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A STUDY ON THE ACQUISITION OF [r] IN CHILDREN

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1. Introduction

[r] is said to be difficult for children to acquire[1], and they often pronounce [j] in place of [r].

In American English, [r] as a glide, is sometimes classified into the same group as [j]. In Japanese, [r] is a flap, which has a stop element though the movement of the tip of the tongue is rather different from [t, d]. In general, stop sounds are earlier consonants to be acquired by children (Jakobson, 1968). Therefore, what makes [r] difficult for children to pronounce remains unsolved.

The purpose of the present study was to explore how a child acquires [r]. Such an exploration may shed some light on the nature of [r] itself.

2. Experimental Procedures

The free conversation of a female child, observed when she was seeing several slide films, was recorded at the age of 2 years 8 months and 2 years 9 months, for 20 minutes each at the speed of 19 centimeters per second.

The taped materials were first evaluated by ear and then analyzed using sound spectrograph. The tape speed was slowed down to 9.5 centimeters per second when necessary, because children's formant frequencies are usually high and difficult to analyze.

3. Results and Comments

Through the first part of the tape, 107 words or word groups are recognized. Among these, the sounds aimed at [r] were as follows, along with their environments.

Table 1

target sound	child sound	environment	number of examples/total
1) r (a)	ϕ (omitted)	ci - a	6 / 9
	j	a - a	2 / 9
	d	# - ai	1 / 9
2) r (i)	r	mo - i	1 / 1

3)	r (u)	j	a - u	5 / 19
			ku - u	6 / 19
		r-like	e - u	4 / 19
			o: - u	1 / 19
		n	e - {d, n}	2 / 19
		ø	e - u	1 / 19
4)	r (e)	ø	o - e	9 / 11
			a - e	2 / 11
5)	r (o)	ø	i - o	1 / 1

3.1 [r] replaced by [j]

S1 pa˥ pa dete kuju ↗ (Father comes out?) (Fig. 1)
S2 kane ka naju ↗ (Bells ring.) (Fig. 2)

Here, a pattern display with a wide-band filter—with or without amplitude display on the upper half—was used. In Fig. 1 (a), in the underlined part of [_uju] the resonance bars shift upward, a typical pattern for [j], and then come down for the following vowel [u].

In Fig. 2 (a), the same movement can be seen. The resonance bars of the vowel [a] rise up and then come down towards [u]. This indicates that there is a [j] element between [a] and [u].

The same materials were reproduced at a slow speed of 9.5 cm/sec and analyzed as shown in Fig. 1 (b) and Fig. 2 (b). These spectrograms show formant patterns similar to those of adults; [j] having F0 at about 200 Hz, and F1 and F2 formant transitions at about 1,800 Hz and 2,400 Hz, respectively.

3.2.1 Sounds very close to [r] (1)

S3 i˥ teruno (He is there.) (Fig. 3)
S4 mieru˥ jo (I can see.) (Fig. 4)
S5 ajuiteru˥ no (He is walking.) (Fig. 5)

In Sentence 3 the middle sound of the underlined part [eru] sounded very close to [r]. In Fig. 3 (a), however, an [r] pattern cannot be found around [ru], and a [u] pattern cannot be found there either. In Fig. 3 (b) (slow reproduction), there are weak formant frequencies around 1,200 Hz and 2,000 Hz between the preceding vowel [e] and the following vowel [u]. At present it is not certain whether this element shows [r] coloring or a simple transition from [e] to [u]. On the other hand, [r] can be heard with the slowed tape speed of 9.5 cm/sec, though rather distorted in its quality; while the [j] sound in S1 and S2 could not be heard as [r] even at the slow speed.

Similar findings were obtained for S4 and S5. In Fig. 4 (a), the [u] pattern rises and falls in accord with the pitch, and in Fig. 5 (a), the [u] pattern rises gradually. Just before these [u] patterns, there is no [j] pattern to be seen. Fig. 4 (b) and Fig. 5 (b) (slow reproduction) show a certain weak discontinuous element between [e] and [u], but such an element cannot be clearly ascertained as [r] at present. With the slowed down tape, the [r] sound was detectable though distorted in its quality.

