

OBSERVATION OF SYMMETRY OF TONGUE MOVEMENT BY USE OF DYNAMIC PALATOGRAPHY

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Symmetry of tongue movement in the utterance of Japanese vowels and semi-vowels was observed by means of computer-controlled dynamic palatography¹⁾, in order to provide supplementary data for the analysis of X-ray and EMG observations as well as for more effective arrangements of a limited number of electrodes in the future manufacture of palatographic plates.

Arrangement of the electrodes

Thin plastic plates with 64 electrodes implanted symmetrically on either side of the mid-sagittal plane (i. e. 32 on each side) were made to fit the upper and the lower sides of the oral cavity of an adult male subject (one of the authors). Figure 1 shows the upper and the lower plates with electrodes, fitted on the plaster casts of the oral cavity. (The electrodes were painted black for ease of identification when photographed.)

The electrodes were arranged in such a manner that they were all located at points of intersection of the curved surfaces of the plates with the selected sets of sagittal and frontal planes. The set of sagittal planes were placed symmetrically on either side of the plates at distances of 5, 10, 15, 20 and 25 mm from the mid-sagittal plane and the set of frontal planes were placed every 5 mm and every 2.5 mm from the frontmost edges of the upper and the lower plates, respectively. The rearmost frontal planes were 45 mm and 50 mm apart from the frontmost edges of the upper and the lower plates, respectively. The transversal projections of the location of the electrodes are shown by dots in Figure 2.

Speech samples

Sixty Japanese words consisting only of vowels and semi-vowels were embedded in a carrier phrase /'ano --- no'atode/ (after that ---) and uttered by the subject five times each in a randomized order, and the contact of the tongue with the upper and the lower plates was recorded under similar conditions on different days.

Processing

The on/off states of tongue contact with the electrodes were sampled every 10 msec, and were displayed both in the form of sequences of the transversal projection of the distribution of the electrodes in contact, and in the form of a time-varying function of the change in the number of electrodes in contact. Speech envelopes were also displayed in the latter case.

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Results

The tongue made contact with the upper plate during the utterance of vowels /i, e, u/ and semi-vowel /j/. The contact patterns for the steady part of the utterance of /i, e, u/ are shown by solid curves on the transversal projection of the location of the electrodes in Figure 2(a). The pattern for /i/ sometimes showed deviations from symmetry as indicated by a dotted curve in the figure.

The tongue made contact with the lower plate for the utterance of all five vowels /i, e, a, o, u/ and two semi-vowels /j, w/. The contact patterns for the steady part of the utterance of five vowels shows slight asymmetry for one or two electrodes along the boundary of contact region as demonstrated in Figure 2(b).

The number of electrodes in contact in each of the left and the right sides and the difference between them are shown in Figure 3 as a time-varying function. One of the five utterances is given as an example for each of the two (out of 60) words. The difference was less than 5% of the number of electrodes in contact on each side in the utterances of all kinds of words except for a transient part of some of them.

Figure 4 shows a series of contact patterns, sampled at 10 msec intervals, of a transient part of the articulation of /--- o'i ---/ corresponding to the upper two examples in Figure 3. Open circles represent electrodes in symmetrical contact while filled circles represent those in asymmetrical contact. (The dots indicate electrodes that were not in contact.) The asymmetrical contact occurs mostly along the boundary of the contact region, which shifts rapidly as shown in this figure.

Remarks

In summary, the tongue movement in the utterance of Japanese vowels and semi-vowels by this subject may be regarded to be fairly symmetrical*, and the contact pattern of one side of the plate will give sufficient information concerning lingual contact.

References

- 1) I. Fujii Tatsumi, "Some Computer Techniques for Dynamic Palatography," Annual Bulletin (Research Institute of Logopedics and Phoniatics, University of Tokyo). No. 6, 15-18 (1972).
- 2) K. Miyawaki, "A Preliminary Study of American English /r/ by Use of Dynamic Palatography," Annual Bulletin (Research Institute of Logopedics and Phoniatics, University of Tokyo). No. 6, 19-24 (1972).

