UltraPhonix: Learning New Articulations with Ultrasound

Ultrasound Tongue Imaging (UTI) is gaining popularity as a visual biofeedback tool that is cost-effective and non-invasive. The evidence for Ultrasound visual biofeedback (U-VBF) therapy is small but promising, with around 20 case or small group studies. However, most studies originate from the USA and Canada, and focus on the remediation of delayed/disordered /r/ production (for example McAllister et al., 2014). While ultrasound is ideal for visualising /r/ productions, it also offers the ability to visualise a much larger range of consonants and all vowels, for example Cleland et al. (2015) report success in treating persistent velar fronting and post-alveolar fronting of /ʃ/. Moreover, most studies use hand-held ultrasound devices, making it difficult to collect and compare ultrasound images across the therapy process. This is important because ultrasound offers additional insights into auditorily imperceptible tongue movements which may give clues as to why persistent speech sound disorders fail to remediate with traditional approaches. This paper will report on a new project, "UltraPhonix" designed to test the effectiveness of U-VBF and record high-speed ultrasound during both assessments and therapy.

Twenty children aged 6 to 15 with persistent speech sound disorders affecting vowels and/or lingual consonants in the absence of structural abnormalities took part in the project. We use a single-subject, multiple baseline design, with different wordlists (untreated probes) utilised in accordance with each child's presenting speech error. We use a high-speed Ultrasonix SonixRP machine running Articulate Assistant Advanced software (Articulate Instruments, 2012) at 121 frames per second allowing us to capture and review dynamic information about the children's speech errors for diagnostic purposes. Each child received 10 sessions of U-VBF therapy, preceded by three baseline probes, and followed by two maintenance measures. Therapy is based on the principles of motor learning, with each child required to perform at 80% accuracy at each level of performance before moving on to a motorically harder level (for example, from single syllable words to multisyllabic words). By gating the therapy process in this way we are able to report how many sessions on average are required to a. learn a new articulation and b. apply that new articulation.

Results from the first cohort of participants show rapid acquisition of new articulations in the first few sessions (mode: session 2) but slower generalisation to untreated words. Ongoing ultrasound analysis suggests a range of abnormal tongue shapes (for example undifferentiated lingual gestures) suggesting a motoric cause of persistent speech sound disorders, even in children with pre-existing diagnoses of "phonological disorder". Results of both the effectiveness of therapy and the underlying causes of speech sound disorders as evidenced by ultrasound will be discussed.

References

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