Up to now, the sounds which are very close to [r] according to ear judgments always occur in the environment of [e_u]; preceded by [e] and followed by [u]. When we move the tongue from the middle front position of [e] to the high back position of [u], we can produce [r] with the little effort of raising the tip of the tongue against the palate. Therefore, it can be assumed that the child here attempted to pronounce a sound close to [r] with a very slight upward movement of the tongue against the palate.

3.2.2 Sounds very close to [r] (2)

Besides the sounds very close to [r] in part (1), there is one more example of an [r]-like sound.

S6 papa acjuko ni o:ɾu nojo (Father is there, isn't he?) (Fig. 6)

As shown in Fig. 6 (a), the spectrogram for [o:ru] does not show a [j] pattern, while that of [nojo] does. Fig. 6 (b), a spectrogram analyzed with a tape speed of 9.5 cm/sec, shows a weak discontinuous element in the transitional part from [o:] to [u] which is somewhat frictionalized.

In this example, the sound environment for the [r]-like sound is different from that of part (1). Here the preceding vowel [o] is fairly prolonged[2] and through this slow movement of the tongue from [o] to [u], the child seemed to pronounce an [r]-like sound with a little raising of the tip of the tongue.

3.3.1 The [r] found in child's speech (1)

S7 moɾi donde (I jump in the forest.) (Fig. 7)[3]

For S7, even at normal tape speed, an [r] sound was heard. In Fig. 7 (a), there are no clear resonance bars to be seen except the voice bar between [o] and [i], where the amplitude decreases. This would suggest that the tip of the tongue made a momentary closure for [r], as was found in a previous preliminary research, "Experimental Comparison between [ja, ju, jo] and [ra, ru, ro]."[4] Fig. 7 (b) (slow reproduction) confirms that there is an [r] between [o] and [i].

Here the sound environment is [o_i]: from the middle back to the high front position. Schematically, the tongue movement in this environment is nearly opposite to that in [e_u], where the [r]-like sound was also produced, as shown below.

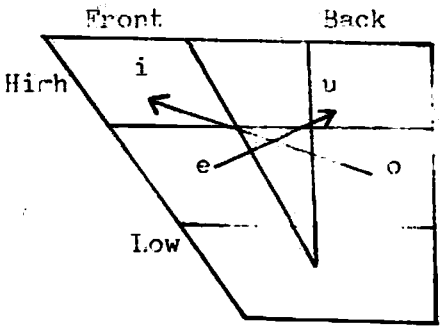

Fig. 11 *Schematic map for [r] or [r]-like sound environment.*

3.3.2 The [r] sound found in child's speech (2)

During the second part of the tape, the following sentences were heard.

S8 koe͡ ikuja ↗ (How much is this?) (Fig. 8)

S9 a͡ mu ikurja ↗ (How much is this ham?) (Fig. 9)

In Fig. 8, the [j] pattern is clearly seen in [uja]: while in Fig. 9, between the off-glide from [u] and the on-glide for [j], there is a space of about 0.07 second where only the voice bar and resonances in the low frequencies are seen. The amplitude also decreases here. This would again suggest that the tip or blade of the tongue made a momentary closure for [r]. [kuja] in Fig. 8 and [kurja] in Fig. 9 are almost the same in duration, lasting about 0.3 second starting from the [k] release. Here, [r] is produced in combination with [j].

The momentary closure for [r] is different from the stop closure in [t] or [d]. Therefore, the child here seemed to pronounce [r] combined with a gliding sound [j], resembling a retroflex as a whole.

4. Conclusion

In this paper [r] has been examined in a female child's free conversation recorded on a tape. Although [j] was often heard in place of [r], especially in the environment of [_u], some of the sounds were judged to be very close to [r] by ear and some were [r] even by analysis with sound spectrograms.

