Perceptual centres in speech and developmental dyslexia: A new hypothesis

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A core difficulty in developmental dyslexia is the accurate specification and neural representation of the sequential sounds of speech (“phonological representation”). A basic auditory processing mechanism that has been unexplored in relation to the development of phonological representation is ‘perceptual centre’ (‘P-centre’) processing. Sounds exist only over time. P-centres represent the way that this existence over time is differentiated: there is a ‘beat’ that occurs later than the physical onset of the sound. For speech, this ‘beat’ corresponds to the point in time at which any syllable is perceived to occur. P-centres are determined by the rate of change of the amplitude modulation in acoustic signals, and are principally determined by the peak increment in mid-band spectral energy (corresponding to vowel onset in speech sounds). Identification of the P-centre in any syllable thus allows its phonological representation in terms of the two sub-syllabic segments of onset (the phonemes preceding the vowel) and rime (the vowel and any following phonemes, e.g. s-eat, sv-eet, str-eet). Onset-rime awareness is known to be deficient in dyslexic children, and to be causally related to reading progress in normally-developing children.

Here we report data from a study of P-centre perception in 73 children (24 9-year-old dyslexic, 24 chronological-age controls and 25 reading-age controls). We measured P-centre processing using a rate of amplitude modulation change task (RAMCT), which yields an increasingly strong perception of a “beat” sound as the rise time of the modulation is shortened. On the basis that onset-rime detection is poorer in dyslexic children, we predicted that they would have poorer sensitivity to P-centres than controls and only perceive the “beat” sound with relatively rapid amplitude increases (i.e., they should perform best when integrating information over short rise times). We found highly significant differences between dyslexic and normally-reading children in P-centre processing, and P-centre processing also strongly predicted reading and spelling acquisition in stringent multiple regression analyses controlling for age, I.Q., vocabulary and phonological processing. Dyslexic children did not have difficulties in perceiving short rise times, as Tallal’s rapid temporal integration hypothesis might predict. We also tested the children with one of Tallal’s tasks (rapid frequency discrimination task, RFD) and a measure of temporal order judgement (dog bark/car horn TOJ). Tallal’s RFD task also distinguished between dyslexics and controls, whereas the TOJ task did not. One explanation of this pattern is that some of the same features that affect P-centre location (rise time of the stimuli) also affect judgements in the RFD task. However, RFD did not show comparable predictive power in the regression analyses for reading and spelling, particularly for spelling. This is conceptually important, as developmental dyslexia in most languages is diagnosed on the basis of spelling rather than reading difficulties.