comprehension development. With poor readers struggling more with refining existing meaning representations, comprehension of texts and struggling with inferring new word meanings from the text. Better readers, who read more accurately and efficiently, are expected to be able to free up cognitive resources for comprehension, which can facilitate learning (Perfetti et al., 2005). However, since previous studies find that the influence of word reading on reading comprehension decreases over reading development (Foorman et al., 2015; Language and Reading Research Consortium, 2015; Lervåg et al., 2018), we expect the direct impact of word reading on reading comprehension to be small at this age. We expected that vocabulary knowledge and reading comprehension ability would be highly correlated. As discussed earlier, knowing more words can aid comprehension of a text, and better comprehension can aid vocabulary learning from texts. Finally, regarding the role of reading experience, we expected that children with better word reading ability would read more, and that more leisure reading would be associated with greater vocabulary knowledge and better reading comprehension skills. More reading exposes children to a greater number of novel words in varied contexts, which enables them to expand and strengthen their lexical representations and support their reading comprehension skills. Our research questions and data collection procedure were pre-registered on the Open Science Framework (<https://osf.io/h8ybz/>). Note that our analysis approach deviated somewhat from our pre-registration because changes were made to our models during the review process. Most notably, we used data at age 12 for the outcome measure, in addition to the age 10 data for the predictor and age 11 data for the mediator variables.

## Method

### Participants

Participants were part of an on-going longitudinal study examining reading development from school entry at age 4 ( $M_{\text{age}} = 4.64$ ,  $SD = .30$  years;  $n = 788$ ; 375 girls; see, Cunningham et al. (2020) for longitudinal analyses from age 4 to 9). From age 10 ( $M_{\text{age}} = 10.29$ ,  $SD = .29$  years;  $n = 598$ ; 285 girls), the focus of the project changed to both reading and vocabulary development, and this is the first report of the findings from age 10 onwards (Figure 1). The students were tested again one year later at age 11 ( $M_{\text{age}} = 11.27$ ,  $SD = .29$  years;  $n = 299$ ; 169 girls), and six months later when they started secondary school (i.e. high school) at age 12 ( $M_{\text{age}} = 11.71$ ,  $SD = .29$  years;  $n = 266$ ; 152 girls). At ages 4, 10 and 11, they attended 16 primary schools in suburban areas of Birmingham UK. School-level data indicated a broad range of SES backgrounds: Index of Multiple Deprivation deciles ranged from 1–10 (Noble et al., 2019), and the proportion within each school who were eligible for Free School Meals (FSM) ranged from 1% – 48% (mean 18%). English as Additional Language (EAL) children made up 10%. At age 12, participants were attending 53 secondary schools; 16% of the participants included in our final time point were eligible for FSM and 9% had EAL. At each testing point, we worked with all participants from the ongoing study for whom we had parental consent and pupil assent. Due to the introduction of the EU General Data Protection Regulation (GDPR), new written consent from



Figure 1. Timeline of the longitudinal study.

parents was needed at age 11, causing the large attrition between ages 10–11. However, as explained below in more detail, the sample of children who were retained in the study was comparable to the sample for which we were not able to gain new written consent. The study received a favorable opinion by Aston University's Ethics Committee.

## Measures

*School-entry measures (age 4).* Before the onset of reading instruction, letter knowledge was assessed with the Letter-Sound Test (LeST; Larsen et al., 2011) in which children were asked to pronounce 25 letters and 26 digraphs. Alongside this, vocabulary knowledge was measured with the British Ability Scales-2 (BAS-2; Elliot et al., 1996) for which children were asked to name pictured objects.

*Word reading efficiency (age 10).* This was assessed with the Test of Word Reading Efficiency – Second edition (TOWRE-2; Wagner et al., 2011). Children were asked to read as many words or nonwords correctly as possible within 45 seconds in the Sight Word Efficiency (SWE) and Phonemic Decoding (PDE) subtests, respectively.

*Leisure reading (age 11).* A subset of the Progress in International Reading Literacy Study (PIRLS; Martin et al., 2007) student questionnaire was used to measure children's reading activity. PIRLS is a well-established questionnaire that contains questions about reading motivation, the amount of reading, and type of reading materials. Given our focus, we included only questions about the time spent reading (novels or books) outside of school: 1) How much time do you spend reading outside of school, 2) How often do you read for fun, 3) How often do you read stories or novels? To check the validity of this self-report measure, we compared it to a reading diary that was administered in a subset of the sample ( $n = 62$ ). Children reported the time spent reading and number of pages read every day for a week. This reading diary correlated well with the PIRLS questions,  $r_s = .60-.66$ .