In the environments where [r] or [r]-like sounds were produced in this child, i.e. in [e_u] and [o_i], it was postulated that the tongue takes a vertical as well as a horizontal movement crossing the central part; a backward rising movement in [e_u] and a forward rising movement in [o_i]. From the articulatory point of view, the backward rising or forward rising movement of the tongue may be helpful for the child to produce an [r] sound. Another example was found in the [o_u] environment, where the preceding sound was pronounced fairly long. This long period may also be helpful for the child to produce an [r] sound.

It has been reported that children take one and a half as much time as adults when they speak (Iwabuchi et al., 1968). They are not good at quick and delicate movements. Such unskillfulness or incorrectness is partly because the movements

of the tongue have not developed enough, and partly because the size of the palate has not grown enough (Ito and Hiki. 1978). Therefore it seems reasonable to assume that taking time for [r] in the [o_u] environment and a transient tongue movement caused by the preceding and following sound as in the [e_u] and the [o_i] environments are helpful for the production of [r]. In this way, the child here appears to have succeeded or nearly succeeded in producing [r].

As for palatal development, it has been said that child's palate in general is not high enough in its front position. Thus, the tongue closure against the palate is apt to take the form of wider contact against the palate (Ito and Hiki, 1978). Therefore it seems reasonable to assume that the child succeeded in producing an [r] sound in the form of [rj_], where a wider touch of the tip or blade of the tongue could occur against the palate than [r] alone[5].

The results of the present study can be summarized as follows: 1) The child here succeeded, or nearly succeeded, in producing [r] in environments where the tongue movement took time; or in environments where the tongue movement of backward rising or forward rising took place. 2) The child also succeeded in producing [r] in the form of [rj_], where a wider contact of the tip or blade of the tongue occurred against the palate than [r] alone.

Acknowledgments

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Notes

1. "Liberman found it interesting that children had more difficulty with /s/, /r/, and /l/ rather than with the stop consonants, /b, d, g; p, t, k; m, n, ng/ because this was the opposite of what might have been expected from their acoustic characteristics." The Genesis of Language, Smith and Miller eds., the M.I.T. Press, 1966, p. 183. For Japanese examples, see H. Kunihiro, "Process Theory and Language Acquisition," Explorations in Linguistics, G. Bedell, et al., eds., Kenkyusha, 1979, pp. 275-276.
2. In Fig. 6, [o:] lasts for about 0.2 sec, while the other vowels last for about 0.1 sec.
3. Sentence 7 is pronounced with a simple melody.
4. Hiroko Kunihiro, unpublished research, 1981.
5. The writer's dynamic palatograms show that the tongue touch of [rja] against the palate is a little larger in area and longer in time than that of [ra]. (Fig. 10)

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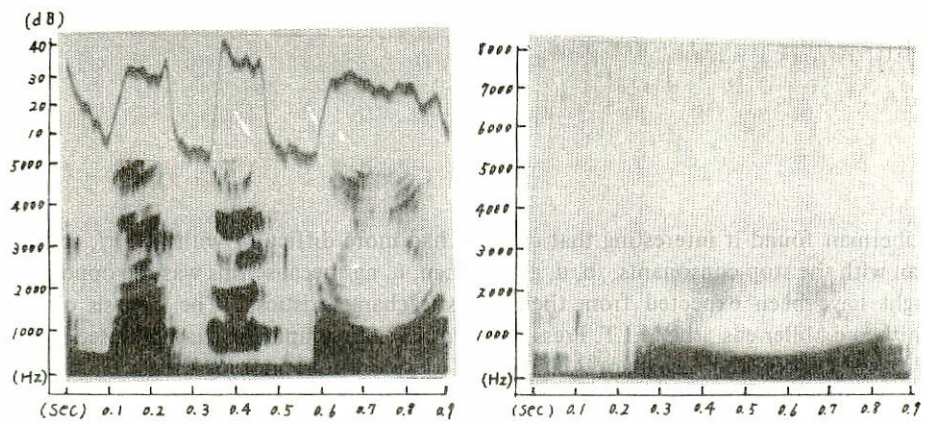

