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

DOI
10.1111/1467-9817.12350

Publication date
2021

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 DOI:10.1111/1467-9817.12350
Volume 44, Issue 3, 2021, pp 453–474

The unique contribution of vocabulary in the reading development of English as a foreign language

Alexander Krepel

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

Elise H. de Bree

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

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

Ludo Verhoeven

Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

Peter F. de Jong

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

The opaque English orthography complicates learning to read, as irregular words, such as the word *pint*, cannot be Addread accurately by decoding. Studies with first language (L1) English children show that vocabulary facilitates word reading, especially in the case of irregular words. It is unclear whether this influence of vocabulary extends to children learning to read English as a foreign language (EFL). When learning EFL, words are often encountered in print first, potentially making orthographic knowledge especially important. Orthographic knowledge might partially account for the effect of vocabulary on irregular word reading. In this study, 455 Dutch students in their first year of formal English education (11–13 years, Grade 7) were followed. Their English vocabulary, orthographic knowledge, and irregular, regular and pseudoword reading skills were assessed in fall and spring. Commonality analyses showed that vocabulary contributed more to irregular than to regular or pseudoword reading, even when

controlling for orthographic knowledge. Additionally, orthographic knowledge was related to irregular word reading concurrently, independent of vocabulary. Longitudinal analyses showed that vocabulary and orthographic knowledge also had independent effects on the *development* of irregular word reading, but not on regular or pseudoword reading. Overall, the predictors for EFL word reading were in line with previous L1 findings. Both EFL and L1 learners use vocabulary and orthographic knowledge to read irregular words. This suggests that the relationship between vocabulary and word reading is related to aspects of the English orthography itself. To enable EFL learners to read irregular words, it is important to teach the other constituents of word knowledge, that is, vocabulary and orthography.

Keywords: irregular word reading, word reading development, vocabulary, orthography, EFL

Highlights

What is already known about this topic

- For L1 English learners, vocabulary facilitates reading of words that cannot be read accurately by decoding (irregular words).
- Orthographic knowledge is also important for word reading, but its relative contribution compared with vocabulary is unknown.
- For L1 learners of more transparent languages, reading is less dependent on vocabulary.

What this paper adds

- We investigated whether effects of vocabulary and orthographic knowledge on reading extend to reading in English as a foreign language for students with a semi-transparent L1.
- For the first time, effects of vocabulary on irregular word reading were investigated longitudinally in a large sample.
- Shared and unique contributions of vocabulary and orthographic knowledge to both irregular and regular word reading were compared.

Implications for theory, policy or practice

- Predictors for word reading are similar in EFL as in L1 English.
- Both vocabulary and orthographic knowledge make independent contributions to irregular word reading, including its *development*.
- To enable EFL learners to read irregular words, it is important to also train the other constituents of word knowledge, that is, vocabulary and orthography.

The opaque orthography of English makes it a difficult language to learn to read (Aro & Wimmer, 2003). Whereas words such as *cat* and *hat* can reliably be decoded using grapheme–phoneme rules, the English language contains many irregular words, which

are words that do not follow the dominant grapheme–phoneme correspondences (Bowers & Bowers, 2017). For example, the 'ea' in the word *beach* is pronounced differently than in *bread* or *break*. As the grapheme–phoneme associations of words are not always straightforward, there are many words that are difficult to read by decoding alone. Often, a reader has to know a specific word to read it correctly. In this study, we investigated the contribution of vocabulary knowledge to learning to read in English as a foreign language (EFL) in Dutch students.

Several studies have found that native English-speaking children with a larger vocabulary tend to be better at reading. Especially for reading irregular words, a large vocabulary is beneficial (Taylor, Duff, Woollams, Monaghan, & Ricketts, 2015). Indeed, vocabulary is correlated more strongly with irregular than with regular word reading ability in 8 to 13-year-olds (Nation & Snowling, 2004; Ricketts, Nation, & Bishop, 2007), although one study with 6-year-olds found that vocabulary was equally important for regular and irregular word reading (Ricketts, Davies, Masterson, Stuart, & Duff, 2016). The connection between vocabulary and word reading is also attested in the finding that vocabulary size correlated more strongly with irregular word reading than with pseudoword reading in native English 5 to 12-year-olds (Ouellette & Beers, 2010; Ricketts et al., 2007). Pseudowords can be deciphered by decoding, similar to reading regular words. The importance of vocabulary size for reading is also underlined in experimental studies with word-level analyses showing that knowledge of a particular word predicted whether this word was read accurately (Nation & Cocksey, 2009; Ricketts et al., 2016).

There is also evidence of the importance of vocabulary for the *development* of irregular word reading. In a longitudinal study, Nation and Snowling (2004) found that semantic word knowledge at 8 years predicted irregular word reading at 13 years. Similar findings have been reported in a small sample of 8 to 9-year-old poor comprehenders, who had comprehension problems but no problems in decoding (Ricketts et al., 2007). After controlling for autoregressive effects, there was a trend of these children's vocabulary to contribute to their irregular word reading 10 months later. Possibly, children with a small vocabulary are less proficient in learning new words (Penno, Wilkinson, & Moore, 2002). Consequently, these children will make less progress in irregular word reading, because this relies in part on vocabulary.

The finding that vocabulary can facilitate irregular word reading is in accordance with models of reading. For example, the triangle model (Harm & Seidenberg, 2004) proposes that words can be read through two pathways that are activated in parallel: a direct phonological pathway in which orthography activates phonology and an indirect semantic pathway in which orthography activates semantics, which in turn activates phonology. The direct phonological pathway is fastest and reflects the grapheme–phoneme mapping process. It is most important for reading regular words. The phonological pathway is also used for reading irregular words, but for these words, the indirect semantic pathway is more important. In this indirect pathway, the orthographic representation activates the phonological representation indirectly via the semantic representation. Hence, learning a word's phonological, semantic and orthographic representation is essential for irregular word reading.

