

## Token frequency in the grammar: A *wug*-test of Voiced Velar Nasalization in Japanese

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**Synopsis:** Corpus evidence advanced by Breiss et al. (2021a) recently demonstrated that the Paradigm Uniformity effect in Voiced Velar Nasalization (VFN) in the Yamanote dialect of Japanese (cf. Ito & Mester 1997) is probabilistic in nature, conditioned by both token frequency of the compound elements involved and principles of Japanese phonology. This paper reports the results of a *wug*-test with speakers of Tōhoku Japanese, a dialect which also exhibits VFN, to provide evidence about the role of frequency in the synchronic grammar, and its interaction with phonological markedness. We find that in existing and novel compounds, VFN is modulated by the token frequency of the second member of the compound. This provides robust evidence that the frequency-conditioning in corpus data found by Breiss et al. (2021a) is indeed representative of the grammar of individual speakers, and is not the result of aggregating across individuals. We take this as evidence supporting the hypothesis that token frequency must be modeled in the synchronic grammar.

**Corpus evidence for VFN:** In various dialects of Japanese, [g] and [ŋ] stand in an allophonic relationship, with [ŋ] occurring in prosodic-word-medial position, and [g] occurring elsewhere (e.g. [gama] “toad” vs. [kaŋami] “mirror”). The relevance of this pattern to theoretical phonology was made clear by Ito & Mester (1997) and explored in quantitative detail by Breiss et al. (2021a). The basic pattern is as follows:

(1) In compounds, when the second member (=N2) begins with [g] and is a free morpheme, voiced velar nasalization targeting that [g] is **optional**.

(a) e.g. N2=/ga/ “moth”, [doku-ga]~[doku-ŋa] “poison moth”

(2) When N2 is a bound morpheme, voiced velar nasalization is **obligatory**.

(b) e.g. N2=/ga/ “fang”, [doku-ŋa], \*[doku-ga] “poison fang”

(1) shows that voiced velar nasalization is not merely a static generalization about surface allophonic patterns, but it in addition manifests itself as an active (morpho)phonological alternation. Ito & Mester (1997) propose that the optionality in (1) arises from the conflict between a force requiring VFN and output-output correspondence between the free [g]-initial form of N2 and its status in the compound. A consequence of this argument is that when N2 is bound, as in (2), output-output correspondence is irrelevant because there is no free [g]-initial form of N2, and thus word-level phonotactic markedness is obeyed, resulting in obligatory VFN. Corpus data from Breiss et al. (2021a) confirm that the vast majority of compounds with bound N2s undergo VFN, supporting (2), while there is substantial variability among compounds with free N2s, supporting (1). Moreover, this variation is conditioned by the relative frequencies of the compound and N2, such that higher relative token frequency of the N2 lowers the probability of the compound undergoing VFN.

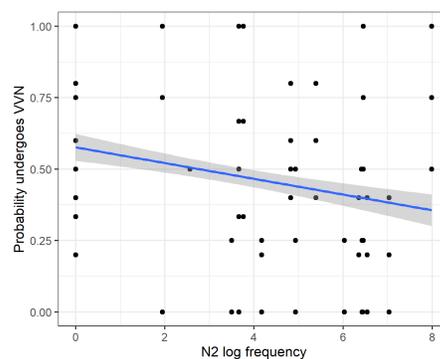
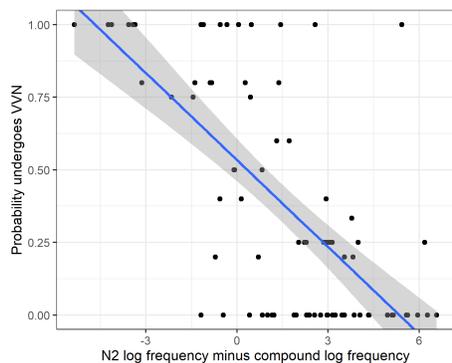
**Experiment: Predictions and goals:** The primary goal of the experiment is to confirm the productivity of the patterns presented by Breiss et al. (2021a,b) within the individual speaker. We do this in two ways: first, we assess the status of speakers’ lexicons by examining existing words for frequency-conditioned variation in VFN application. If we find that speakers exhibit frequency-conditioned variation at the level of the individual word, we can conclude that the token frequency of the N2 plays a role in the realization of these forms, rather than simply being a lexical distribution with no correlate in the synchronic grammar. However, because existing words are often listed whole as well as derived online (Zuraw 2000, 2010; Zuraw et al. 2015, 2020), we cannot conclude from this evidence alone that the phonological grammar is sensitive to token frequency - the data might be explainable via probabilistic, frequency-mediated retrieval of morphologically-complex forms with VFN already applied. Therefore, second, we examine

whether the phonological grammar itself needs to be sensitive to N2 token frequency: in novel compounds, if we find that N2 token frequency still plays a role in determining VVN application, we can conclude that the outputs of the phonological grammar itself must be influenced by the token frequency of the morphemes involved. We also probe the effect of prosodic length, and the saltatory interaction of VVN with Rendaku, as reported by Breiss et al. (2021a), but do not report those results here for the sake of space. *Participants and procedure:* We recruited 5 participants living in the Tōhoku dialect region of Japan, who spoke a dialect

known to exhibit VVN.

The experiment was conducted in the style of an interview, conducted by a native speaker of Japanese who asked participants to read stimuli presented by powerpoint aloud.

During the experiment, participants first



indicated their familiarity with each N1 and N2, as well as existing compounds; then, participants read each compound aloud in a random order. Participant responses were coded as containing [g] or [ŋ] as the initial segment of N2. *Stimuli:* 301 stimuli were selected with the aid of the *NHK Pronunciation and Accent Dictionary*, which varied the status of N2 (free vs. bound), the log-token-frequency of free N2s (low to high), the status of the compound (existing vs. novel), and the initial segment of N2 (/g/ vs. /k/). *Results:* We find that in existing compounds with /g/-initial N2s, there is a robust effect of relative N2 token frequency (left figure) (Bayesian mixed effects logistic regression:  $\beta = -0.77$ , 95% Credible Intervals [-1.21, -0.39],  $p(|\beta|>0) = 0.99$ ). In novel compounds with /g/-initial N2s, we also find a robust frequency effect ( $\beta = -0.22$ , 95% Credible Interval [-0.39, -0.08],  $p(|\beta|>0) = 0.99$ ), but smaller in magnitude (right figure).

**Discussion:** These findings have two important consequences for our understanding of the synchronic phonological grammar and its relationship to the lexicon. First, existing words display conditioning based on token frequency as in the corpus: we take this as evidence in favor of some version of the dual-route hypothesis of lexical storage (in the vein of Zuraw 2000 *et seq.*), in which existing morphologically-complex words are listed in the lexicon wholesale, but compete with forms derived on-the-fly by the phonological grammar in speech production. Our finding adds token frequency of the parts to the list of lexical characteristics which can influence this selection in real time (Zuraw et al. 2015, 2020; Hay & Baayen 2003), and also to the body of work emerging on the status of gradiently active or probabilistically-present morpheme boundaries in lexical items (Kawahara & Tanaka, 2021). The second major finding is that the application of VVN in entirely novel compounds is conditioned by N2 token frequency. We take this as evidence that even in the absence of lexically-listed forms, the phonological grammar itself must be modeled as sensitive to the lexical characteristics of the morphemes involved. More broadly, this work suggests that there is much more to be learned about the nature and structure of the grammar by examining how and whether morpheme-level token frequency influences variable phonological phenomena.