Impact of word-to-text integration processes on reading comprehension development in English as a second language

Mulder, E.; van de Ven, M.; Segers, E.; Krepel, A.; de Bree, E.H.; de Jong, P.F.; Verhoeven, L.

DOI
10.1111/1467-9817.12441

Publication date
2024

Document Version
Final published version

Published in
Journal of Research in Reading

Journal of Research in Reading
UKLA
The United Kingdom Literacy Association

Journal of Research in Reading, ISSN 0141-0423
Volume 47, Issue 1, 2024, pp 83–102
DOI:10.1111/1467-9817.12441

Impact of word-to-text integration processes on reading comprehension development in English as a second language

Evelien Mulder

Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

Marco van de Ven

Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

Eliane Segers

Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

Alexander Krepel

Kohnstamm Institute, Amstelveen, The Netherlands

Elise H. de Bree

Education and Pedagogy – Development & Education of Youth in Diverse Societies, Utrecht University, Utrecht, The Netherlands

Peter F. de Jong

Research Institute of Child Development and Education, University of Amsterdam, Amsterdam, The Netherlands

Ludo Verhoeven

Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

Background: Word-to-text integration (WTI) can be challenging for second-language (L2) learners, although it can positively contribute to reading comprehension. The present study examined the role of WTI, after controlling for decoding, vocabulary and morphosyntactic awareness, in predicting English as an L2 reading comprehension development in 441 Dutch seventh-grade students.
Methods: At the beginning (Time 1 [T1]) and the end (Time 2 [T2]) of the school year, students were tested on their English decoding, vocabulary, morphological and syntactic awareness and reading comprehension with paper-and-pencil tasks and on WTI with a self-paced reading task with reading times being compared on passages with unknown versus known words and passages with and without anomalies.
Results: Mediation analyses showed small indirect effects of processing argument overlap and anomalies on T2 reading comprehension, via T1 reading comprehension.

Conclusions: WTI explained unique variance in reading comprehension at T2 via reading comprehension at T1, suggesting that it moderately impacts initial stages of reading comprehension in English as a second language (ESL).

Keywords: reading comprehension, second language, word reading

Highlights

What is already known about this topic

- WTI is important for reading comprehension but challenging for L2 learners.
- Lexical skills are also important for reading comprehension.

What this paper adds

- Novice L2 learners can distinguish between passages with unknown and known words and with and without anomalies (WTI).
- These WTI skills have small effects on reading comprehension development.

Implications for theory, policy or practice

- WTI can provide unique insights into reading comprehension development of L2 learners.
- These insights can inform our understanding of why some students with sufficient lexical skills nevertheless show insufficient reading comprehension skills.

Reading comprehension is the complex process of understanding a text. The goal of reading comprehension is to form mental representations of texts (Kintsch, 1988). According to the Reading Systems Framework (Perfetti & Stafura, 2014), one important process in forming these mental representations is word-to-text integration (WTI): the ability to integrate separate words into the meaning of the rest of the text. WTI requires readers to deal with the challenges that texts may pose, such as reading unknown words or determining whether a word is anomalous in a certain context. WTI has been studied in many ways: within and across sentence boundaries, examining various relationships between words, using different techniques and in various participant groups (Burkhardt, 2006; Ditman et al., 2007; Hessel et al., 2021; Hessel & Schroeder, 2022; Kuperberg et al., 2011; Kutas & Hillyard, 1980; Yang et al., 2005, 2007). These studies have in common that WTI is proposed to become more effortful as the text poses more challenges on the reader: for example, because of the presence of unknown (Hessel & Schroeder, 2022) or anomalous words (Kutas & Hillyard, 1980). Such adaptations in WTI have been proposed to be reflected in higher event-related potential (ERP) amplitudes and longer reading times (RTs). WTI – and as a result reading comprehension (Lesaux et al., 2006) – may be particularly challenging for novice English as a second language (L2; ESL) learners: They could have a hard time identifying words in the text, because of insufficient reading fluency (Melby-Lervåg

& Lervåg, 2014). Furthermore, L2 readers often have less vocabulary knowledge than first-language (L1) learners (Melby-Lervåg & Lervåg, 2014). This makes it more difficult to understand texts and requires readers to infer the meaning of unknown words using the rest of a text. Also, because of their limited vocabulary knowledge, it may be hard for readers with low L2 vocabulary to detect anomalies when reading an L2 text (Hessel et al., 2021). Therefore, this study examined the unique influence of WTI on the reading comprehension development after controlling for decoding, vocabulary and morphosyntactic awareness in novice ESL learners.

WTI Across Manipulations and Readers

Previous studies have operationalised WTI – or effortful reading – using diverse stimuli and paradigms in L1 adults with various outcomes as a result. For example, several studies examined WTI looking at the extent to which reading was effortful as a result of semantic manipulations, using ERPs in adult L1 learners. The texts were multi-sentence passages that varied in complexity because of causal coherence (Kuperberg et al., 2011) or because of the ease with which semantic anaphors could be solved (Ditman et al., 2007). Studies examining given over new information found that integration is easier with given compared to new information with determiner phrases in two-sentence passages (Burkhardt, 2006).

When establishing how WTI can best be measured in novice L2 learners, it should be taken into account that novice L2 learners often have low vocabulary (Melby-Lervåg & Lervåg, 2014) and may particularly often have to bind words through lexical inferencing due to argument overlap (Perfetti et al., 2008). Lexical inferencing can be described as 'making informed guesses as to the meaning of a word, in light of all available linguistic cues in combination with the learner's general knowledge of the world, her awareness of context and her relevant linguistic knowledge' (Haastrup, 1991, p. 40). Argument overlap has been examined in the light of the construction–integration (CI) model by Kintsch (1988). According to the CI model, three levels of representation arise when a text is read: the surface structure of a text, the text base and propositions, and a situation model. The situation model includes inferences that need to be made about information that is not explicitly mentioned in text (McNamara & Magliano, 2009). It could be hypothesised that integrating unknown words into the situation model of the text requires readers to make an inference about the meaning based on the context of a passage that requires effortful reading, whereas a repetition of a known word requires less reading effort. In other words, the degree of inferencing required may reflect a form of integration complexity.

Readers need not only make inferences during text comprehension; they also aim to establish links between read concepts to achieve local coherence (Graesser et al., 1997). This could again be particularly challenging for novice L2 learners (e.g., Hessel et al., 2021). *Anomaly detection* is the process in which readers need to detect discontinuities in text. In order to comprehend language, readers constantly update their mental representations of a text, integrating semantics of separate words into the sentence context (Hagoort, 2017; Kutas & Hillyard, 1980). Anomalous sentences have been shown to elicit larger N400 effects in adult L1 learners (van Berkum et al., 1999), indicating integration difficulty, than passages without anomalies.

