



*Why So Fast? An Investigation of the Cognitive and Affective Processes  
Underlying Successful and Failing Development of Reading Fluency.*

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# Summary

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Even though the human brain is probably not equipped with a specialized reading area, most adults in western countries are able to recognize written words with great ease and speed. In fact, the ability to read fluently has become essential for successful participation in modern society. Despite the importance of fluent reading skills, most research thus far has focused on reading accuracy (Share, 2007). Reading accuracy is a highly important element of reading development in nontransparent orthographies such as English, where the relation between letters and the pronunciation of these letters is often unpredictable (compare the pronunciation of /o/ in 'rock', 'no', 'down', 'love' en 'lose'). However, in transparent languages such as Dutch, where relations between letters and speech sounds are more straightforward, reading accuracy is typically achieved rapidly by beginning readers (Seymour, Aro & Erskine, 2003), whereas fluency in reading takes much longer to develop (Vaessen & Blomert, 2010). Moreover, dysfluent reading constitutes the most persistent symptom of children with dyslexia (Blomert, 2011; Wimmer & Mayringer, 2002). This suggests that after accurate reading skills are established, an important phase of reading development concerns the fine tuning of reading skills into a rapid and efficient word recognition system. The studies in the current thesis aimed to improve our understanding of this phase in which reading fluency develops, both in typical readers and children with dyslexia. The studies specifically focused on the cognitive and affective mechanisms that underlie successful and failing reading fluency development.

The first two chapters focus on the formation of orthography-phonology connections, i.e. the connections between the written form (orthography) and spoken form (phonology) of words. Efficient integration of orthography and phonology during reading has been shown to constitute an essential component of reading fluency (Blau et al., 2009; 2010), and impairments in the timing of orthography-phonology integration have been assumed to underlie the dysfluency that characterizes dyslexic readers (Breznitz, 2002; 2006; Breznitz and Misra, 2003). However, the exact timing of orthography-phonology integration during reading in Dutch is thus far unknown, and it is unclear how this timing develops when children learn to become fluent readers. Therefore, in chapters two and three, the timing of orthographic and phonological activation during word reading was examined in skilled and developing Dutch readers at incremental levels of reading development.

The first study (chapter two) investigated how quickly skilled readers can activate orthographic codes during reading, and how quickly these orthographic codes are subsequently translated into phonological codes in order to access word meaning. To this end, a masked priming paradigm was used to study orthographic and phonological priming effects, since this paradigm allows investigation of the early stages of the reading process in which activation of orthography and phonology occurs. In typical Dutch words, orthography and phonology appeared to be so strongly interconnected that effects of orthography and phonology could not be separated. However, with the use of stimulus words that allowed better differentiation between orthography and phonology, it became clear that orthographic and phonological code activation follow distinct time courses. Orthography seemed to be accessed initially yet orthographic codes were quickly translated into phonological codes with

phonological influences dominating the remainder of the lexical access stage. A comparison to time courses previously reported for skilled readers of the nontransparent French orthography (Ferrand & Grainger, 1993), suggests that the translation of orthographic representations into phonological representations occurs slightly earlier in transparent than opaque orthographies.

The first study identified the timing of orthographic and phonological processing in readers who had fully integrated orthography-phonology associations. The second study (chapter 3) investigated how these orthography-phonology associations develop when children learn to become fluent readers. Therefore we used the same masked priming paradigm as in chapter 2 with children at incremental levels of reading development (grade 2, grade 6, grade 8). Even the youngest children in this study, who had received 1,5 year of reading instruction, seemed able to access orthographic representations during the first, not fully conscious, lexical access stage of the word recognition process. During reading development, orthographic codes became increasingly early accessible, which suggests increasing levels of automatization. In contrast, phonological representations did not seem to be accessed during the early lexical access stage of word recognition in developing readers. This tentatively suggests that phonological processes are not yet automatized in 2<sup>nd</sup> to 6<sup>th</sup> grade readers, and that automatic phonological processing emerges later in development.

The third and fourth study did no longer focus on orthography-phonology integration, but on other processes that underlie reading fluency. The third study (chapter 4) examined the effects of phonological processing skills and feelings of uncertainty on word recognition fluency in children with dyslexia. The dyslexic children experienced impairments in visual word recognition, which appeared to primarily result from underlying phonological processing deficits. However, the impact of the phonological deficits seemed to be exacerbated by uncertainty. This suggests that the heightened levels of uncertainty that children with dyslexia experience are not only a consequence but also a cause of their word reading difficulties. The reading and emotional problems of dyslexic children therefore appear mutually reinforcing. The phonological processing deficits were also found to impair the children with dyslexia on auditory word recognition, specifically on speech-in-noise perception. However, uncertainty did not hamper dyslexic children during the recognition of auditory words. This suggests that the negative influence of emotional problems is specific to the task on which children with dyslexia have experienced repeated failure: reading.

In the fourth study (chapter 5), the focus shifted to the acquisition of reading fluency in a foreign language. This study investigated to what extent the influence of underlying language and cognitive skills is similar across foreign languages, or dependent on the language's orthographic transparency or writing system. To this end we studied children who were fluent readers of Dutch and were simultaneously learning to read in Spanish (a transparent alphabetic orthography), French (a deep alphabetic orthography) and Chinese (a morphosyllabic orthography). Some of the cognitive skills that underlay foreign language reading acquisition appeared to have a universal influence and to play a role in all three

## Summary

languages studied. However, the skills that most strongly affected foreign language reading acquisition depended on characteristics of the language concerned. That is, when native speakers of a language with a transparent alphabetic orthography (Dutch) learn to read in another transparent alphabetic orthography (Spanish), they seem to mainly adopt the reading skills that they already established in their native language to acquire knowledge about the new orthography. However, when the foreign orthography employs more complex letter-speech sound mappings (French), the letter-sound connections of the native language are insufficiently informative, and broader linguistic knowledge and reasoning skills need to be called upon to get a grip on the orthographic structure of the new language. When reading skills are acquired not in the familiar alphabetic writing system, but by means of visually complex characters (Chinese), visual and nonverbal skills become important to decode these characters and attach meaning to their visual forms.

Although speculative, these findings suggest that different patterns of cognitive skills may be related to successful reading acquisition in different foreign languages. For example, children with strong phonological skills seem likely to achieve high reading proficiency in foreign languages with alphabetic orthographies. Children with poor phonological skills and naming speed but adequate reasoning and visual skills, including many children with dyslexia, may expect greater academic success when learning a nonalphabetic orthography.

The joint results of the four studies in the current thesis have added new insights to our understanding of word reading fluency development, and have implications for both theories of reading and for reading education. These implications, as well as suggestions for further research are discussed in chapter 6.