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COMPARISON OF VELOCITY AND DURATION BETWEEN OPEN TO CLOSE VOWEL TRANSITIONS AND CLOSE TO OPEN VOWEL TRANSITIONS

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Introduction

There have been reported several phenomena in which articulatory movements in opposite directions appear to exhibit different temporal characteristics.[1-4] In the present study, the movements of the jaw in the production of vowel sequences were observed and the velocity and duration in open to closed vowel transitions and closed to open vowel transitions were compared.

Method

To observe the jaw movement, the movement of a LED on a solid wire fixed to the lower front teeth was recorded using a PSD (optical spot position sensitive detector). The details of this method are described elsewhere.[5] The speech materials were the meaningless sequences /aiai/. /iaia/, /eiei/ and /ieie/. The test words were uttered in the carrier phrase /__desu/. The sentences were produced at three different speaking rates: 1) slow; 2) fast; 3) very fast. There were ten tokens for each utterance at each speaking rate.

For each utterance, the moment of the maximum displacement of the jaw for the individual vowels were determined by a visual inspection of the time function of the jaw movement. The time interval between the successive peaks was measured as the duration of the transition movement. At the same time, the peak velocity and the displacement during this period were measured.

Results

Figure 1 shows the magnitude of displacement versus the peak velocity for the /ia/, /ai/, /ie/ and /ei/ transitions in each test word. Each data point in the figure represents an average value over ten utterance tokens. There have been several reports that velocity is generally proportional to the magnitude of displacement. In the following, the value peak-velocity/displacement, representing the 'transition speed' will be compared for the opening and closing movements of the jaw.

It can be seen in the figure that, in the case of Subject 1, the transition speed was greater for the /ia/ transition than for the /ai/ transition at the slow speaking rate. In the utterance /iaia/, the difference between the /ai/ and /ia/ transitions

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becomes smaller, while the speaking rate becomes faster. For the /ie/ and /ei/ transitions, the transition speed for /ie/ is also faster than that for /ei/ at the slow speaking rate, and in the utterance /ieie/ at a faster speaking rate the difference becomes smaller.

For Subject 2, there was generally no apparent difference between the /ai/ and /ia/ transitions. However, this subject also showed a difference between the /ie/ and /ei/ transitions, the transition speed for /ie/ being greater than that for /ei/.

Figure 2 compares the durations of the open to closed vowel transition and the closed to open vowel transition. It can be noted that when the difference in the transition speed between the pair of transitions was large, the difference in the duration was also large. That is, for Subject 1, the difference between the duration of the /ai/ and /ia/ transitions in /iaia/ and the /ie/ and /ei/ transitions in /ieie/ at a faster speaking rate was smaller than that at the slow speaking rate. Similarly, for Subject 2, the difference between the /ai/ and /ia/ transitions was small, whereas the difference between the /ie/ and /ei/ transitions were clear. Thus, it appears that there was a negative correlation between the transition speed and the duration of the transition movement. It may be concluded that the slower speed in the transition movement is compensated for by the longer duration of the transition. Further quantitative analysis of the temporal pattern of the jaw movement is being carried out.

References

1. Kiritani, S., K. Itoh, H. Hirose and M. Sawashima (1977): Coordination of the Consonant and Vowel Articulations. Ann. Bull. RILP, 11, 11-21.
2. Fujisaki, H. and N. Higuchi (1979): Temporal Organization of Segmental Features in Japanese Disyllables. Ann. Bull. RILP, 13, 155-161.
3. Sawashima, M., H. Hirose, K. Honda and M. Sugito (1980): Relative Timing of Articulatory and Phonatory Controls in Japanese Word Accent. Ann. Bull. RILP, 14, 139-147.
4. Sonoda, Y. and S. Wanishi (1980): Ring-core Magnetometer Sensor for Articulatory Movements-Preliminary Studies of Jaw Movements. Tr. IECE Japan, J63-A, 6, 335-340.
5. Kiritani, S., T. Tanaka, K. Hashimoto, S. Masaki and K. Shirai (1983): Contextual Variation of the Jaw Movement for the Intervocalic Consonant in VCV utterances. Ann. Bull. RILP, 17, 37-44.