The aforementioned studies demonstrated that complexities in the texts invoked more effortful reading, which was reflected by ERP amplitudes in L1 adult readers, compared to one or multiple baseline conditions, but outcomes may be different for (novice) L2 learners. In the studies, L1 and L2 readers of English read English passages ending in either an expected or unexpected noun. Participants' ability to predict the upcoming noun was indexed by the amplitude of the N400, with a more negative N400 suggesting less prediction of the final word. L2 readers did not show an increase, whereas L1 readers did. This inability to anticipate on requirements of the text could be perhaps even more the case for novice L2 learners, who are less fluent in reading and have smaller vocabularies (Melby-Lervåg & Lervåg, 2014). Hessel et al. (2021) compared 9- to 10-year-old children who were L1 learners of English with L2 learners of English (who spoke a variety of L1s). Participants read English texts with consistent words (e.g., 'the puppy is barking') versus inconsistent words (e.g., 'The kitten is barking'), and their eye movements were measured. All participants reread inconsistent texts; however, there were no differences in rereading behaviour between L1 and L2 readers. Regardless of language status, individual differences in decoding and vocabulary were associated with variation in WTI: Better decoding was associated with faster reading, and children with larger vocabularies showed more effortful reading (as reflected by rereading of passages). Furthermore, 13- to 17-year-old L2 learners indeed showed increased rereading of inconsistent versus consistent text. (Hessel & Schroeder, 2022). To summarise, processing complex text requires readers to either slow down or reread, compared to reading a baseline passage. In the present study, we examined how novice L2 learners read unknown versus known words and anomalous versus continuous words and whether they were indeed able to adapt their reading behaviour to the needs of the text.

Not only the types of stimuli and measures used to operationalise WTI are relevant for the outcomes: Individual differences between readers should also be taken into account. Although the aforementioned studies controlled for some other predictors, such as decoding accuracy (Ehri et al., 2001) and vocabulary (Hirsh & Nation, 1992), they did not control for morphological (Carlisle, 1995) and syntactic awareness (Cain, 2007). Controlling for these predictors is important, because according to the lexical quality hypothesis, retrieval of words while reading text depends on the robustness with which their orthographic, phonological and semantic features are represented in the mental lexicon (Perfetti & Hart, 2002). In order to comprehend text, readers need sufficient vocabulary knowledge (Hirsh & Nation, 1992). Furthermore, morphological awareness (i.e., the awareness of the smallest meaningful units in words; Carlisle, 1995) could facilitate reading comprehension. Using morphological cues in a word, that is, morphological inferencing, can be utilised to uncover the meaning of an unknown word (Haastrup, 1991). The relationship between a word and other words in text can be determined once this word has been identified and can be integrated into a mental representation of the text (Perfetti & Stafura, 2014). Morphological knowledge (Kieffer & Lesaux, 2012; Shahar-Yames et al., 2018) is often a relative strength (compared to other language skills) in L2 learners. Moreover, syntactic awareness (i.e., the ability to reflect on and manipulate grammatical structures) has been found to contribute to reading comprehension. For example, in 8- to 10-year-old L1 learners, syntactic awareness explains variance in reading comprehension after controlling for, among others, vocabulary size (Cain, 2007). All of the aforementioned results are also in line with the Reading Systems Framework (Perfetti & Stafura, 2014) in which reading comprehension is proposed to emerge from processes on a word identification level and WTI level. In agreement with the lexical quality hypothesis, word identification is established through activating orthographic, phonological and semantic units. This process of word identification interacts with WTI processes, during which a sentence representation is constructed and, as a result, a text and situation model can be constructed.

Measuring the Online Nature of WTI

In previous studies, larger ERPs, rereading and longer RTs were considered indicators of attempts to integrate words into texts, and more effortful reading was observed on complex compared to baseline passages (Hessel & Schroeder, 2022; Kuperberg et al., 2011; Kutas & Hillyard, 1980; Yang et al., 2005). Therefore, in the present study, we examined processing costs (Mulder et al., 2020) with the use of word-by-word self-paced reading (Graesser et al., 1997). A graphical overview of the design of the task with example passages is displayed in Figure 1. The stimuli had two text types, 'argument overlap' and 'anomaly detection'. Each had 12 stimuli to invoke more effortful reading, and each stimulus was paired with a baseline, which should invoke less effortful reading. Within a pair, passages were identical, except for the target word, which was proposed to invoke either more or less effortful reading (in line with Bultena et al., 2015). First, the argument overlap passages required students to read known words (less effort) or read an unknown word (more effort) and make a lexical inference about the meaning using the rest of the passage (Haastrup, 1991). Second, during the anomaly detection passages, students read passages either with (more effort) or without an anomaly (less effort). In line with previous studies, we reasoned that the unknown and anomalous passages required students to read with more effort, that is, slow down, whereas they could keep their reading pace constant while reading passages with known words and without anomalies. In other words, readers who were good at WTI showed a larger difference between the passages. Indeed, better WTI abilities at the beginning of the school year, as reflected by larger processing costs for unknown and anomalous words compared to passages with known words and continuous passages, were found to be related to better reading comprehension skills (Mulder et al., 2020).

The Present Study

In summary, WTI is a multidimensional process that relies on different levels of linguistic representation and that may show variation within novice L2 learners, due to individual differences in skills underlying WTI and reading comprehension (e.g., Hessel et al., 2021; Hessel & Schroeder, 2022). Argument overlap and anomaly detection can be considered

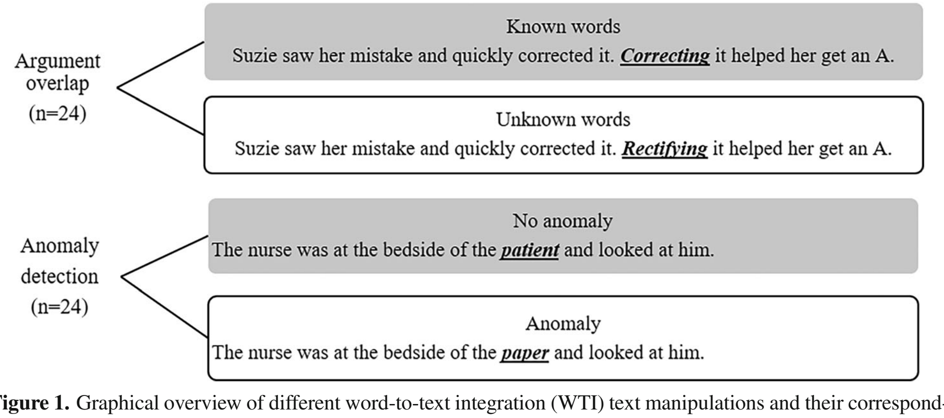

Figure 1. Graphical overview of different word-to-text integration (WTI) text manipulations and their corresponding baseline and manipulated sentence passage. Targets are underlined, printed in bold and in italics.

reflections of complexity during the WTI process but have been examined only separately without controlling for a combination of other predictors of reading comprehension.

WTI ability appears to be related to reading comprehension in novice ESL learners, as shown by Mulder et al. (2020). The question arises what the unique contribution of such measures of WTI is to reading comprehension development, after controlling for learners' decoding accuracy and vocabulary, syntactic and morphological awareness. Therefore, we measured students' decoding accuracy, vocabulary size, morphological and syntactic awareness and both WTI processing and WTI speed (reading fluency) just after the beginning (Time 1 [T1]) and near to the end (Time 2 [T2]) of the school year. All measures were in English. WTI processing reflected WTI specificity, by comparing RTs on complex versus baseline passages. On top of that, WTI speed, examined by observing RTs, is an indication of WTI fluency. An overview of the WTI task can be found in Figure 1. Reading comprehension in English is one of the main goals in Dutch secondary education, and Dutch students often enter secondary school with large individual differences in their English skills (Thijs et al., 2011). Therefore, we focused on Dutch seventh-grade (year when Dutch students enter secondary school) students' ESL skills.