Similar to the triangle model, the lexical quality hypothesis (Perfetti & Hart, 2002) emphasises the importance of tight connections between orthographic, phonological and semantic representations for word reading. Vocabulary knowledge is also important to overcome the distance between the spelling pronunciation of a written word and its standard pronunciation (Elbro & de Jong, 2017; Elbro, de Jong, Houter, & Nielsen, 2012). A spelling pronunciation refers to the pronunciation a reader arrives at when a word is

decoded using the standard grapheme–phoneme correspondences. For words with an irregular spelling, this spelling pronunciation will not be the correct pronunciation, as the word *island*, for instance, will be read as /IslAnd/ (Elbro & de Jong, 2017). According to Elbro and de Jong (2017), the ability to bridge the distance between the spelling pronunciation of a written word and its standard pronunciation stored in memory contributes to individual differences in word reading (see also Tunmer & Chapman, 2012). In regular words, the distance between spelling pronunciation and standard pronunciation is negligible, but for irregular words, this distance is larger, and it seems almost impossible to get to the standard pronunciation without a representation of the (meaning of the) word in memory.

Because English has many words with irregular spellings, it is a challenging language to learn to read. In English, a single grapheme often has multiple possible pronunciations; for example, 'ea' is pronounced differently in *bread*, *beach* and *break*. However, when the surrounding graphemes are taken into account, the regularity of the English orthography tends to increase (Treiman, 2017). For instance, when *ea* is followed by *d*, it is often pronounced as /.eop;/, as in *bread* (although there are exceptions, such as *bead*; Treiman, 2017). Dutch orthography is far more transparent than English (Patel, Snowling, & de Jong, 2004; Seymour, Aro, & Erskine, 2003), making it generally easier to acquire (Seymour et al., 2003). Moreover, deviations from the standard grapheme–phoneme correspondences are mostly based on a few rules. A difficulty in grapheme–phoneme correspondences is, for example, the phoneme /.eop;ɪ/, which can be spelled as either *ei* or *ij*. This makes Dutch easier to read than spell, similar to other orthographies (Bosman, Vonk, & Van Zwam, 2006). Most words (84.5%) can be reliably transformed from the orthography to the correct phonology. For example, the word *reiger* [heron] is always pronounced as /r.eop;ɪɣər/, while only 36.8% of words can be transformed from the phonology to the correct orthography. Although /rɛɪɣər/ might be spelled as either *reiger* or *rijger*, only *reiger* is the correct spelling. This difference is due to morphological and orthographic rules, which complicate spelling but are not problematic during reading (for more extensive information on Dutch, see Booij, 1987; Nunn, 1998).

In Dutch, decoding is often an adequate reading strategy, as many words have regular spellings (Ellis, 2002). Indeed, even adult readers in semi-transparent languages, such as German and Dutch, more often appear to use a decoding strategy in comparison with English readers (Marinus, Nation, & de Jong, 2015; Ziegler, Perry, Jacobs, & Braun, 2001). This raises the question of how Dutch students, who rely more on decoding, learn to read in EFL, in which decoding is a less adequate reading strategy.

An important difference between learning to read English as an L1 or as a foreign language (FL) is that FL learners generally already know how to read. The reading skills students have acquired in their L1 might support EFL reading (Figueredo, 2006; Koda, 2007). However, the amount of support of their L1 reading ability depends on the similarity between both languages (Geva & Siegel, 2000). For example, EFL learners can rely more on their L1 skills if the L1 is also alphabetic (Korean) than if their L1 is non-alphabetic (Chinese) (Pasquarella, Chen, Gottardo, & Geva, 2015). For Dutch students learning English, both languages are alphabetic, but they differ in orthographic opacity. There is some evidence to suggest that Dutch students rely more on their L1 reading skills when learning an FL with a transparent orthography (Spanish or German), than an FL with an opaque orthography (French) (Zeguers, van den Boer, Snellings, & de Jong, 2018). Similarly, it seems likely that Dutch students can use their decoding skills to read regular English words as most of the standard grapheme–phoneme correspondences are similar, especially for the consonants. However, with respect to reading irregular words, it can be

expected that they need English vocabulary knowledge, like L1 readers do, as vocabulary is critical for deciphering irregular words. However, to our knowledge, no studies have looked into the role of vocabulary in the development of regular and irregular word reading separately in EFL students.

In L1, lexical representations of preliterate children consist of a phonological and semantic representation, without an orthographic representation: children often first learn the semantics and phonology of a word and do not get exposed to the orthography until they learn to read and write. In contrast, FL learners are likely to already know the meaning of the word in L1, especially in the early stages of acquisition. They thus need to learn the form of the word (orthography and phonology) and link it to a known concept (Jiang, 2000).

Often, FL learners will encounter the written and the spoken form of English words simultaneously or, maybe even more often, are exposed first to the orthographic form of a word (Bassetti, 2008). Therefore, unlike in L1, FL learners might acquire the phonology and orthography of many words during the same period of time. This probably leads to the joint learning of orthography, phonology and semantics (or translation) in EFL. Therefore, and in contrast to L1 learners of English, the EFL learner will more often know both the meaning and the orthographic form of a word. Consequently, it is more difficult to disentangle vocabulary and orthographic knowledge in EFL. This raises the question to what extent the relationship between vocabulary and irregular word reading can be accounted for by orthographic knowledge.

It is generally believed that reading and spelling ability depend on the same orthographic lexicon (Jones & Rawson, 2016; Purcell, Jiang, & Eden, 2017). Therefore, spelling is often taken as an indicator of orthographic knowledge (e.g., Gangl et al., 2018). Following Share's (2008) self-teaching hypothesis, orthographic knowledge is acquired through repeated decoding irrespective of the regularity of the word, although irregular words might need more decoding attempts than regular words to get to the same amount of orthographic knowledge (e.g., Wang, Nickels, Nation, & Castles, 2013). Indeed, L1 studies that looked into the relationship between orthographic knowledge and reading showed that orthographic knowledge correlated more strongly with irregular word reading than with pseudoword reading. This was found when orthographic knowledge was derived from the amount of print exposure (Griffiths & Snowling, 2002) or measured by orthographic choice tasks (Castles, Datta, Gayan, & Olson, 1999; Manis, Seidenberg, Doi, McBride-Chang, & Petersen, 1996; Ricketts et al., 2007; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009). As studies on the role of vocabulary in learning to read English have not taken the effect of orthographic knowledge into account, it is not entirely clear whether vocabulary and orthographic knowledge have independent effects on irregular word reading, or whether, especially in EFL, the effect of vocabulary on irregular word reading is due to orthographic knowledge.

