The Effect of Pitch-Accent on the Articulation of Coda Nasals in Japanese

Maho Morimoto[1, 2], Ai Mizoguchi[3, 4], and Takayuki Arai[1]

[1]*Sophia University (Japan),* [2]*Japan Society for the Promotion of Science (Japan),*
[3]*Maebashi Institute of Technology (Japan),* [4]*National Institute for Japanese Language and Linguistics (Japan)*

Background: While Japanese is often characterized as a "mora language", the syllable also plays a key role in certain phenomena (Kubozono 1998; Kawahara 2016). One of the main arguments for the role of the syllable in Japanese is pitch-accent assignment, in which the "default" pitch-accent (as manifested in loanwords and nonce words) is assigned to the syllable containing the antepenultimate mora (McCawley 1968). This formalization not only accounts for regular cases in which the pitch fall is realized across the antepenultimate and the penultimate mora (e.g., /puro$\underline{\text{gu}}$ramu/ 'program'), but also ensures that the pitch fall starts on the nucleus when the antepenultimate mora is a coda (e.g., /ad$\tilde{\text{e}}$Ndamu/ 'addendum'). It also highlights the importance and affinity of the syllable as a prosodic unit, as well as the deficiency or dependency of the coda in Japanese. However, it is not clear whether we should assume such syllabic affinity when a syllable does not bear pitch-accent. Is it possible that the coda in an unaccented syllable is more independent than the coda in an accented syllable? In this study, we address the role of the syllable from an articulatory point of view, by investigating whether the accentedness of a CVN syllable affects the degree and timing of the articulation of coda nasals. We hypothesize that the coda nasal in an unaccented syllable is more articulatorily independent than one in an accented syllable. Using ultrasound to capture the oral constriction of a coda nasal assimilating to the following /t/ as a test ground, we predict that: (a) coda nasal articulation starts earlier in unaccented CVNs compared to accented CVNs; and (b) unaccented CVNs have a higher degree of coda nasal constriction than accented CVNs, due to the relative independence of the mora in unaccented CVNs.

Methods: The current study reports data from five native speakers of Japanese (three female and two male, all in their 20s). We report the articulatory results for seven repetitions of nonce-word /baNta/ in two different pitch-accent conditions: HLL (accented) and LHH (unaccented), where H is high-pitch and L is low-pitch associated with each mora. The utterances were collected in a carrier phrase and in randomized order. Audio and ultrasound recordings were obtained simultaneously using AAA (Articulate Instruments Ltd. 2023). The probe was stabilized using a headset (Spreafico et al. 2018). The midsagittal tongue contours at the acoustic midpoint of the rhyme and the nasal consonant were manually traced using GetContours (Tiede 2023).

Results & Discussion: Figure 1 shows the tongue contours at the midpoints of the rhyme /VN/ (solid lines) and the coda nasal /N/ (dashed lines) for the two pitch-accent patterns in each speaker, predicted from the repetitions with 95% confidence intervals using the generalized additive model (GAM; Wood 2006). Overall, the tongue positions at the midpoint of the /VN/ intervals suggest that the coronal gesture of the nasal assimilated to /t/ is closer to completion in the unaccented items than in the accented items. This tendency is consistent with our prediction that lingual gesture for /N/ starts early for an unaccented syllable. Furthermore, the tongue positions at the midpoint of /N/ suggest that the lingual constriction of the coda is stronger for the unaccented items than for the accented items. Exceptions to this generalization were BJM29 and BJF21, who achieve a higher degree of tongue tip constriction in an accented condition. Auditory inspection of the recorded sounds suggests that while most of the speakers produced an initial rise for the unaccented items (i.e., the nucleus is low-pitched and the pitch rises around the coda nasal), such pitch excursion was very limited for BJM29 and BJF21. This variability is understandable, given that the initial rise is an optional characteristic of Tokyo Japanese (Vance 2008), and we speculate that there was a higher degree of mora independence for the unaccented items with initial rise.

Conclusion: The current study investigated whether the accentedness of a CVN syllable affects the articulation of the coda nasal. Our results show tendencies consistent with the view that a coda nasal in an unaccented syllable is more articulatorily independent than in accented syllables, with some exceptions. Our results, while preliminary, provide insights into the gestural organization within and across prosodic units, as well as the general phonetic correlates of pitch-accent in Japanese. In future studies, we plan to further examine the dynamic relationship among articulatory gestures, F0, and duration, as well as to address individual and regional variability in the realization of pitch-accent and intonation.