*Vocabulary knowledge (age 12).* The British Picture Vocabulary Scale – Third edition (BPVS-3; Dunn et al., 2009) was used to measure everyday vocabulary. Participants heard a word and were asked to indicate which of four pictures represented its meaning. The test consisted of 14 sets of 12 items, increasing in difficulty. The test was discontinued after 8 or more errors within a set. In addition, two curriculum-aligned vocabulary tasks were developed to capture academic vocabulary. The curriculum vocabulary tasks included words from the age-appropriate science curriculum (physics and biology) and were selected from teacher resources (<https://www.stem.org.uk>) and verified and reviewed by teachers. Both the physics and biology tasks were discontinued if a child scored below 40% correct.

*Reading comprehension (age 12).* Children read two passages from the York Assessment of Reading for Comprehension secondary school edition (YARC; Stothard et al., 2010). One fiction and one nonfiction passage were selected. To cover the range of ability, one of these was an easier passage (a nonfiction text designed for pupils aged 8–9) and one was harder (an age-appropriate



fiction text). The easier passage was read aloud and the harder passage was read silently. After reading each passage, participants answered 13 open-ended questions that measured literal and inferential comprehension.

### Procedure

At age 4, letter knowledge and vocabulary were measured (for more details, see, Cunningham et al., 2015; 2020). At three further time points (age 10, 11, 12), children's leisure reading activity, vocabulary, word and nonword reading ability were measured, and at two of these time points (ages 11 and 12), reading comprehension was measured. At each time point, tasks were administered in a fixed order, in one 45-minute session. Reading tasks were administered individually by a trained research assistant, remaining tasks were administered on a laptop.

### Approach to analysis

Analyses were conducted using the *lavaan* package (Rosseel, 2012) in R (R Core Team, 2013). First, Pearson correlations for observed variables were calculated to assess the relation between oral vocabulary and reading comprehension. Second, a measurement model was fitted to establish the factor structure. Third, a structural model was fitted to test whether word reading ability at age 10 predicted vocabulary and reading comprehension at age 12: both directly and indirectly via leisure reading (partial mediation); or indirectly via leisure reading at age 11, by removing direct links between word reading ability and the outcome measures (full mediation). Given that we expected that early differences in oral vocabulary and reading would be persistent and highly stable over time (Bornstein et al., 2014; Ricketts et al., 2020; Verhoeven et al., 2011), oral vocabulary and letter knowledge at school-entry were added to the model to take individual differences in these early reading-related skills into account.

Full information maximum likelihood (FIML) was used to handle missing data. Models were compared using Chi-square tests. The goodness-of-fit of the models was evaluated with the Chi-square statistic ( $\chi^2$ ), the comparative fit index (CFI), and root mean square error of approximation (RMSEA). The criteria for a well-fitting model were: a non-significant  $\chi^2$  value, CFI >.96, and the RMSEA <.06 (Hu & Bentler, 1999). For all measures, raw scores were used for the analyses.

We also checked for any effects of attrition on our models. Since we measured vocabulary at both age 10 and 11, we conducted multiple group models for vocabulary outcomes, comparing children who were retained in the study at age 11 (after the large attrition) with children who were only tested at age 10. When parameters for these two groups were constrained to be equal, it did not significantly change the model fit,  $\Delta\chi^2(3) = 2.403$ ,  $p = .49$ , providing reassurance that our final accepted model adequately reflected the full sample.

### Results

Table 1 displays the means and standard deviations, the extent of missing data and reliability estimates for the observed variables. Pearson correlations between observed variables are displayed in Table 2. As expected, all reading and vocabulary measures were correlated. Notably, only the "how often do you read for fun/do you read stories or novels" questions correlated with all reading and vocabulary measures. The "time spent reading outside of school" question only correlated with word reading ability.