Present study

In this study, we investigated whether vocabulary is more important for irregular than for regular word reading and pseudoword reading in EFL, while controlling for orthographic knowledge. We also examined the effects of vocabulary and orthographic knowledge on the (short-term) *development* of word reading. EFL vocabulary, orthographic knowledge and reading skills of Dutch Grade 7 students (11–13 years) were assessed, at the beginning

of the school year. Word reading skills involved both reading accuracy and fluency. All students had learned to read in Dutch, a semi-transparent orthography (Borgwaldt, Hellwig, & De Groot, 2005). Their EFL reading skills were measured again 4–5 months later.

This study is designed to elucidate the role of vocabulary in (irregular) word reading in EFL learners. Studies with English as L1 (Ricketts et al., 2007; Roman et al., 2009; Taylor et al., 2015) suggest that students would read the regular words by decoding but would rely more strongly on vocabulary and orthographic word knowledge for reading irregular words. Consequently, in the beginning of Grade 7, the contribution of vocabulary would be larger for reading irregular than regular or pseudowords, even after controlling for orthographic knowledge. With respect to reading development, in line with studies on L1 English reading development (Nation & Snowling, 2004; Ricketts et al., 2007), it would be expected that vocabulary contributes more to the development of irregular than regular or pseudoword reading throughout the seventh grade.

On the other hand, studies with Dutch as L1 (de Jong & van der Leij, 1999; Verhoeven, van Leeuwe, & Vermeer, 2011) suggest that vocabulary would not be a significant predictor for reading in Dutch L1 students learning English. Due to the transparency of Dutch, the relationship between vocabulary and reading is low, suggesting that Dutch students hardly rely on vocabulary while reading in Dutch (de Jong & van der Leij, 1999; Verhoeven et al., 2011). Therefore, as an alternative, it might be expected that Dutch EFL learners rely less on vocabulary when reading in English than L1 learners of English. Our aim was to explore these two alternative hypotheses to gain more understanding in the development of EFL reading.

Method

Participants

In this study, 503 students participated from 18 classes across seven schools in the Netherlands. Only the 485 students that completed all measures at both Time 1 and Time 2 were selected. The 30 students who reported speaking English with their parents or caregivers were excluded. The final sample consisted of 455 students (246 boys and 209 girls), with a mean age of 12 years and 7 months (range = 11–13 years, *SD* = 5 months). Of these 455, 118 students (26.5%) did not have Dutch as their native language, and 35 (7.9%) did not speak Dutch with their parents or caretakers. However, all students were proficient Dutch speakers and outcomes from the analyses did not change depending on including or excluding this group: they were included in the analyses. In the Netherlands, Grade 7 is the first year of secondary school and the start of formal English education. English is one of the core subjects and students typically receive 135 to 180 minutes of English instruction weekly by teachers with a (vocational) university degree in the English language. This instruction focuses on reading, writing and oral proficiency through listening and speaking. One of the goals related to these skills is acquisition of basic vocabulary and learning strategies for vocabulary acquisition. Detailed outcome goals and levels are set (Trimbos, 2007) and are adhered to. Schools and teachers can design their classes of English in the way that they consider that these goals and levels can be attained. Teachers are therefore free to shape vocabulary learning in the classroom and often use the existing (orthography-based) methods available. There are different published instructional methods and textbooks that schools can use to reach these goals.

All except for seven students had some English classes in primary school, starting mostly in Grade 5 (54.6%). From Grade 5, English education is obligatory in the Netherlands; however, there are considerable differences in the quality and quantity of English instruction in primary school compared with secondary school (Thijs, Trimbos, Tuin, Bodde, & De Graaff, 2011). Lessons are focused on oral proficiency and are mostly (86%) taught for 30–60 minutes per week. Instruction is provided by the class teacher who instructs students in all subjects. In general, these class teachers are non-native speakers with very limited training in English instruction. In contrast, English teachers in secondary education are specialised in English language instruction and generally only teach English. Therefore, Grade 7 students can be regarded as beginning EFL learners. Parents of all students were informed of the study and could refuse participation of their child.

Materials

Vocabulary. English vocabulary was measured using a shortened version of the Peabody Picture Vocabulary Test, Fourth Edition (Dunn & Dunn, 2007). This shortened version consists of a selection of 60 items to allow administration in a plenary classroom setting. The original Peabody Picture Vocabulary Test is administered individually and consists of 19 sets of 12 items each. For the shortened version, we selected four items (every third item) from set 1 to set 15. Previous studies show that this procedure results in a reliable test (Sparks & Deacon, 2015; Wang et al., 2013). The selection covered a wide range of vocabulary knowledge to capture the anticipated large variation within this group. Students received a booklet with the four picture options per item. The students heard the target word (e.g., "carrot") and then marked the best fitting picture. All answers were scored as correct or incorrect with a maximum score of 60. Cronbach's alpha of the task was .77.

Orthographic knowledge. Orthographic knowledge was measured using a dictation task of English (developed by Van Viersen and De Bree, personal communication, October 2016), because spelling taps into retrieval of orthographic mental representations and orthographic pattern knowledge (Apel, 2011; Gangl et al., 2018). The task consisted of 20 words embedded in sentences that were read aloud by the experimenter. These words were selected from different English methods used in the Dutch Grade 7 curriculum, as Dutch EFL learners might be exposed to different words than L1 English learners. After each sentence, the experimenter repeated the word that had to be spelled ("This flower looks beautiful. – beautiful"). The student then wrote down the target word. Items increased in word length and difficulty (ranging from *two* to *mathematician*). The word *pedestrian* was an item in both the vocabulary and the dictation task; all other words were unique to the dictation task. There were two reasons why the task contained mostly irregular words. The first was that a task with regular words would likely be too easy for the participants. Despite the differences in transparency between Dutch and English, there is considerable overlap in the grapheme–correspondence associations. For simple regular words, only limited knowledge of English grapheme–phoneme correspondences is needed to spell these words correctly. For instance, even using Dutch spelling rules would result in correct English spellings for some words, such as *hot*, *bin* or *pet*. The second reason for including irregular words was that we are interested in word-specific knowledge of English words. The first 15 words were nouns (*headache*), adjectives (*beautiful*) and conjunctions (*except*); the last

five words consisted of verbs (*coughed*). Items were scored as correct or incorrect with a maximum of 20. Cronbach's alpha of the task was .80.

