Effect of vowel height and position on jaw opening patterns in Japanese

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This study examines jaw opening patterns of 8 Japanese sentences using electromagnetic articulography (EMA). The sentences end in *da,* the five Japanese vowels occur in the first and second mora (*ika, muda, eda, soko, hana, maru, tsuri, ame)* and no words had lexical pitch accents. Fig.1 compares jaw opening patterns of *hana da* (low vowel in first mora) with *ika da* (high vowel in first mora).

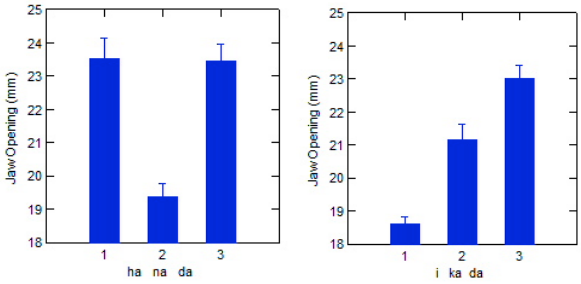

Figure 1. Jaw opening (mm) for *hana da* and *ika da*

In *hana da,* all vowels are [a], yet the amount of jaw opening varies according to position in the utterance. In *ika da*, [i] has less jaw opening than [a]; the final [a] has more jaw opening than the middle [a]. A multiple regression was run with jaw opening as dependent variable, and position, height, backness of the vowels as independent variables. Both position and height had significant effects ($t=3.59$, $p<.001$ and $t=4.93$, $p<.001$), but backness did not ($t=1.01$). Focusing on effect of height, the coefficient is 1.94mm. With each level of height, jaw opening increases by this amount. Post-hoc comparisons show that from low to mid vowels, the coefficient estimate is 1.71mm ($p<.001$) and from mid to high vowels, it is 2.87mm ($p<.001$).

These results show that jaw opening is dependent on vowel height and position in the utterance. Similar findings were reported for English [2], but this is the first time this has been shown for Japanese. Using a vowel neutralization algorithm [3], we neutralized the effect of vowel height to show only the prosodic (position) effects, shown in Figure 2. If we assume jaw opening as an indicator of phrasal stress [1], Japanese has both initial and final phrasal stress. More work is being done along these lines to substantiate these findings.

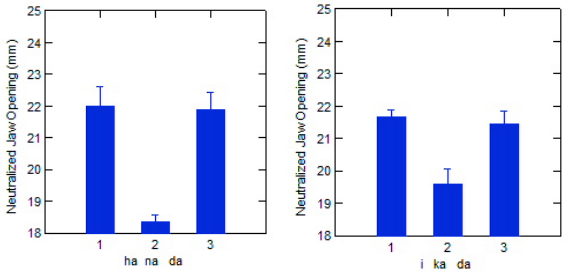

Figure 2. Neutralized jaw opening (mm) for *hana da* and *ika da*

References.

1.Fujimura, O. (2003) Stress and tone revisited: skeletal *vs*. melodic and lexical *vs*. phrasal. *"Cross-Linguistic Studies of Tonal Phenomena: Historical Development, Phonetics of Tone, and Descriptive Studies*, S. Kaji, Ed. (Tokyo University of Foreign Studies, ILCAA, Tokyo) pp. 221-236.

2.Menezes, C., and Erickson, D. (2103) Intrinsic variations in jaw deviation in English vowels. *POMA*, **19**, 060253.

3.Williams, J.C., Erickson, D., Ozaki, Y., Suemitsu, A. Minematsu, N., Fujimura, O. (2013).Neutralizing differences in jaw displacement for English vowels, *Proceedings of POMA*, **19**,