In this study, two questions were addressed:

1 To what extent can reading comprehension development in ESL be predicted by decoding accuracy, vocabulary, and morphological and syntactic awareness (control predictors)?
2 What is the unique role of WTI in reading comprehension development after inclusion of control predictors?

As previous studies have shown that reading comprehension is dependent on decoding accuracy, vocabulary, morphosyntactic awareness and WTI, we used these measures (at T1) as predictors of T1 reading comprehension. Furthermore, empirical evidence supports that the proposed predictors indeed facilitate reading comprehension. Therefore, we created a mediation model (Hayes, 2014), with T2 reading comprehension as the dependent variable, T1 reading comprehension as the mediator and all other T1 predictors as independent variables. Regarding the first research question, we hypothesised that there would be indirect effects of all measures on T2 reading comprehension, through T1 reading comprehension. We expected the effect of decoding (Melby-Lervåg & Lervåg, 2014) and morphological awareness (Kieffer & Lesaux, 2012) to be the strongest, as these often vary largely between L2 readers. Our hypothesis for the second research question was that T1 WTI measures would uniquely predict T1 reading comprehension and T2 reading comprehension after controlling for its autoregressor and the other predictors of reading comprehension. As a modest amount of variation in reading comprehension was explained by WTI in a previous study (Mulder et al., 2020), we also expected a modest effect of WTI in the present study.

Methods

Participants

Participants of this study were 501 Dutch seventh-grade students in their first year of secondary education, of which 441 completed all measures at T1 and T2 and were thus included in further analyses (203 girls and 238 boys). The participants were between 11 and 13 years old (M = 12 years and 4 months; SD = 6 months). All participants followed ESL education in primary school. The education within primary school focuses on oral communication skills (Thijs et al., 2011), whereas, in secondary education, this is combined with language awareness elements. At study onset (November 2016; T1), students had received 3 months of formal English education at secondary school. At T2 (April 2017), this amount of education had increased to 8 months. We informed parents of all students included in the study, and parents could refuse their child's participation.

Materials

Reading Comprehension

A selection of items from a nationally standardised reading comprehension test (College voor Toetsen en Examens – Board for Assessment and Exams, 2016) was used to measure reading comprehension as a group test. The participants were instructed to read three different expository texts and answer questions. The task consisted of 12 items, which were 10 multiple-choice questions with three to five options and two open-ended questions. Reading comprehension was scored as follows: For each multiple-choice question, one answer was correct. A correct answer was granted 1 point and an incorrect answer or no answer 0 points. There were two questions that were not multiple choice: Item 5 and Item 10.2. After an introduction, in Question 5, students were asked: 'In what sentence has the writer mentioned this before?' They had to cite the two words of the start of this sentence. After an introduction, for Question 10.2, students were asked: 'Cite (=copy from the text) the first two and last two words from the full sentence, on which you base your answer.' For Questions 5 and 10.2, if students had indeed written down these two words or if they had written down the two words and the rest of the sentence, they were granted 1 point. A maximum of 12 points could be attained for reading comprehension. Students read the same texts at T1 and T2. Reliability of the reading comprehension measure was $\alpha = .66$, which can be considered acceptable (Kline, 1993). Reliability could not be further improved by omitting items.

Decoding Accuracy

Decoding accuracy was individually measured using the Sight Word Efficiency subtest of the Test of Word Reading Efficiency Second Edition (TOWRE; Torgesen et al., 2012). Students were presented with 109 regular and irregular English words of increasing difficulty (such as 'go' and 'embassy'). They were instructed to read these words as quickly and accurately as possible within 45 seconds. The decoding accuracy score was the number of words read aloud correctly, with a maximum of 109. In our sample, reliability was $\alpha = .88$, which can be considered excellent (Kline, 1993).

Vocabulary

To measure vocabulary, 60 items of the Peabody Picture Vocabulary Test (PPVT), Fourth Edition (Dunn & Dunn, 2007), were used as a group test. Every third item from Sets 1 to 15 was selected (resulting in four items from each of these sets). The test was administered in a classroom setting. For each item, words were read aloud by the researcher (e.g., *ball*) and students were to check the correct box of the picture, choosing from four options, that matched the word they heard. The maximum score was 60. Reliability of the PPVT was $\alpha = .77$ in the current sample, which is considered good (Kline, 1993).

Morphological Awareness

Morphological awareness was measured using the first two subtests of the Singson Tasks (Singson et al., 2000) following Siegel (2008) as a group test. The first subtest consisted of 10 multiple-choice items. Students were presented with a short sentence, in which a morpheme in the final word was omitted, for example: 'She hoped to make a good _____ A. impressive, B. impressionable, C. impression, D. impressively.' They were to choose out of four options which was the correct morpheme to complete the word. The second subtest was similar, except that students were to complete pseudowords, for example: 'I admire her _____ A. sufilive, B. sufilify. C. sufflation. D. sufilize'. The maximum score was 20. Reliability was $\alpha = .77$, which can be considered good (Kline, 1993).

Syntactic Awareness

Syntactic awareness was measured with an oral cloze task to measure syntactic awareness (Siegel, 2008) in a group setting. This task consisted of 20 cloze items. Students were presented with a sentence, in which one word was omitted, for example: 'The __________ put his dairy cows in the barn.' They were instructed to fill out a word that was semantically, grammatically and orthographically correct. Words that were semantically, syntactically and orthographically correct were granted 1 point. In the example sentence, 'farmer' is semantically, syntactically and orthographically correct. An example of a semantically incorrect answer is 'carrot', of a syntactically incorrect answer 'boys', as there is no anaphoric agreement between 'boys' and 'his', and of an orthographically incorrect answer 'farer'. The maximum score was 20. Reliability of this task was $\alpha = .79$, which is considered good (Kline, 1993).

WTI

To measure WTI, a computerised word-by-word self-paced reading task with a moving window paradigm was used (see Figure 1; Mulder et al., 2020) in Inquisit 4 (2015). Students read passages of two text types: argument overlap and anomaly detection. Argument overlap passages required readers to infer word meanings, while anomaly detection passages had anomalies, both demanding more effortful reading compared to passages with known words or passages without anomalies. Each passage had two versions, one for more effortful reading and one baseline for less effortful reading. This resulted in 12 pairs for each text type. In each pair, the passages were the same except for one word, which was designed to either increase or decrease reading effort. Using a within-subjects, between-items design, students were provided with either of the versions at T1 and vice versa at T2. After each passage, students were asked to answer a comprehension question (different for each type of text manipulation), in order to verify that they were actively reading.

