Learnability of length-referencing alternations: evidence from artificial language learning

Summary. This study shows that a learning bias against referencing length can account for the non-internalized pattern of Voiced Velar Nasalization (VVN) in Yamanote Japanese and the typological gap of length-based alternations across-linguistically by conducting an artificial language learning test targeting a structure akin to Japanese VVN. **Conclusion**: Length-referencing phonological alternations are always underlearned, no matter what exact length is involved as the condition in a rule's context.

Non-internalized VVN in Japanese. The tendency for compound-medial /g/ to nasalize to /ŋ/ in Yamanote Japanese in the corpus is non-deterministically conditioned by both **(i.)** the nasality of the proceeding sound (e.g., *gin-**ŋ**a* but **noo-**ŋ**eka*) and **(ii.)** the mora length of the compound (e.g., *ki-**ŋ**a* but **toushi-**ŋ**ahou*) (see fig. 1) (Breiss et al. 2022). The statistics on the former factor is internalized during a wug test but the regularity on the latter factor cannot be productively extended to nonce words (Jiang 2023), appearing to constitute an example of 'surfeit of the stimulus' (Becker et al. 2011), indicating there may be a learning bias against length-based alternations which can explain the non-internalization of the effect of mora length, if it can not (fully) be explained by words' frequency in each length.

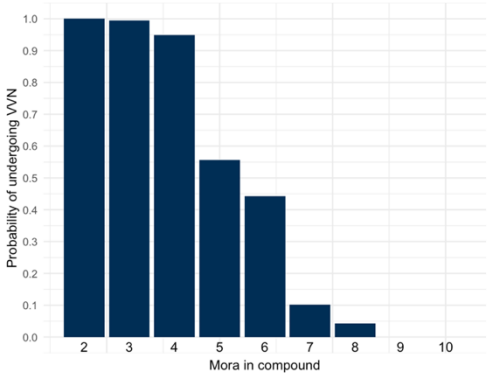
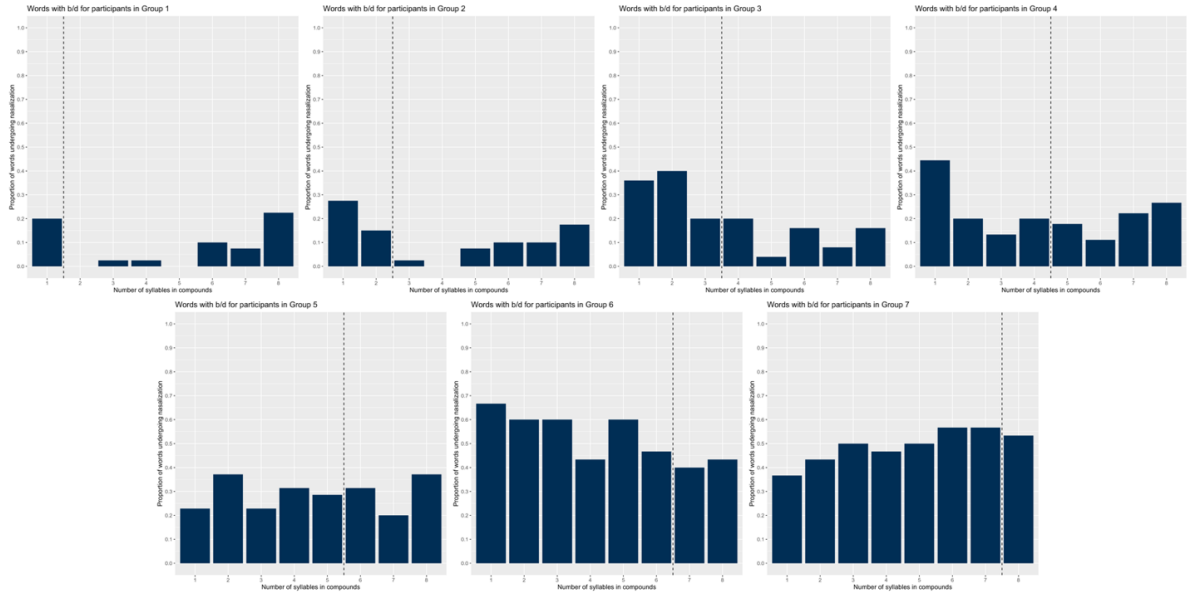


