



# The specific relation of visual attention span with reading and spelling in Dutch



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## ABSTRACT

Visual attention span, the number of orthographic units that can be processed at a glance, has been shown to predict reading performance in orthographically opaque languages (i.e., French and English), independent from phonological awareness. Whether this relation is also found in Dutch, a more transparent orthography, was examined in two studies. Two unresolved issues are addressed. First, whether the contribution of visual attention span to reading was independent of rapid naming. Participants were 117 second graders and 111 fifth graders. Visual attention span was a significant predictor of both beginning and advanced word reading fluency, after controlling for rapid naming. Second, we examined the relation of visual attention span with spelling performance in a sample of 255 fourth graders. Visual attention span was a unique predictor of both orthographic knowledge and spelling performance. Based on the results we discuss the possibility of a slightly different interpretation of visual attention span.

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## 1. Introduction

Reading requires mapping written word forms to spoken, phonological forms. Therefore, phonological skills have been put forward as the key factor determining reading performance (e.g., Ramus et al., 2003; Vellutino, Fletcher, Snowling, & Scanlon, 2004). Indeed, phonological awareness and rapid naming have been shown to predict reading performance in many languages, both concurrent and longitudinally, in typically developing children, as well as children with dyslexia (e.g., de Jong & van der Leij, 1999; Kirby, Parrila, & Pfeiffer, 2003; Landerl & Wimmer, 2008; Lervåg, Bråten, & Hulme, 2009; Moll, Fussenegger, Willburger, & Landerl, 2009; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997; Vaessen & Blomert, 2010; Wolf & Bowers, 1999; Wolf et al., 2002; Ziegler, Bertrand et al., 2010).

However, there is by no means a perfect relation between phonological skills and reading. More recently, the role of visual rather than phonological processing in reading development has received more attention. This was, for example, stimulated by complaints of individuals with dyslexia that letters and words move around, blur and/or merge (e.g., Stein & Walsh, 1997; Vidyasagar & Pammer, 2010). Visual factors already featured prominently in the first description of reading difficulties, as *word blindness*, or a defective visual memory for words

(Morgan, 1896). A more recent multiple case study also indicated that two classes of impairments contribute to reading disabilities, namely phonological and visual impairments (White et al., 2006).

A prominent visual theory is the visual attention span hypothesis. According to this hypothesis, the visual attention span, that is the number of orthographic units (e.g., letters, letter clusters or syllables) that can be processed simultaneously at a glance, is a core skill determining reading performance, independent from phonological skills (e.g., Valdois, Bosse, & Tainturier, 2004; Valdois et al., 2003). Theoretically, the visual attention span hypothesis is grounded in the multiple-trace memory model (Ans, Carbonnel, & Valdois, 1998; Valdois et al., 2004). In this model of the reading process, two successive reading procedures are distinguished. In the global procedure words are processed as a whole. Only if a word is not identified through the global procedure, the analytic procedure is activated and the word is read through serial activation of smaller orthographic units, such as syllables, letter clusters or letters, for which phonological outputs are successively generated and maintained in short-term memory. To enable processing through the global procedure, the visual attentional window, through which information from the orthographic input can be extracted, needs to extend over the entire letter string. If the visual attentional window does not cover the entire word, words cannot be processed in parallel, the analytic procedure is activated, and visual attention is focused successively on sublexical units. In other words, visual attention span, as a measure of the visual attentional window, plays a crucial role in parallel word processing.

Visual attention span has been shown to contribute to reading performance, independent from phonological skills in typically

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developing children (Bosse & Valdois, 2009; van den Boer, de Jong, & Haentjens-van Meeteren, 2013), and in children with dyslexia (Bosse, Tainturier, & Valdois, 2007). In the first grade visual attention span correlated with reading rate, as well as accuracy, of both words and pseudowords (Bosse & Valdois, 2009). These relations decreased in Grades 3 and 5, with the exception of irregular word reading accuracy, for which visual attention span remained a stable predictor across grades. These findings suggest that visual attention span, fostering parallel word processing, is especially important in reading irregular or exception words, for which serial analytic processing could result in incorrect pronunciations. Similarly, visual attention span has been linked to the acquisition of orthographic knowledge. If the visual attention span covers the entire word, a whole word orthographic representation can be acquired, enabling word identification through the global procedure. Indeed, it has been shown that orthographic learning benefits from the availability of whole-word orthographic forms (Bosse, Chaves, Largy, & Valdois, 2013).

