Modelling the spread of sound change using dynamic parameters in an agent-based model.

Jonathan Harrington & Florian Schiel

The focus of the presentation is on the development of an agent-based model in order to relate the conditions that give rise to sound change to its spread around a community of speakers. One of the model's characteristics is that the interacting agents were based directly on real speaker recordings; another is that phonological categories in an agent's memory were updated by producing and perceiving dynamically parameterised speech.

The agent-based model was designed to test whether the inherent biases in coarticulation and undershoot that provide the conditions for sound change to take place (e.g. Beddor, 2009; Ohala, 2012, Solé, 2007) can be magnified as speakers modelled as agents communicate with and imitate each other over many iterations. This test was carried out on data analysed in Harrington et al (2008) of older and younger speakers of Standard Southern British (SSB) who had produced isolated minimal-pair /CVd/ words (V = /i, ju, u/ e.g. *feed*, *feud*, *food*).

There was one agent for each of these speakers. Each agent had a lexicon whose words were associated with dynamically parameterised signals of the vowels. Communication involved transmitting a word category label and a randomly generated dynamic signal from an agent-producer to an agent-perceiver. The signal was generated from a Bayesian model formed from the existing signals of the transmitted word category stored in the agent producer's memory. If the transmitted signal was probabilistically closest to the agent perceiver's corresponding vowel category (e.g. closer to /i/ than to /ju, u/ if the perceived word was *feed*), then it was added to the agent perceiver's memory. Following such an addition, the least probable signal of the same vowel category was removed from the agent perceiver's memory in one version of the model; in another, it was the oldest signal that was removed.

Consistently with the direction of sound change observed in SSB (Harrington et al, 2008; Hawkins & Midgley, 2005; McDougall & Nolan 2007) and in other (Cox & Palethorpe, 2001; Fridland, 2008; Hall-Lew, 2011) varieties of English, the results over several thousands of randomly selected agent-pairs and words showed that the agents representing older speakers with a retracted /u/ accommodated much more to the phonetically advanced /u/ of the younger speaker-agents than the other way round. It is suggested that the reason for this asymmetric shift is because synchronically coarticulation and undershoot are more likely to front a retracted /u/ than to retract a phonetically front or central /u/ (e.g. Harrington et al, 2011). Because the imitations were based on exchanging and updating dynamic signals, the outcome following agent-based modelling can be (and was) changes to the entire shape of formant trajectories. The advantage of this approach is that it can be used to model sound changes by which monophthongs can develop early or late targets (as in Australian English /i, u/) or diphthongise (as in the Great Vowel Shift).

Current research is focused on adapting the agent-based model to incorporate the possibility of the many kinds of sound change that involve phonological splits and mergers.

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