Figure 1. Probability of undergoing VVN for words of different mora lengths

Typological gap of length-based alternations. No similar patterns (involving counting to 7) to Japanese VVN is spotted in human languages, to the best of my knowledge. This may stem from difficulties in accessing precise information regarding the number of specific phonological units, as phonology does not count to a number larger than 2 (e.g., McCarthy & Prince 1999) and phonological generalization counting to more than 2 is almost unattested (Paster 2019). Aside from the difficulty in formally modeling this pattern, I hypothesize that alternations involving a counting process, may be influenced by a learning bias, and I will show its effect through experimentation.

Method. To test this hypothesis, 70 English speakers were recruited to an online test where they were ramdonly divided into 7 groups, each learning an artificial language with a unique syllable length boundary ranging from 1 to 7. It was shown to subjects in the training phase that a bimorphemic compound containing /b/ or /d/ underwent nasalization (b/d → m/n) if and only if the syllable length of the word fell below the particular length boundary in the group of the subject. Subjects were required to choose a correct answer between non-nasalized and nasalized versions of a compound. Fillers were incorporated to prevent learners from learning 'short compounds have nasals.' All nonce words, created by manipulating their length (i.e., number of syllables), were identical across groups except whether to nasalize.

Results. The test results are presented in fig. 2 through 7 (next page). Overall, whether each response underwent nasalization does not differ significantly on either side of the boundary ($Pr(>|z|)=0.363$, $Pr(>Chisq)=0.378$), according to a mixed-effect model reduced by backward stepwise comparison. Only the group condition is a siginificant predictor. Moreover, subjects extended the pattern of /b/ or /d/ nasalization to filler words, in which it was other segments that were present in the positions where /b/ or /d/ could have occurred. Similarly, boundary side does not affect the learnability in these words, either. Finally, there is no observed difference in the learning performance between words with b/d and filler words. To conclude, during the learning process of the length-referencing alternations, subjects not only failed to grasp the distinction in whether a word should undergo nasalization on the two sides of the length boundaries but also did not learn what the target of the rule was.



Figures 2 through 7. Proportions of words with /b/ or /d/ undergoing nasalization for subjects in each of the 7 groups. X-axis represents the number of syllables in a compound; different figures represent group conditions. The dashed line in each figure is the length boundary and words whose syllable length falls below it nasalize.

Discussion. The underlearnability of the b/d nasalization rule directly supports the idea that the effect of mora length on Japanese VVN is unlikely to be active. The results also explain why phonological generalizations involving counting as a condition are rare across languages, as the learning bias prevents learners to accurately access the exact number of a phonological units.

Additionally, the results in fig. 2 through 7 implies that the increasing effect of different groups largely obeys the Law of Frequency Matching (Hayes et al. 2009), as subjects in each group not only learned languages with different length boundaries, but also had varying exposure levels to stimuli with the nasalization rule applied, ranging from 5 to 35 out of 80 for groups 1 to 7, which roughly equals the average proportion of words undergoing nasalization in each figure. However, the quantity of such stimuli is not controllable in the present test if we aim for only minor differences in the position of the length boundary among the languages in each group, as the central concern is to compare the learning results on two sides of the length boundary.

Finally, the presentation condition of this test favored subjects making product-oriented generalizations (Kapatsinski 2012), so the fact that they did not learn the length-referencing rule might be because they did not well learn source-oriented generalizations. This could be addressed in future work by modifying the task with piloting to ensure there is appropriate exposure (e.g., consecutive nasalization) for subjects to fully learn the input-output mappings.

Selected References:

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