Fig. 1 *A spectrogram of [pa⁻¹pa dete kuju ↗], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

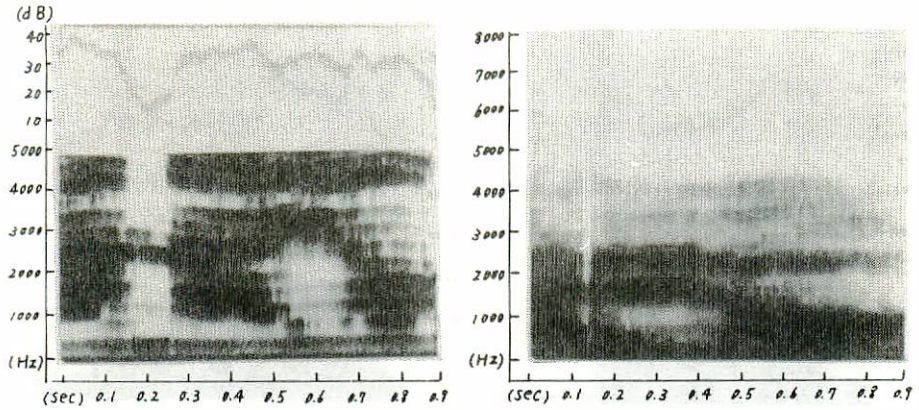

Fig. 2 *A spectrogram of [kane ka naju ↗], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

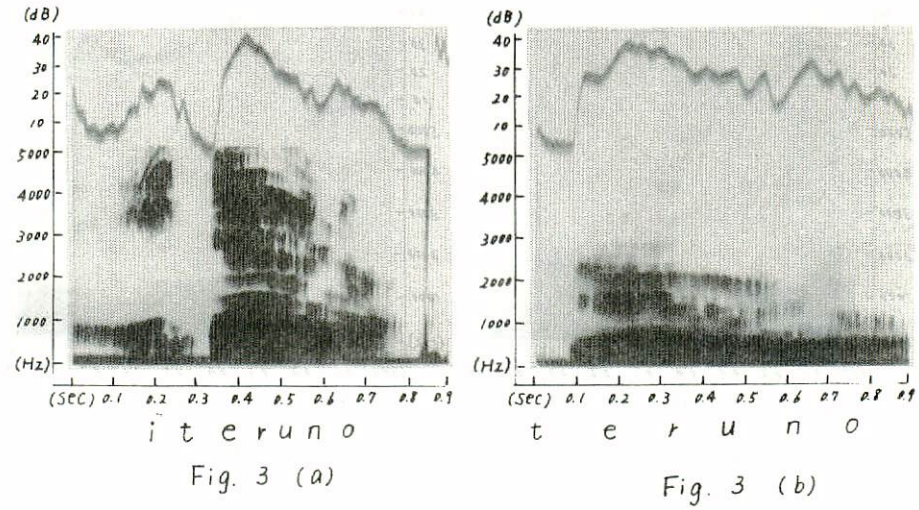

Fig. 3 *A spectrogram of [i˥teruno], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

