THE ULTRAPHONIX PROJECT: ULTRASOUND VISUAL BIOFEEDBACK FOR HETEROGENEOUS PERSISTENT SPEECH SOUND DISORDERS

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BACKGROUND

- Ultrasound Visual Biofeedback (UVB) shows promise as a technique for the remediation of persistent Speech Sound Disorders (SSDs).³
- UVB allows the surface of the tongue (Fig 1) to be imaged in real time and used as a biofeedback device in a motor-learning paradigm.
- Many current studies focus on the remediation of /r/ (e.g. North America) despite ultrasound being useful for imaging most lingual consonants and all vowels.
- Most current studies use a hand-held ultrasound probe and thus do not report on diagnostic information and phonetic insights gleaned through recording of high-speed ultrasound.

ANALYSIS

- Data is acquired at each assessment and therapy session.
- Six untreated assessment probes (grey boxes) are prioritised for ultrasound and perceptual analysis.
- Ongoing annotation of the therapy target and any minimal pairs. For example, for children who are persistently velar fronting, the burst of /r/, /l/ in all words and /r/, /l/ from suitable minimal pairs are annotated.
- Spline fits are exported to the AAA Workspace for qualitative analysis and co-ordinates are exported for quantitative analysis of differences in tongue shape.

Example Ultrasound Results: 04M

Perceptual Analysis

The DEAP phonotest subtest and probe wordlist are transcribed by a phonetician blind to the diagnosis of each child and to the intervention time point.

- DEAP is scored for % consonants correct (PCC).
- Probes are scored for % treated segment correct (PCC:PTC).

For example, if velars are treated, the number of correct-sounding (i.e. phonetically accurate) velar stops from a 105 item list are presented as a % PCC.

Preliminary Results: First Cohort

- Six children completed or near completion.
- Table (below) shows the age of the children and the phonological/phonetic pattern targeted in therapy alongside the number of sessions required to learn the new articulation.

Example ultrasound analysis

Participant | Sex | Age | Target | First New Articulation | First New Articulation (FNA) Date |
---|---|---|---|---|---|
01 | F | 8.8 | Velar fronting | Session 2 | 04 Average (FNA) [tabs] |
02 | F | 7.8 | Cluster Reduction | Session 1 | 02 Average (FNA) [tabs] |
03 | F | 10.11 | Velar fronting | Session 2 | 03 Average (FNA) [tabs] |
04 | F | 7.2 | Velar fronting | Session 3 | 04 Average (FNA) [tabs] |
05 | M | 6.5 | Vowel Disorder | Session 3 | 05 Average (FNA) [tabs] |
06 | M | 6.4 | Post Alveolar fronting | Session 4 | 06 Average (FNA) [tabs] |

Inclusion and exclusion criteria:

- 20 Scottish English children aged 6 to 15.
- Include difficulty with lingual articulations.
- Include children with diagnosis of SSD, e.g. articulation disorder, phonological disorder, Childhood Apraxia of Speech.
- Include concomitant language impairments, mild hearing loss or mild learning difficulties.
- Exclude major physical disability or structural abnormality of the vocal tract are excluded.
- Threshold: must be less than 20% correct at baseline in targeted consonants/vowels.
- Baselines: must be stable.

Design:

- Single-subject designs are recommended in clinical therapies research to explore feasibility and client outcomes with newer and little studied therapies.
- Using a multiple baseline design across participants allows us to create individual targets for therapy where the participant group is likely to be heterogeneous.

PARTICIPANTS and DESIGN

Ultrasound Setup

- Ultrasound Sonolof machine, C9-5/10 probe.
- Articulate Assistant Advanced User Guide.
- DEAP is scored for % treated segment correct (PCC).
- Headset (Fig 1, left) used to stabilize the ultrasound probe during assessments and therapy.
- Simultaneous acoustic and lip-camera recordings.

PROTOCOL

- Participant Referred from Speech & Language Therapist.
- The Intelligence and Context Scale (ICS).
- Target Selection.
- DEAP: Phonetic and phonological process analysis performed. Common systematic error (developmental /r/ errors expected) identified and untrained Probe wordlist identified.
- Therapy: 10 Sessions of UVB.
- Mid-Therapy Probe: Motor-based therapy, beginning with elicitation of the new articulation in a facilitative coarticulatory context.
- Begin with level 0, the child progresses to the next level only when they are able to produce 8/10 tokens at that level correctly.

CONCLUSIONS

- Ultrasound Visual Biofeedback shows promise as both a diagnostic tool and motor-based speech therapy in children with persistent Speech Sound Disorders.
- Results so far show rapid acquisition of new articulations in the first few sessions (mode = session 1) but slower generalisation to untreated words.
- Ongoing ultrasound analysis is also providing evidence of 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".

References