**Table 1.** Means and standard deviations for the observed variables.

	Task	Age (years)	n	M	SD	Sample min	Sample max	Task max	Cronbach's $\alpha$
School entry variables	Letter knowledge	4	788	12.82	9.09	0	42	51	.74
	Naming Vocabulary	4	782	22.97	3.15	5	33	36	.74
Word reading efficiency	Phonemic decoding	10	597	40.40	10.98	7	64	66	.96
Leisure reading	Sight word reading	10	598	68.63	10.97	21	95	108	.94
	Time spent reading	11	298	2.18	0.97	1	4	4	
	Read for fun	11	298	2.89	1.07	1	4	4	
Vocabulary	Read stories or novels	11	298	2.96	1.00	1	4	4	
	BPVS everyday vocabulary	12	261	135.05	14.18	83	162	168	.95
	Physics vocabulary set 1	12	259	6.25	2.93	0	13	17	.63
	Physics vocabulary set 2	12	246	8.92	3.02	1	16	16	.68
	Biology vocabulary set 1	12	259	9.56	3.04	1	16	16	.71
Reading comprehension	Biology vocabulary set 2	12	246	8.81	2.75	0	15	15	.70
	Easier passage	12	242	8.58	2.36	1	13	13	.66
	Harder passage	12	232	7.81	2.64	0	13	13	.72

**Table 2.** Pearson correlations between observed variables. \* $p < .05$ ; \*\* $p < .01$ 

	1	2	3	4	5	6	7	8	9	10	11
1. Letter Knowledge age 4	-										
2. Vocabulary age 4	.46**	-									
3. Sight Words age 10	.26**	.15**	-								
4. Phon Decoding age 10	.19**	.14**	.72**	-							
5. Time spent reading age 11	.06	.07	.15*	.19**	-						
6. Read for fun age 11	.23**	.16*	.22**	.30**	.51**	-					
7. Read novels age 11	.21**	.16*	.20**	.22**	.35**	.54**	-				
8. Reading comprehension easier passage age 12	.44**	.34**	.32**	.34**	.03	.23**	.27**	-			
9. Reading comprehension harder passage age 12	.38**	.31**	.28**	.33**	.02	.31**	.34**	.62**	-		
10. BPVS Vocabulary age 12	.45**	.55**	.32**	.33**	.02	.26**	.28**	.57**	.56**	-	
11. Physics vocabulary age 12	.38**	.41**	.21**	.15*	.06	.18**	.13	.32**	.30**	.61**	-
12. Biology vocabulary age 12	.40**	.42**	.29**	.28**	.09	.27**	.32**	.44**	.47**	.70**	.54**

### **Modeling the association between word reading ability, leisure reading, and vocabulary and reading comprehension**

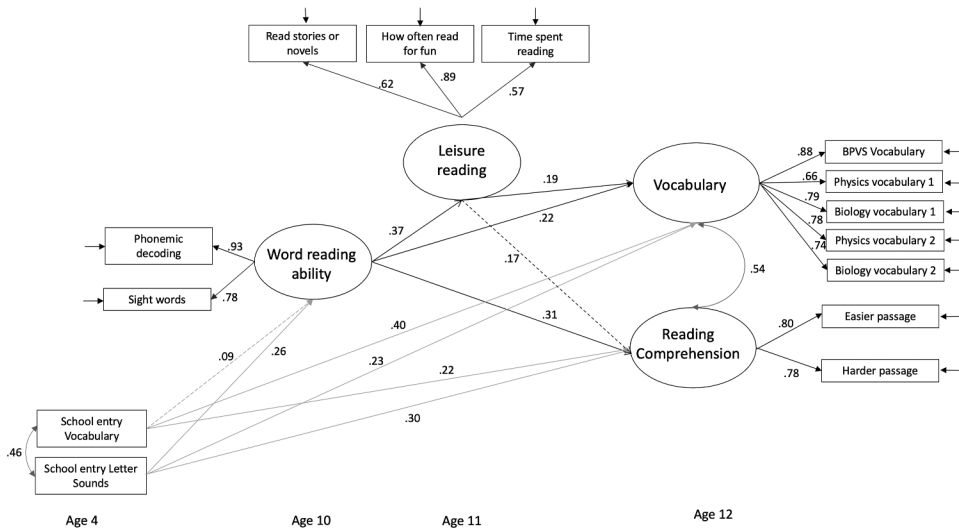
#### **Confirmatory factor analysis**

A confirmatory factor analysis (CFA) showed that a four-factor model with separate factors for leisure reading, word reading ability, vocabulary and reading comprehension fitted the data well,  $\chi^2(48) = 71.92$ ,  $p < .001$ , CFI = .98, RMSEA = .027, 90% CI = .013–.039.