* The contact pattern for some of the consonants of the carrier phrase, however, showed a significant asymmetry. Further observations on the asymmetry of lingual contact in the utterance of various kinds of consonants are planned.

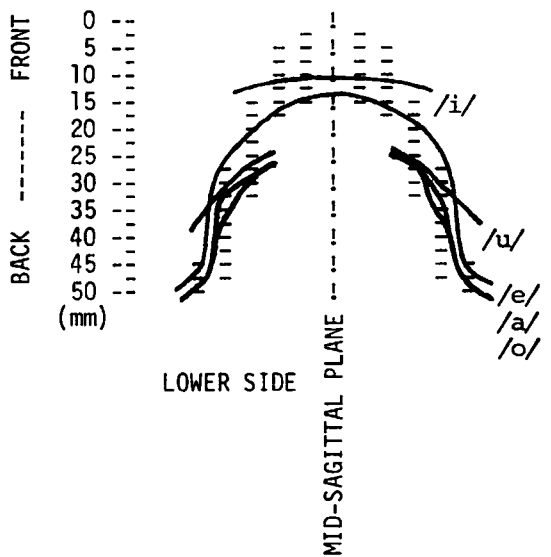
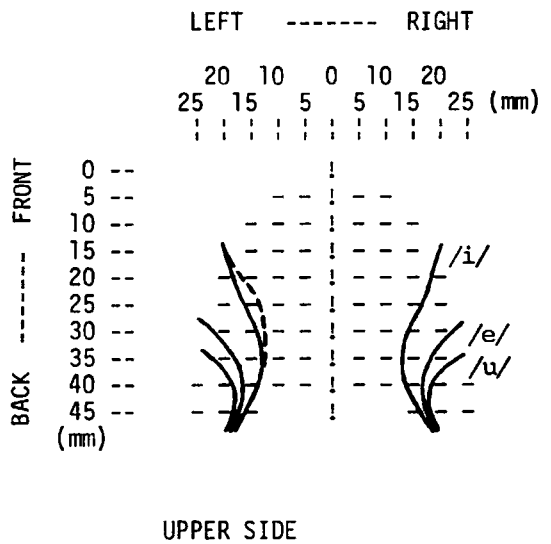
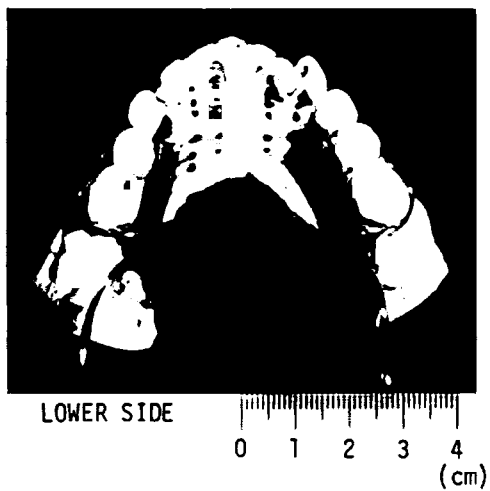
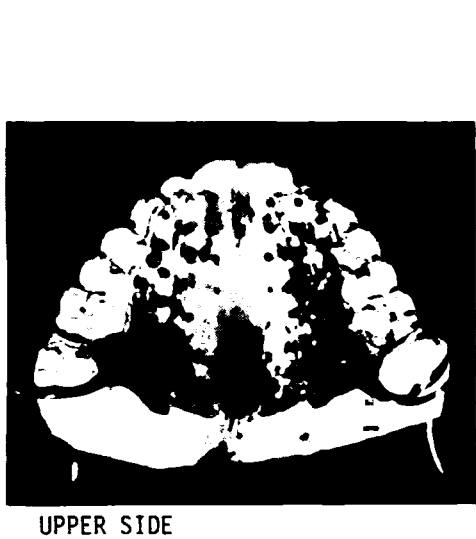


Fig. 1 (left). The upper and the lower plates with electrodes.

Fig. 2 (right). Patterns of tongue contact with the upper (a) and the lower (b) plates for the steady part of vowels.

