Bridging the Gap: Grammatical and Non-Grammatical Factors in Phonological Variation

Significant advances have been made over the past two decades with regard to incorporating variation into generative models of phonology (Anttila 1997, Boersma & Hayes 2001, etc.). However, the models that have been developed in this tradition are exclusively grammatical, implying that grammar is solely responsible for variation. This runs counter to evidence from the variationist sociolinguistic tradition, and the speech production/perception literature. Research in these fields have documented that, in addition to grammar, other social and cognitive factors influence variation. A more complete model of variation will allow input from multiple factors, and have an explicit integration function for combining the contribution of different factors.

Coetzee and Kawahara (to appear) recently proposed such an integration function, based on an augmented version of noisy Harmonic Grammar (noisy-HG; Coetzee & Pater 2011). In noisy-HG, candidates are evaluated by weighted constraints, and a goodness score (H-Score) is calculated for each candidate, based on its constraint violations. The constraints used in noisy-HG are grammatical, therefore capturing the contribution of phonological grammar. In the augmented version, the weights of faithfulness constraints are scaled up or down by non-grammatical factors. Factors promoting application of a variable process scale faithfulness down, so that application of the process (unfaithfulness) becomes more likely. Conversely, inhibiting factors scale faithfulness up. The H-score formulas for classic and weight-scaled noisy-HG are given in (1). The augmented formula is an explicit hypothesis about the integration function mentioned above. In this talk, we apply this augmented model to two phenomena.

\[ t/d\text{-deletion (west~wes\textsubscript{r}) and usage frequency. We show that frequent words (just) are more likely to undergo t/d-deletion than infrequent words (bust). In classic noisy-HG, all words are treated alike (since classic generative grammar doesn’t encode word-specific information such as frequency). In the augmented version, however, faithfulness is scaled up for infrequent words (inhibiting deletion), and down for frequent words (promoting deletion). This results in a better fit to actual deletion patterns, as shown in Figure 1.} \]

\[ \text{Nasal place assimilation and speech rate. Variable cross-word nasal place assimilation depends on grammar (more with velars (gree[ŋ] card) than labials (gree[m] box)), and on speech rate (more at faster than slower speech). In a series of speech perception experiments, we found that listeners rely on both grammar and speech rate. They are more likely to perceptually undo assimilation in a velar context (to perceive green in gree[ŋ] card than gree[m] box), and in faster speech. We develop a model of this performance in classic noisy-HG that ignores speech rate, and in scaled noisy-HG. In the scaled version, faithfulness is scaled up for slower speech (inhibiting assimilation), and down for faster speech (promoting assimilation). Figure 2 compares classic and scaled noisy-HG, showing the improvement of the scaled version.} \]

We end by comparing the properties of the integration function proposed here with other existing proposals (such as variable rules), showing that our proposal gives primacy to grammar over non-grammatical factors, while other proposals do not. This leads to different predictions about the kinds of variation patterns that are possible.

\[ (1) \quad \text{Classic noisy-HG} \]

\[ H(cand) = \sum \{w_i + n_c\} C(cand) \]

Where \( w_i \) is the weight of constraint \( C_i \), \( n_c \) the noise associated with constraint \( C_i \) at this evaluation occasion, and \( C(cand) \) is the number of violations of candidate \( cand \) in terms of \( C_i \) expressed as a negative integer.

(Length = 500 words exactly!)
Scaled noisy-HG

\[ H(cand) = \sum_{i=1}^{\infty} (w_i + n_{Z_i}) M_i(cand) + \sum_{j=1}^{\infty} (w_j + n_{Z_j} + sf) F_j(cand) \]

Where \( M_i \) is the \( i \)-th markedness constraint, \( w_i \) the weight associated with \( M_i \), \( n_{Z_i} \) the noise associated with \( M_i \) at this evaluation occasion, and \( M_i(cand) \) the number of violations of candidate \( cand \) in terms of \( M_i \) expressed as a negative integer; and where \( F_j \) is the \( j \)-th faithfulness constraint, \( w_j \) the weight associated with \( F_j \), \( n_{Z_j} \) the noise associated with \( F_j \) at this evaluation occasion, and \( F_j(cand) \) the number of violations of candidate \( cand \) in terms of \( F_j \) expressed as a negative integer; and where \( sf \) is the scaling factor associated with the non-grammatical factor (frequency or speech rate in this presentation).

Figure 1: \( t/d \)-deletion in the Buckeye Corpus in three phonological contexts. Deletion rate is shown on the \( y \)-axis and the CELEX log frequency of words on the \( x \)-axis. Broken lines show the predictions of classic noisy-HG and solid lines of scaled noisy-HG.

Figure 2: Undone nasal place assimilation in perception at different speech rates. White bars show performance of listeners in the experiment. Grey bars show predictions of classic noisy-HG, and black bars predictions of scaled noisy-HG. Note the significant better fit of the scaled version at the faster speech rate.

References