Students' self-paced RTs were recorded on the target word, target plus 1 and target plus 2 (following Bultena et al., 2015; Mulder et al., 2020). These RTs were logged for all further analyses. WTI speed was reflected by the average logged RT on the target, target plus 1 and target plus 2, averaged across items, per text manipulation. This resulted in argument reading speed and anomaly reading speed. WTI processing ability was proposed to be reflected by the additional self-paced RT required to read the target, target plus 1 and target plus 2 in more effortful compared to less effortful passages (Mulder et al., 2020). We chose to create separate indices for the two text types and for each word position as to disentangle whether effortful on the target, target plus 1 or target plus 2 (Bultena et al., 2015; Mulder et al., 2020). For each text manipulation (argument overlap and anomaly detection) and word position (target, target plus 1 and target plus 2), we computed an index of WTI ability by dividing the RT on each effortful item by the average RT on all baseline passages, which served as a processing measure. To avoid a potential time confound, we only divided RTs collected at the same time point by each other. We illustrate the calculation with the following example:

Participant 1:

After being dropped from the plane, the bomb hit the ground and exploded. The detonation was quickly reported to the commander. (unknown word, T1)

Logged RT for Participant 1 reading the underlined target word in the unknown word passage above: 7.5

Mean logged RT for **all target words** in known word passages at T1 (i.e., a collective measure over all target words in known word passages): 6

WTI processing index:

Logged RT for given unknown target word (in this example 7.5)/mean RT across known target words (here 6) = 1.25

After being dropped from the plane, the bomb hit the ground and exploded. The explosion was quickly reported to the commander. (known word, T2)

In the example mentioned above, the reader indeed distinguished between the two passages: The reader took more time, that is, more effortful processing, on the passage with an unknown word than on the passages with a known word. In other words, the WTI processing index gives an indication of the additional processing cost for WTI of an unknown target word compared to that of a known target word. Larger scores are assumed to be indicative of more WTI processing difficulties. To have a manageable measure, we calculated the average of the index on each word position per text manipulation. Hence, the index for each word position separately was composed out of 12 scores, and the index for a text manipulation (taking together the average across word positions) consisted of three indices per word position, resulting in one index for argument processing and one index for anomaly processing.

The argument overlap passages, adapted from a study by Yang et al. (2007), always consisted of two sentences. One passage required the reader to derive the meaning of an unknown word from the context, that is, make an implicit inference, whereas the other passage contained an explicit repetition of a known word earlier in the passage. The passages were 12 to 19 words long. The target word was always placed at the beginning of the second sentence in the text passage and was between the 8th and 17th positions ($M = 11.38$, $SD = 2.66$). Reliability for argument processing was $\alpha = .79$, which can be considered acceptable (Kline, 1993). Anomaly detection passages were constructed for the purpose of this study and always consisted of one sentence. One passage contained an anomaly, whereas the other passage within this category did not. Passages were 7 to 14 words long. The target word was placed between the 4th and 10th positions in the passage ($M = 7.03$, $SD = 2.37$). Reliability for anomaly processing was $\alpha = .72$, which can be considered acceptable (Kline, 1993).

Procedure

The participants in this study were part of a larger, longitudinal study. Data were collected between November 2016 (T1) and April 2017 (T2). Participants were tested individually in a 45-minute session and in two plenary classroom setting sessions of 50 minutes at both time points. All tests were administered in a group setting, except for decoding and WTI, which were measured individually. During the WTI task, students were placed approximately 30 cm away from the computer screen. Words were presented in Consolas font, and students were instructed to read carefully and silently. They were told to do so at a normal pace, without trying to memorise the passages but merely to comprehend the passages and to answer a comprehension question after each passage. After the instruction, students were presented with practice trials, after which they were allowed to ask questions. Students received a 1-minute break after completing half of the passages. Trials were built up as follows: Students were presented with a screen that had a dash to represent each word of the passage and instructed to press the space bar when they had read the word. This word would disappear as a result, and the next word would appear. Measures for vocabulary, morphological and syntactic awareness and reading comprehension were administered during the classroom sessions. Except for WTI, all measures were paper-and-pencil tasks.

Analyses

We examined both direct and indirect effects of all predictors on reading comprehension, using mediation analysis with the PROCESS plug-in (Hayes, 2014) in SPSS 26 (IBM Corp, 2019). PROCESS uses ordinary least squares (OLS) regressions to calculate all effects: direct (independent to dependent), indirect (independent via mediator to dependent) and total (direct and indirect combined). Effects are calculated as unstandardised regression coefficients. T2 reading comprehension was the dependent variable and T1 reading comprehension the mediator. The independent variables were decoding, vocabulary, and morphological and syntactic awareness (control predictors) and the WTI measures: argument and anomaly processing and speed at T1. All direct effects of the T1 predictors on T2 reading comprehension can be interpreted as effects of the T1 independent variables on T2 reading comprehension at T2, while controlling for the effect of T1 reading comprehension (on T2 reading comprehension) (see Figure 2). Indirect effects of T1 predictors on T2 reading comprehension through T1 reading comprehension indicate how T1 predictors influence T1 reading comprehension and how this, in turn, influences T2 reading comprehension (see Figure 2). Total effects are combinations of both the direct and indirect effects of independent variables on the dependent variable (see Figure 2). Significance of indirect effects was evaluated using bootstrapped 95% confidence intervals, as these indirect effects often are not normally distributed (Hayes, 2014). Completely standardised indirect effects of the independent variables on T2 reading comprehension were reported as an indication of effects size of the indirect effects (Hayes, 2014). When the confidence interval does not include zero, the indirect effect is significant. Bootstrapping was set to 5000 cycles (Preacher & Hayes, 2004).

Results

Descriptive statistics and correlations are displayed in Tables 1 and 2. Reading comprehension significantly improved from T1 to T2, $t(427) = 4.99$ $p < .001$, Cohen's $d = 0.34$. We created a mediation model with decoding, vocabulary, and morphological and syntactic awareness (control predictors), argument processing and reading speed, and anomaly