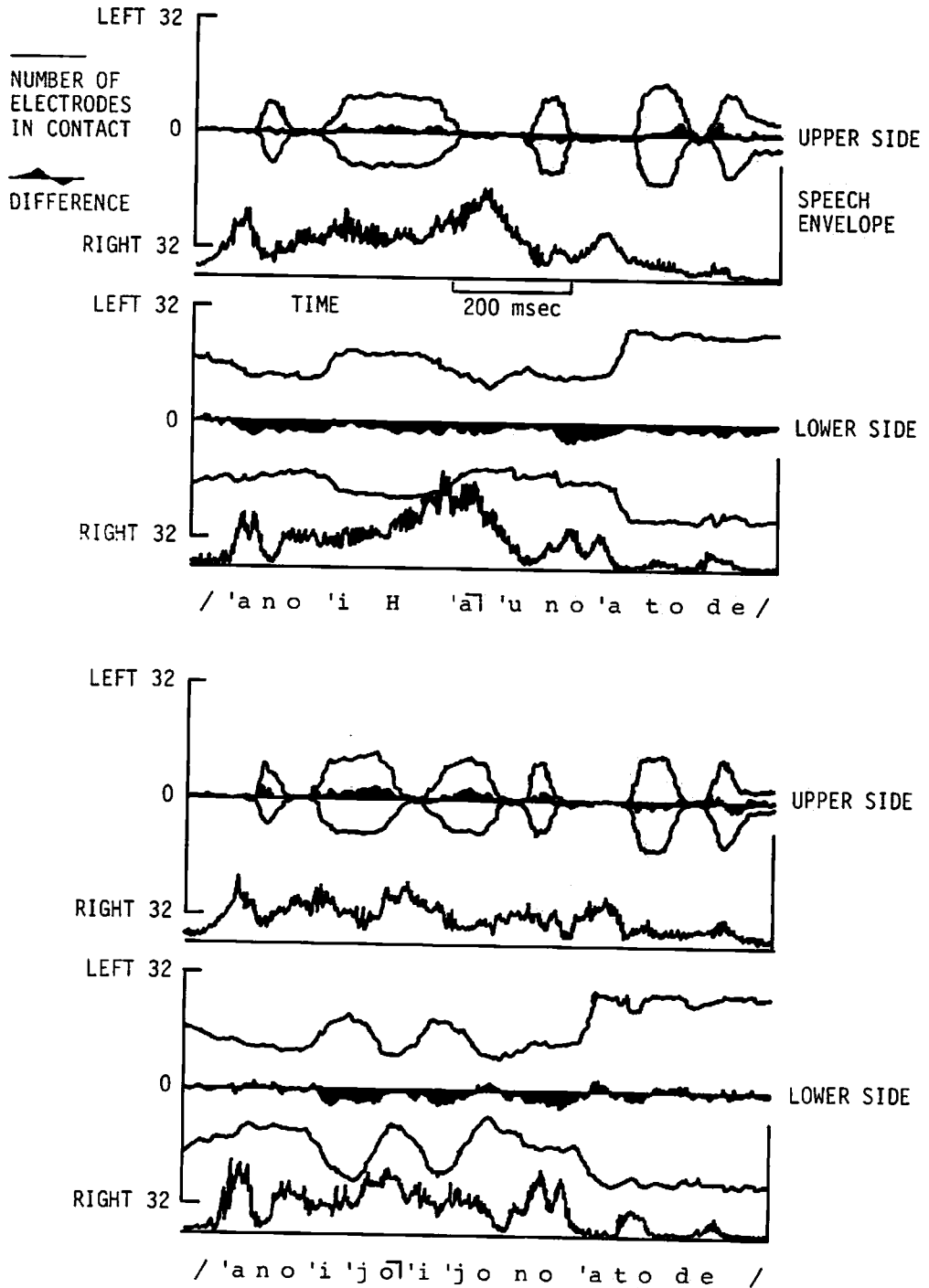


Fig. 3. The number of electrodes in contact in each of the left and the right sides of the plates and the difference between them, shown as a time-varying function.