#### **Mediation model**

A structural equation model was fitted including word reading ability at age 10, leisure reading at age 11, and vocabulary and reading comprehension at age 12 (Figure 2). For both vocabulary and reading comprehension, removing the direct link with word reading ability (full mediation) significantly decreased the model fit, vocabulary  $\Delta\chi^2(1) = 9.43$ ,  $p = .002$ , reading comprehension,  $\Delta\chi^2(1) = 13.93$ ,  $p < .001$ . The partial mediation model in which reading comprehension and vocabulary were allowed to correlate fitted the data very well,  $\chi^2(66) =$





**Figure 2.** Mediation model showing standardized coefficients for the association between word reading efficiency (age 10), leisure reading (age 11), reading comprehension and vocabulary (age 12).

92.07,  $p = .02$ , CFI = .99, RMSEA = .021, 90% CI = .009–.031. Word reading ability predicted both vocabulary and reading comprehension directly. Word reading ability also predicted leisure reading, and the indirect pathway from word reading to vocabulary knowledge via leisure reading was significant,  $\beta = .07$ ,  $p = .02$ . This indirect pathway was not significant for reading comprehension,  $\beta = .06$ ,  $p = .09$ . Both school-entry vocabulary and letter knowledge significantly predicted later reading comprehension and vocabulary, independent of the effects of word reading and leisure reading.

## Discussion

We tracked leisure reading, word reading efficiency, vocabulary and reading comprehension in adolescents between the ages of 10 and 12 years to test whether leisure reading mediates relations between word reading, vocabulary knowledge and reading comprehension. Our longitudinal data provide compelling evidence that: (i) word reading ability exerts a direct effect on leisure reading, vocabulary and reading comprehension; (ii) that leisure reading predicts vocabulary, but not reading comprehension; and (iii) that word reading ability indirectly influences vocabulary via leisure reading.

Our results showed that children with better word reading ability read more in their own time than their peers with lower word reading ability (consistent with Kavanagh, 2019; McGeown et al., 2016; Mol & Bus, 2011; Torppa et al., 2020; Van Bergen et al., 2019). This also underlines how poor reading skills could present a barrier to leisure reading. It has indeed been shown that children who struggle with reading are less motivated to read than their more proficient-reader peers (McGeown et al., 2016; Schiefele et al., 2012). This seems to be especially the case for fiction book reading, compared to other types of reading materials, such as nonfiction or schoolbook reading (McGeown et al., 2016). Our results build on this previous work by demonstrating that children's leisure reading activity, in turn, contributed to vocabulary knowledge, supporting the hypothesis that regular leisure reading promotes vocabulary development. Currently, theories of reading focus on the importance of spoken language, reading processes (e.g., word reading, inferencing whilst reading) and background knowledge (e.g., Ahmed et al., 2016; Gough & Tunmer, 1986; Perfetti & Stafura, 2014). Our findings demonstrate that theories need to take into account how reading experience interacts with knowledge and skills in the development of reading (cf., Nation, 2017).

Although leisure reading was significantly correlated with reading comprehension, when these factors were modeled together with vocabulary and word reading ability, leisure reading at age 11 did not significantly predict subsequent reading comprehension ability. This initially appears to contrast with several longitudinal studies that have found evidence for a strong link from leisure reading to reading comprehension (e.g., Locher & Pfof, 2020; Torppa et al., 2020). Nevertheless, previous findings are somewhat mixed, with a weaker relationship observed in other studies (e.g., Erbeli et al., 2020). Our study adds to this evidence base and suggests that the relationship between leisure reading and reading comprehension ability may be partly explained by vocabulary knowledge. Given that we observed a direct pathway from leisure reading to vocabulary, and that vocabulary is essential for reading comprehension (e.g., Ricketts et al., 2020), previous findings could reflect a more complex interplay between leisure reading, vocabulary knowledge and reading comprehension that could not be observed without vocabulary measurement. For example, leisure reading may build vocabulary, which in turn strengthens comprehension, a testable hypothesis that could be addressed in future studies that also include subsequent measures of reading comprehension.

We also observed a direct predictive effect of word reading on vocabulary and reading comprehension outcomes, even when accounting for vocabulary and letter knowledge prior to the onset of reading instruction. This finding highlights the importance of fast and accurate retrieval of words for facilitating text comprehension. These findings also suggest that the quality of existing lexical representations is key to integrating new words in the lexicon. Specifically, both word reading speed and vocabulary knowledge reflect lexical integrity, where fast and efficient retrieval of word forms and meanings reflects high quality representations (Yap et al., 2009). According to this view, a person's accuracy and efficiency of word reading is an indicator of their orthographic and phonological knowledge and the robustness of the connections between these representations. The more high-quality representations someone has, the easier it is for them to integrate novel (semantic) representations in the mental lexicon (James et al., 2017; Mak & Twitchell, 2020). In sum, the more proficient someone is at word reading, the easier it is for them to develop and refine their vocabulary knowledge from written text.

