

Auditory Perception of Frequency-Modulated Sweeps and Reading Difficulties in Chinese

Authors : Hsiao-Lan Wang, Chun-Han Chiang, I-Chen Chen

Abstract : In Chinese Mandarin, lexical tones play an important role to provide contrasts in word meaning. They are pitch patterns and can be quantified as the fundamental frequency (F0), expressed in Hertz (Hz). In this study, we aim to investigate the influence of frequency discrimination on Chinese children's performance of reading abilities. Fifty participants from 3rd to 4th grades, including 24 children with reading difficulties and 26 age-matched children, were examined. A series of cognitive, language, reading and psychoacoustic tests were administered. Magnetoencephalography (MEG) was also employed to study children's auditory sensitivity. In the present study, auditory frequency was measured through slide-up pitch, slide-down pitch and frequency-modulated tone. The results showed that children with Chinese reading difficulties were significantly poor at phonological awareness and auditory discrimination for the identification of frequency-modulated tone. Chinese children's character reading performance was significantly related to lexical tone awareness and auditory perception of frequency-modulated tone. In our MEG measure, we compared the mismatch negativity (MMNm), from 100 to 200 ms, in two groups. There were no significant differences between groups during the perceptual discrimination of standard sounds, fast-up and fast-down frequencies. However, the data revealed significant cluster differences between groups in the slow-up and slow-down frequencies discrimination. In the slow-up stimulus, the cluster demonstrated an upward field map at 106-151 ms ($p < .001$) with a strong peak time at 127ms. The source analyses of two dipole model and localization resolution model (CLARA) from 100 to 200 ms both indicated a strong source from the left temporal area with 45.845% residual variance. Similar results were found in the slow-down stimulus with a larger upward current at 110-142 ms ($p < 0.05$) and a peak time at 117 ms in the left temporal area (47.857% residual variance). In short, we found a significant group difference in the MMNm while children processed frequency-modulated tones with slow temporal changes. The findings may imply that perception of sound frequency signals with slower temporal modulations was related to reading and language development in Chinese. Our study may also support the recent hypothesis of underlying non-verbal auditory temporal deficits accounting for the difficulties in literacy development seen developmental dyslexia.

Keywords : Chinese Mandarin, frequency modulation sweeps, magnetoencephalography, mismatch negativity, reading difficulties

Conference Title : ICCSLA 2017 : International Conference on Cognitive Systems and Language Acquisition

Conference Location : Melbourne, Australia

Conference Dates : February 02-03, 2017