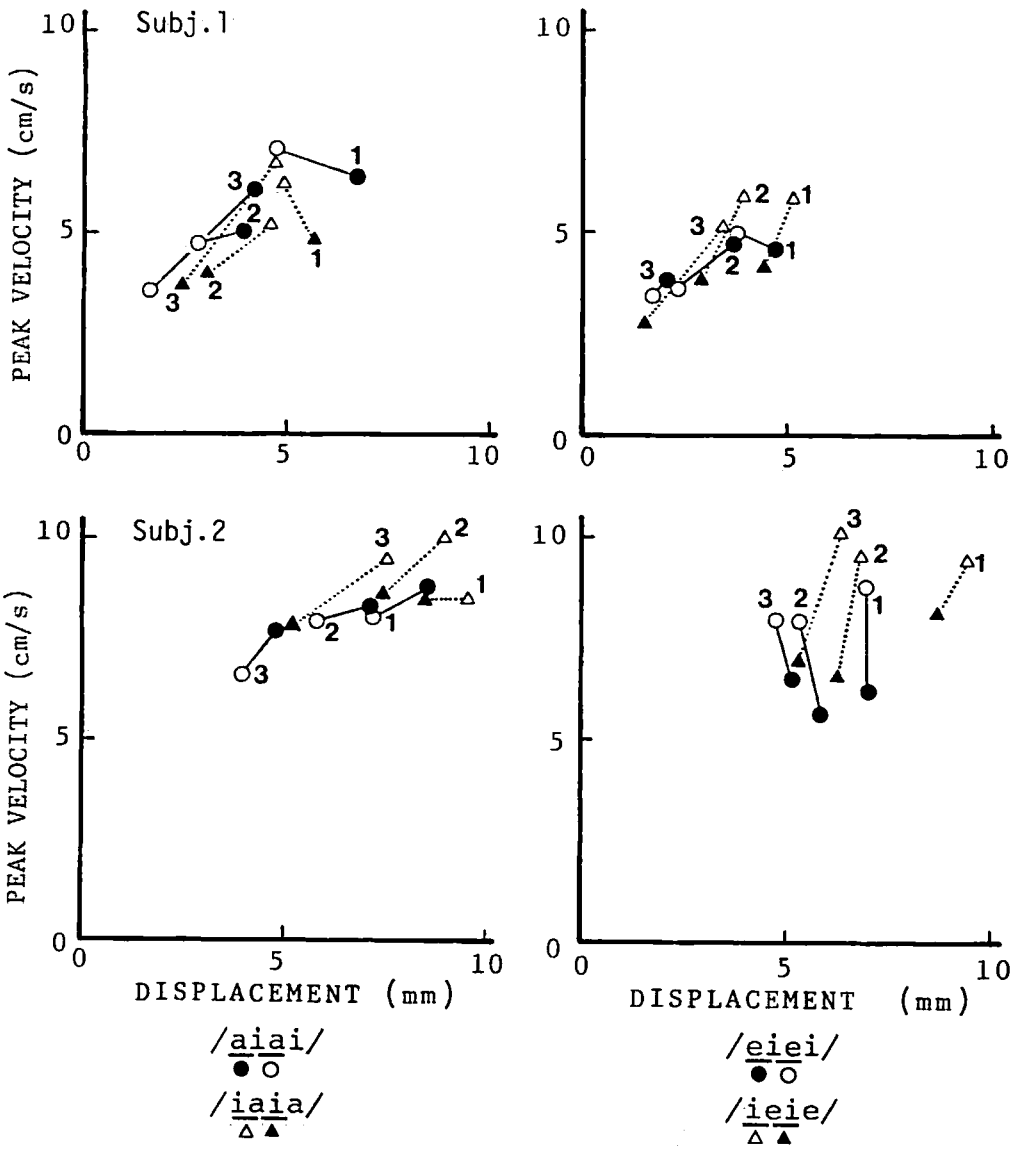

Fig. 1 *Displacement versus peak velocity for the /ia/, /ai/, /ie/ and /ei/ transitions. 1-slow, 2-fast, 3-very fast speaking rates.*