Before considering the theoretical and practical implications of our findings, it is worth mentioning some potential weaknesses. We were not able to model the stability of our measures over time. For instance, a random intercept cross lagged panel model (RI-CLPM), would have allowed us to model autoregressive effects of all variables and to model both within and between-person change (see, Hamaker et al., 2015; Torppa et al., 2020). However, this approach would have required reading comprehension measures from at least three testing points. In addition, we were not able to fit this model because our variables showed strong correlations with each other and limited growth over time (cf., Ricketts et al., 2020). To test this model in the future, it may be necessary to measure vocabulary and reading development over a longer timeframe, or with greater spacing between measurements. Nevertheless, we did include early indicators of reading and vocabulary to capture autoregressor effects. Both early letter knowledge and vocabulary at age 4 predicted reading comprehension and vocabulary at age 12. Whilst this shows the strong stability of reading and vocabulary knowledge over time, we were unable to include an early indicator of reading experience at age 4 (e.g., home literacy environment).

An important next step for research will be to test both the direct pathways between word reading, reading experience, vocabulary and comprehension and the indirect mediating role of reading experience in an experimental design that is causally sensitive. For example, by intervening to increase word reading or reading amount, and measuring impacts on leisure reading, vocabulary and reading comprehension. Such research would also provide important practical insights about how to promote reading and language skills. Indeed, our findings suggest that we should continue to provide support for word reading abilities in late childhood and early adolescence, and that doing so may promote leisure reading, vocabulary knowledge and reading comprehension ability. There is strong evidence about how to improve basic word reading skills (e.g., Snowling & Hulme, 2011). However, these interventions have focused on younger children and it is important to consider carefully whether they translate to readers aged 10 years and above (Clarke et al., 2017). Further, our findings also point to the importance to targeting the amount of reading. Here, there is very little evidence about what will be efficacious with

children and adolescents (see, McGeown et al., 2015). There is a clear need for research that evaluates interventions aimed at increasing reading skill and reading amount in adolescents, if we are to further our theoretical understanding of reading and develop practical strategies for instruction and support.

## Conclusion

Our study showed that word reading ability is directly associated with both vocabulary and reading comprehension in early adolescence. Further, the extent to which children engage in leisure reading mediates the relation between word reading and vocabulary knowledge: better readers read more in their spare time, with positive effects on vocabulary knowledge. Our findings are important as they provide crucial evidence for the role of reading experience in the development of vocabulary knowledge. Theoretical approaches tend to focus on language and reading skills and processes, neglecting the importance of experience as it accumulates over development (but see, Nation, 2017). Our findings also lead to a testable hypothesis that intervening to support word reading skills in early adolescence should benefit vocabulary knowledge directly, and indirectly through the amount of leisure reading.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

This study is supported by the Nuffield Foundation [EDO/43287]; investigators Shapiro (PI), Ricketts and Burgess.

## ORCID

Sanne W. van der Kleij  <http://orcid.org/0000-0002-2749-3015>

Adrian P. Burgess  <http://orcid.org/0000-0002-0977-8105>

Jessie Ricketts  <http://orcid.org/0000-0002-2760-3990>

Laura R. Shapiro  <http://orcid.org/0000-0002-3276-457X>

## Data availability statement

The data for this project are openly available in the UK Data Archive: <https://reshare.ukdataservice.ac.uk/853894/>

## References

- Ahmed, Y., Francis, D. J., York, M., Fletcher, J. M., Barnes, M., & Kulesz, P. (2016). Validation of the direct and inferential mediation (DIME) model of reading comprehension in grades 7 through 12. *Contemporary Educational Psychology, 44-45*, 68–82. <https://doi.org/10.1016/j.cedpsych.2016.02.002>
- Bornstein, M. H., Hahn, C.-S., Putnick, D. L., & Suwalsky, J. T. D. (2014). Stability of core language skill from early childhood to adolescence: A latent variable approach. *Child Development, 85*(4), 1346–1356. <https://doi.org/10.1111/cdev.12192>
- Cain, K., & Oakhill, J. (2011). Matthew effects in young readers: Reading comprehension and reading experience aid vocabulary development. *Journal of Learning Disabilities, 44*(5), 431–443. <https://doi.org/10.1177/0022219411410042>
- Cain, K., Oakhill, J., & Lemmon, K. (2004). Individual differences in the inference of word meanings from context: The influence of reading comprehension, vocabulary knowledge, and memory capacity. *Journal of Educational Psychology, 96*(4), 671–681. <https://doi.org/10.1037/0022-0663.96.4.671>
- Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest, 19*(2), 5–51. <https://doi.org/10.1177/1529100618786959>
- Clarke, P. J., Paul, S. A. S., Smith, G., Snowling, M. J., & Hulme, C. (2017). Reading intervention for poor readers at the transition to secondary school. *Scientific Studies of Reading, 21*(5), 408–427. <https://doi.org/10.1080/10888438.2017.1318393>