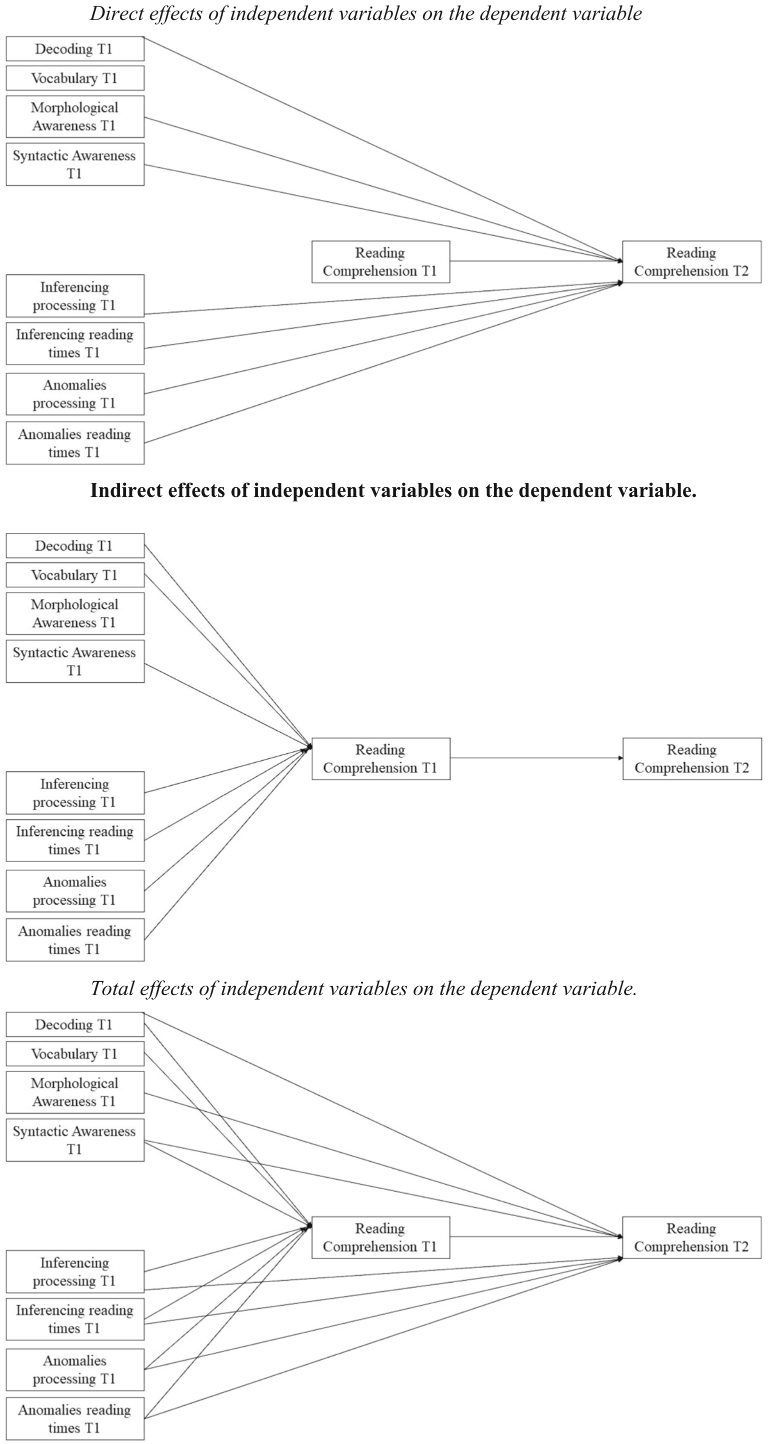

Figure 2. Graphical overview of hypothesised mediation model. Direct effects of independent variables on the dependent variable. Indirect effects of independent variables on the dependent variable. Total effects of independent variables on the dependent variable.

Table 1. Means and standard deviations of decoding, vocabulary, morphological awareness and syntactic awareness (control predictors); WTI: argument overlap and anomaly detection processing (WTI index) and speed (logged reading times) at T1; and RC at T1 and T2.

	M (*SD*)	Range	Skewness	Kurtosis
Control predictors				
1. Decoding	60.70 (10.57)	22–101	−0.24	0.70
2. Vocabulary	39.30 (5.99)	21–65	0.26	0.53
3. Morphological awareness	10.68 (4.06)	2–20	0.25	−0.90
4. Syntactic awareness	7.48 (4.16)	0–18	0.22	−0.66
WTI				
5. Argument processing	1.02 (0.03)	0.94–1.10	0.06	0.38
6. Argument reading speed	6.40 (0.27)	5.67–7.23	0.40	0.22
7. Anomaly processing	1.01 (0.02)	0.94–1.09	0.25	0.20
8. Anomaly reading speed	6.36 (0.27)	5.59–7.34	0.42	0.38
RC				
9. RC T1	5.35 (2.45)	0–12	0.03	−0.32
10. RC T2	6.22 (2.64)	0–12	−0.03	−0.48

Abbreviations: RC, reading comprehension; T1, Time 1; T2, Time 2; WTI, word-to-text integration.

processing and reading speed and examined all indirect effects through T1 reading comprehension and direct effects on T2 reading comprehension (see Figure 3). The correlations in Table 2 suggest that, except for argument reading speed, the predictors were significantly correlated with T1 and T2 reading comprehension. Furthermore, all control variables were correlated with one another, as were nearly all of the WTI measures, except for the processing and speed measures of argument overlap, which were not related to the speed and processing of the other WTI components, respectively. Outcomes of the mediation analyses are displayed in Table 3.

Relationship Between Control Predictors and Reading Comprehension

Total effects of decoding, morphological awareness and syntactic awareness on T2 reading comprehension were found. Interestingly, there was a direct effect of morphological awareness on T2 reading comprehension. There were no other direct effects on T2 reading comprehension. There were, however, indirect effects of decoding, vocabulary and syntactic awareness via reading comprehension at T1 on reading comprehension at T2. T1 decoding, vocabulary and syntactic awareness were significant predictors of T1 reading comprehension performance, which in turn predicted T2 reading comprehension. These results revealed an effect of T1 decoding, vocabulary and syntactic awareness on T2 reading comprehension, which is explained by mediation through T1 reading comprehension. It must be noted that all indirect effects, as reflected by completely standardised indirect effects (Hayes, 2014), were small. There is no evidence suggesting an effect of decoding,

Table 2. Correlations between decoding, vocabulary, morphological awareness and syntactic awareness (control predictors); WTI: argument overlap and anomaly detection processing (WTI index) and speed (logged reading times) at T1; and RC at T1 and T2.

	1	2	3	4	5	6	7	8	9
Control predictors									
1. Decoding	-								
2. Vocabulary	.47***	-							
3. Morphological awareness	.52***	.62***	-						
4. Syntactic awareness	.59***	.63***	.66***	-					
WTI									
5. Argument processing	.13**	.14**	.15**	.10*	-				
6. Argument reading speed	−.16**	−.01	−.10*	−.09	.13**	-			
7. Anomaly processing	.18***	.16***	.18***	.15**	.11*	.01	-		
8. Anomaly reading speed	−.08	.05	0	−.01	.08	.90***	0	-	
RC									
9. RC T1	.46***	.46***	.46***	.52***	.19***	.02	.12*	.10*	-
10. RC T2	.42***	.42**	.46***	.47***	.17***	.02	.16**	.07	.53***

Abbreviations: RC, reading comprehension; T1, Time 1; T2, Time 2; WTI, word-to-text integration.
*$p < .001$.
**$p < .05$.
***$p < .01$.

vocabulary and syntactic awareness on T2 reading comprehension independent of the mediation through T1 reading comprehension.

Relationship Between WTI and Reading Comprehension

There were no significant total or direct effects of the WTI measures on reading comprehension at T2. Argument processing and anomaly reading speed were significant predictors of T1 reading comprehension performance. These effects indicated that larger processing costs for passages with an unknown word compared to passages with a known word and faster RTs for anomaly detection were related to better reading comprehension. Similar to the control predictors, there were indirect effects of these WTI measures: T1 reading comprehension significantly mediated the effect between T1 argument processing and T2 reading comprehension, and between T1 anomaly reading speed and T2 reading comprehension. In other words, although there were no direct effects of the WTI measures on T2 reading comprehension, results revealed a mediation effect via T1 reading comprehension. It must be noted that all mediation effects, as reflected by completely standardised indirect effect (Hayes, 2014), were small.