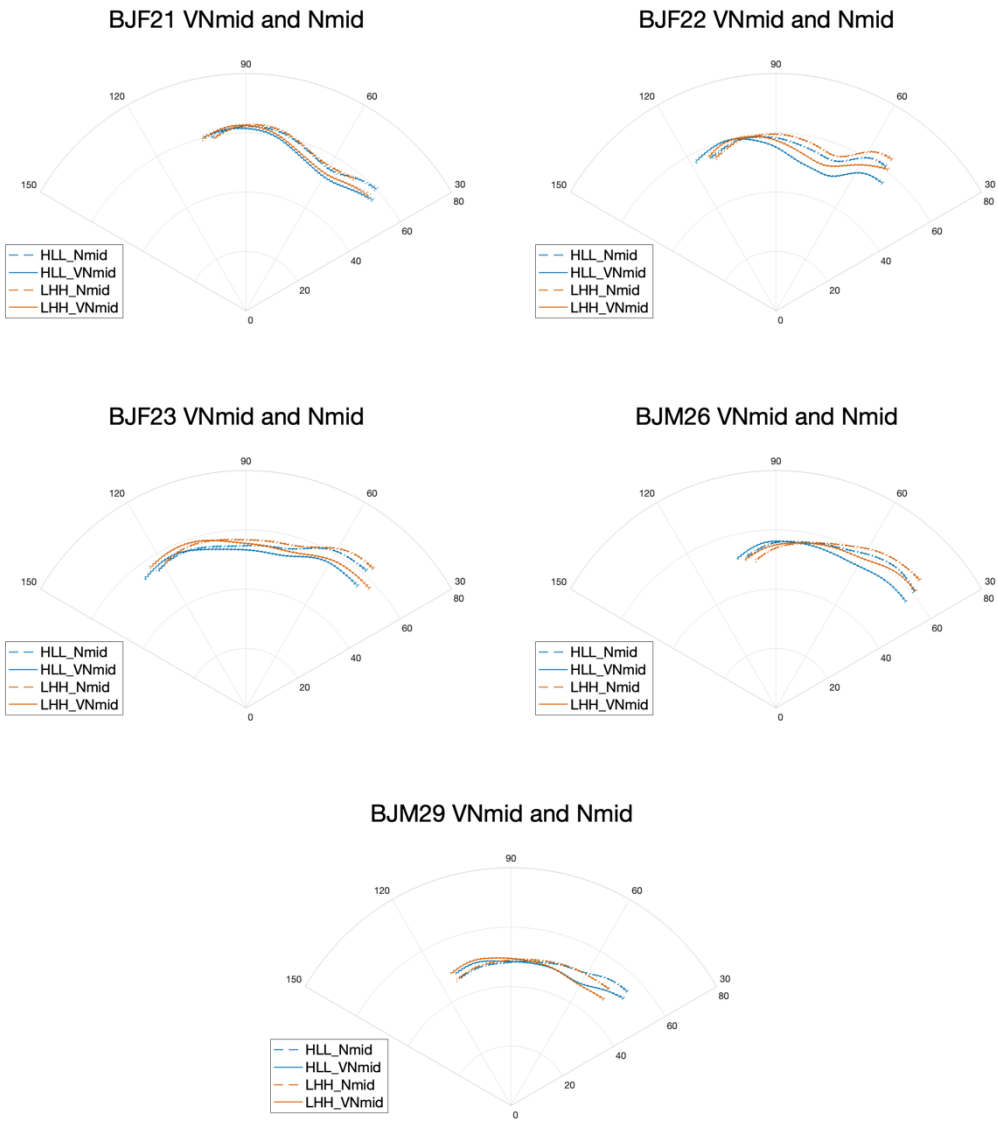

Fig. 1. GAM contours for the seven repetitions of /baNta/ with accented (blue) and unaccented (orange) pitch-accent patterns in each speaker. Solid lines show the tongue contours at the midpoint of /aN/ and dashed lines show the tongue contours at the midpoint of /N/. Dotted lines show the 95% confidence intervals.

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