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REVIEW

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VALÉRIA CSÉPE (ed.), *Dyslexia: different brain, different behaviour*. New York: Kluwer Academic/Plenum Publishers, 2003. Pp. 193. ISBN 0-306-47752-1.

The initiative of this book is very welcome at a time when many institutions throughout the world have taken on the task of unravelling the mechanisms of developmental dyslexia at the neural level. What used to be an already vast field of behavioural research has now become a major research track in cognitive neuroscience. The aim of the book is to give an interdisciplinary overview of ongoing research on developmental dyslexia. Various methodologies (e.g. behavioural measures, event-related potentials, magnetoencephalography, and structural neuroimaging) and different theoretical frameworks (e.g. phonological hypothesis, deficit in fast acoustic transitions, slowness of visual processing, magnocellular theory) are presented to sum up current research questions in the field. Overall, the book is informative and a good source of references. All chapters are not equally clear and insightful, however.

In Chapter 1, Goswami provides a theoretical overview of the phonological deficit hypothesis, one of the core characteristics of developmental dyslexia. It is admirable that Goswami's approach is crosslinguistic, which allows her to show that the phonological deficit does not manifest itself in the same way in different orthographic systems. It must be noted that she argues for a phonological deficit before literacy is established, a deficit that has measurable consequences on performance once children learn to read. The author provides strong evidence for intimate relationships between weak phonological representations and deficiency in verbal working memory and in speeded naming, which are commonly observed in developmental dyslexia. The chapter is extremely well written and constructed: firstly, the author addresses the development of phonological representation by reviewing the results of a number of phonological awareness tasks. She highlights differences between languages varying in their phonological similarity and shows how these differences may affect phonological awareness. Secondly, Goswami describes the rich interactions between literacy acquisition and phonological representations in the context of languages with different orthographic transparencies. Thirdly, phonological representations are related to the pattern of performance in dyslexic children. This allows the author to show that literacy acquisition has retroactive effects on phonological skills in both normally developing and dyslexic readers. In conclusion, Goswami explains that the phonemic

awareness deficit in developmental dyslexia should not be seen as a cause of reading impairments but rather a correlate of them, whereby phonological representation and literacy shape one another in the course of spoken and written language acquisition. This excellent overview of experimental work spanning 25 years is concise and sharp, i.e. well worth reading!

In Chapter 2, Breznitz, Shaul & Gordon use event-related potentials to address the question of a low-level visual perceptual deficit in developmental dyslexia. The transition with the first chapter of the book is a little rough because the possible relationship between a phonological impairment and a perceptual deficit in the visual modality is not addressed: the authors only refer to the functional heterogeneity of the individuals diagnosed with developmental dyslexia. The short introduction to the principles of ERPs promises that 'areas of brain specialization can be identified by observing amplitude and latency variations of the ERP components' (p. 43), but this is misleading. ERP components cannot be linked to regions of the cerebral cortex directly (this requires brain source localization, which is known to have considerable methodological and theoretical limitations). The authors then attempt a brief review of the main visual ERP components relevant to the study of reading in general and dyslexia in particular. It must be acknowledged that giving a synthetic overview of electrophysiological results obtained in the field of developmental dyslexia is very difficult since different research teams use different paradigms, stimuli, recording and processing techniques, and results are often inconsistent. As a consequence, this section is rather confusing, with quantities of seemingly disconnected results. Unfortunately, the massive result summary in the form of a table in the appendix fails to establish any clear trend in the pattern of results or provide any theoretical insights. Part 4, 'speed of visual processing', is the most interesting part of the chapter because it describes the authors' hypothesis of 'slowness of processing' in the visual modality, which has connections with the magnocellular hypothesis. The conclusion is, however, somewhat uninformative. Overall the chapter provides rather little new insight and contains some misconceptions about ERPs. (For instance, ERP components are not supposed to peak in different time windows at different recording sites across the scalp as is described on p. 44 concerning the N1; see Picton *et al.*, 2000).

