Vowel harmony and disharmony are not equivalent in learning

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General vowel harmony and disharmony rules have comparable formal complexity, but differ dramatically in typological frequency and phonetic motivation. Vowel harmony is frequent and phonetically motivated, whereas vowel disharmony is rare and unmotivated. These properties have given vowel harmony and disharmony a prominent position in the literature comparing substantive biases and complexity biases in phonology (for discussion, see Moreton & Pater, 2012a, 2012b). Earlier studies found no difference in learning between vowel harmony and disharmony, though both were easier to learn than arbitrary vowel co-occurrence patterns (Pycha, Nowak, and Shin, 2003; Skoruppa and Peperkamp, 2011, but cf. Martin and Peperkamp, 2020), supporting the view that substantive biases are weak or non-existent whereas complexity biases are strong and robust.

In the current study, we show that there is in fact a clear difference in learning between vowel harmony and vowel disharmony—namely, learners readily infer a vowel harmony pattern but not a vowel disharmony pattern. This difference went undetected in previous studies because their test phases did not require participants to generalize beyond the types of cases presented in training.

Experiment. Our design and analysis plan were pre-registered on the OSF platform. We taught participants an artificial language with either a backness vowel harmony pattern or a disharmony pattern, depending on condition. The experiment was conducted online with English-speaking participants recruited from Amazon's Mechanical Turk. Participants who failed attention-check mechanisms were excluded and replaced (total analyzed = 120; 60 per condition). In the training phase, participants heard nonce CVCV noun stems (e.g., harmonic condition: *peti*; disharmonic: *petu*) followed by two single-suffix options, one correct and one incorrect (e.g., *peti-fi* or *peti-fu*). Participants never saw orthographic forms of the stimuli. After making a selection, participants received feedback about whether they were correct or incorrect. There were two suffixes, *-fi/-fu* and *-be/-bo*, which meant plural and diminutive (counterbalanced). Participants saw both suffixes in training, but they only saw one suffix at a time. In the test phase, participants were tested on novel CVCV stems and CVCV-CV single suffix forms, and they no longer received feedback. Crucially, they were also tested on forms with both suffixes at once, which they had never encountered before. These double suffix trials had four options (e.g., for disharmony: *peko-fu-bo*, *peko-fu-be*, *peko-fi-bo*, *peko-fi-be*). The correct response, assuming participants had learned a general harmony/disharmony pattern, was a fully harmonic word in the harmony condition (e.g., *peke-fi-be*) or a form with fully alternating feature values in the disharmony condition (e.g., *peko-fi-bo*).

Results. The data were analyzed with mixed effects logistic regression models. There was no difference between conditions for single suffix test trials ($\chi^2(1) < 1$; Figure 1), replicating Pycha et al., 2003. However, in double suffix trials, participants were more likely to choose the correct response in the harmony condition than in the disharmony condition ($p < .001$; Figure 2, left). This difference is even more striking when we consider only participants who (individually) performed significantly above chance on the single suffix trials according to a binomial test (Figure 2, right).

Discussion. The results show that learners do not readily infer a general vowel disharmony pattern, but they do converge on a general harmony pattern. This suggests that, contrary to earlier claims, there is a fundamental learnability difference between vowel harmony and disharmony. The findings are consistent with a substantive learning bias favoring vowel harmony, but they might also reflect the fact that multiple analytical approaches support a harmony analysis, while only a

subset of these lead to a disharmony analysis. We will consider these possibilities in light of a more detailed look at individual learners and their preferences, especially in the disharmony condition.

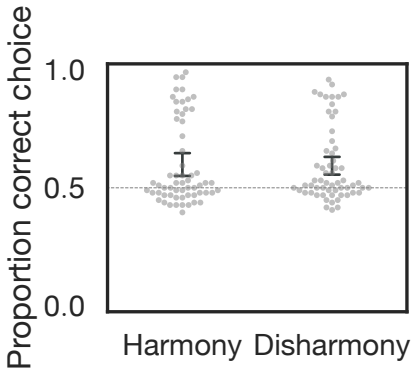

Figure 1: Proportion correct on single suffix trials by condition for all participants. Each point represents a participant and error bars represent 95% confidence intervals calculated on participant means. The broken line represents chance level (0.5).

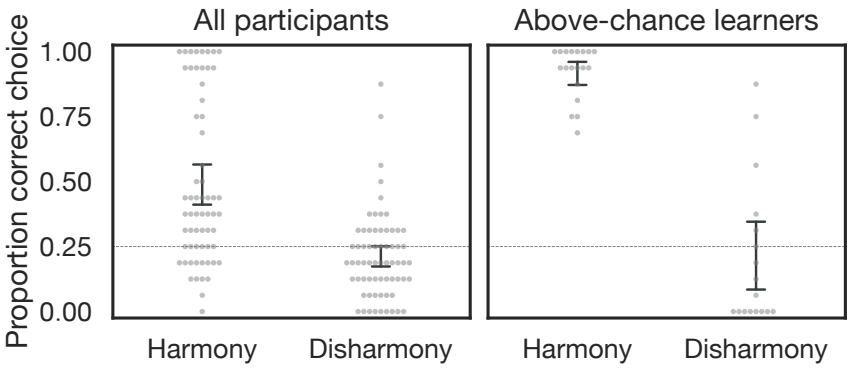

Figure 2: Proportion correct on double suffix trials by condition for all participants (left) and above-chance learners (right). Each point represents a participant and error bars represent 95% confidence intervals calculated on participant means. The broken line represents chance level (0.25).

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