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## Visual and auditory perception in preschool children at risk for dyslexia<sup>☆</sup>



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### ABSTRACT

Recently, there has been renewed interest in perceptive problems of dyslexics. A polemic research issue in this area has been the nature of the perception deficit. Another issue is the causal role of this deficit in dyslexia. Most studies have been carried out in adult and child literates; consequently, the observed deficits may be the result rather than the cause of dyslexia. This study addresses these issues by examining visual and auditory perception in children at risk for dyslexia. We compared children from preschool with and without risk for dyslexia in auditory and visual temporal order judgment tasks and same-different discrimination tasks. Identical visual and auditory, linguistic and nonlinguistic stimuli were presented in both tasks. The results revealed that the visual as well as the auditory perception of children at risk for dyslexia is impaired. The comparison between groups in auditory and visual perception shows that the achievement of children at risk was lower than children without risk for dyslexia in the temporal tasks. There were no differences between groups in auditory discrimination tasks. The difficulties of children at risk in visual and auditory perceptive processing affected both linguistic and nonlinguistic stimuli. Our conclusions are that children at risk for dyslexia show auditory and visual perceptive deficits for linguistic and nonlinguistic stimuli. The auditory impairment may be explained by temporal processing problems and these problems are more serious for processing language than for processing other auditory stimuli. These visual and auditory perceptive deficits are not the consequence of failing to learn to read, thus, these findings support the theory of temporal processing deficit.

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## 1. Introduction

Despite growing knowledge of the causes and manifestations of dyslexia, affected children are not diagnosed until they have revealed problems learning to read. However, these children show symptoms that predict reading difficulties even before school age. Nowadays, there is a substantial body of evidence that supports phonological awareness and rapid naming as the best predictors of reading accuracy and fluency (Blachman, 1984; Kim & Pallante, 2012; Lundberg, Olofsson & Wall, 1980; Stanovich, Cunningham & Cramer, 1984; Wolf & Bowers, 1999). However, more knowledge about the precursors of dyslexia is needed to detect it early enough to prevent reading deficits. One area of research that has drawn considerable

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attention centers on temporal perceptive processing as a predictor of children's later reading acquisition (e.g., Boets, Wouters, van Wieringen, & Ghesquière, 2007; Hood & Conlon, 2004; Talcott et al., 2002). The temporal processing refers to the ability to process the temporal properties of stimuli (order, duration, relative timing, and rhythm).

Developmental dyslexia has repeatedly been found to coexist with impaired temporal information processing (Helenius, Uutela, & Hari, 1999; Meyler & Breznitz, 2005; Ortiz, Estévez, & Muñetón, 2014; Overy, Nicolson, Fawcett, & Clarke, 2003; Stein & McAnally, 1995; Tallal, Miller, & Fitch, 1993; Tallal, Merzenich, Miller, & Jenkins, 1998; Vandermosten et al., 2011; Witton et al., 1998). The temporal processing deficit theory holds that dyslexia results from a temporal processing impairment within auditory, visual, or even more generally across multiple modalities (for reviews of this hypothesis see Farmer & Klein, 1995; Habib, 2000). Several studies support this theory (e.g., Habib et al., 2002; Hari & Kiesila, 1996; Kinsbourne, Rufo, Gamzu, Palmer, & Berliner, 1991; Rey, De Martino, Espesser, & Habib, 2002; Stein & McAnally, 1995; Tallal, 1980). But, some researchers have questioned the support of this theory:

“Thus, the auditory temporal processing theory has almost exclusively been based upon cross-sectional adult and school-aged data. Such data cannot discern whether the observed sensory deficits are the result rather than the cause of differences in reading ability. In this respect, Talcott and Witton (2002) suggested that it would not be too far-fetched to expect the auditory skills of good readers to be more finely tuned than those of dyslexics by virtue of their more highly trained phonological system” (Boets et al., 2007, p. 1610).

Therefore, it is necessary to investigate temporal processing in children before they learn to read. The presence of a temporal perception deficit in preschooler children at risk for dyslexia would suggest that the temporal processing deficit may be a cause and not an effect of later reading problems. For this reason, the present study examines the temporal processing of children at risk for dyslexia in preschool (i.e., just before the initiation of formal reading instruction).

Little is known about the temporal processing abilities of preschooler children at risk for dyslexia because the few studies which have assessed these abilities have yielded mixed results. Heath and Hogben (2004) tested a sample of 227 preschoolers on phonological awareness (PA). The upper and lower quartiles of the PA distribution were selected as being at lowest and highest risk, respectively, for reading failure. Children with lowest and highest risk were tested on auditory temporal order judgment tasks. This task examines temporal processing of rapid sequences by presenting a child with two nonlinguistic complex sounds of high and low pitch. The child has to identify the tones and specify the order in which they occur. The results showed that preschoolers at risk for dyslexia were less competent at auditory temporal processing than control preschoolers. Conversely, Boets, Wouters, van Wieringen, & Ghesquière (2006a) did not find any significant differences in auditory processing between the high family risk for dyslexia group and the control group of children from 'normal reading families'. They used psychophysical threshold tasks in which the subject's task was to identify the 'odd' stimulus, the one that sounded different from the other two.

The examination of temporal processing skills in children at risk of dyslexia has not just been confined to the auditory modality. In the visual domain, Boets, Wouters, van Wieringen, & Ghesquière (2006b) assessed coherent motion detection in preschool children at family risk for dyslexia. They did not observe any significant differences between the high and low risk groups. By contrast, Kevan and Pammer (2008) found that at-risk children were significantly less sensitive to seeing the coherent motion. The different stimuli and tasks in the studies may be a possible explanation for the conflicting results on perceptive processing abilities of pre-reading children at risk for dyslexia. It is not clear whether the deficit found relates to both linguistic and nonlinguistic stimuli. In most studies with visual or auditory stimuli, these stimuli are nonlinguistic (Boets et al., 2006a, 2006b; Heath & Hogben, 2004; Kevan & Pammer, 2008). In addition, so far, we have not found any studies that examine both, visual and auditory temporal processing in the same children at risk of dyslexia.

The temporal processing deficit hypothesis of dyslexia focuses on the causal role of auditory and visual perceptual deficits. Such a claim would require demonstrating that before the initiation of formal reading instruction the same individuals are impaired in both modalities (visual and auditory) in tasks using similar procedures to assess temporal processing. Only tasks that require perceiving temporal properties of the stimulus (duration, sequence, relative timing, and rhythm) can assess temporal processing. Taking into account the problems in temporal processing assessment mentioned above, we compared children with and without risk for dyslexia on the auditory and visual temporal order judgment (TOJ) tasks and control tasks. These control tasks (same-different discrimination tasks) require perception of rapidly presented visual and auditory information but no temporal processing is required. The current study examines visual and auditory processing in children at risk of dyslexia from a typical population of preschool children. We seek to contribute to existing knowledge of temporal processing deficits among preschooler children at risk for dyslexia by examining this issue, for both linguistic and nonlinguistic stimuli in the same child population, and in the two modalities most involved in reading: visual and the auditory. We addressed three questions:

1. Do preschool children at risk for dyslexia show a perceptive deficit specific to auditory processing or a more general perceptive deficit? In order to answer this question, we compared children with and without risk for dyslexia in auditory and visual perception tasks. If the at-risk children show auditory-specific deficit, then the perception of the visual stimuli should not differ in the control versus at-risk children. The prediction of temporal processing theory is that the at-risk children will show a general perceptive deficit, and therefore, the visual as well as auditory perception would be impaired.

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