Front/Back Asymmetries in Height Harmony

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This paper argues for substantive biases in phonological generalization using data from an artificial grammar learning experiment involving vowel height harmony. Vowel height harmony appears in a wide number of Bantu languages (Hyman, 1999) and a number of Romance varieties (Penny, 1970), vowel height harmony is much more restrictive than other types of vowel harmony (Linebaugh, 2007). In Bantu, the majority of height harmony languages show a front-back asymmetry in which front vowels are more likely to undergo harmony than back vowels (Hyman 1999). In this paper, we provide evidence for the substantive nature of this asymmetry. If the learner is equipped with both a bias for front vowel height harmony and a dispreference for back vowel height harmony, it is possible that learners of a vowel height harmony language will apply the height harmony rule to front vowels more often than to back vowels, even if the learners are exposed only to back vowel alternations during training. Our results provide support for these biases– adult English learners of a height harmony language were more likely to apply a height harmony rule to suffixes containing front vowels than suffixes containing back vowels, even when participants were trained only on back vowel suffixes.

The front/back asymmetry in height harmony arises from the phonetic markedness of alternations involving /u/ to [o]. This cross-linguistic avoidance is explained by the fact that [o] is phonetically more marked than [u]; the higher the round vowel, the less marked it is, as cues for rounding decrease as the height of the vowel decreases. This general phonetic markedness is increased when front, unround vowels trigger height harmony because the perceptibility of [o] is particularly weak after front, unround vowels (Kaun, 2004). These factors can lead to a strong dispreference for back vowels undergoing height harmony. If learners of a height harmony language share this general dispreference, then we expect it to be reflected in their performance– greater adherence for front vowel alternations than back vowel alternations.

Participants in our experiment (n = 60; 20 in each condition) were exposed to a stem-controlled height harmony system in which harmonic stems (e.g., [pidu, gobe]) induced alternations in either a front vowel suffix ([gi]/[ge]) (Front Suffix Training) or a back vowel suffix ([gu]/[go]) (Back Suffix Training). Training consisted of exposure to 24 stems, each immediately followed by their concatenated form (e.g., [pidu, pidu-gi]), repeated 5 times each. All stems contained the vowels [i, e, u, o] and the consonants [p, t, k, b, d, g, m, n]. All consonant and vowel combinations occurred with equal frequency. Following training, participants were tested via a forced choice task: one item contained a harmonic suffix ([pidu-gi]) the other item contained a disharmonic suffix (*[pidu-ge]). Test items were divided into three types (12 items for each type): Old Stems/Old Suffix, which contained items identical to those heard at training, New Stems/Old Suffix, which contained novel stem items, but the identical suffix vowel, and Old Stems/New Suffix Vowel, which contained the same stems as heard in training, but with a reversal in backness from training (e.g., if trained on [-gi]/[-ge], were tested with [-gu]/[-go]).

Results showed a strong preference for harmonic responses for front vowel suffixes. In the Front Vowel Training condition, there was a significant effect of training for Old items and New stem items, but not for New Suffix Vowel test items (t(38) < 1), indicating learning for front vowel suffixes, but a lack of generalization to back vowel suffixes. Interestingly, participants showed an effect of learning for front vowel suffixes even when participants were trained on back vowels. In the Back Vowel Training condition, participants showed no effect of training for Old Stems or New Stems, but showed a significant effect of training for New Suffix Vowel items (t(38) = 3.58; p < 0.01), indicating an effect of learning for novel suffix vowels. These results suggest a strong preference for front vowel height harmony over back vowel height harmony. Note that Control participants showed no preference for front vowel suffixes over back vowel suffixes, suggesting that participants learned a harmony rule that was more robust for front vowels. Our results support the hypothesis that learners are biased towards front vowel height harmony.
To ensure that our results were not due to acoustic differences in F1 in the test stimuli, we compared the F1 values for front and back vowels. High vowels had significantly lower F1 values for both front and back vowels (F(1, 32) = 147.28; p < 0.001) but there was no interaction (F < 1), indicating that the degree of F1 difference for high and mid vowels is the same for both front and back vowels. Thus, the preference for front vowel harmony alternations is not an artifact of our stimuli.

![Figure 1: Proportion of Height-Harmonic Responses](image)

The results of our experiment pose a unique problem for both exemplar (e.g., Nosofsky, 1986; Pierrehumbert, 2000) and abstract, categorical theories of processing (e.g., Optimality Theory (Prince & Smolensky, 1993/2004)). Exemplar models predict that the highest level of performance should be for items specifically trained on, but our results show minimal evidence of learning for trained-on back vowel items, but strong evidence of learning for novel front vowel test items. An abstract model with a bias for front vowel height harmony (e.g., front vowel height harmony outranking back vowel height harmony in an Optimality Theoretic model) can provide an account of the differential treatment for front and back vowels in height harmony. However, such an account cannot explain the gradience of learning data (i.e., non-categorical performance across participants and test items), and why height harmony learning data is less robust than back vowel harmony learning data (Linebaugh & Cole, 2005; Pycha, Nowak, Shin, & Shosted, 2003). We propose a model of learning that takes into account both the strengths of the exemplar models and the OT models. The model incorporates substantive biases for vowel harmony typologies that regulate the learnability of different harmony structures, explaining the difference in robustness of back harmony compared to height harmony.

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References