- Cunningham, A. J., Burgess, A. P., Witton, C., Talcott, J. B., & Shapiro, L. R. (2020). Dynamic relationships between phonological memory and reading: A five year longitudinal study from age 4 to 9. *Developmental Science*, 24(1), e12986. <https://doi.org/10.1111/desc.12986>
- Cunningham, A. E., & Stanovich, K. E. (1998). What reading does for the mind. *American Educator*, 22(1–2), 8–15.
- Cunningham, A. J., Witton, C., Talcott, J. B., Burgess, A. P., & Shapiro, L. R. (2015). Deconstructing phonological tasks: The contribution of stimulus and response type to the prediction of early decoding skills. *Cognition*, 143, 178–186. <http://dx.doi.org/10.1016/j.cognition.2015.06.013>
- Duff, D., Tomblin, J. B., & Catts, H. (2015). The influence of reading on vocabulary growth: A case for a Matthew effect. *Journal of Speech Language and Hearing Research*, 58(3), 853–864. [https://doi.org/10.1044/2015\\_JSLHR-L-13-0310](https://doi.org/10.1044/2015_JSLHR-L-13-0310)
- Dunn, L. M., & Dunn, D. M., & NFER. (2009). *British picture vocabulary scale - Third Edition* (3rd ed.). GL Assessment Ltd.
- Echols, L. D., West, R. F., Stanovich, K. E., & Zehr, K. S. (1996). Using children's literacy activities to predict growth in verbal cognitive skills: A longitudinal investigation. *Journal of Educational Psychology*, 88(2), 296–304. <https://doi.org/10.1037/0022-0663.88.2.296>
- Elliot, C. D., Smith, P., & McCulloch, K. (1996). *British ability scales II*. NFER-Nelson.
- Erbeli, F., van Bergen, E., & Hart, S. A. (2020). Unraveling the relation between reading comprehension and print exposure. *Child Development*, 91(5), 1548–1562. <https://doi.org/10.1111/cdev.13339>
- Foorman, B. R., Herrera, S., Petscher, Y., Mitchell, A., & Trueman, A. (2015). The structure of oral language and reading and their relation to comprehension in Kindergarten through Grade 2. *Reading and Writing*, 28(5), 655–681. <https://doi.org/10.1007/s11145-015-9544-5>
- Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education*, 7(1), 6–10. <https://doi.org/10.1177/074193258600700104>
- Hamaker, E. L., Kuiper, R. M., & Grasman, R. P. (2015). A critique of the cross-lagged panel model. *Psychological Methods*, 20(1), 102–116. <https://doi.org/10.1037/a0038889>
- Harlaar, N., Deater-Deckard, K., Thompson, L. A., Dethorne, L. S., & Petrill, S. A. (2011). Associations between reading achievement and independent reading in early elementary school: A genetically informative cross-lagged study. *Child Development*, 82(6), 2123–2137. <https://doi.org/10.1111/j.1467-8624.2011.01658.x>
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- James, E., Gaskell, M. G., Weighall, A., & Henderson, L. (2017). Consolidation of vocabulary during sleep: The rich get richer? *Neuroscience & Biobehavioral Reviews*, 77, 1–13. <https://doi.org/10.1016/j.neubiorev.2017.01.054>
- Joseph, H., & Nation, K. (2019). Examining incidental word learning during reading in children: The role of context. *Journal of Experimental Child Psychology*, 166, 190–211. <https://doi.org/10.1016/j.jecp.2017.08.010>
- Kavanagh, L. (2019). Relations between children's reading motivation, activity and performance at the end of primary school. *Journal of Research in Reading*, 42(3–4), 562–582. <https://doi.org/10.1111/1467-9817.12284>
- Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology*, 100(1), 150–161. <https://doi.org/10.1037/0022-0663.100.1.150>
- Language and Reading Research Consortium. (2015). Learning to read: Should we keep things simple? *Reading Research Quarterly*, 50(2), 151–169. <https://doi.org/10.1002/rrq.99>
- Larsen, L., Kohnen, S., McArthur, G., & Nickels, L. (2011). *Letter-sound test (LeST)*. Macquarie University.
- Leppänen, U., Aunola, K., & Nurmi, J. E. (2005). Beginning readers' reading performance and reading habits. *Journal of Research in Reading*, 28(4), 383–399. <https://doi.org/10.1111/j.1467-9817.2005.00281.x>
- Lervåg, A., Hulme, C., & Melby-Lervåg, M. (2018). Unpicking the developmental relationship between oral language skills and reading comprehension: It's simple, but complex. *Child Development*, 89(5), 1821–1838. <https://doi.org/10.1111/cdev.12861>
- Locher, F. M., & Pfost, M. (2020). The relation between time spent reading and reading comprehension throughout the life course. *Journal of Research in Reading*, 43(1), 57–77. <https://doi.org/10.1111/1467-9817.12289>
- Mak, M. H. C., & Twitchell, H. (2020). Evidence for preferential attachment: Words that are more well connected in semantic networks are better at acquiring new links in paired-associate learning. *Psychonomic Bulletin & Review*, 27(5), 1059–1069. <https://doi.org/10.3758/s13423-020-01773-0>
- Martin, M. O., Mullis, I. V., & Kennedy, A. M. (2007). Progress in International Reading Literacy Study (PIRLS): PIRLS 2006 Technical Report. International Association for the Evaluation of Educational Achievement.
- McGeown, S. P., Duncan, L. G., Griffiths, Y. M., & Stothard, S. E. (2015). Exploring the relationship between adolescent's reading skills, reading motivation and reading habits. *Reading and Writing*, 28(4), 545–569. <https://doi.org/10.1007/s11145-014-9537-9>
- McGeown, S. P., Norgate, R., & Warhurst, A. (2012). Exploring intrinsic and extrinsic reading motivation among very good and very poor readers. *Educational Research*, 54(3), 309–322. <https://doi.org/10.1080/00131881.2012.710089>