Nevertheless, the effect of purely visual skills on reading development in general, and reading performance of children with dyslexia in particular, as proposed by the visual attention span hypothesis, is still widely debated (Hawelka & Wimmer, 2008; Lobier, Zoubinetzky, & Valdois, 2012; Valdois, Lassus-Sangosse, & Lobier, 2012; Ziegler, Pech-Georgel, Dufau, & Grainger, 2010). On the one hand, Ziegler, Pech-Georgel, et al. (2010) showed that performance of children with dyslexia was impaired on a two-alternative forced choice task including letter and digit strings. When symbol strings were presented, however, their performance did not differ from that of average readers. Based on these results, the authors argued that only symbols that map onto phonological codes pose a challenge for children with dyslexia. In other words, their symbol-to-sound mapping is impaired. Similarly, Hawelka and Wimmer (2008) found that children with dyslexia and non-impaired readers showed similar performance on a visual target detection task of letters and pseudoletters when the task did not require verbal report of the letters. On the other hand, Valdois et al. (2012) argued that the verbal mapping account of a visual attention span deficit is incorrect, since performing a concurrent phonological task did not hamper letter-string report of children with dyslexia more than that of typically developing children. Furthermore, Lobier et al. (2012) showed that dyslexics with a visual attention span impairment performed worse than controls on a visual categorization task with both verbal and nonverbal stimuli. More specifically, the visual attention span impairment predicted performance on the nonverbal version of the task.

In the current paper we present two studies that further examine the nature of visual attention span and its relation with reading fluency. The work of Valdois and colleagues (Bosse & Valdois, 2009; Bosse et al., 2007; Valdois et al., 2003, 2004) clearly shows that visual attention span is an important predictor of reading performance. However, this relation has only been established for children learning to read an opaque orthography (i.e., French and English). Therefore, the joint aim of the two studies is to examine whether visual attention span is also a predictor of reading skills for children learning to read Dutch, a more transparent orthography, and thereby to establish whether visual attention span, similar to phonological awareness and rapid naming, can be considered a key predictor of reading performance across languages. In addition, the studies address two unresolved issues concerning visual attention span that could further specify the nature of its relation with reading.

First, the contribution of visual attention span has been shown to be independent of phonological awareness (e.g., Bosse & Valdois, 2009), but rapid naming, another important predictor of reading performance, has not been controlled for. Rapid naming, especially of letters, requires processes similar to those of visual attention span, which is typically measured as the ability to report back briefly presented strings of five letters (e.g., R H S D M). Both tasks require participants to quickly

identify and name the letters. However, as argued by Bosse and Valdois (2009), there are also important differences between the tasks. For example, visual information is available only briefly in a visual attention span task, but remains available in rapid naming tasks. In Study 1 we examined the predictors of reading performance, and included both tasks to determine whether it is the similarities with or the differences from rapid naming that characterize the relation of visual attention span with reading performance. In a previous study (van den Boer, de Jong, & Haentjens-van Meeteren, 2013) we have shown that visual attention span is related to naming speed of single words, independent from rapid naming, in Grade 2 beginning readers. In the current study we aimed to extend this finding, by including both beginning (i.e., Grade 2) and advanced (i.e., Grade 5) readers, and by looking at the effects on a standardized continuous measure of word reading fluency.

In Study 2 the same variables were examined as predictors of both word and nonword reading performance in a large sample of fourth graders. Furthermore, this study addressed a second unresolved issue, that is the relation of visual attention span with spelling performance. To our knowledge this relation has not yet been studied, although it could be of importance in unraveling the nature of visual attention span. Given that in a spelling task phonological rather than orthographic word forms are presented, a relation of visual attention with spelling performance might not be expected if visual attention span reflects parallel visual processing of orthographic units within a fixation.

Alternatively, visual attention span could be related to spelling given that reading and spelling both rely on orthographic knowledge at a lexical as well as a sublexical level (e.g., Ehri, 2000; Tainturier & Rapp, 2000). Visual attention span has been shown to be related to the acquisition of orthographic knowledge (Bosse et al., 2013). Accordingly, a relation with spelling performance could be expected. This relation, however, is probably indirect, rather than direct. According to the self-teaching hypothesis (Share, 1995, 1999), orthographic representations are mainly acquired through phonological recoding of letter strings encountered during reading. Every time a word is successfully decoded into its phonological code, a link can be established between the written and spoken word forms, and an orthographic representation can be built or strengthened. In line with this theory, the relation between visual attention span and spelling could be mediated by reading skills. Visual attention span could affect reading and thereby the acquisition of orthographic knowledge, which in turn affects performance on spelling tasks.

## 2. Study 1 – method

### 2.1. Participants

One hundred and seventeen second-grade (52 boys, 65 girls), and 111 fifth-grade (51 boys, 60 girls) children from six schools in the Netherlands participated in the study. The mean ages of the children were 8 years ( $SD = 5.70$  months) in Grade 2, and 11 years ( $SD = 5.86$  months) in Grade 5. All children attended mainstream primary education. At the time of testing, second and fifth graders had received approximately one year five months and four years five months of instruction, respectively.

### 2.2. Measures

#### 2.2.1. Word reading fluency

Word reading fluency was assessed with the One Minute Test (*Eén Minuut Test*; Brus & Voeten, 1995). This standardized reading test is regularly used as a measure of reading achievement in Dutch schools. The test consists of 116 words of increasing length and difficulty. Children were asked to read the words aloud as quickly and accurately as possible for 1 min. The score consisted of the number of items read correctly.

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