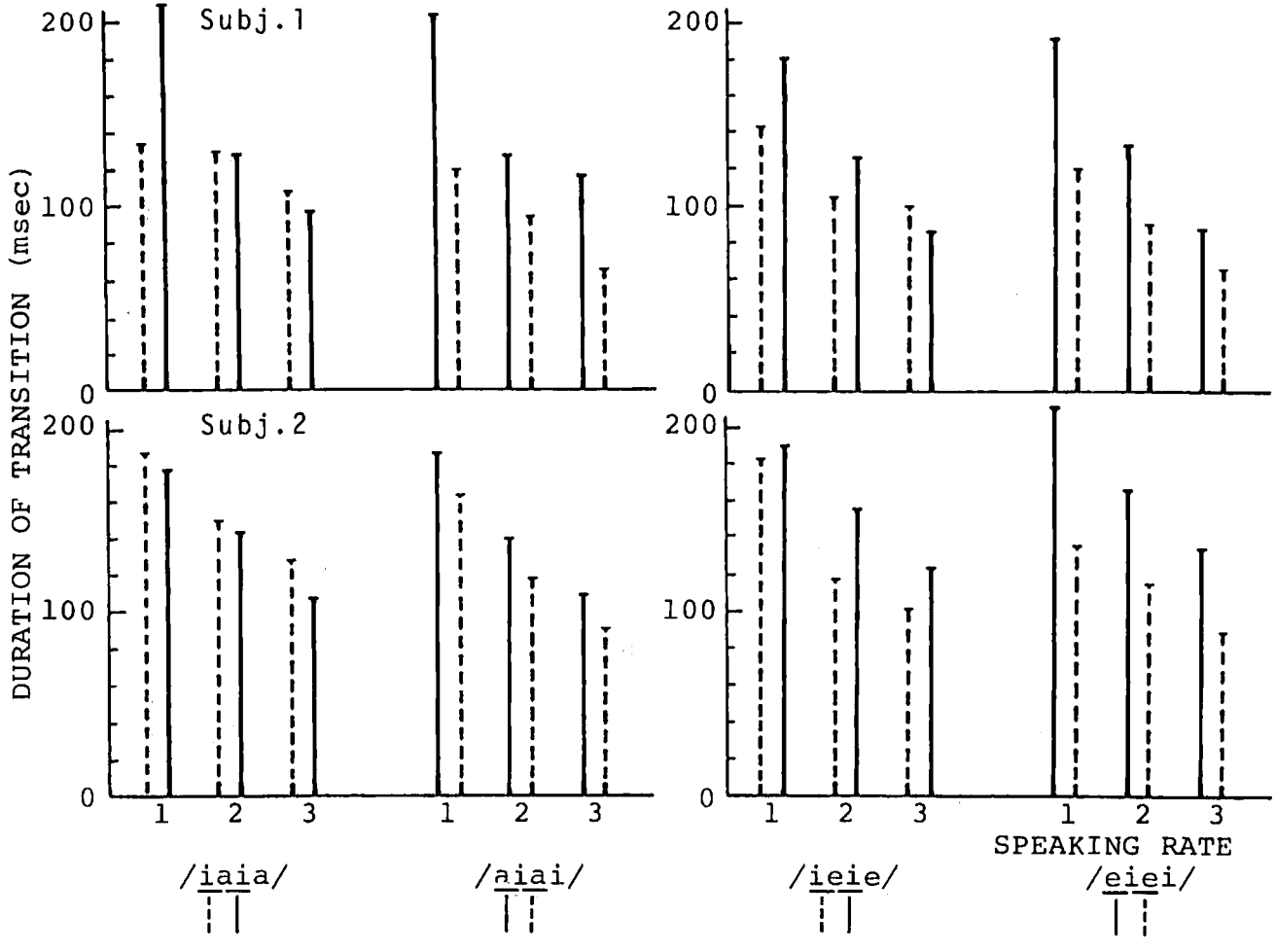

Fig. 2 *Comparison of the duration of the /ai/ and /ia/ transitions and the /ie/ and /ei/ transitions.*