Reading

Reading accuracy. Reading accuracy in English was measured using the regular and irregular words from the Castles & Coltheart 2 Task (Castles et al., 2009). The word list contained the 40 regular (e.g., *check*) and 40 irregular (e.g., *ceiling*) words in the same order as the original test. Regular and irregular words had been matched on word length, frequency and grammatical class. In the original task, words are presented on flash cards. In our study, words were printed in two columns on a sheet of paper. Students were instructed to read the entire list as accurately as they could, and the experimenter emphasised that students did not have to read as fast as possible. Cronbach's alphas of the task were .782 and .752 for regular words and .777 and .761 for irregular words at Time 1 and Time 2, respectively.

The students in the current sample had a Dutch accent in English, which was taken into account when scoring the reading tasks. As we were interested in reading accuracy and decoding ability, we aimed to separate systematic articulation errors due to accent from decoding errors. To separate these types of errors, we composed a list of acceptable and unacceptable pronunciations (available upon request from the corresponding author). For example, as the <th> is difficult for Dutch speakers, pronouncing the word <thing> (with voiceless *th*) similar to <fing> (with voiceless fricative *f*) was scored as correct, but pronouncing it differently such as <zing> (with voiced fricative *z*) was scored as incorrect. Decoding errors, such as pronouncing the word <thing> as <think>, were scored as incorrect as per the original guidelines. All experimenters were trained by practicing scoring two reading tests and comparing the results with the lead experimenter. Differences in scoring between the experimenters were discussed until agreement was reached on how to score a pronunciation.

Reading fluency. Reading fluency in English was measured with the two subtests of the Test of Word Reading Efficiency second edition (TOWRE, Torgesen, 2012). Word reading fluency was measured using the Sight Word Efficiency subtest, consisting of 109 words of increasing difficulty (e.g., *go*, *horizon*). The list contains both regular and irregular English words. Pseudoword reading fluency was measured using the Phonemic Decoding Efficiency subtest. This list consists of 66 pseudowords that all have a regular pronunciation (e.g., *pog*, *throbe*). In both tasks, students had 45 seconds to read as many words accurately as possible. The score is the total number of targets read aloud correctly. Experimenters used the same scoring rules as for the reading accuracy tasks. However, the first 10 items of the pseudoword reading task were all short words with no obvious correct pronunciation (e.g., *pu* or *ku*). Because there are hardly any English words that end on *u* (loanwords and the low-frequent word *flu*), the rules on how to exactly pronounce *u* at the end of a word are unclear, especially for beginning students. In addition, the words *ik* and *dat* are actual existing words in the Dutch language. These items were thus confusing for our sample of Dutch students, who were instructed to read these words using an English pronunciation. Consequently, these first 10 words were difficult to score reliably and were therefore all scored as correct. As we are primarily concerned in individual differences between students across time, this decision does not affect the findings. The full test is known to be reliable for native English speakers, with an internal consistency ranging from .86 to .97

(Hayward, Stewart, Phillips, Norris, & Lovell, 2008). The high correlations with the other reading tests (see Results section) suggest that this is also the case for Dutch EFL readers.

Procedure

The students completed all tests in the beginning (November–January) and at the end (April–June) of the school year. The vocabulary task and dictation task were completed in a classroom setting during English classes with the teacher present. Reading tasks were administered individually in a quiet room by an experimenter. In both sessions, other measures of English proficiency were also administered as part of a larger study. This larger study consisted of an EFL intervention study, of which the current sample functioned as the control group. The individual session took approximately 25 minutes and the classroom session approximately 50 minutes.

Analysis

Regression analyses were conducted to estimate the contributions of vocabulary and orthographic knowledge to the prediction of the different reading outcomes, while simultaneously controlling for general reading ability. To compare the contributions of vocabulary and orthographic knowledge, the explained variance of vocabulary and orthographic knowledge is broken down into unique and shared contributions, using commonality analysis. Significance levels of the unique and shared contributions were obtained from bootstrapped confidence intervals using the package yhat (Nimon, Oswald, & Roberts, 2013) in R (R Core team, 2018).

To assess whether vocabulary and orthographic knowledge predicted more variance in irregular than regular word reading accuracy, separate analyses were conducted for the two word reading tasks. In these analyses, we controlled for regular word reading accuracy in the analysis of irregular word reading accuracy and, vice versa, we controlled for irregular word reading accuracy in the analysis of regular word reading accuracy. Similar regressions were conducted to investigate whether vocabulary and orthographic knowledge contributed more to word reading fluency than to pseudoword reading fluency. In these analyses, we controlled for pseudoword reading fluency when predicting word reading fluency and, vice versa, controlled for word reading fluency in pseudoword reading fluency. Longitudinal regressions were performed to examine the contributions of vocabulary and orthographic knowledge to development in reading development. In these analyses, vocabulary and orthographic knowledge at Time 1 were used to predict variance in Time 2 reading accuracy and reading fluency, while controlling for the autoregressive effect of reading at the earlier occasion.

Results

The results will be described in three sections. In the first section, we inspect the descriptive statistics. Second, we investigate the contributions of vocabulary and orthographic knowledge to reading outcomes concurrently, followed by longitudinal analyses in which contributions on the development of reading are examined.

Descriptives

Means and standard deviations of all the variables as well as their correlations are reported in Table 1. Based on the TOWRE norm scores (Torgesen, 2012), the mean word reading fluency score of the Dutch EFL students was at the level of the average 8-year-old native English student, and the mean pseudoword reading fluency score at the level of the average 11 to 12-year-old native English student. The relatively low scores on the spelling task indicate that this task was quite difficult, but scores did not show a floor effect. A repeated measures multivariate analysis of variance showed progress on all reading tasks from Time 1 to Time 2, $F(6,444) = 123.420$, $p < .001$, $\eta_p^2 = .625$.