/ 'a n o ' i H ' a ' u n o ' a t o d e /

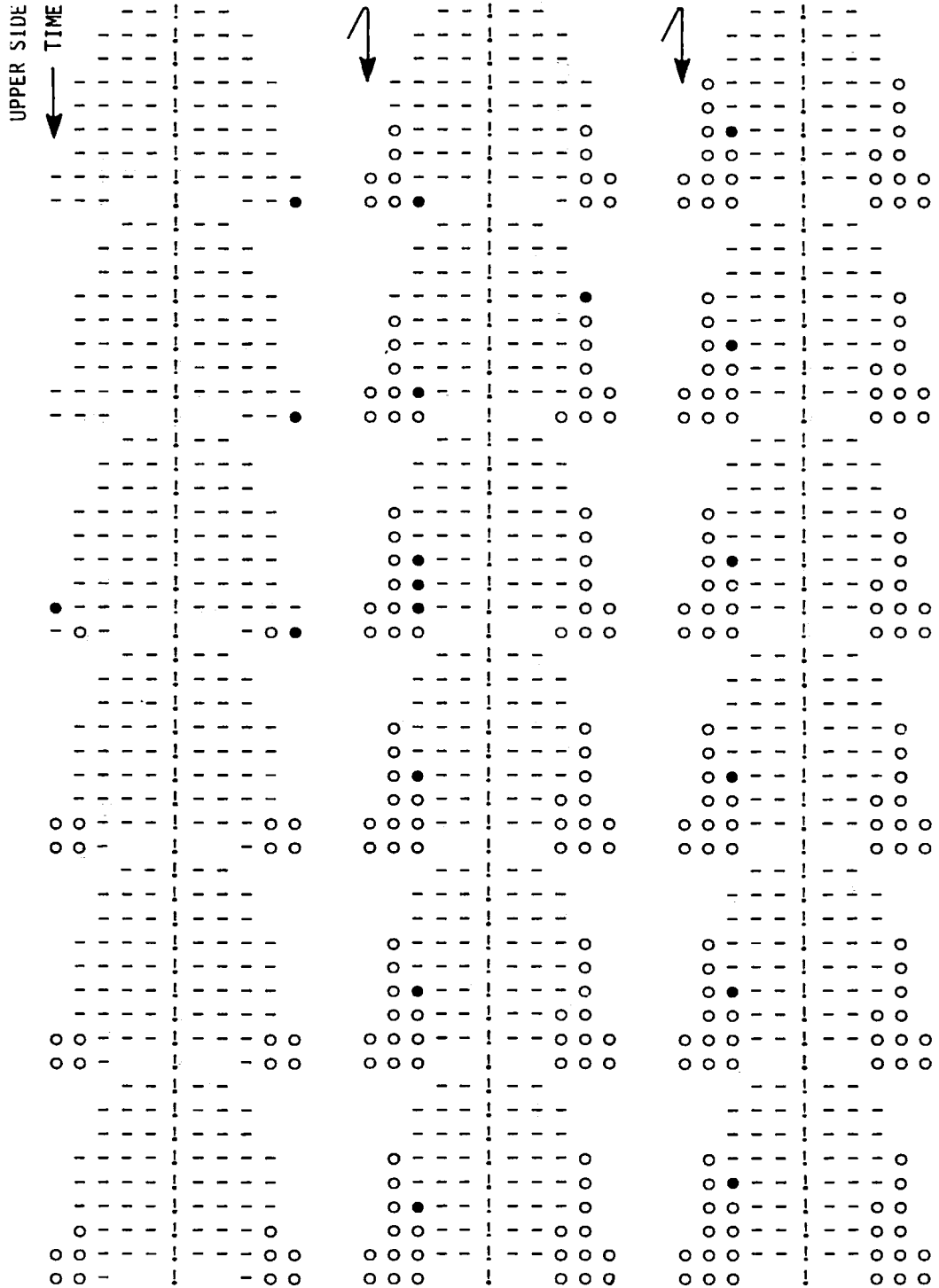


Fig. 4a. Examples of change in contact pattern for upper side of a transient part of /---o'i---/.