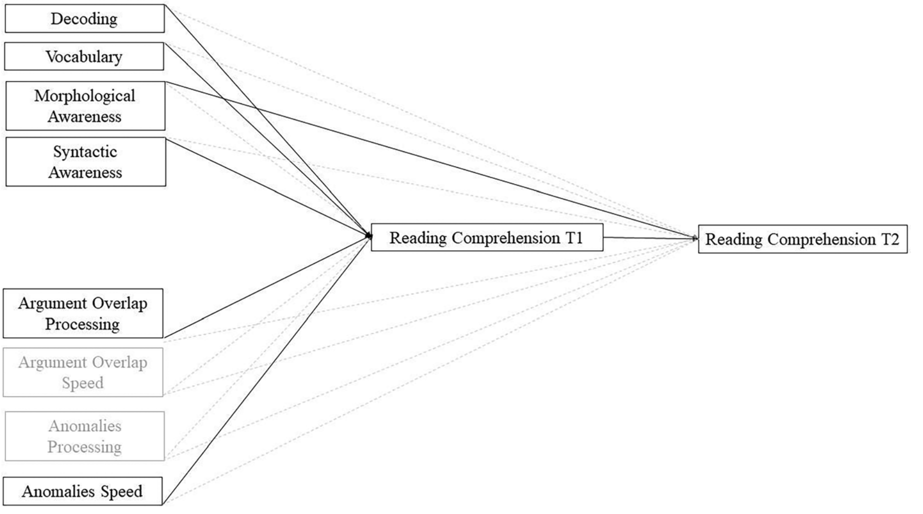

Figure 3. Graphical overview of mediation outcomes with reading comprehension at Time 2 (T2) as the dependent variable; decoding, vocabulary, morphological and syntactic awareness, argument processing and speed, and anomaly processing and speed at Time 1 (T1) as independent variables; and reading comprehension at T1 as a mediator. All black, solid arrows indicate significant paths. Nonsignificant paths are indicated with grey dotted arrows. Names of predictors that had no significant effects are displayed in grey.

Discussion

In this study, we examined the unique role of WTI for reading comprehension in novice ESL learners after controlling for other predictors of reading comprehension. We measured WTI using two different text types: In the argument overlap condition, students read passages with an unknown word, which required them to derive the meaning using the previous sentence and a passage that contained an explicit repetition of a known word. In the anomaly detection condition, students read passages with an anomaly, which required them to detect this word was implausible in this context (anomaly), and passages that contained a plausible word (no anomaly). WTI was proposed to be reflected by the fact that readers could keep their reading at the same pace when reading passages with known and plausible words, whereas they had to slow down when they read passages with unknown and implausible words; that is, they would show larger processing cost on these passages. The results showed that, in addition to the control predictors, processing cost of argument overlap and speed of anomaly detection predicted reading comprehension at T2, albeit indirectly via reading comprehension at T1, on top of the other predictors.

Our first hypothesis was that there would be indirect effects of all measures on T2 reading comprehension, through T1 reading comprehension. With the exception of morphological awareness, argument reading speed and anomaly processing, we found small indirect effects of all measures on T2 reading comprehension, through T1 reading comprehension. In more detail, we found that T2 reading comprehension was predicted by decoding, vocabulary, syntactic awareness, and processing cost of argument overlap and speed of anomaly detection via T1 reading comprehension. These results are largely in line with the lexical quality hypothesis (Perfetti & Hart, 2002): It seems that readers who have robust representations of words in the form of orthographic, phonological and semantic knowledge are able to decode words fluently and access word meanings from their lexicons

Table 3. Results of mediation analyses with reading comprehension at T2 as the dependent variable; decoding, vocabulary, and morphological and syntactic awareness (control predictors), argument processing and speed, and anomaly processing and speed at T1 as independent variables; and reading comprehension at T1 as a mediator.

Dependent variable	Independent variables	*B*	*SE*	*t*	*p*	R^2
Reading comprehension at T1	Decoding*	0.045	0.012	3.802	<.001	
	Vocabulary*	0.050	0.022	2.245	.025	
	Morphological awareness	0.054	0.034	1.567	.118	
	Syntactic awareness*	0.152	0.035	4.335	<.001	
	Argument processing*	10.394	3.864	2.690	.007	
	Argument reading speed	−0.920	0.851	−1.081	.280	
	Anomaly processing	−0.420	4.038	−0.104	.917	
	Anomaly reading speed*	1.733	0.814	2.130	.034	
						.359*
Reading comprehension at T2	Decoding	0.023	0.013	1.775	.077	
	Vocabulary	0.026	0.024	1.094	.275	
	Morphological awareness*	0.095	0.037	2.552	.011	
	Syntactic awareness	0.071	0.038	1.838	.067	
	Argument processing	4.816	4.186	1.151	.251	
	Argument reading speed	0.168	0.915	0.184	.854	
	Anomaly processing	4.429	4.338	1.021	.308	
	Anomaly reading speed	0.255	0.879	0.290	.772	
	Reading comprehension T1*	0.341	0.053	6.494	<.001	
						.366*
	Independent variables	*B*	*SE*	95% CI		CSIE
Mediation effects on RC2 via RC1	Decoding*	0.015	0.005	0.007	0.025	.061
	Vocabulary*	0.017	0.008	0.002	0.034	.039
	Morphological awareness	0.018	0.013	−0.005	0.045	.028
	Syntactic awareness*	0.052	0.014	0.026	0.082	.082
	Argument processing*	3.546	1.500	1.173	7.074	.035
	Argument reading speed	−0.314	0.296	−0.992	0.245	−.032
	Anomaly processing	−0.143	1.313	−2.828	2.458	−.001
	Anomaly reading speed*	0.591	0.287	0.102	1.239	.062

Abbreviations: CI, confidence interval; CSIE, completely standardised indirect effect; RC, reading comprehension; T1, Time 1; T2, Time 2.
*Significant at <.05.

and, in turn, have better reading comprehension skills. A study examining L1 adults also suggested that better lexical quality eases reading comprehension (Yang et al., 2005). Previous studies also demonstrated that syntactic awareness played an important role in reading comprehension, albeit as a mediator between vocabulary and reading comprehension in L1 and L2 learners (Raudszus et al., 2018). However, while L2 learners are often found to be skilled decoders, they also seem to be at risk for vocabulary and syntactic awareness problems (Melby-Lervåg & Lervåg, 2014). It must be noted that these studies mainly focused on L2 learners who were younger or older than the participants in this study. We only found an effect of T1 morphological awareness on T2 reading comprehension, in line with, for example, Deacon et al. (2014). Our results are also in line with the Reading Systems Framework: It seems that novice L2 readers can use resources on a word level – decoding, vocabulary knowledge and morphological awareness – and on a sentence level – syntactic awareness– to improve reading comprehension.

Our second hypothesis was that T1 WTI measures would uniquely predict T1 reading comprehension and T2 reading comprehension after controlling for its autoregressor and the other predictors of reading comprehension. Argument processing and anomaly reading speed were related to T1 reading comprehension and, in turn, to T2 reading comprehension, but these effects were small. Although we found direct effects of morphological awareness on T2 reading comprehension, no direct effects of WTI on T2 reading comprehension were found. This may be explained by the fact that the participants in this study were still in their early stages of learning ESL. Morphological awareness has been found to be a relative strength in novice L2 learners (Kieffer & Lesaux, 2012). Once the basic skills have been sufficiently developed, integration processes can start to play a part as well. WTI does predict T1 reading comprehension, but reading comprehension development seems to be fostered by the more basic skills.