The correlations on the same measures between time points were high, indicating that the abilities were stable across time. Moreover, vocabulary and orthographic knowledge were substantially correlated, showing that students with a larger vocabulary also had more orthographic knowledge. As expected, vocabulary and orthographic knowledge were more strongly correlated with the reading measures containing irregular words than those consisting of only regular or pseudowords. Fisher's r to z transformation showed that vocabulary correlated more strongly with irregular than with regular word reading accuracy ($z = 3.042$, $p = .001$) and more strongly with word reading fluency than pseudoword reading fluency ($z = 5.909$, $p < .001$). Similarly, orthographic knowledge correlated more strongly with word reading fluency than pseudoword reading fluency ($z = 3.904$, $p < .001$). However, for reading accuracy, the correlation of orthographic knowledge with irregular word reading did not differ from regular word reading ($z = .0929$, $p = .176$). Vocabulary and orthographic knowledge at Time 1 also correlated with reading 4 months later. As expected, vocabulary was more strongly correlated with irregular than regular word reading accuracy at Time 2 ($z = 4.371$, $p < .001$) and more with word reading fluency than pseudoword reading fluency at Time 2 ($z = 6.456$, $p < .001$). Likewise, orthographic knowledge correlated more with Time 2 irregular than regular word reading accuracy ($z = 2.526$, $p = .006$) and more with Time 2 word reading fluency than pseudoword reading fluency ($z = 5.667$, $p < .001$).

Concurrent analyses

In a series of regression analyses, we investigated the contributions of vocabulary and orthographic knowledge to reading accuracy (regular and irregular words) and reading fluency (words and pseudowords). In the prediction of reading ability for one type of words, the measure of the other type of words was taken into account. In regression analyses, the predictors explained between 44.9% and 61.2% of the variance in the different reading outcomes (see supplemental materials). Using commonality analysis, the contributions of vocabulary and orthographic knowledge were broken down in their unique and shared components. The results are reported in Table 2.

The rows in Table 2 show the various sources of variance through which vocabulary and orthographic knowledge explain variance in reading. The first source of variance is the variance shared among the particular type of reading ability in the analysis, vocabulary and spelling. The next rows show how much additional variance is explained on top of that by pairwise combinations of predictors. The last row shows the total amount of variance that vocabulary and spelling describe in the reading of a type of words/pseudowords. For our research question, of specific interest are the shared and unique percentages of variance

Table 1. Descriptive statistics and correlations for the English proficiency measures at Time 1 and Time 2.

	T1						T2			
	Vocabulary	OK	IRA	RA	WRF	PRF	IRA	RA	WRF	PRF
T1 Vocabulary	-									
T1 OK	0.49**	-								
T1 IRA	0.50**	0.59**	-							
T1 RA	0.39**	0.56**	0.62**	-						
T1 WRF	0.42**	0.55**	0.57**	0.64**	-					
T1 PRF	0.22**	0.43**	0.43**	0.64**	0.71**	-				
T2 IRA	0.57**	0.62**	0.69**	0.55**	0.52**	0.33**	-			
T2 RA	0.42**	0.53**	0.52**	0.72**	0.58**	0.52**	0.62**	-		
T2 WRF	0.43**	0.57**	0.49**	0.59**	0.82**	0.66**	0.57**	0.61**	-	
T2 PRF	0.23**	0.41**	0.40**	0.59**	0.68**	0.77**	0.44**	0.60**	0.75**	-
M	38.78	6.32	17.67	33.29	60.21	38.59	18.52	34.07	64.06	41.89
SD	5.70	3.35	4.29	4.17	10.09	10.10	4.13	3.89	9.04	9.89
Maximum possible score	60	20	40	40	109	66	40	40	109	66

IRA, irregular word reading accuracy; OK, orthographic knowledge; PRF, pseudoword reading fluency; RA, regular word reading accuracy; WRF, word reading fluency.
*$p < .001$.

Table 2. Outcomes of the commonality analyses predicting the contributions of vocabulary and spelling in reading concurrently in percentages of variance explained.

	Vocabulary	Spelling
Irregular word reading accuracy		
1. Common of regular reading, spelling and vocabulary	15.1**	15.1**
2. In common with regular reading	2.3**	11.5**
2. In common with spelling	4.3**	-
2. In common with vocabulary	-	4.3**
3. Unique variance	3.6**	4.1**
Total	25.2**	35.0**
Regular word reading accuracy		
1. Common of irregular reading, spelling and vocabulary	12.9**	12.9**
2. In common with irregular reading	1.7	13.1**
2. In common with spelling	0.8	-
2. In common with vocabulary	-	0.8
3. Unique variance	0.1	5.1**
Total	15.4**	31.8**
Word reading fluency		
1. Common of pseudoword fluency, spelling and vocabulary	10.3**	10.3**
2. In common with pseudoword fluency	0.2	12.9**
2. In common with spelling	4.6**	-
2. In common with vocabulary	-	4.6**
3. Unique variance	2.9**	2.7**
Total	18.0**	30.6**
Pseudoword reading fluency		
1. Common of T1 word fluency, spelling and vocabulary	5.3**	5.3**
2. In common with word fluency	−1.3	13.2**
2. In common with spelling	−0.5	-
2. In common with vocabulary	-	−0.5
3. Unique variance	1.3**	0.7
Total	4.9**	18.7**

Notes: Percentages explained are incremental. Step 1 concerns the common variance shared by all predictors, step 2 concerns to pairwise combinations of predictors on top of step 2 and step 3 refers to unique variance explained by a single predictor on top of steps 1 and 2.
** $p < .01$.
* $p < .05$.

of vocabulary and orthographic knowledge in the prediction of the various measures of reading.

As expected, both vocabulary and orthographic knowledge uniquely contributed to the prediction of irregular word reading accuracy (3.6% and 4.1%) in a significant regression model, $F(3,451) = 145.08$, $p < .001$. Their common addition in variance was 4.3%. Also as expected, vocabulary did not have a unique contribution on regular word reading, but orthographic knowledge did (5.1%). The shared contribution of vocabulary and orthographic

knowledge was 0.8% in a significant regression model, $F(3,451) = 237.56$, $p < .001$. In line with our expectations, vocabulary and orthographic knowledge contributed less to regular word than to irregular word reading. Independent from general reading ability, vocabulary and orthographic knowledge jointly accounted for only 5.9% of variance in regular word reading accuracy, compared with 12% of variance in irregular word reading accuracy.

