

Dyslexia as a window into language

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Recent research has uncovered deficits with rhythmic processing in children and adults with developmental dyslexia (DD) and an association between these deficits and reading (e.g., Baldeweg et al., 1999; Corriveau et al., 2007; Hämäläinen et al., 2013; Overy et al., 2003; Thomson & Goswami, 2008; Thomson et al., 2006; Wolff, 2002; Ziegler et al., 2012, among others). Beyond these deficits, often, children with DD display problems with language that go beyond the well-recognized weaker phonological skills (Cantiani et al., 2013; 2015; Rispens et al., 2007). In addition, some studies supported the relevance of the link between rhythm perception and grammar (see Gordon et al., 2015). Finally, the literature reveals that children with DD experience fine and gross motor problems (Cappellini, Coppede & Valle 2010, Cheng-Lai et al. 2011, Nicolson & Fawcett 2011; Thompson et al. 2015). Overall, these findings show heterogeneity in the population of individuals with DD and comorbidity of different deficits. At the same time, this heterogeneity seems to have a common thread. Reading, language, and motor activities are all activities that unfold in time and in which the single acts are interdependent (Lashley, 1951). As such, they all involve “co-articulation” in a broad sense; that is, what one does at time N is influenced or somehow linked by what one has to do at time $N+1$. For example, the form of the lips in pronouncing /t/ depends on the following vowel, /a/ or /u/. In handwriting, the form of a letter depends on the next one. In reading, one is already processing the material ahead when reading the word X . All these examples show that to cope with activities that unfold in time, one needs to be de-synchronized; that is, while doing X at time t , one will have to already prepare for doing Y at time $t+1$. In other words, to co-articulate, one needs to be in an anticipatory or predictive modality; that is, she must be ready to act in the single precise moment WHEN it is required. But one can anticipate/predict only if rhythmic principles regulate the behaviour. In our view, rhythm, as also other researchers have claimed, is the common thread underlying language, handwriting and reading. Rhythm is a

key to understanding what goes awry in individuals with dyslexia (and not only, see Ladany et al. 2020). We assume a definition of rhythm which includes a basic periodic pulsation (e.g., tactus, or a metronome) and crucially at least one level of temporal organization (London, 2012a, b; Overy, 2012) that allows one to orient oneself in time and act at the precise moment that is required (Fraisse, 1982; Overy, 2012; Pagliarini et al., 2020). Accordingly, two skills are needed to display a rhythmic behaviour: synchronising to the periodic pulsation and anticipating/predicting WHEN to act, that is, the precise moment for starting the necessary action. We propose that a deficit in the anticipatory mechanism impairs reading, some motor activity, as handwriting, rhythmic processing and language. This hypothesis will be referred to as the *Inefficient Anticipation Hypothesis*. We provide evidence that individuals with dyslexia have anticipation/prediction deficits, explaining why these deficits affect reading. Anticipation skills allow us to deal with timing and require a hierarchical organization, as we find in language and motor activities. We speculate that anticipation is a mechanism that has been recruited by language to linearize our internal thoughts, which must be hierarchically organized.