**BACKGROUND**

- Velars are normally acquired by 3.6 years.
- Velar fronting (substituting [t] for [k] with [t] and [d] n) is a well attested phonological process in typical children and older children with speech sound disorders (SSD).
- Absence of velars in the phonetic inventory at three years of age is predictive of phonological disorder.
- Some children become persistent velar fronters (VF), still unable to articulate velar consonants well into the school years.

**Purpose**

- To compare velar and alveolar productions at multiple time points during the therapy process.

**Participants**

- Four children with persistent velar fronting (VF), reported in Cleland et al. (2015), EPSRC Ultra project, aged 6 to 8 years.
- All children reported to have VF and glide only.
- VF perceived as [t] in all four speakers.
- 3D Typically developing children from the Ultra Corpus, Group 1, aged 5 to 6, used for comparison data.

**Therapy**

- Participants OSM, O6M, O7T: 1 block of 12 sessions of U-VBF. Participant O4M: 10 sessions (no progress in R1).
- Motor based approach.

**Data points**

- Pre-Therapy, mid-therapy, post-therapy and 6 weeks post therapy, [t] and [k] productions compared.

**METHOD: Data Collection**

**Ultrasound Setup**

- Ultrasound SoniSpor machine, CF-5/10 probe.
- Articulate Assistant Advanced software (2015).
- 121 frames per second (fps) with 15° field of view (FOV).
- Fig 1 shows a typical ultrasound image (right).
- Headset used to stabilise the ultrasound probe during assessments and therapy.

**Wordslist**

- SSD Participants: Untreated wordlists of velars and minimal pairs in a variety of word contexts and word positions.
- SSD Participants: Focus here is on [t] and [k] for quantitative ultrasound measurements.
- TD Participants: [n], /i/, /d/, /eta/, /t/, /d/, nonwords.

**RESULTS: Ultrasound**

**Typical Children Average Tongue Shapes**

- Average tongue shapes show clear co-articulatory effects on location of [k] and [t] and on the extent of the difference between them.
- Clear differentiation in tongue body in low versus high contexts.
- Tip and tongue crossing points delimiting the KT-crossent are clearly visible.
- If we take a as our comparison for SSD children, we expect a height difference of 11.9mm +/- 1SD as normal. Range: 8.9mm to 14.3mm.

**Children with SSD Tongue Shapes over Time**

- All children begin with negligible differences in tongue height between [t] and [k].
- Two children (OSM & O6M) show steady increasing differences in pre.
- Two children (O4M & O7T) show ‘overhead’ with abnormally large differences in tongue height at mid therapy-transcription in [k].
- All children move towards tongue height differences in line with TD children.

**CONCLUSIONS**

- Ultrasound Visual Biofeedback can be used to remediate persistent velar fronting in school aged children.
- Ultrasound analysis provides evidence of gradual change, in line with theories of motor-speech disorder, rather than the categorical shift predicted from theories of phonological delay and recorded in PCC values.
- Results of a perception experiment somewhat confirm the gradual change, with listeners sometimes identifying improvement between some time points which have significant transcription-based scores.

**References**