Why sound change is quantal

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This paper addresses the observation that sound change tends to "jump" qualitatively from one sound to another (e.g., from /p/ to /f/), skipping over many possible phonetic gradations in between. Qualitative shifts in language have been fruitfully modeled as phase transitions in population-based models of sound change (Wang et al. 2006, etc.). A model of widespread quantal (qualitative, nonlinear) phonetic effects is proposed to underlie this observation. In the past, quantal effects have mainly been thought to be confined to articulatory-acoustic relations: The classic example of a quantal effect (from Stevens 1972, 1989, etc.) shows how the tongue can move around within some regions of the vocal tract with little acoustic change, while in other regions, very small movements can have large effects on the acoustic output. This effect can be thought of as demonstrating that some regions of the articulatory-acoustic space are nonlinear, with speech sounds tending to cluster in those regions that allow more variation. Linguists have long observed that many independent factors contribute to sound change, including “articulatory ease”, “perceptual salience” or “social constraints”. Each of these factors contributes nonlinearities to the sound change process. The present paper will use the ArtiSynth simulation platform (www.artisynth.org) to show examples of powerful biomechanically based nonlinearities, and will propose a model in which nonlinearities across multiple dimensions interact, creating stable regions that act as attractors in learner-based models of sound change.