What matters in artificial learning, sonority hierarchy or natural classes?

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In recent phonological research, an artificial grammar (AG) paradigm (e.g., Moreton & Pater 2012 a, b, Finley 2011, Nevins 2010, Moreton 2008, Wilson 2006) has been used to test language universals. This paradigm allows the study of aspects of proposed universals that can be hard to test with real language. My research examines one proposed universal, the implicational nasal hierarchy scale, testing whether this scale is found with speakers of a language with no clear evidence for a nasal hierarchy.

Walker (2011) proposes a universal implicational nasalized segment scale based on evidence from typological frequency, Vowels > Glides > Liquids > Fricatives > Stops. She argues that if a more marked blocker class blocks harmony (vowels are least marked targets, so least likely to be blockers, and most likely to be targets), so do the less marked blocker classes (stops are most marked targets, so most likely to be blockers, and least likely to be targets). I address whether a pattern that is predicted by this implicational universal is easier to learn than one that is not. In particular, I investigate if it is easier to make a generalization when a more marked blocker (vowel)/target (stop) is presented during training and a less marked blocker (stop)/target (vowel) in testing rather than vice versa.

In the experiments, different groups were presented with the four patterns as in Table 1. The predictions are based on expectations if the nasal hierarchy is universal: it should be easier to learn a grammar if in the test phase the new segment is more sonorant than the target (cf. Pattern 1) or equivalent in sonority to the blocker (cf. Patterns 3, 4) in the exposure phase. If the test segment is less sonorant than the target (cf. Pattern 2), then there is essentially no prediction.

A critical prediction then is that what I call **direction** is important: exposure to a less sonorant target makes predictions about the treatment of a more sonorant sound, but exposure to a more sonorant target makes no predictions about the treatment of a less sonorant sound.

Table 1. Four patterns

	exposure	test	prediction
Pattern 1	more sonorant: target **s** less sonorant: blocker k	new segment **w**: more sonorant than target	new segment is a target
Pattern 2	more sonorant: target **w** less sonorant: blocker k	new segment **s**: less sonorant than target	no prediction
Pattern 3	more sonorant: target s less sonorant: blocker **k**	new segment: **t** same class as blocker	new segment is blocker

Pattern 4	more sonorant: target w less sonorant: blocker **k**	new segment: **t** same class as blocker	new segment is blocker

Learners fell into two distinct categories, what I call categorization learners and statistical learners. The former grouped new segments with old segments, while the latter used fragmentary knowledge (e.g., phonotactic information) to determine what served as a blocker and what as a target. I focus on the results for the categorization learners. Categorization learners appears at first to focus more on natural classes: for instance, with exposure to k and w, they group k and test segment s together as well as k and test segment t together. In general then, the categorization learners appeared to be comparing whether a new segment's natural class is closer to an old segment's natural class, and pattern the new segment with that old one. Based on descriptive statistical findings, direction did not seem to matter with the categorization learners: it appeared from these statistics that they were simply creating **natural classes**.

However, the inferential statistics tell a different story: they show a positive influence of direction for both groups (Patterns 1, 2) of categorization learners, with testing on a more sonorant segment than learners were exposed to (Pattern 1) being better learned than testing on a less sonorant segment (Pattern 2). The inferential statistics suggests that a **hierarchy (nasalized segment scale)** matters to categorization learners.

In sum, the current study is a new kind of paradigm to investigate with the Artificial Grammar paradigm - most of the work in this area tests natural classes, while this study examines **the relationship between natural classes as well**. Both descriptive and inferential statistics show evidence that both natural classes (new segment is of the same natural class as the blocker) and a hierarchy play an important role in learning for the categorization learners.

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