We added to the existing body of literature by demonstrating that several WTI components are predictive of reading comprehension. Specifically, inferencing skills that need to be applied in the case of argument overlap have been found to differ between weak and poor comprehenders in the L1 (Yang et al., 2005), but no previous studies related inferencing processing to reading comprehension performance using standardised measures in novice L2 learners. Furthermore, this study examined inferencing in the case where novice L2 readers – who often have insufficient vocabulary knowledge (Melby-Lervåg & Lervåg, 2014) – had to read passages with unknown words. They had to use information from a previous sentence to make sense of the meaning of the unknown words. We demonstrated that students who show larger processing costs for passages with such an unknown word (implicit inference) compared to those with an explicit repetition of a known word also have better reading comprehension skills at T1 and, as a result, better reading comprehension skills at T2, although it should be noted that no comparison between groups took place. This means that those students who pause during reading to deal with demanding linguistic features of the text also have better reading comprehension skills than those who continue reading or do not distinguish between more and less demanding text. This may be explained by the fact that unknown words are more effortful compared to reading a known word. Students who distinguish between the two and indeed show more effort on passages with unknown than known words also have better T2 reading comprehension through T1 reading comprehension, in line with literature about L2 comprehension monitoring (e.g., Hessel et al., 2021). The fact that an effect of argument processing was present, while an effect of anomaly processing was absent, could be explained by the fact that, in the argument manipulation, students were to make an implicit inference combining information from two sentences. This could be considered a higher order process than detecting an anomaly within one sentence.

The effects of anomaly reading speed are in line with previous studies. These studies suggest that reading anomalies may result in different reading behaviour than reading non-anomalous passages (van Berkum et al., 1999) and that inconsistent passages invoked different reading than consistent passages (Hessel et al., 2021), showing the relationship between reading accuracy and fluency to reading comprehension. However, no effects of the processing costs of anomaly detection on reading comprehension were found.

With regard to the speed of anomaly detection, previous studies have demonstrated that reading anomalous passages with subtle indications of anomalies may result in different ERP responses, with larger N400 effects for anomalies presented in local discourse than anomalies in a wider global discourse (e.g., van Berkum et al., 1999). We added to this, demonstrating that faster RTs for passages containing an anomaly are related to reading comprehension development, even after controlling for, among others, word decoding ability. Students who detected such anomalies more quickly at T1 also had better T1 reading comprehension skills, which resulted in better T2 reading skills. This effect may also be explained by the fact that slow readers have the greatest potential learning gain. We were the first to combine different WTI measures to predict reading comprehension while controlling for other common predictors of reading comprehension.

In the light of the Reading Systems Framework (Perfetti & Stafura, 2014), WTI has been proposed to have an important role. Results from this study add to the model that, when specifically examining the contribution of argument overlap and anomaly detection, we can disentangle their separate effects on reading comprehension. Furthermore, this study adds that WTI plays a modest part in reading comprehension, perhaps because these novice L2 readers have to rely more on lower order, word processes, because their WTI skills are not as well developed yet as in more proficient readers. Previous studies have demonstrated shifts in ERP voltages to be related to integrating words into a situation model in adult L1 and L2 learners (Helder et al., 2019; Perfetti & Helder, 2020; Yang et al., 2005), and we have added to this body of literature by demonstrating that, when examining shifts in reaction times, this is predictive of reading comprehension in novice L2 learners. Taking into consideration the construction integration model (Kintsch, 1988), this study demonstrated that students who take more time to process a passage that requires inferencing, compared to a passage that does not require inferencing, show better reading comprehension. Future studies could examine what the students' situation models specifically looked like. We have added to the body of literature about text coherence (e.g., Graesser et al., 1997) that students who take more time to process an anomaly, that is, trying to achieve coherence, compared to a passage without an anomaly are also better at reading comprehension.

This study has several limitations that merit mention. First, internal consistency of the reading comprehension measure could be improved in future research by including more items. Second, both the explicit repetition and implicit inferences could be related to a resonance-based memory mechanism with no necessity to be relevant to inference processing: Participants did not need to add elaboration of meaning beyond what was stated in the text, whereas previous studies did examine this. Third, it must be noted that all indirect effects were small and that 35% of the variance in reading comprehension was explained by all predictors. This suggests that there were only modest effects of the predictors on reading comprehension and variance could be explained by other predictors, such as working memory or other WTI indicators. Finally, many of the previous studies compared L2 readers with L1 readers, and we were unable to make such a comparison in this study.

Several implications for educational practice follow from this study. WTI can provide unique insights into L2 reading comprehension development. These insights can inform our understanding of why some students with sufficient lexical skills nevertheless show insufficient reading comprehension skills. As there are large individual differences in L2 learners (Lesaux et al., 2006), insight into WTI skills may aid teacher practices to improve reading comprehension deficiencies.

In conclusion, we showed that the self-paced reading paradigm can be used to derive manageable measures of components of WTI that predict reading comprehension, after controlling for decoding, vocabulary, and morphological and syntactic awareness. WTI measures, in turn, may explain unique variance in the development of reading comprehension in ESL.

Acknowledgements

This research was supported by Grant No. 405-14-304 from the Nationaal Regieorgaan Onderwijsonderzoek (NRO) Programme Council for Educational Research (PROO). We thank all the university students, participants, schools and staff that helped to make this project possible.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

Bultena, S., Dijkstra, T., & Van Hell, J. G. (2015). Language switch costs in sentence comprehension depend on language dominance: Evidence from self-paced reading. *Bilingualism: Language and Cognition*, *18*(3), 453–469. https://doi.org/10.1017/S1366728914000145

Burkhardt, P. (2006). Inferential bridging relations reveal distinct neural mechanisms: Evidence from event-related brain potentials. *Brain and Language*, *98*(2), 159–168. https://doi.org/10.1016/j.bandl.2006.04.005

Cain, K. (2007). Syntactic awareness and reading ability: Is there any evidence for a special relationship? *Applied PsychoLinguistics*, *28*(4), 679–694. https://doi.org/10.1017/S0142716407070361

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189–210). Lawrence Erlbaum. https://doi.org/10.4324/9780203773291-17

College voor Toetsen en Examens – Board for Assessment and Exams. (2016). Examen Engels KB VMBO, 1e tijdvak 2016 en VMBO-GL/TL, 2e tijdvak 2012 (English exam 1st time block 2016, and 2nd time block 2012). https://www.examenblad.nl

Deacon, S. H., Kieffer, M. J., & Laroche, A. (2014). The relation between morphological awareness and reading comprehension: Evidence from mediation and longitudinal models. *Scientific Studies of Reading*, *18*(6), 432–451. https://doi.org/10.1080/10888438.2014.926907

Ditman, T., Holcomb, J., & Kuperberg, G. R. (2007). The contributions of lexico-semantic and discourse information to the resolution of ambiguous categorical anaphors. *Language & Cognitive Processes*, *22*(6), 793–827. https://doi.org/10.1080/01690960601057126

Dunn, L. M., & Dunn, D. M. (2007). *PPVT-4: Peabody Picture Vocabulary Test*. NCS Pearson. https://doi.org/10.1007/springerreference_180377

Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T. (2001). Phonemic awareness instruction helps children learn to read: Evidence from the National Reading Panel's meta-analysis. *Reading Research Quarterly*, *36*(3), 250–287. https://doi.org/10.1598/RRQ.36.3.2

Graesser, A. C., Millis, K. K., & Zwaan, R. A. (1997). Discourse comprehension. *Annual Review of Psychology*, *48*, 163–189. https://doi.org/10.1146/annurev.psych.48.1.163

Haastrup, K. (1991). *Lexical inferencing procedures or talking about words: Receptive procedures in foreign language learning with special reference to English*. Gunter Narr Verlag. https://doi.org/10.1057/9780230593404_3

