

## **Ultrasound-based tongue root imaging and measurement**

**James Scobbie**

Queen Margaret University, [jscobbie@qmu.ac.uk](mailto:jscobbie@qmu.ac.uk)

Ultrasound imaging has been used over the last twenty years by phoneticians, predominately in a clinical context, for capturing images of the tongue. The images are obtained by placing a probe under the chin and recording the television-quality output together with an audio channel, which has to be time-aligned. The technique is safe, gives instant results and can be used for qualitative and quantitative research into spatial and, to some extent, temporal dynamics of tongue movement. Typically, a mid-sagittal image of the tongue surface is captured, from the blade down to the root, where the tongue meets the epiglottis, or where an acoustic shadow cast by the hyoid bone obscures the tongue root. The location of the rear pharyngeal wall cannot be determined, so pharyngeal constrictions are identified by changes in the location of the tongue root itself. The main advantages of the technique are its instant usability, ease of use, safety, and low cost. Disadvantages include image quality (especially with older adults and male speakers), acoustic alignment, large storage demands for digitised data, acoustic alignment, the physiological differences between different speakers, the lack of information on cross-sectional area, and the lack of well-established analysis techniques.

In this talk I will demonstrate the technique using data collected with Articulate Assistant Advanced. This software is also used for analysis. It provides functions to annotate speech, filter tokens with those annotations, trace the tongue surface, encode its location in a coordinate space, and export the location of those surfaces using a scripting language. Additionally I will describe the head-stabilisation system developed by Articulate Instruments Ltd, an aluminium headset which holds the probe steady during data capture.

Data will be drawn from a corpus of 15 younger teenage speakers of Scottish English, as well as other observations. In Scottish English, we have been looking at the patterns of pharyngealisation in the consonants /r/ and /l/ that contribute to their dark quality. In addition to this secondary articulation in contemporary Scottish English, some speakers may vocalise these consonants. In the case of /l/, there can be a loss of alveolar contact, promoting the dorsal articulation in importance. In either case, the constriction seems to be in the upper pharynx or uvular region. Coda /r/ may likewise lose or delay its post-alveolar constriction, giving the retraction of the tongue root in the a lower pharynx likewise greater prominence in the pronunciation of this phoneme. An added complexity, well-known in other varieties of English, is that an /r/ with a double articulation may have quite different-looking articulatory configurations, including at least bunched/tip-down and retroflexed/tip-up types.

The vowel system in Scottish English is also of interest and shows wide differences in pharyngealisation/tongue root retraction. Scottish English has 9 monophthongs, three of which might be lax members of tense/lax pairs (the vowels in KIT, DRESS, and STRUT). We will examine the relative degree of pharyngealisation in different plain vowels across speakers (see figure for an example).

