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ATTENTIONAL CONTROL OVER LANGUAGE LATERALIZATION IN DYSLEXIC CHILDREN: DEFICIT OR DELAY?

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Abstract—Two previous verbal dichotic studies by Kershner and Morton (*Neuropsychologia* **28,** 181–198, 1990) using the forced-attention methodology (Bryden, *Strategies of Information Processing*, Academic Press, London, 1978) demonstrated that the order in which the ears were monitored (LE first or RE first) determined whether learning disabled children compared to age-matched nondisabled children were more weakly or strongly lateralized. The same technique was used with the addition of controls for lateral head and eye movements, specific diagnostic criteria to include only phonological dyslexics, IQ and reading level. Dyslexic vs age-matched comparisons replicated the previous studies. The dyslexics produced a weaker REA in the LE first order but a greater number of subjects with a REA in the RE first order. Reading-matched comparisons suggested that the order-specific reduced REA in the dyslexics may reflect a causal deficit of the disorder, whereas the order-specific increase in the number of dyslexic subjects with a REA was no different than the reading-matched group, implicating a developmental delay. The results suggest that children with dyslexia may suffer from a primary attentional impairment in altering the REA. This implicates an underlying difficulty of flexible verbal processing in response to the rapidly changing cognitive requirements of reading.

INTRODUCTION

An important modulatory role for neural networks of selective attention in cognitive processing is now well-established [8, 27, 38]. Thus, in theory, attentional factors may be one of the processes implicated in the etiology of learning disorders.

In particular, programmatic dichotic listening research† with normal and dyslexic children, a neurodevelopmental reading impairment of presumed neurological etiology [17], demonstrates that: (a) attentional variables have significant effects on the REA [2, 9, 11, 13, 24, 34, 39]; and (b) when differences in the REA can be demonstrated between children with

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†A right ear advantage (REA) in dichotic performance is interpreted, tempered by certain methodological and theoretical qualifications, as an indication of linguistic specialization of the left cerebral hemisphere. This inference is based on studies indicating that (a) the left hemisphere is preprogrammed when activated differentially for attending selectively to the right side of space (i.e. right ear), (b) the contralateral pathways are prepotent over ipsilateral (same ear-hemisphere) auditory pathways, and (c) in most right-handed people the left hemisphere is specialized for linguistic processing. Thus, auditory–verbal information perceived dichotically at the right ear is easier to code and process than the same information arriving at the left ear.

dyslexia and nondisabled children, such differences are produced largely by attentional factors [3, 5, 15, 19, 20, 22, 23, 28, 30–34, 41]. For instance, differences in the REA between dyslexics and age-matched good readers have been produced by lateral changes in head position relative to the body midline [5], cued selective report from a designated ear [21, 33, 35], changing the dichotic response from oral to written [20, 23, 41], the order of presentation of different types of dichotic stimuli [28], and the order in which the ears are monitored [22].

A reasonable inference from these experiments is that children with dyslexia do not suffer from poor or incomplete hemispheric specialization for language as has been claimed [37]. These studies, however, are consistent in demonstrating that dyslexic children differ from age-matched good readers in how attention interacts with cerebral specialization in dichotic listening tasks. Processing of receptive speech appears to cause strong group differences in the REA. But, paradoxically, while most studies have found an attentionally-induced, decreased REA in dyslexic children [5, 21, 32, 35], an attentionally-induced, increased REA has also been reported [3, 33]. Therefore, the dichotic literature seems to offer "incompatible" data in favor of both a right hemisphere excessive activation model (failure of the left hemisphere to engage and/or inhibit the right hemisphere) and a left hemisphere excessive activation model of dyslexia (see [22] and [30] for reviews of these models). Alternatively, a more dynamic theoretical account of attentional interactions with age-invariant hemispheric specialization has been suggested by other studies. For example, it has been shown that the phasic, situation-specific nature of the REA may be sufficiently malleable to produce weaker and stronger REAs in dyslexic children when they are compared to age-matched controls [20, 22, 23]. It appears, therefore, that the REA in dyslexics may be subserved by an impaired attentional system which puts them at risk for both underlateralized and overlateralized verbal processing. It remains to be seen whether such attentional effects have any etiological significance to the neuropathology of the disorder.

The present study addresses these issues in a modified replication of two of these previous studies which were conducted with two different cohorts of learning disabled children [22]. In a forced-attention dichotic task (requiring exclusive surveillance and report from each ear in a predetermined sequence) dyslexics vs age-matched comparisons showed that the REA interacted uniquely in each group with the order in which the ears were monitored. The dyslexics in comparison to the good readers produced a lower REA when directed left first and a higher REA when directed right first. In the right ear first order the dyslexic children also demonstrated a greater number of subjects with a REA.

Although these dichotic order effects were replicated originally in successive experiments, several methodological limitations called for cautious interpretations pending additional research. For instance, without experimental controls for IQ and reading-level, we were unable to infer causality or to determine the etiological significance of the findings. Reading-matched controls can eliminate the possibility that unique patterns of performance in dyslexic subjects may be due secondarily to their immature reading proficiency as opposed to qualifying as a putative cause of their poor reading [4]. To support a claim for causality, the logic of the reading-matched design requires a demonstration of dichotic differences between the dyslexics and both normal control groups. Such results would permit the observed difference to be treated as a potential primary deficit underlying dyslexia. Dichotic differences that emerge between the dyslexics and the age-matched group but not between the dyslexics and the reading-matched group, would constitute qualifying evidence for a developmental delay interpretation of that difference (related perhaps to a lack of experience