In Chapter 3, Csépe reviews a corpus of studies dedicated to the MISMATCH NEGATIVITY (MMN) in developmental dyslexia. MMN studies correspond to the bulk of auditory perception investigations using ERPs. First, the author introduces the auditory deficit hypothesis and sets out a fundamental question: if dyslexia is intrinsically linked to an auditory perceptual deficit, is it at the level of elementary acoustic features (i.e. global) or is it specific to the sounds of language (i.e. phonological)? In this section, Csépe reviews papers supporting the views of Tallal and colleagues,

according to whom developmental language disorders originate in a (global) deficit in processing rapid acoustic transitions. Then, after a short mention of the phonological deficit hypothesis and the distinction between phonetics and phonology, the author introduces ERPs as a high temporal resolution index of cognitive operations. In this first section on ERPs, Csépe reviews some initial studies supporting a deficit at both phonological and low-level perceptual levels. However, she stresses the fact that results obtained from adults are very different from those obtained from children, and she warns the reader about the difficulty of interpreting ERP components in children and infants. The next section is devoted to the MMN. The MMN is a negative ERP variation peaking between 150 and 250 ms after stimulus onset and elicited by a change in the acoustic input (i.e. by an infrequent stimulus presented within a stream of frequent stimuli). The author reminds us that the automatic nature of the MMN (attention need not be engaged) makes it an ideal candidate to study auditory perceptual deficits in infants and children, since no active engagement or behavioural responses are required. Csépe reviews MMN studies in infants, showing that the MMN effect is rather consistently measured using pure or harmonic tones as stimuli as early as birth, before showing that reliable MMNs can also be elicited by language sounds in normally developing children. The next section provides a good synthesis of abnormal MMN patterns in dyslexic children. Although the evidence favours a speech-specific MMN deficit, some studies have found signs of more fundamental auditory deficits as indexed by the MMN. In the subsequent section, Csépe summarizes interesting results of her own group showing that the most reliable difference between dyslexic children and age-matched controls is in the processing of consonants differing in place of articulation or voicing. In the last section, the author summarizes findings from her group of substantial differences between dyslexic and non-dyslexic children in the processing of speech and non-speech sounds as well as of vowels and consonants. She believes these findings are not incompatible with a low-level perceptual deficit. The conclusion is a rather complex picture, and no consensus is reached on the language-specificity of the auditory impairment in dyslexia, due to the subtle interplay of acoustic and phonological factors and to the variability of results in different age groups/subgroups. The chapter contains a great deal of useful information but makes difficult reading in places due to a number of stylistic oddities.

In Chapter 4, Lyytinen, Leppännen, Richardson & Guttorm report a series of results from a longitudinal study of dyslexia conducted in Finland. The experiment series focused exclusively on speech sounds and used behavioural measures (Head Turn procedure) and the MMN ERP effect. The authors limited their investigation to the perception and discrimination of duration in speech stimuli because (i) experimenters have full control

over duration in stimulus preparation, (ii) duration has an important role in Finnish, and (iii) dyslexics are particularly liable to make duration errors when reading. The chapter is extremely well written and crystal clear. First, the authors report the results of categorical speech perception studies. Dyslexic adults (all parents of at-risk infants involved in the longitudinal study) displayed a categorization function similar in shape to that of normal readers, but they needed a longer duration of the closure of the medial consonant /t/ in the pseudoword /atta/ to distinguish it from /ata/. An ingenious adaptation of this paradigm using the Head Turn procedure allowed the authors to find a congruent pattern in at-risk infants. Second, Lyytinen *et al*. report results from MMN studies in which the duration of the vowel or consonant in a syllable was varied between a standard condition (i.e. the frequent stimulus presented on 80% of trials or more) and a deviant condition (i.e. the infrequent stimulus presented on 20% of trials or less). They found (a) particularly large positive ERP modulations over the right scalp peaking around 300 ms after stimulus onset and elicited by vowel duration changes in at-risk newborns and 6-month-olds; (b) smaller responses over the left scalp elicited by consonant duration changes in at-risk 6-month-olds; (c) larger differences over the right scalp between ERPs elicited by different CV syllables in at-risk newborns. Each of these results are dealt with in separate sections and discussed in light of the literature. Notably, the authors have managed to derive from the data in (b) above an ERP lateralization index which correlates with behavioural performance in the head turn procedure and corroborates neuropsychological and neuroimaging evidence on the lateralization of speech processing. These results are discussed in the context of general mechanisms of dyslexia, including genetic considerations, morpho-anatomical differences, and rapid acoustic transition deficit theory. In sum, this is a very rich and well-constructed chapter.

