Developmental dyslexia and phonological decoding

Developmental dyslexia (DD) is a neurobiological disorder (see Habib, 2000; Démonet & Reilhac, 2012 in the present book for reviews) characterized by difficulties in reading acquisition despite adequate intelligence, conventional education, and motivation (American Psychiatric Association, 1994). It is widely believed that impaired phonological processing characterizes individuals with DD (see Ramus, 2003; Vellutino et al., 2004; Shaywitz & Shaywitz, 2005; Gabrieli, 2009 for reviews). Thus children and adults with DD display poor phonological awareness, slow lexical retrieval, and poor phonological short-term memory. These phonological deficits interfere with one of the most critical skills for successful reading acquisition, that is, phonological decoding (e.g. Ziegler et al., 2003; Ziegler & Goswami, 2005). Phonological decoding is based on letter-to-sound conversion, allowing children to make the connection between novel letter strings and words that are already stored in their phonological (spoken word) lexicon (Share, 1995). Efficient phonological decoding requires accurate auditory representations at the phoneme level (e.g. Harm & Seidenberg, 1999; Perry et al., 2007). Since Italian letter-to-sound orthography is particularly regular, phonological decoding is crucial for learning to read. Nevertheless, it is also essential for learning to read in more irregular letter-to-sound orthographies, such as English (Share, 1995).

Developmental dyslexia and auditory processing

Many studies have sought to explain impaired phonological skills in terms of lower-level deficits, with special reference to sensory and attentional auditory processing. They indicate that auditory deficits impair speech perception, which, in turn, affects grapheme-to-phoneme mapping and phonological short-term memory (Ramus, 2003). Indeed, developmental deficits that affect speech perception do increase the risk of language and literacy problems. Recent biobehavioural evidence supports the idea that individuals with DD and/or with specific language impairment (SLI) are impaired in their perception
with both DD and/or SLI (e.g. Geiger et al., 1994; Facetti et al., 2003; Stevens et al., 2008). In particular, these studies consistently demonstrate that the inhibitory aspects of attention—that are crucial for perceptual noise exclusion—can be remediated by appropriate rehabilitation programmes (Geiger et al., 1994; Facetti et al., 2003; Stevens et al., 2008). Our data demonstrate that a pure visual spatial treatment (based on rapid letter string presentation) not only improved phonological decoding, but also improved the inhibitory attentional mechanisms required for left-to-right serial searching of letter strings (Facetti & Lorusso, unpublished data; see Vidyasagar & Pammer, 2010 for discussion). In fact, even the 'pure' phonologically-based treatment programmes that are typically used to rehabilitate DD, have to make use of fundamental auditory attentional mechanisms.

It is intriguing to note that playing action video games significantly improves visual attentional orienting and engagement (for a recent review see Dye et al., 2009). Critically, this increase in rapid attentional orienting generalizes to various tasks beyond game situations. Thus action video game play improves general attentional resources, allowing gamers to better allocate their attention across both space and time (Dye et al., 2009). Video gaming might, therefore, provide an efficient attentional training regimen to induce reading improvement in DD children as well as in pre-reading children at risk of DD. Overall, the findings reported here offer the possibility of developing new, more efficient, treatments of DD through the use of intensive training to improve multisensory orienting of spatial attention in pre-reading children at risk of reading failure.

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