



**Phonology, phonetics, and temporal processing in developmental dyslexia:  
from mechanisms to remediation**

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Evidence of a phonological deficit as a cause of developmental dyslexia has been accumulating largely in the last two decades, yet the mechanisms underlying this deficit remain controversial. Some authors assume that a temporal processing deficit is the source of the phonological disorder observed in dyslexic children. Others maintain that the phonological deficit in dyslexia is basically linguistic, not acoustic, in nature. This debate is not only theoretical; it also has important practical implications, since at least two studies have suggested the value of intensive daily training of dyslexic children with exercises based on the temporal processing theory.

Our group has been involved in both theoretical and remedial aspects of this issue.

- 1) We first tested the impact of the temporal alteration and the impact of complex syllabic structure on consonant order judgments with a Temporal Order Judgment (T.O.J.) task using the sequential order of two consonants (/ps/ or /sp/) within a cluster. In order to test the possible relevance of the temporal deficit hypothesis, the task also included two additional conditions where either the two stimuli were artificially slowed or two phonological structures were opposed (CCV, CVCV). As expected, the T.O.J. performance was significantly poorer in dyslexics than in controls. Moreover, in the "slowed speech" condition dyslexics' performance improved to reach the normal controls' level, whereas manipulating the complexity of the phonological structure provided no significant improvement. Finally dyslexics' performances, especially on the slowed condition, were correlated with several tests of phonological processing.
- 2) Three separate studies have been successively carried out in our laboratory to assess the usefulness of a daily training method such as that proposed by Merzenich *et al.* (1996) and Tallal *et al.* (1996), including both artificial slowing of natural speech stimuli and amplification of brief, unstable portions of the speech signal. In the first study, 12 dyslexic children, aged 10-12, received either such modified speech or normal speech 1 hour a day, 5 days a week, during 5 weeks, and were assessed on phonological tasks before, during and after training. A significant advantage for the modified speech group was found both in pre-post training improvement and in day-to-day progression on phonological performance. In a second study, 29 children with dyslexia, aged 5-12, received a similar training but only 15 minutes a day, 7 days a week, during 6 weeks, part at the speech therapist office, part at their own home. The finding of comparable improvement in more 'natural' environment and in children over a wider age range, indicates both the efficacy and feasibility of the method in usual clinical practice. However, this study also showed that one out of four children did not improve to the expected point, prompting a third study, where 23 other children underwent specific tasks presumably exploring various aspects of temporal processing in order to find predictors of training efficacy. The "temporal order judgement" (TOJ) task was found to be best correlated with post-training improvement, suggesting that it could be used to identify the most suitable candidates for temporo-phonological training. This observation lends further support to the temporal processing theory of dyslexia.

Merzenich M., Jenkins B., Johnston P., Schreiner C., Miller S., Tallal P. (1996) Temporal processing deficits of language-learning impaired children ameliorated by training. *Science* 271, 77-80.

Tallal P., Miller S., Bedi G., Byma G., Wang X., Nagarajan S., Schreiner C., Jenkins B., Merzenich M. (1996) Language comprehension in language-learning impaired children improved with acoustically modified speech. *Science* 271, 77-80.

