Decomposing naturalness in phonological rule learning: the role of phonetic distance

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Recent work has shown that both adults and infants can use statistical information during phonological acquisition. Several studies have shown that linguistic knowledge - in the form of constraints on naturalness - is exploited as well (e.g. Pycha et al. 2003, Wilson 2006, Peperkamp et al. 2006, but see Seidl & Buckley 2005). In our work, we seek to disentangle the influence of different factors that are usually grouped together under the term *naturalness*. Here, we focus on phonetic distance (as opposed to, for instance, whether the alternation is assimilatory or not, or whether it targets natural classes). Specifically, using an artificial language-learning paradigm, we show that French adults learn alternations on segments which are phonetically close to each other more easily than alternations on phonetically distant segments.

We created four languages containing different alternation patterns involving obstruents, as shown in Table 1. The two 'natural' languages (N1 and N2) each contained alternations involving two pairs of phonetically close sounds, which differed only in one feature (place of articulation). The alternations in each of the two 'unnatural' languages (U1 and U2), however, concerned sound pairs whose members were phonetically very distant; they differed in three features (place, manner, voicing).

Participants were native speakers of French, a language that does not contain alternations comparable to any of the ones above. They were divided into four groups, corresponding to the four languages. They were informed that they would hear two-word phrases consisting of an adjective (either /nø/ meaning 'big' or /re/ meaning 'small') and a noun. The experiment consisted of two parts. In the first part, participants were exposed to adjective-noun phrases, and had to produce the same noun with the other adjective. Then they heard the correct answer. Crucially, the alternations were conditioned by the preceding adjective. For participants in the N1 group, for example, the correct response to [nø **p**umi] was [re **t**umi]. Two additional nouns with initial liquids and nasals that did not alternate were used as fillers (e.g. [nø **m**api] – [re **m**api]). Each noun was repeated six times in random order. In the second part, participants performed the same task as before without feedback. They were tested twice on the six known nouns as well as on twelve new nouns.

Independent t-tests show that participants exposed to natural alternations had steeper learning curves during the first part than those learning the unnatural ones (Figure 1). They also gave significantly more correct responses in the second part (Figure 2), both for known and for new words. These results provide evidence that the acquisition of phonological alternations is constrained by the phonetic distance between the segments involved. We are currently testing the intermediate case of a two-feature-change alternation (place and manner, e.g. [p] – [s]), in order to examine whether the effect of phonetic distance is gradual. Preliminary results suggest that this is not the case: participants in this experiment seem to exhibit the same performance as those exposed to a three-feature change. We will discuss the consequences of our results for models of phonological acquisition.

Table 1: Alternating and non-alternating obstruents in four artificial languages

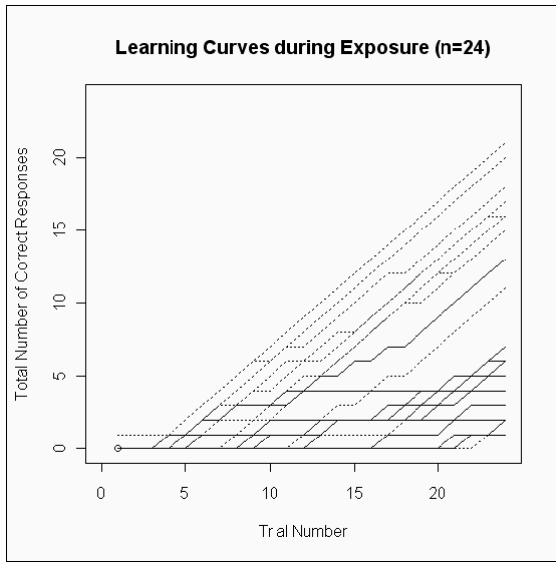|	Natural (1-feature change)		Unnatural (3-feature change)	
	N1	N2	U1	U2
alternating	[p-t] [z-ʒ]	[b-d] [s-ʃ]	[p-z] [t-ʒ]	[b-s] [d-ʃ]
non-alternating	[b],[d],[s],[ʃ]	[p],[t],[z],[ʒ]	[b],[s],[d],[ʃ]	[p],[z],[t],[ʒ]

Figure 1: Learning curves during the first part of subjects learning 1-feature-changes (dotted lines) and of subjects learning 3-feature changes (solid lines).
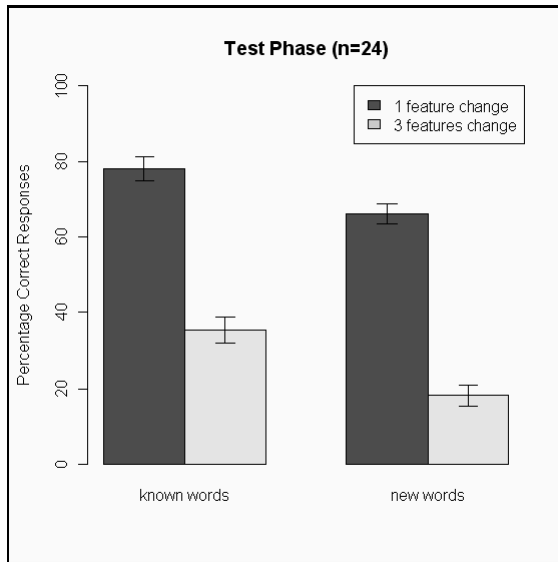

Figure 2: Mean percentage of correct responses during the second part for subjects learning 1- and 3-feature changes.

References

Peperkamp, S., Skoruppa, K**.,** and Dupoux, E. (2006). *The Role of Phonetic Naturalness in Phonological Acquisition.* In: Bamman, D., Magnitskaia T., and Zaller, C. (eds.). *Proceedings of the 30th Annual Boston University Conference on Language Development*. Sommerville, MA : Cascadilla Press. 464-475.

Pycha, A., P. Nowak, E. Shin and R. Shosted (2003). Phonological rule-learning and its implications for a theory of vowel harmony. G. Garding and M. Tsujimura (eds) *Proceedings of WCCFL 22*. Somerville, Cascadilla Press: 423-435.

Seidl, A**.** and Buckley, E. (2005). On the learning of arbitrary phonological rules. *Language Learning and Development*, 1, 289-316.

Wilson, C. (2006): Learning Phonology with Substantive Bias: An Experimental and Computational Study of Velar Palatalization. *Cognitive Science*, 30 (5), 945-982.