Editorial to Clinical Linguistics and Phonetics Special Issue: Insights from Ultrasound: Enhancing Our Understanding of Clinical Phonetics.

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In 1969 Kelsey, Minifie and Hixon proposed ultrasound as a viable speech imaging alternative to X-ray, stating that "*The study of both normal and pathological speech production would be greatly aided by techniques that would provide information on the configuration and motion of the vocal tract without the use of extraneous devices in the tract itself*" (Kelsey et al., 1969, p564). Whilst this and other early studies sought only to investigate articulation, a decade later clinicians saw the potential power of ultrasound tongue imaging (UTI) as a biofeedback tool for modifying atypical articulations in speech disordered speakers. In their 1985 study Shawker and Sonies showed a speaker with hearing impairment real-time dynamic images of her own tongue with ultrasound and used that information to help her learn new articulations. This early stage of ultrasound tongue imaging was fraught with practical problems with cumbersome hospital ultrasound equipment, low frame rates and difficulties analysing the resultant ultrasound data. Even so, the potential for ultrasound as both a powerful articulatory technique and a tool for remediating persistent speech disorders was evident.

Since then, ultrasound equipment has become smaller, more portable, faster, and methods of stabilising the ultrasound probe to ensure good quality images have been developed. Likewise, the capability to synchronise audio with ultrasound is now affordable and the development of software for analysing ultrasound has accelerated. A decade ago in a special issue of this very journal on "Ultrasound Imaging of the Tongue", Stone (1995) said that "*Ultrasound is a tool that is limited only by a researcher's creativity*" (p453). It is apt, then, that almost exactly ten years later this special issue of Clinical Linguistics & Phonetics demonstrates clearly that creativity, with papers representing populations as diverse as blind speakers (Ménard et al.) and pre-school children (McCabe et al.) and topics as diverse as tongue shape classifying (Dawson et al.) and acquisition of rhotics (Boyce et al.). The timing of this special issue was in part inspired by the 6th Ultrafest conference in Edinburgh in 2013, a meeting in which phoneticians, clinicians and engineers working in ultrasound tongue imaging came together. We invited contributions from these and other experts in the field working with ultrasound as a tool for investigating clinical populations; as a biofeedback device in speech therapy; or as a tool for investigating typical speech production, with a view to informing investigations of clinical populations.

The resulting papers cover all these areas. First, the need to further describe typical articulations, especially in languages other than English, is highlighted in a cross-linguistic study of /r/ by Suzanne Boyce, Sarah Hamilton and Ahmed Rivera-Campos and a description of affricates in Kannada is provided by Alexei Kochetov and N. Sreedevi. Turning to clinical populations, Lucie Ménard and colleagues give us an insight into the speech of visually impaired speakers, showing that lip perturbation affects blind and sighted individuals differently, with blind speakers modifying tongue-shape parameters when sighted individuals do not. Other important theoretical questions about disordered speakers are addressed by Tara Mcallister Byun, Adam Buchwald and Ai Mizoguchi who demonstrate that ultrasound can be used to identify covert contrast in young children presenting with velar fronting. Moreover, Qi Wen Heng and colleagues show us that ultrasound might be an appropriate technique for remediating this particular speech disorder, even in very young pre-school children. However, Jonathan Preston and colleagues caution that, at least in older children with persistent speech sound disorders (Childhood Apraxia of Speech) ultrasound biofeedback does not necessarily lead to generalisation of new articulations. This is perhaps because, as Suzanne Boyce points out, /r/ is particularly difficult to master due to the necessity to incorporate tongue root movement towards a pharyngeal articulation alongside the coronal gesture. Nevertheless, Tim Bressmann and colleagues echo previous research showing that acceptable productions of /r/ can be achieved with ultrasound biofeedback, though perhaps with no greater success than traditional speech therapy methods. Turning to cleft lip and palate, a population with a well-documented history of the benefits of instrumental analysis and biofeedback therapy, Zoe Roxburgh, Joanne Cleland and James Scobbie show us a new method of determining perceptually whether speech is improved following intervention with ultrasound by using multiple phonetically trained listeners.

Two studies use ultrasound to investigate speech in persons who stutter, with Stefan Frisch, Nathan Maxfield and Alissa Belmont finding no differences in co-articulation compared to typical speakers, but nonetheless evidence of less adult-like articulatory systems evidenced by reduced stability in velar closures. Cornelia Heyde and colleagues focus on analysis techniques on their paper on stuttering. Highlighting that a technique as dynamic as ultrasound deserves a dynamic approach to analysis and making the most of the ability of high-speed ultrasound to capture subtle phonetic phenomena in the gestural coordination of the fluent speech of people who stutter. The need for better ways of analysing disordered speech is echoed by Kele Xu and co-authors who show promise of better automatic tongue contour tracking and by Katherine Dawson, Mark Tiede and Doug Whalen who propose several methods of quantifying tongue shape in their paper. The need to measure changes in tongue shape and movement after therapy to quantify improvement is

highlighted by Tim Bressmann and co-authors who offer a method for measuring tongue displacement following therapy to establish rhotics. All of these analysis methods hold promise for future analysis of disordered speech.

It is clear that ultrasound tongue imaging is a promising technique for both answering theoretical phonetics questions and remediating intractable speech sound disorders. Whilst in the past there has perhaps been a dichotomy between these fields, with ultrasound biofeedback sitting quite separately from instrumental articulatory analysis of the very disordered speech it hopes to treat, this has at least in part been due to historical difficulties with equipment, frame rates and analysis techniques. This special issue, along with other papers in regular issues of CLP in this and recent years, serves to remind us that these fields can and should work together and that ultrasound provides new insights into clinical populations and enhances our understanding of articulatory phonetics.

References

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