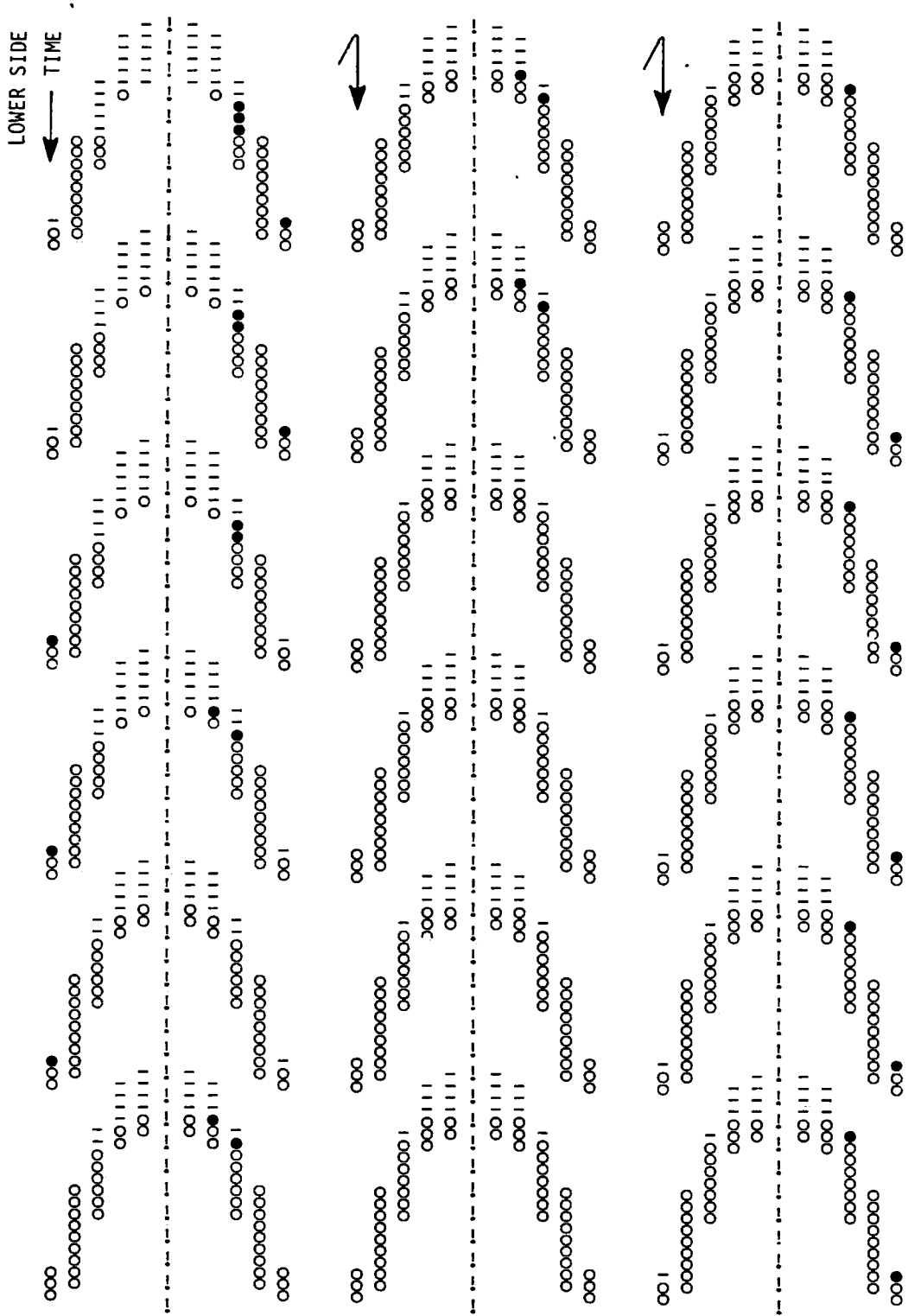


Fig. 4b. Same as Fig. 4a, for lower side.