- McGeown, S. P., Osborne, C., Warhurst, A., Norgate, R., & Duncan, L. G. (2016). Understanding children's reading activities: Reading motivation, skill and child characteristics as predictors. *Journal of Research in Reading*, 39(1), 109–125. <https://doi.org/10.1111/1467-9817.12060>
- Mol, S. E., & Bus, A. G. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin*, 137(2), 267–296. <https://doi.org/10.1037/a0021890>
- Nagy, W. E., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, 19(3), 304–330. <https://doi.org/10.2307/747823>
- Nagy, W. E., Anderson, R. C., & Herman, P. A. (1987). Learning word meanings from context during normal reading. *American Educational Research Journal*, 24(2), 237–270. <https://doi.org/10.3102/00028312024002237>
- Nagy, W. E., Herman, P. A., & Anderson, R. C. (1985). Learning words from context. *Reading Research Quarterly*, 20(2), 233–253. <https://doi.org/10.2307/747758>
- Nation, K. (2017). Nurturing a lexical legacy: Reading experience is critical for the development of word reading skill. *Npj Science of Learning*, 2(1), 1–4. <https://doi.org/10.1038/s41539-017-0004-7>
- Noble, S., McLennan, D., Noble, M., Plunkett, E., Gutacker, N., Silk, M., & Wright, G. (2019). *The English indices of deprivation 2019*. Ministry of Housing, Communities and Local Government. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/833947/1oD2019\\_Research\\_Report.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833947/1oD2019_Research_Report.pdf)
- Perfetti, C., & Hart, L. (2002). The lexical quality hypothesis. In L. Verhoeven, C. Elbro, & P. Reitsma (Eds.), *Precursors of functional literacy* (Vol. 11). John Benjamins Publishing Company. (pp. 67–86).
- Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. J. Snowling & C. Hulme (Eds.), *Blackwell handbooks of developmental psychology. The science of reading: A handbook* (pp. 227–247). Blackwell Publishing. <https://doi.org/10.1002/9780470757642.ch13>
- Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading*, 18(1), 1–16. <https://doi.org/10.1080/10888438.2013.827687>
- Pfost, M., Dörfler, T., & Artelt, C. (2013). Students' extracurricular reading behavior and the development of vocabulary and reading comprehension. *Learning and Individual Differences*, 26, 89–102. <https://doi.org/10.1016/j.lindif.2013.04.008>
- Quinn, J. M., Wagner, R. K., Petscher, Y., & Lopez, D. (2015). Developmental relations between vocabulary knowledge and reading comprehension: A latent change score modeling study. *Child Development*, 86(1), 159–175. <https://doi.org/10.1111/cdev.12292>
- R Core Team. (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <http://www.R-project.org/>
- Ricketts, J., Bishop, D. V. M., Pimperton, H., & Nation, K. (2011). The role of self-teaching in learning orthographic and semantic aspects of new words. *Scientific Studies of Reading*, 15(1), 47–70. <https://doi.org/10.1080/10888438.2011.536129>
- Ricketts, J., Lervåg, A., Dawson, N., Taylor, L. A., & Hulme, C. (2020). Reading and oral vocabulary development in early adolescence. *Scientific Studies of Reading*, 24(5), 380–396. <https://doi.org/10.1080/10888438.2019.1689244>
