A PRELIMINARY STUDY OF AMERICAN ENGLISH /r/ BY USE OF DYNAMIC PALATOGRAPHY

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Introduction

Dynamic palatography (henceforth DP)[1], along with other research tools such as cineradiography, fiberoptic and ultrasonic techniques, seems to be a promising means for studying the (dynamic) articulatory aspect of speech phenomena. The present report gives some of the results obtained from a preliminary study on American English by use of DP, and suggests some possible future uses of this experimental method.

Material and Procedures

Among the utterance samples produced by one male native speaker of American English,[2] those pertaining to the so-called retroflex-r were chosen as the object of the present study. They are of the two types: 1) those with word initial /r/, and 2) those with word medial /r/ in both pre- and post-stress positions. The list of the English words recorded in the data body are given below:

Type 1 --- word initial		Type 2 --- word medial	
		pre-stress	post-stress
reap	rock	bereáve	Bírrel
rake	raw	perípheral	bérry
rap	rust	beréft	párallel
rid	row	parábola	júry
red	room	Perú	sórrow

1) For some of the earlier studies on DP see Kuzmin (1962), Kydd and Belt (1964), Rome (1964), Shibata (1968), and Hardcastle (1969); for more up-to-date works, Fujii (1970), Fujii et al. (1971), Fujimura et al. (1972), and Tatsumi (1972).

2) Professor A. M. Liberman at the University of Connecticut kindly participated in this preliminary study serving as the subject while he was visiting with our laboratory in 1971.

Each of the Type-1 (Type-2) words were produced 4 (2) times in isolation.

The artificial palate used for the present study had 64 electrodes, arranged as shown below schematically (Fig. 1).[3] Successive palato-lingual contact patterns were displayed and visually examined on the oscilloscope surface at different speeds. Some detailed accounts of the data read-in, data processing and other technical procedures are reported elsewhere (Fujimura et al. 1972, Tatsumi 1972).

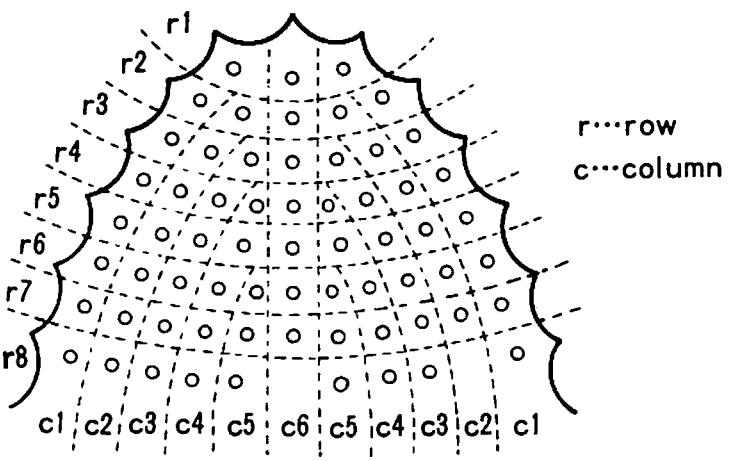

Fig. 1. Schematic representation of the arrangement of the electrodes together with the indication of rows and columns.

Results and Discussions

Initial-r

From the observation of Type-1 samples the following can be said about the articulatory behaviour of the utterance initial /r/.

The consecutive palato-lingual contact patterns of the sequence /#rV__/

3) One electrode (r6, c2) was broken in the process of making the palate and thus failed to give the on/off contact signal in this preliminary experiment.

may be conveniently divided into three phases, the "pre-r phase, " the "r-phase, " and the "post-r phase. "

i. "pre-r phase"

This lasts for 30 - 40 msec prior to the "r-phase" (infra) and is characterized first by the appearance of 2 adjacent on-contact electrodes (c1-c2 contact) on r3 and/or r4 on either or both sides of the palate[4]: at this stage the posterior rows have on-contact electrodes only in the outermost column, i. e. c1, while the anterior rows show no sign of contact whatever (Fig. 2). During this phase usually the number of c1-c2 contacts increases in the direction of the posterior rows (never in the anterior direction) but r7 and r8 generally retain the single contact pattern (Fig. 2).