In predicting word reading fluency, vocabulary uniquely contributed 2.9% and orthographic knowledge uniquely contributed 2.7%. The shared variance of vocabulary and orthographic knowledge was 4.6%. Taken together, vocabulary and orthographic knowledge accounted for 10.2% of the variance in word reading fluency in a significant regression model, $F(3,451) = 237.56$, $p < .001$. As expected, vocabulary and orthographic knowledge explained a smaller amount of variance in pseudoword reading fluency than word reading fluency. Vocabulary uniquely contributed 1.3% to pseudoword reading fluency, but orthographic knowledge did not have a unique contribution. Vocabulary and orthographic knowledge jointly accounted for only 1.5% of the variance in pseudoword reading fluency compared with 10.2% in word reading fluency. So, vocabulary and orthographic knowledge hardly contributed to pseudoword reading fluency, but did contribute to the reading fluency of (regular and irregular) words. The entire regression was significant, $F(3,451) = 166.39$, $p < .001$.

As Table 2 shows, there appears to be negative explained variance in the prediction of pseudoword reading fluency by vocabulary, indicating a negative commonality coefficient. Such a negative coefficient suggests a suppressor effect (Ray-Mukherjee et al., 2014). This is understandable: both vocabulary and word reading fluency are positively related to pseudoword reading fluency. However, what regular word reading fluency and vocabulary have in common (word knowledge) is irrelevant for the prediction of pseudoword reading. The suppressor effect occurs because the (irrelevant) variance of vocabulary in word reading fluency has been partialled out in the prediction of pseudoword reading. As a result, the relationship between word reading fluency and pseudoword reading fluency increases and the contribution of vocabulary to word reading becomes slightly negative. However, because the values of these negative variances are small as well as non-significant, the size of this suppressor effect should be qualified as small.

Longitudinal analyses

The contributions of vocabulary and orthographic knowledge to reading development were analysed in regression analyses (see supplementary material). In total, the predictors in these regression analyses explained between 50.4% and 70.0% of variance. In particular, the contributions of the predictors beyond the autoregressive effect are of interest, as these indicate how the predictors affect reading *progress*. Using commonality analysis, the contributions to reading development are broken down in the unique and shared contributions of vocabulary and orthographic knowledge (see Table 3). Vocabulary accounted for 3.7% of unique variance to irregular word reading at Time 2 and orthographic knowledge 3.9% (see Table 3). The shared contribution of vocabulary and orthographic knowledge was 2.9%. Jointly, vocabulary and spelling accounted for 10.5% in Time 2 irregular word reading after controlling for the autoregressive effect and each accounted for unique variance. The total regression was significant, $F(3,451) = 211.60$, $p < .001$.

Regarding development in regular word reading accuracy, vocabulary uniquely contributed 1.0% and orthographic knowledge 1.2%. Together, vocabulary and orthographic

Table 3. Outcomes of the commonality analyses predicting the contributions of vocabulary and spelling in reading longitudinally in percentages of variance explained.

	Vocabulary	Spelling
Irregular word reading accuracy		
1. Common of T1 irregular reading, spelling and vocabulary	20.3**	20.3**
2. In common with T1 irregular reading	5.6**	11.4**
2. In common with spelling	2.9**	-
2. In common with vocabulary	-	2.9**
3. Unique variance	3.7 **	3.9**
Total	32.5**	38.6**
Regular word reading accuracy		
1. Common of T1 regular reading, spelling and vocabulary	13.1**	13.1**
2. In common with T1 regular reading	2.2**	12.9**
2. In common with spelling	1.2**	-
2. In common with vocabulary	-	1.2**
3. Unique variance	1.0*	1.2*
Total	17.5**	28.4**
Word reading fluency		
1. Common of T1 word reading fluency, spelling and vocabulary	15.1**	15.1**
2. In common with T1 word reading fluency	2.8**	15.6**
2. In common with spelling	0.6**	-
2. In common with vocabulary	-	0.6**
3. Unique variance	0.2	1.3**
Total	18.8**	32.5**
Pseudoword reading fluency		
1. Common of T1 pseudoword reading fluency, spelling and vocabulary	5.0**	5.0**
2. In common with T1 pseudoword reading fluency	0.0	11.3**
2. In common with spelling	0.3	-
2. In common with vocabulary	-	0.3
3. Unique variance	0.1	0.4
Total	5.4**	17.1**

Notes: Percentages explained are incremental. Step 1 concerns the common variance shared by all predictors, step 2 concerns to pairwise combinations of predictors on top of step 2 and step 3 refers to unique variance explained by a single predictor on top of steps 1 and 2.
** $p < .01$.
* $p < .05$.

knowledge at Time 1 accounted for approximately 2.8% of variance in regular word reading accuracy in a significant regression model, $F(3,451) = 181.58$, $p < .001$. As predicted, vocabulary and orthographic knowledge accounted for substantially more variance in the development of irregular word reading accuracy (10.5%) than in the development of regular word reading accuracy (3.4%).

The shared contribution of orthographic knowledge and vocabulary in the development of word reading fluency was 0.6%. Additionally, orthographic knowledge contributed a

small amount of unique variance (1.3%), while vocabulary did not have a unique contribution (0.2%). Overall, neither orthographic knowledge nor vocabulary contributed substantially to development of word reading fluency, explaining only 2.1% above and beyond the autoregressive effect. The entire regression was significant, $F(3,451) = 181.58$, $p < .001$.

Similarly, vocabulary and orthographic knowledge did not have substantial contributions to pseudoword reading fluency, as there were no significant shared or unique contributions. After controlling for autoregressive effects, vocabulary and orthographic knowledge explained very little variance (0.8%) in pseudoword reading fluency at Time 2. The total regression was significant, $F(3,451) = 228.15$, $p < .001$. Thus, for both fluency tasks, vocabulary and orthographic knowledge at the beginning of the year predicted very little in students' development in word reading fluency and pseudoword reading fluency between Time 1 and Time 2.

Discussion

Studies with English children show that semantic knowledge helps them to read the many irregular words in their native language (Ricketts et al., 2007; Taylor et al., 2015). In this study, we investigated if we could replicate these findings in EFL children. A particular feature of EFL learning is that students are often simultaneously exposed to the meaning and the orthography of novel words. Therefore, as a novel element of this study, we examined whether the potential concurrent effects of vocabulary on irregular word reading can be accounted for by orthographic knowledge. Finally, we explored the role of vocabulary and orthographic knowledge in the development of irregular word reading.