- Rossee, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, 48(2), 1–36. <https://doi.org/10.18637/jss.v048.i02>
- Schiefele, U., Schaffner, E., Möller, J., & Wigfield, A. (2012). Dimensions of reading motivation and their relation to reading behavior and competence. *Reading Research Quarterly*, 47(4), 427–463. <https://doi.org/10.1002/RRQ.030>
- Sénéchal, M. (2006). Testing the home literacy model: Parent involvement in kindergarten is differentially related to grade 4 reading comprehension, fluency, spelling, and reading for pleasure. *Scientific Studies of Reading*, 10(1), 59–87. [https://doi.org/10.1207/s1532799xssr1001\\_4](https://doi.org/10.1207/s1532799xssr1001_4)
- Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, 55(2), 151–218. [https://doi.org/10.1016/0010-0277\(94\)00645-2](https://doi.org/10.1016/0010-0277(94)00645-2)
- Snowling, M. J., & Hulme, C. (2011). Interventions for children's language and literacy difficulties. *International Journal of Language & Communication Disorders*, 47(1), 27–34. <https://doi.org/10.1111/j.1460-6984.2011.00081.x>
- Spear-Swerling, L., Brucker, P. O., & Alfano, M. P. (2010). Relationships between sixth-graders' reading comprehension and two different measures of print exposure. *Reading and Writing*, 23(1), 73–96. <https://doi.org/10.1007/s1145-008-9152-8>
- Stothard, S., Hulme, C., Clarke, P. J., Barnby, P., & Snowling, M. (2010). *The York Assessment of Reading for Comprehension (YARC): Passage reading secondary*. GL Assessment.
- Sullivan, A., & Brown, M. (2015). Reading for pleasure and progress in vocabulary and mathematics. *British Educational Research Journal*, 41(6), 971–991. <https://doi.org/10.1002/berj.3180>
- Torppa, M., Niemi, P., Vasalampi, K., Lerkkanen, M. K., Tolvanen, A., & Poikkeus, A. M. (2020). Leisure reading (but not any kind) and reading comprehension support each other—A longitudinal study across grades 1 and 9. *Child Development*, 91(3), 876–900. <https://doi.org/10.1111/cdev.13241>
- van Bergen, E., Snowling, M. J., de Zeeuw, E. L., van Beijsterveldt, C. E. M., Dolan, C. V., & Boomsma, D. I. (2019). Why do children read more? The influence of reading ability on voluntary reading practices. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 59(11), 1205–1214. <https://doi.org/10.1111/jcpp.12910>

- Verhoeven, L., van Leeuwe, J., & Vermeer, A. (2011). Vocabulary growth and reading development across the elementary school years. *Scientific Studies of Reading, 15*(1), 8–25. <https://doi.org/10.1080/10888438.2011.536125>
- Wagner, R. K., & Meros, D. (2010). Vocabulary and reading comprehension: Direct, indirect, and reciprocal influences. *Focus on Exceptional Children, 2010*, 1G1–245473138.
- Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (2011). *Test of word reading efficiency (Second Edition (TOWRE-2) ed.)*. Pro-Ed.
- Yap, M. J., Tse, C. S., & Balota, D. A. (2009). Individual differences in the joint effects of semantic priming and word frequency revealed by RT distributional analyses: The role of lexical integrity. *Journal of Memory and Language, 61*(3), 303–325. <https://doi.org/10.1016/j.jml.2009.07.001>