



Early Identification and Intervention in Children at Risk for Reading Difficulties
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Summary

In most children, learning to read is a process that follows a regular course across several years. While still a pre-reader prior to the onset of formal reading instruction, within half a year a typical child develops into beginning reader, to become an advanced reader in another year. With more experience, reading fluency is acquired enabling the child to process written or printed information (almost) effortlessly. In some children however, learning to read presents a daily struggle and worry, from which they cannot escape: in a literate society every child is expected to become a reader.

Around five per cent in the population has such severe reading problems that they are identified as 'dyslexic'. People with dyslexia may never obtain a level of reading that is fluent, involuntarily and effortless, and that can be called automatized. For children having one or more close relatives like a (grand) parent or sibling with dyslexic problems the chance of becoming a dyslexic reader is greatly increased to about 20 to 35 per cent. Thus, although having a familial history of dyslexia does not necessarily result in a reading impairment, in pre-readers it should be considered a not-to-ignore risk signalling future reading difficulties.

Among researchers of dyslexia there is broad consensus that developmental dyslexia has a genetic component, that dyslexic brains differ from those of normal readers, both functional and structural, and that a phonological deficit is at the core of the learning disorder. Furthermore, sensory deficits might also be implicated as well a (more general) learning deficit as reflected in problems with the automatization of cognitive skills. Recent cognitive and neurological findings regarding important markers or precursors of later reading skills provide an opportunity to identify children - with and without a familial risk of dyslexia - expected to develop problems with reading acquisition, and act accordingly. Intervention research shows that early intervention is more effective than remediation of reading deficits at a later stage of development. Training in phonological awareness has found to facilitate the process of learning to read, but the effects on reading skill become stronger when incorporating knowledge of grapheme-phoneme correspondences, the most important predictor in a fairly consistent orthography like Dutch. Much less is known about the significance of neural precursors of reading difficulties in pre-readers, in particular with respect to

early markers outside the literacy domain such as information processing deficits of interest to this thesis.

The aims of the current thesis are to study early identification and intervention in children at risk for later reading difficulties. In the first three studies carried out as part of the DDP, the participants were from the same sample comprising only children from families identified as having a familial history of dyslexia or not. In the fourth study carried out according to the programme 'Onderwijs Bewijs I' [Educational Evidence], another sample was recruited in which children were included on the basis of a cognitive risk profile.

The thought that deficits in visual information processing might be implicated in children at familial risk was studied in *Chapter 2*. The research question whether deficits in the learning mechanisms of dyslexic children may be more general than specific, was investigated using a habituation paradigm. Orienting behaviour to a series of visual standards was recorded with event-related potentials (ERPs) in a sample of pre-reading children with ($N = 24$) and without ($N = 14$) a familial risk (FR) of dyslexia. Subsequently, at the end of Grade 2 the acquisition of reading and spelling was assessed in order to relate pre-attentive learning in the pre-reading phase to attentive learning performance as implicated in reading and spelling. After being regrouped into three groups according to literacy level and risk factor, single-trial analyses revealed significant group differences in the N1 and P3 components. No P3 habituation was found in either group, but in the 12 normal-reading noFR controls, the N1 showed the expected decrease in strength of amplitude across 14 trials. In both other groups, strength of N1 to the initial standard was relatively reduced, but interesting differences between these two groups were found to the subsequent standards. The 15 normal FR readers displayed a lack of N1 habituation and prolonged N1 and P3 latencies, indicating possible compensation for their reduced neuronal activity during initial information extraction. In contrast, the group of 9 poor readers showed an increase in N1 strength without prolonged latencies, which might suggest inefficient processing in an early time window and explain automatization difficulties in dyslexic readers.

Chapter 4 relates early identification to early intervention by examining the differential effects of pictorial priming and congruency on word recognition in low ($N = 13$) and high responders ($N = 14$) to early literacy intervention recruited as a subsample of the FR kindergartners participating

in Chapter 3. ERPs were recorded to word-picture pairs in which either the word preceded the picture (unprimed word) or vice versa (primed word). Primed words could be either congruent or incongruent with the picture.

As picture processing may facilitate the activation of phonological information and thereby the integration of phonological and orthographic information, the question was how picture priming would affect phonological encoding and congruency processing in children with low and high phonemic skills under different conditions. Both behavioural responses (accuracy and speed) and neural correlates of priming (topography and extent of brain activation) were analysed. Picture priming appeared to reduce the group difference in accuracy found to unprimed words, and it also modulated the topographic distribution in the time window related to phonological recoding (280-400 ms), such that the group difference to unprimed words was absent to picture-primed words. In a later time window (560-700 ms) only the high responders showed indications of tuning of attentional and integrative processes as a function of congruency. The absent divergence in topographic distribution between congruent and incongruent responding in the lower skilled subgroup suggests that atypical neural responding associated with integrating congruent information signals already at kindergarten age later reading difficulties.

Chapter 3 and *Chapter 5* are both dedicated to early intervention in children at-risk for reading difficulties. The main differences between the studies of Chapter 3 versus Chapter 5 are in time of enrolment (kindergarten versus begin Grade 1), inclusion criteria (familial risk versus cognitive risk), tutoring (at home versus at school), and duration (14 weeks versus two years). In both studies the same computer-assisted program was used in which phonological awareness and grapheme-phoneme correspondences were trained in the context of word reading, but whereas in the shorter intervention decoding restricted itself to simple one-syllable words, the longer intervention included training in all relevant word structures. Compared to a FR control group the short intervention appeared to be effective in the short-term, but the improved letter knowledge and phonemic awareness did not transfer to reading ability. In contrast, completing the sustained intervention resulted in better reading skills as compared to the at-risk controls with the proportion of very poor readers (lowest 10% in word reading fluency) in the intervention subgroup approaching norm-referenced standards.

Chapter 6 discusses the findings and implications of the current studies with regard to the main topics in this thesis. In the first part the central focus is whether and to what extent known behavioural and neurobiological indicators of risk for reading difficulties permit early identification on the individual level. The second part evaluates the benefits of implementing an extended early intervention as opposed to a shorter one. Finally, suggestions for future research and educational practice are given.