In Chapter 5, Service, Helenius & Salmelin report results from three experiments using magnetoencephalography (MEG). MEG has the important advantage over EEG and functional imaging of providing excellent temporal resolution and fairly reliable spatial localization of brain activation via electrical source modelling. Service and colleagues first report a study of word/pseudo-word reading in developmental dyslexics and control participants. They found between 5 and 13 sources activated in each participant between 150 and 600 ms after stimulus onset. Importantly, a source peaking at 180 ms after stimulus onset and located in the inferior temporo-occipital region was systematically found to be active in controls but not in dyslexics. Dyslexic participants failed to show activity in this region during the first 200 ms. The authors also report differences occurring between 200 and 400 ms: activity mainly originated from the left superior temporal lobe in control participants but from the left inferior frontal lobe in dyslexic individuals. The results are interpreted as evidence in

support of delayed access to the visual lexicon and are discussed in the light of the functional neuroimaging literature. Service and co-authors then report results from a study using the classical semantic violation paradigm (first introduced by Kutas & Hillyard, 1980), adapted to test semantic versus phonological expectations in MEG. Interestingly, they found fewer differences between controls and dyslexic individuals in this experimental context than in the preceding one, and the temporal window analysis revealed no significant differences. The main difference was in the time course of the N400m (the magnetic counterpart of the ERP N400), which was delayed in dyslexic participants by approximately 100 ms. Finally Service *et al*. show that a region of the left visual association cortex on the ventral surface of the brain appears to respond weakly to visual word degradation in dyslexic individuals. In the conclusion, the authors bring together the three studies and interpret them as evidence for a deficit in the processing of sub-lexical information in dyslexia, whereas semantic processes appear to be more preserved. The chapter is nicely written and the authors do not tend to over-interpret their results. It might have been beneficial to discuss some methodological limitations of MEG, however. For instance, it must be kept in mind that source localization is based on models of head anatomy, tissue properties and electromagnetic conductance and that MEG is virtually blind to radial electrical sources, and much less reliable for deep sources than sources close to the scalp.

In Chapter 6, Hugdahl & Heiervang use MRI and dichotic listening tasks to address morpho-anatomical markers of dyslexia. The authors review some empirical evidence for the key involvement of the left planum temporale (PT) of the human brain in processing spoken language. Following on the finding of structural abnormalities in the PT of dyslexic individuals, Hugdahl & Heiervang studied morpho-anatomical properties of the left and right PT in dyslexic and control 12-year-olds. Following a stringent selection of participants, the authors showed that, despite a similar level of left/right PT asymmetry in both groups, the left PT of dyslexic children was on average 10% smaller in surface than that of children matched for age and nonverbal performance. These authors then used a dichotic listening task (simultaneous presentation of two different stimuli in the left and right ear) to test whether there was a functional counterpart to this structural difference. Although dyslexic children did not exhibit a greater right ear (left hemisphere) dichotic advantage than controls, the authors found a positive correlation between left PT size and right ear dichotic listening recall. An interesting result is highlighted: dyslexic children appear to fail to overcome their right ear advantage when instructed to pay attention to stimuli presented to the left ear. This leads the author to hypothesize a deficit in attention, at least for processing phonological stimuli. This hypothesis is very interesting, and it would have been nice to see it discussed in relation to the literature. This chapter is very clear

and interesting but rather short, and results are perhaps too swiftly discussed.

Overall this book gives good, detailed insight into main-stream neuroscientific investigations of developmental dyslexia. It is perhaps a shame that the different chapters are disconnected from one another and that no general discussion integrating the different approaches is attempted. This probably reflects the fact that inter-disciplinary research on dyslexia is only in its beginnings. Nevertheless, some key hypotheses as to the bases of dyslexia at the physiological level are reviewed and some important recent findings are summarized. It would have been useful, however, to have a chapter on functional neuroimaging to enable a comparison of its outcomes in the field of developmental dyslexia with other approaches reported in the book. On the theoretical side, it would have been interesting to read more about the cerebellar hypothesis (e.g. Nicolson, Fawcett & Dean, 2001) and the hypothesis of attentional deficits in dyslexia (e.g. Hari & Renvall, 2001; Valdois, Bosse & Tainturier, 2004).

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