Our findings establish the importance of vocabulary for reading irregular words in EFL. Even after controlling for orthographic knowledge, vocabulary contributed more to reading tasks with irregular words (irregular word reading accuracy and word reading fluency) than tasks consisting of regular words (regular word reading accuracy) or (regular) pseudowords (pseudoword reading fluency). In contrast, the role of vocabulary in regular word reading was limited. This larger role of vocabulary in irregular word reading aligns with the predictions from the triangle model (Harm & Seidenberg, 2004) with the indirect semantic pathway (orthography–semantics–phonology) being mainly important for irregular word reading.

Even though the semi-transparent L1 orthography of our Dutch participants led to the expectation that they might rely less on vocabulary in EFL reading, the findings on the contributors to regular and irregular word reading are comparable with L1 English studies (Nation & Snowling, 2004; Ricketts et al., 2007). The relationship between vocabulary and irregular word reading is thus similar across different educational systems, whether it is learning to read English as an L1 in an English-speaking country or learning it as an FL as a student in secondary school. Because vocabulary is not a strong predictor for word reading in Dutch (de Jong & van der Leij, 1999; Verhoeven et al., 2011), the pattern of relationships between vocabulary and word reading seem due to aspects of the English orthography itself.

Although somewhat speculative, the latter conclusion raises the suggestion that L1 skills are only involved in FL reading to the extent that they can be applied in that specific FL. In this case, reading without relying on vocabulary might be effective in Dutch, but less so in English. The extent to which L1 skills can be used in an FL likely depends on the orthographic overlap between the languages (Pasquarella et al., 2015). For instance, L1 reading

skill in Dutch contributes more to reading development in an FL with a similar orthography, such as the transparent alphabetic Spanish, than an FL with a more different orthography, such as the opaque alphabetic French and non-alphabetic Chinese (Zeguers et al., 2018). The features of the FL will thus mostly determine whether L1 skills play a role.

Although vocabulary contributed to irregular word reading, we cannot establish from the current study whether word *meaning* was actually accessed during irregular word reading. Semantic knowledge was measured using a vocabulary task in which both phonological and semantic knowledge were necessary, because students had to select the meaning based on a given pronunciation. They had to know both the pronunciation and the meaning to answer correctly. Therefore, any effects of vocabulary might be due to semantic knowledge, phonological knowledge or a combination of both. Theoretical models differ in their assumption of whether semantic word knowledge is necessary for irregular word reading (as in the triangle model, Harm & Seidenberg, 2004) or that knowledge of the pronunciation can be sufficient (as in the dual route model, Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). In an L1 study (Nation & Cocksey, 2009), semantic knowledge of irregular words did not facilitate reading these specific words when the effect of word-specific phonological knowledge was controlled (see also Duff & Hulme, 2012; McKague, Pratt, & Johnston, 2001). In contrast, Ricketts et al. (2016) did find a unique contribution of semantic knowledge on irregular word reading, even when phonological knowledge was controlled. Because our study did not contain a measure of phonological knowledge, more research is needed to disentangle the exact influence of phonological and semantic knowledge on irregular word reading.

Unlike previous studies with L1 English children, we examined whether orthographic knowledge had a specific effect on word reading, that is, after controlling vocabulary knowledge. While orthographic knowledge is important in both L1 and FL learning, we reasoned that orthographic knowledge would be especially important for EFL reading, because of the prominent role of orthography in FL instruction (Bassetti, 2008). The concurrent analyses showed that orthographic knowledge contributed to irregular and regular word reading accuracy and word reading fluency, but not to pseudoword reading fluency. These contributions of orthographic knowledge to word reading were partly shared with vocabulary, but importantly, orthographic knowledge also contributed independently. The importance of orthographic knowledge matches previous L1 studies (Castles et al., 1999; Griffiths & Snowling, 2002; Manis et al., 1996; Ricketts et al., 2007; Roman et al., 2009) and our expectations considering the amplified role of orthography in lexical representations in EFL. Because of the demonstrated importance of orthographic knowledge in EFL reading, it is important for future studies to take orthographic knowledge into account and see if these findings are replicated in L1 by measuring both vocabulary and orthographic knowledge.

Against our expectations, orthographic knowledge had similar relations to regular and irregular word reading accuracy in the concurrent analyses. However, we did find that orthographic knowledge contributed more to word reading fluency than pseudoword reading fluency, as expected. A similar pattern was also shown by Roman et al. (2009), who found that children relied on orthographic knowledge for reading regular and irregular existing words, but less for reading pseudowords. Orthographic knowledge, at least at the word level, might not contribute to the reading of pseudowords. This seems understandable, as students are unlikely to have prior orthographic knowledge of these unknown pseudowords and thus cannot recognise these words by sight. In contrast, regular words were not necessarily decoded, but at least a proportion of the regular words were read by recognising the

orthography. The finding that orthographic knowledge affects both regular and irregular word reading independently from vocabulary fits within the triangle model of reading (Harm & Seidenberg, 2004), in which the direct phonological pathway (orthography–phonology) is activated for reading both regular and irregular words. However, in the longitudinal analyses, orthographic knowledge did not contribute to regular word reading development, whereas it did contribute to irregular word reading development. So, with the exception of the concurrent analyses on reading accuracy, the general findings indicate that orthographic knowledge is more important for reading irregular than regular words.

We also examined whether vocabulary and orthographic knowledge contributed to reading development. As expected, vocabulary and orthographic knowledge had a shared and unique contribution to word reading development, which was larger for irregular than regular word reading. This was only apparent in the reading accuracy tasks, because vocabulary and orthographic knowledge did not contribute to reading fluency development. Better orthographic and vocabulary knowledge were an advantage for development of irregular word reading accuracy. This is in line with previous longitudinal L1 English findings (Nation & Snowling, 2004; Ricketts et al., 2007) and has now received more firm support in a large EFL sample and controlling for autoregressive effects.

