Learnability of Two Vowel Harmony Patterns with Neutral Vowels

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The relationship between the complexity of a phonological pattern and its learnability is one of the noteworthy questions in phonological theory. The Complexity Hypothesis in (1) states that a less complex pattern is easier to learn than a more complex pattern.

(1) *Complexity Hypothesis*
If $x <_{complex} y$ then $x <_{learn} y$:
If x is less complex than y, then x is easier to learn than y.

In this study, the Complexity Hypothesis is instantiated as the *Subregular Hypothesis*, which measures complexity in terms of the Subregular Hierarchy. The Subregular Hierarchy classsifies logically possible phonotactic patterns into different classes (Heinz, 2010; Heinz et al., 2011; Rogers and Pullum, 2011; Rogers et al., 2013). Since higher classes in the Subregular Hierarchy are deemed more complex than the lower classes, patterns in the higher classes are predicted to be more difficult to learn than the lower classes. The Subregular Hypothesis has been shown to successfully capture differences in learning (Lai, 2012, 2015). Lai's (2012; 2015) studies showed that participants in an artificial language learning experiment showed more difficulty in learning a pattern in a higher class in the Subregular Hierarchy than the one in a lower class. Like Lai's research, this study reports results from artificial language learning experiments which support the Subregular Hypothesis (though the patterns under investigation here compare different classes than the ones investigated by Lai).

Specifically, this study investigates the learning of vowel harmony patterns with neutral vowels that belong to different classes in the Subregular Hierarchy. An artificial language learning experiment was conducted to test the hypothesis. In Finley (2015), artificial language learning experiments were conducted to compare the learning of vowel harmony patterns with opaque vowels and with transparent vowels. The result of the study showed that participants were better at learning the pattern with opaque vowels than the one with transparent vowels. (However, participants could learn the transparent vowel pattern with more exposure.) In this study, two vowel harmony patterns with transparent vowels were tested. The two vowel harmony patterns belonged to different subregular classes. One pattern was in the Star-free class, and the other was in the lower Locally Testable class. In both patterns, there were five vowels [i, e, a, u, o], and a suffix which alternated between [-se/-so].

The pattern in the Star-free class is called the Rightmost pattern. In the Rightmost pattern, the suffix agrees with the frontness of the rightmost non-neutral vowel of the word. The neutral vowel in the Rightmost pattern is the low vowel [a]. If the rightmost non-neutral vowel is the front vowel [i] or [e], then the word selects the suffix [-se], and if the rightmost non-neutral vowel is the back vowel [u] or [o], then the word selects the suffix [-so]. For example, a word like *'pukina'* selects the suffix [-se] because the rightmost non-neutral vowel is the front vowel, and a word like *'pikuna'* selects the suffix [-so] because the rightmost non-neutral vowel is the back vowel.

The other pattern in the Locally Testable class is called the At Least One (ALO) pattern. In this pattern, if there is at least one front vowel in the word then the suffix agrees in frontness with it. Since the suffix agrees only with the front vowels, the back vowels [u] and [o] behave as if they were neutral vowels in this pattern, like the low vowel [a]. For example, both of the words *'pukina'* and *'pikuna'* select the suffix [-se] because there is a front vowel [i] in the word. Notice that the word *'pikuna'* selects a different suffix depending on whether it follows the Rightmost pattern or the ALO pattern.

The experiment were composed of two sessions: training and test. Participants were trained in one of the patterns depending on the condition. The test session was the same across all conditions. There were three conditions: Rightmost, At Least One, and Control condition. The Rightmost condition and ALO condition were based on the vowel harmony patterns discussed above. The critical stem type of interest was FBL type, where F refers to the front vowels, B to the back vowels, and L to the low vowel. In the Rightmost condition, the FBL word types take the suffix [-so] since the rightmost non-neutral vowel is the back vowel. In the ALO condition, the FBL word types take the suffix [-se] because there is a front vowel in the stem. In the training of the Control condition, half of the words took the suffix [-se] and the other half of the words took the suffix [-so]. So half of the FBL training words took [-se] and half took [-so]. The Control condition can be used as a reference level for the other two conditions.

A total of 79 students (26 each in the Rightmost and Control conditions, and 27 in the At Least One condition) from University of Delaware participated in the study. In the test session, participants were asked to choose a word with the suffix that they think belongs to the language that they were trained on during the training session. There were 60 randomized test items and the suffixes were counter-balanced.

The results were analyzed by selection of the suffix [-se] in each condition. When the Rightmost condition and the ALO condition were compared directly, the difference between the two conditions in selecting the suffix [-se] was statistically significant ($p = 0.000462$) in the expected direction. When the two conditions were compared to the Control condition, the difference between the ALO condition and the Control condition was statistically significant ($p = 0.000178$), but the Rightmost condition and the Control condition were not ($p = 0.127639$). The results show that participants were better at learning the ALO pattern than the Rightmost pattern. In other words, participants were better at learning the less complex pattern than the more complex pattern, where complexity is measured by the Subregular Hierarchy. Hence, these results provide additional support for the Subregular Hypothesis. The results for other word types, how these results fare with other potential explanations and how they bear on other complexity hypotheses will also be discussed.

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