Computational modeling of nonfinality effects on stress typology

Avoidance of final stress is found in many phonological systems, and is analyzed as an extrametricality rule (Liberman and Prince, 1977) or nonfinality constraint (Prince and Smolensky, 1993/2004). These analyses have been argued to be grounded in perception or production (e.g. Gordon, 2000; Lunden, 2006). I show that incorporating such a phonetic bias against final stress in a simulated iterated learning model allows us to capture three skews in typological frequency: the greater frequency of penultimate stress over peninitial stress, the greater frequency of final over initial stress windows, and the greater frequency of trochaic over iambic footing.

The learners use standard OT stress constraints and probabilistically misperceive final stress. Learners represent their hypotheses as Maximum Entropy grammars (Goldwater and Johnson, 2003) and respond to input data with Stochastic Gradient Ascent (Jäger, 2007). In the perception bias component, input data with final stress is probabilistically manipulated to remove that stress. I contrast the possible methods of reassigning stress under perception errors. The results of learning are iterated, generation to generation (e.g. Griffiths and Kalish, 2005), to give predictions for typological frequency. Results presented are the statistics computed over many repeated instances of simulated learning. Essentially, these simulations show how the behavior of an error-driven learner can be altered if it is occasionally “misled” about its language due to some aspect of its perceptual system. This work offers a way to combine perceptual biases with grammatical theories to build substantive models of typological frequency.

I discuss results for three asymmetrical parts of the typology in which the right edge shows greater typical typological “complexity” attributable to nonfinality:

1. **Fixed stress** typology shows an overabundance of penultimate stress compared to peninitial (110 vs. 16 languages in Goedemans and van der Hulst, 2013). This is not expected *a priori*—both patterns place stress one syllable away from an edge. This distinction is modeled as emerging from avoidance of final stress with no accompanying avoidance of initial stress.

2. **Stress windows** are more frequent on the right edge of the word (120 vs. 40 languages in Kager, 2012). Nonfinality contributes to this by “pushing” stress away from the word edge, thus extending the length of final windows and disrupting long initial windows. Fig. 1 shows the asymmetry between two- and three-syllable windows on the left edge (2L/3L) compared with two- and three syllables on the right (2R/3R) resulting from one simulation. The two- and three-syllable frequencies are themselves asymmetrical due to learning biases emerging from the constraint set itself.

3. **Iambic patterns** are less common than trochaic ones (153 vs. 31 languages in Goedemans and van der Hulst, 2013). Iambs, being right-headed, easily create patterns with final stress. Fig. 2 shows a relative increase in trochaic patterns over time in the iterated learning results.

My simulations show that simple models of perceptual biases can have broad consequences for typological frequency. Computational modeling builds an explicit link between these biases and typology—a link that is otherwise only assumed. This work connects relatively low-level concerns about perception and production with work in comparatively abstract phonological grammars.
Best fit frequencies of window stress systems.

Frequency of foot types across generations.

References