The additional effect of vocabulary on the development of irregular word reading, controlling for autoregressive effects, implies that vocabulary at Time 1 was actually more related to reading at Time 2 than to reading at Time 1. Possibly, students were better able to apply their vocabulary knowledge at Time 2 than at Time 1. For example, students might have known the word *flood*, but used a spelling pronunciation at Time 1 (rhyming with *food*), because they were not able to bridge the distance between the spelling pronunciation and the irregular correct pronunciation (Elbro & de Jong, 2017). If the students repeatedly encounter this word between Time 1 and Time 2, they would have increased practice in linking the spelling pronunciation to the actual correct pronunciation. Subsequently, they would be better at connecting the spelling pronunciation to the correct pronunciation, resulting in an increased likelihood of reading the word correctly at Time 2.

Individual differences in orthographic knowledge also predicted the development in irregular word reading: students with more orthographic knowledge might find it easier to learn spellings of newly encountered words and will have more orthographic knowledge at the end of the year, being advantageous for irregular word reading. This interpretation is supported by experimental findings that students with more orthographic knowledge are more adept at orthographic learning (Cunningham, 2006; Wang et al., 2013). However, to shed further light on acquisition, more research focusing on how individual differences in orthographic learning skill relate to reading development is needed.

Contrary to our expectations, neither vocabulary nor orthographic knowledge contributed substantially to word reading fluency development. Reading fluency contains two underlying skills: reading speed (number of words read) and accuracy (total correct). Scores show that students improved more in their reading speed (a difference of 3.75 words between Time 1 and 2) than in their accuracy (a difference of 0.1 words), so development in reading fluency seems mainly driven by changes in reading speed. Because the unexplained variance in the longitudinal analysis on word reading fluency concerns changes in reading speed, it follows that reading speed is apparently relatively unaffected by vocabulary and orthographic knowledge, whereas reading accuracy is affected by both. This is supported by the considerable contribution of vocabulary and orthographic knowledge to word reading fluency concurrently and irregular word reading accuracy concurrently and longitudinally.

Limitations

Unlike previous studies (Castles et al., 1999; Griffiths & Snowling, 2002; Manis et al., 1996; Ricketts et al., 2007; Roman et al., 2009), we measured orthographic knowledge through dictation instead of orthographic choice. Arguably, a dictation task does not only measure word-specific orthographic knowledge but also more general orthographic pattern knowledge, such as how letters may represent speech sounds (Apel, 2011). However, because the spelling task consisted of mostly irregular words and did not have a meaningful contribution to pseudoword reading fluency, we can infer that the current spelling task largely reflects word-level orthographic knowledge. Given that both word-level orthographic knowledge and orthographic pattern knowledge might be important for word reading (Apel, 2011), it would be interesting to include both an orthographic choice and a dictation task in future studies.

As the majority of the words in our spelling task were irregular, the task mainly measured orthographic knowledge of irregular words. Thereby, the task seems better aligned to irregular than to regular word reading. However, because regular words can often be spelled by straightforward phoneme-to-grapheme conversion, the correct spelling of regular words would not reflect orthographic knowledge, but instead more general knowledge of grapheme–phoneme correspondences. Because the EFL students in our study were proficient readers in L1, a spelling task with only regular words would therefore probably be too easy for the Grade 7 students. The validity of the task is further underlined by the finding that the correlations between reading and spelling were around .60, a comparable size as reported in previous studies (e.g., Georgiou et al., 2020).

In the current study, the reading accuracy and fluency tasks did not contain the same types of words. For example, our measure of reading accuracy lacked a measure of pseudoword reading, whereas in the fluency tasks, the irregular and regular words were combined in one task. To more systematically study how exactly pseudoword versus regular word reading is affected, it would be of interest to measure all word types separately in both accuracy and fluency tasks. However, overall, our two reading accuracy and two fluency tasks substantially differed in the number of irregular words. Our results clearly show the importance of vocabulary and orthographic knowledge for both reading accuracy and reading fluency tasks that contain irregular words.

Our study included a sample of EFL learners with Dutch as L1. Whether the contribution of vocabulary in EFL reading is similar for EFL students with a different L1 is unclear, because the extent to which L1 and FL impact on FL reading development depends on the similarity of the L1 and FL orthographies (Figueredo, 2006; Geva & Siegel, 2000; Zeguers et al., 2018). As Dutch and English are both alphabetic orthographies, students may in part rely on their L1 reading skills to read in EFL. The size of the influence of the L1 on EFL reading in the current study is, however, difficult to examine, because all students had the same language (Dutch) as their L1. Future studies should investigate whether the contribution of vocabulary to EFL reading generalises to other EFL learners by studying populations with different L1s. Additionally, such an approach could also evaluate the role that EFL plays on reading strategies in the L1 (e.g., Murphy, Macaro, Alba, & Cipolla, 2015).

Conclusions

Many studies show the importance of vocabulary in reading English, especially for irregular words (Taylor et al., 2015). Our study reveals that this is also the case for Dutch

EFL learners, both concurrently and longitudinally. Moreover, orthographic knowledge cannot fully account for this effect of vocabulary and makes an independent contribution to word reading. Therefore, to enable Dutch EFL learners to read irregular words, it is important to also teach the other constituents of word knowledge, that is, vocabulary and orthography.

Data availability statement

Research data are not shared due to privacy or ethical restrictions.

Acknowledgements

This work is financed by the Dutch Research Council (NWO), project number 405-14-304.

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Alexander Krepel is a PhD student at the Research Institute of Child Development and Education of the University of Amsterdam.

Elise de Bree is an assistant professor at the Research Institute of Child Development and Education of the University of Amsterdam.

Evelien Mulder is a PhD student at the Behavioural Science Institute at Radboud University Nijmegen.

Marco van de Ven is a postdoctoral researcher in the Behavioural Science Institute at Radboud University.

Eliane Segers is a professor of Learning and Technology at the Behavioural Science Institute at Radboud University Nijmegen.

Ludo Verhoeven is a professor in Communication, Language and Literacy at the Behavioural Science Institute at Radboud University Nijmegen.

Peter F. de Jong is a professor of Psychology and Education at the Research Institute of Child Development and Education of the University of Amsterdam.

Received 31 July 2019; revised version received 13 November 2020.

Address for correspondence: Alexander Krepel, Research Institute of Child Development and Education, University of Amsterdam, P.O. box 15780, 1001 NG Amsterdam, The Netherlands. E-mail: a.krepel@uva.nl