Hagoort, P. (2017). The neural basis for primary and acquired language skills. In E. Segers & P. van den Broek (Eds.), *Developmental perspectives in written language and literacy: In honor of Ludo Verhoeven* (pp. 17–27). John Benjamins Publishing Company. https://doi.org/10.1075/z.206.02hag

Hayes, A. F. (2014). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). The Guilford Press. https://doi.org/10.1111/jedm.12050

Helder, A., Perfetti, C. A., van den Broek, P., Stafura, J. Z., & Calloway, R. C. (2019). ERP indicators of local and global text influences on word-to-text integration. *Language, Cognition, and Neuroscience*, *34*, 13–28. https://doi.org/10.1080/23273798.2018.1496268

Hessel, A. K., Nation, K., & Murphy, V. A. (2021). Comprehension monitoring during reading: An eye-tracking study with children learning English as an additional language. *Scientific Studies of Reading*, *25*, 159–178. https://doi.org/10.1080/10888438.2020.1740227

Hessel, A. K., & Schroeder, S. (2022). Word processing difficulty and executive control interactively shape comprehension monitoring in a second language: An eye-tracking study. *Reading and Writing*, *35*, 2287–2312. https://doi.org/10.1007/s11145-022-10269-3

Hirsh, D., & Nation, P. (1992). What vocabulary size is needed to read unsimplified texts for pleasure? *Reading in a Foreign Language*, *8*(2), 689–696. https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/04d7edf5-be1c-4a1e-9c91-995135ac4120/content

IBM Corp. (2019). *IBM SPSS Statistics for Windows, Version 26.0*. IBM Corp.

Kieffer, M. J., & Lesaux, N. K. (2012). Knowledge of words, knowledge about words: Dimensions of vocabulary in first and second language learners in sixth grade. *Reading and Writing: An Interdisciplinary Journal*, *25*(2), 347–373. https://doi.org/10.1007/s11145-010-9272-9

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review*, *95*(2), 163–182. https://doi.org/10.1037/0033-295X.95.2.163

Kline, P. (1993). *Handbook of psychological testing*. Routledge. https://doi.org/10.4324/9781315812274

Kuperberg, G. R., Paczynski, M., & Ditman, T. (2011). Establishing causal coherence across sentences: An ERP study. *Journal of Cognitive Neuroscience*, *23*(5), 1230–1246. https://doi.org/10.1162/jocn.2010.21452

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science*, *207*(4427), 203–205. https://doi.org/10.1126/science.7350657

Lesaux, N. K., Lipka, O., & Siegel, L. S. (2006). Investigating cognitive and linguistic abilities that influence the reading comprehension skills of children from diverse linguistic backgrounds. *Reading and Writing: An Interdisciplinary Journal*, *19*, 99–131. https://doi.org/10.1007/s11145-005-4713-6

McNamara, D. S., & Magliano, J. (2009). Toward a comprehensive model of comprehension. *Psychology of Learning and Motivation*, *51*, 297–384. https://doi.org/10.1016/S0079-7421(09)51009-2

Melby-Lervåg, M., & Lervåg, A. (2014). Reading comprehension and its underlying components in second-language learners: A meta-analysis of studies comparing first- and second-language learners. *Psychological Bulletin*, *140*(2), 409–433. https://doi.org/10.1037/a0033890

Mulder, E., van de Ven, M., Segers, E., Krepel, A., de Bree, E. H., de Jong, P. F., & Verhoeven, L. (2020). Word-to-text integration in English as a second language reading comprehension. *Reading and Writing*, *34*, 1049–1087. https://doi.org/10.1007/s11145-020-10097-3

Perfetti, C. A., & Hart, L. (2002). The lexical quality hypothesis. In L. Verhoeven, C. Elbro, & P. Reitsma (Eds.), *Precursors of functional literacy* (pp. 67–86). John Benjamins Publishing Company. https://doi.org/10.1075/swll.11.14per

Perfetti, C. A., & Helder, A. (2020). Incremental comprehension examined in event-related potentials: Word-to-text integration and structure building. *Discourse Processes*, *1-20*, 2–21. https://doi.org/10.1080/0163853X.2020.1743806

Perfetti, C. A., & Stafura, J. Z. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading*, *18*(1), 22–37. https://doi.org/10.1080/10888438.2013.827687

Perfetti, C. A., Yang, C., & Schmalhofer, F. (2008). Comprehension skill and word-to-text integration processes. *Applied Cognitive Psychology*, *22*, 303–318. https://doi.org/10.1002/acp.1419

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, *36*(4), 717–731. https://doi.org/10.3758/BF03206553

Raudszus, H., Segers, E., & Verhoeven, L. (2018). Lexical quality and executive control predict children's first and second language reading comprehension. *Reading and Writing*, *31*, 405–424. https://doi.org/10.1007/s11145-017-9791-8

Shahar-Yames, D., Eviatar, Z., & Prior, A. (2018). Separability of lexical and morphological knowledge: Evidence from language minority children. *Frontiers in Psychology*, *9*, 163. https://doi.org/10.3389/fpsyg.2018.00163

Siegel, L. S. (2008). Morphological awareness skills of English language learners and children with dyslexia. *Topics in Language Disorders*, *28*, 15–27. https://doi.org/10.1097/01.adt.0000311413.75804.60

Singson, M., Mahony, D., & Mann, V. (2000). The relation between reading ability and morphological skills: Evidence from derivational suffixes. *Reading and Writing*, *12*(3), 219–252. https://doi.org/10.1023/A:1008196330239

Thijs, A. M., Trimbos, B., Tuin, D., Bodde, M., & De Graaff, R. (2011). *Engels in het basisonderwijs: Vakdossier [English in primary education: Subject file]*. SLO. https://slo.nl/publish/pages/3780/3-5-engels-in-het-basisonderwijs.pdf

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (2012). *TOWRE 2: Test of word reading efficiency*. Pro-Ed.

Van Berkum, J. J. V., Hagoort, P., & Brown, C. M. (1999). Semantic integration in sentences and discourse: Evidence from the N400. *Journal of Cognitive Neuroscience*, *11*(6), 657–671. https://doi.org/10.1162/089892999563724

Yang, C. L., Perfetti, C. A., & Schmalhofer, F. (2005). Less skilled comprehenders' ERPs show sluggish word-to-text integration processes. *Written Language & Literacy*, *8*(2), 157–181. https://doi.org/10.1075/wll.8.2.10yan

Yang, C. L., Perfetti, C. A., & Schmalhofer, F. (2007). Event-related potential indicators of text integration across sentence boundaries. *Journal of Experimental Psychology*, *33*, 55–89. https://doi.org/10.1037/0278-7393.33.1.55

Evelien Mulder is a teacher and researcher at Radboud University.

Marco van de Ven is an assistant professor at Radboud University.

Eliane Segers is a professor at Radboud University.

Alexander Krepel is a researcher at Kohnstamm Institute.

Elise H. de Bree is a professor at Utrecht University.

Peter F. de Jong is a professor at the University of Amsterdam.

Ludo Verhoeven is a professor at Radboud University.

Received 1 July 2022; revised version received 11 October 2023.

Address for correspondence: Evelien Mulder, Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands. Email: evelien.mulder@ru.nl