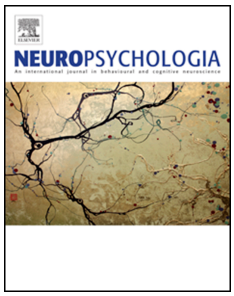
Accepted Manuscript



Introduction to the special issue: Developmental Dyslexia: from Genes to Remediation

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PII: S0028-3932(19)30155-1

DOI: https://doi.org/10.1016/j.neuropsychologia.2019.06.003

Reference: NSY 7117

To appear in: *Neuropsychologia*

Please cite this article as: Facoetti, A., Gori, S., Vicari, S., Menghini, D., Introduction to the special issue: Developmental Dyslexia: from Genes to Remediation, *Neuropsychologia*, https://doi.org/10.1016/j.neuropsychologia.2019.06.003.

Introduction to the special issue: Developmental Dyslexia: from Genes to Remediation

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Twelve papers (10 research articles and 2 perspective reviews) on the topic of developmental dyslexia (DD), a heritable neurobiological disorder in which reading and spelling acquisition are severely impaired, comprise this special issue of *Neuropsychologia*.

The neuropsychological causes of this highly frequent neurodevelopmental disorder are not clear yet. The leading theory of DD suggests that an auditory-phonological deficit is the primary cause (Peterson and Pennington, 2015). However, recent and consistent evidence suggest that a multi-componential neuropsychological deficit could be at the basis of DD (e.g., Menghini et al., 2010). Auditory and visual, as well as motor deficits are present in children with DD, and these deficits have been causally linked to DD in both longitudinal (e.g., Carroll et al., 2015) and training studies (e.g., Franceschini et al., 2013).

In this special issue, sophisticated experimental methods are used to investigate the potential neuropsychological causes of DD. These include studies employing cases vs. reading-level controls, (e.g., Frey et al., 2019), genetic (e.g., Perdue et al., 2019), longitudinal (Bertoni et al., 2019) and training (e.g., Costanzo et al., 2019; Bertoni & Franceschini, 2019) methods.

Four research articles in this special issue investigated the nature of phonological processing deficits in DD. Frey et al. (2019) investigated speech-sounds processing in children with DD and in two control groups: one chronological-age (CA) and one reading-level-matched control group. Behavioral and electrophysiological results are discussed in the context of the perceptual noise exclusion deficit theory of DD (Hancock et al., 2017). Partanen et al. (2019) compared the performance of good and poor readers on a spelling task and a rhyming task while subjects were scanned using functional magnetic resonance imaging, before and after 3 months of school-based intervention. Poor readers showed a pattern of increased activation in bilateral inferior frontal cortex, bilateral insula, right parietal cortex and left cerebellum following the intervention. Wang et al. (2019) found that both CA and RL showed greater gray matter volume in the left putamen and in the right dorsal lateral frontal cortex compared to individuals with DD. These results were interpreted as suggesting that reduced volume of the left putamen may contribute to phonological deficits found in DD. These three research articles suggest that phonological processing deficits in DD could be linked to a more general perceptual developmental disorder in which subcortical neural networks are also clearly involved. Costanzo et al. (2019) demonstrated that non-invasive brain stimulation (i.e., transcranial direct current stimulation) modulated reading ability in individuals with DD by facilitating underactive neural pathways supporting reading. Importantly, the active (but not the sham) group showed long-lasting benefits in reading ability, suggesting a promising new training approach for the remediation of DD.

Despite evidence of a substantial heritable component in DD – typical of complex traits such as reading -- the specific connections between reading and the genome are not well understood. Two intriguing genetic studies in this special issue attempted to shed some light on this debated topic. Recently, the SETBP1 gene has been implicated in several complex neurodevelopmental syndromes and disorders that affect language (Veltman et al., 2012). Perdue et al. (2019) examined the relationship between common polymorphisms in this gene and reading and reading-associated behaviors. Their findings suggest that a common genetic variation within SETBP1 is associated with reading behavior and reading-related brain activation patterns in the general population. Among DD candidate genes, associations with DCDC2 are among the most well replicated, with rs793862, READ1 and rs793842 likely contribute to phenotypic variability in reading ability. Riva et al. (2019) tested the effects of these genetic variants on DD as a categorical trait and on quantitative reading-related measures in a large sample of 555 Italian nuclear families with 930 offspring, of which 687 were diagnosed with DD. Their findings add further evidence supporting the hypothesis of a DCDC2 contribution to inter-individual variation in reading ability.

Two new perspective reviews are also presented in this special issue. These reviews suggest innovative theories about the causes of DD in which visual and auditory attention is particularly relevant to the development of orthographic and phonological processing, respectively. Vidyasagar (2019) suggests an etiological theory of DD that may help in developing new remediation strategies, specifically aimed at improving visual attention and neuronal synchrony oscillations. Stein (2019) argues that DD is characterized by poor temporal processing, and hence impaired visual and auditory sequencing caused by impaired development of the transient/magnocellular processing stream.

Valdois et al. (2019) reported an interesting single case study in which visual attention span (associated with lexical reading in children with DD) is severally impaired, whereas automatic spatiotemporal shifting of visual attention (associated to sub-lexical reading in children with DD) is spared. Their findings suggest that different attentional systems, associated with specific reading routes, can be selectively impaired in DD. Tulloch and Pammer (2019) employed tablet games to measure dorsal-magnocellular stream performance in a relatively uncontrolled school setting. Their results demonstrated that performance on the visuo-spatial tasks (i.e., visual search speed and change detection) accounted for significant unique variance in reading rate, controlling for IQ, age and phonological ability. In a clinical study, Franceschini and Bertoni (2019) showed that, after an attentional intervention based on action video games, both phonological decoding speed and phonological short-term memory increased exclusively in the children with DD, in tandem with improvements in their video game scores. These findings confirm that action video game training enhances the efficiency of both visual and auditory spatiotemporal attention. Finally, a large study by Bertoni et al. (2019) -- reporting 5 experiments -- revealed that: (i) an excessive crowding, only at unattended locations, was present in children with DD; (ii) an extra-large spaced text increased reading in children with DD; (iii) efficient attentional action video game training reduced crowding together with accelerating reading speed in two groups of children with DD, and; (iv) pre-reading crowding longitudinally predicts future poor reading ability. Their results implicate multiple causal links between visual crowding and the process of learning to read.

This special issue was inspired by the International Conference hosted in Rome in 2016 entitled “Dyslexia and developmental disorders: New directions in clinical and in research” in which several world-class scientists were invited on the basis of their impressive contributions in the field of DD. The conference participants engaged in a lively exchange of ideas regarding DD, in an extremely stimulating forum.

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This is the order of the articles (following the First name of the authors) in which they must appear on publication:

1. Frey et al.

2. Partanen et al.

3. Wang et al.

4. Costanzo et al.

5. Perdue et al.

6. Riva et al.

7. Vidyasagar

8. Stein

9. Valdois et al.

10. Tulloch and Pammer

11. Franceschini and Bertoni

12 Bertoni et al.