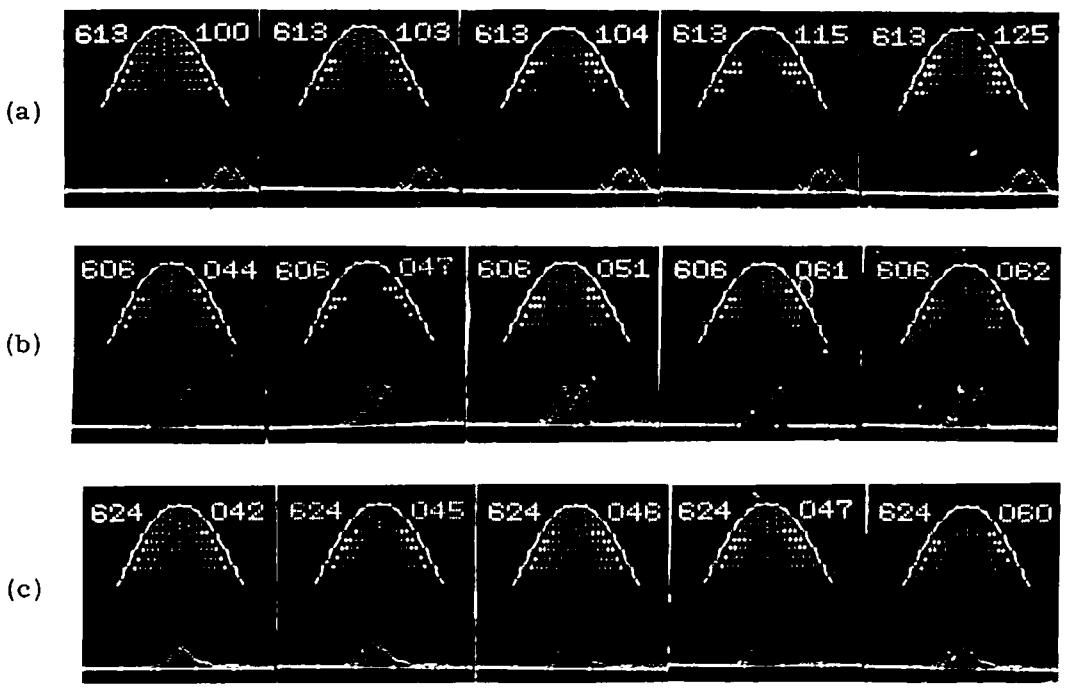

Fig. 2. Selected palato-lingual contact patterns of the utterance initial /r/ followed by three different vowels; a) /i/, b) /a/, and c) /u/, displayed at a rate of 100 frames per second. The number on the left indicates the utterance number and the one on the right the frame number. Each contact pattern is of the moment indicated by the bright spot on the amplitude curve below.

4) For the compartmentalization of the electrodes into rows and columns see Fig. 1.

ii. "r-phase"

This phase is characterized by the presence of at least one set of 3 adjacent on-contact electrodes (c1-c2-c3 contact) on either r4, r5 or r6. This phase lasts for 100 - 120 msec throughout which the anterior three rows and the columns 5 and 6 remain entirely free of lingual contact. The number of c1-c2-c3 contact, always confined to r4, r5 and r6, reaches its maximum -- usually three, but sometimes two or four -- towards the middle of the phase, when, for approximately 50 msec, the contact pattern stays unchanged. The c1-c2-c3 contact then disappears, beginning with the posterior-most row. In the case of /#ri__/ where the vowel, high-front, has its inherent significant palato-lingual contact, the indication of the contact pattern for the following vowel can already be detected at this stage.

iii. "post-r phase"

The palato-lingual contact pattern enters this last phase when there is no c1-c2-c3 contact left on the palate. Thus the overall contact pattern resembles that of the "pre-r phase" at first but is ultimately replaced by the contact pattern for the following vowel.

Medial-r in pre- and post-stress positions

One or two tentative conclusions concerning pre- and post-stress intervocalic /r/ may be drawn from the observation of Type-2 utterance samples. The most apparent tendency of the behaviour of post-stress /r/ seems to be the incomplete realization of the "r-phase" in the course of its consecutive contact pattern change. That is to say, while the typical region of off-contact (supra) is preserved, the pattern with the c1-c2-c3 contact almost never appears during this phase of the post-stress /r/. This may be interpreted as a case of "undershoot," where, most probably, the tongue tip is curved in but not to the extent of attaining the target /r/ configuration. A typical example is given in Fig. 3. On the other hand, the pre-stress /r/ never fails to fulfill the conditions of the "r-phase" (Fig. 3). Also, with some of the utterance samples containing the pre-stress /r/, there is, 1) a tendency for the c1-c2-c3 contact to appear on r7, the row which usually shows a single contact on c1, and 2) a higher probability for c1-c2-c3 contact to appear in

the course of the /r/ articulation. This seems to indicate that the tongue movement is more distinctly characteristic of the consonant when that consonant is followed by a stressed vowel.

(a)

(b)

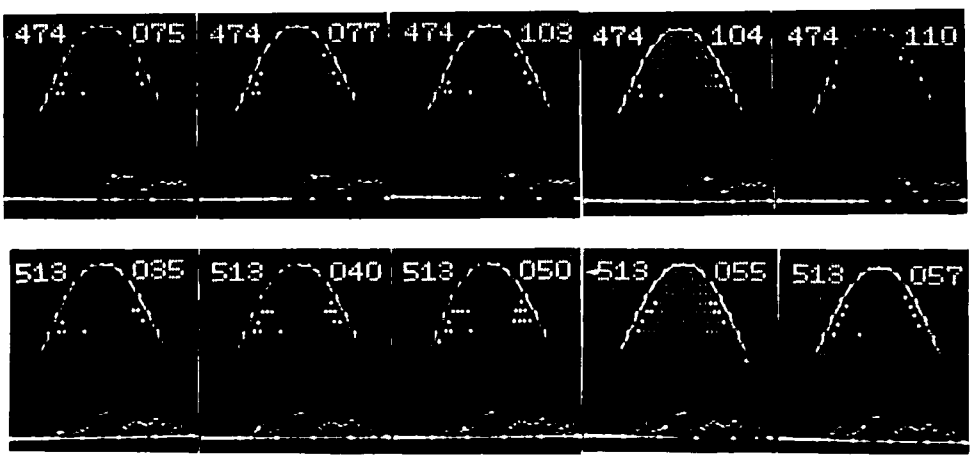

Fig. 3. Selected palato-lingual contact patterns of the utterance medial /r/ in post-stress ("párallel") (a) and pre-stress ("parábola") positions (b).

Remarks

The experiment described above was conducted as part of preliminary exploration about the use of DP in the efforts to find out essential characteristics of tongue movements in consonantal articulations, including testing of some computer programs and designing artificial palates with appropriate electrode locations. The characterization of the American English /r/ in different phonetic contexts can be considered only as tentative. Some more systematic study is under way.

References

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