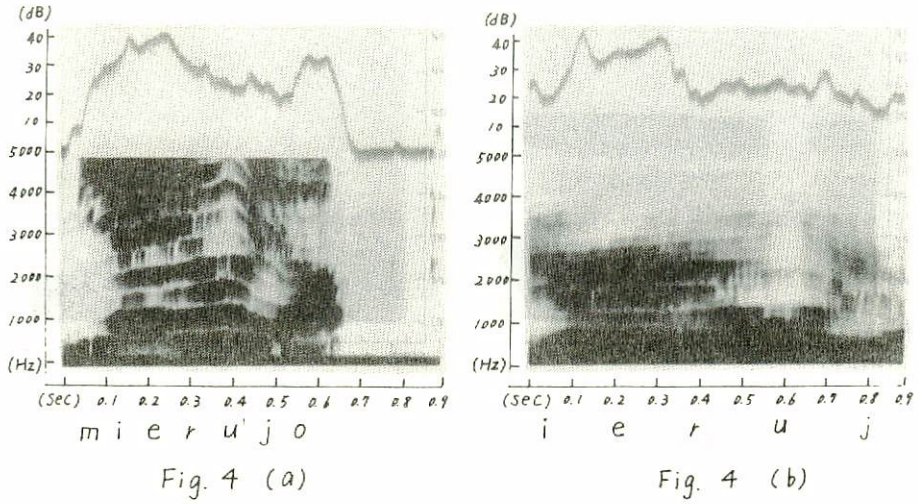

Fig. 4 *A spectrogram of [mieru⌝jo], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

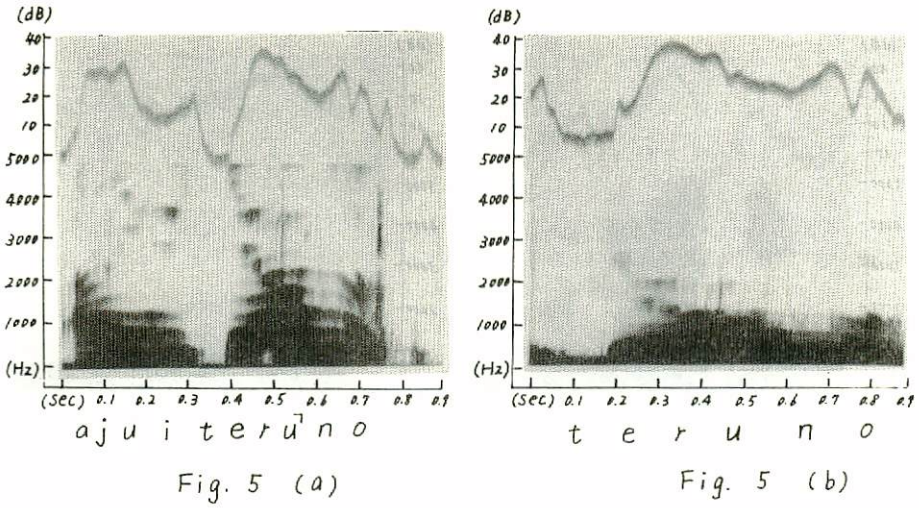

Fig. 5 *A spectrogram of [ajiteru⌝no], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

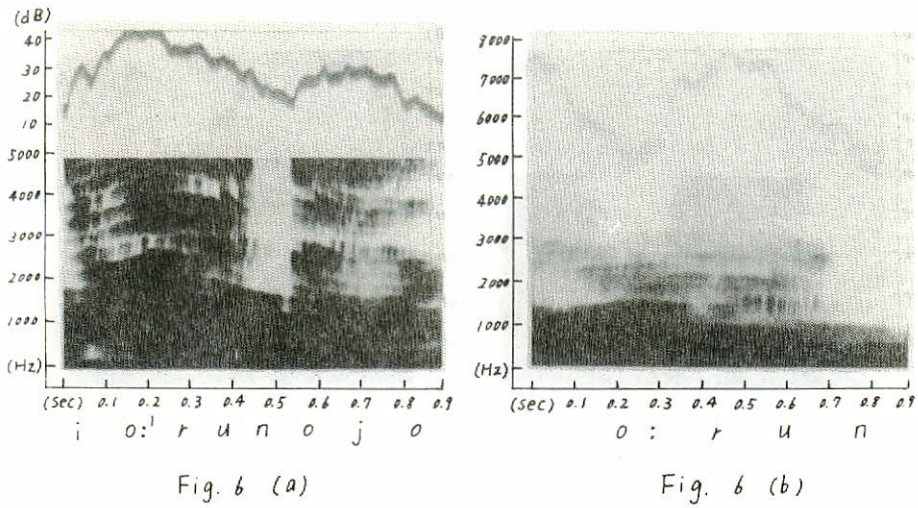

Fig. 6 *A spectrogram of [papa acjuko ni o:˥ ru nojo], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

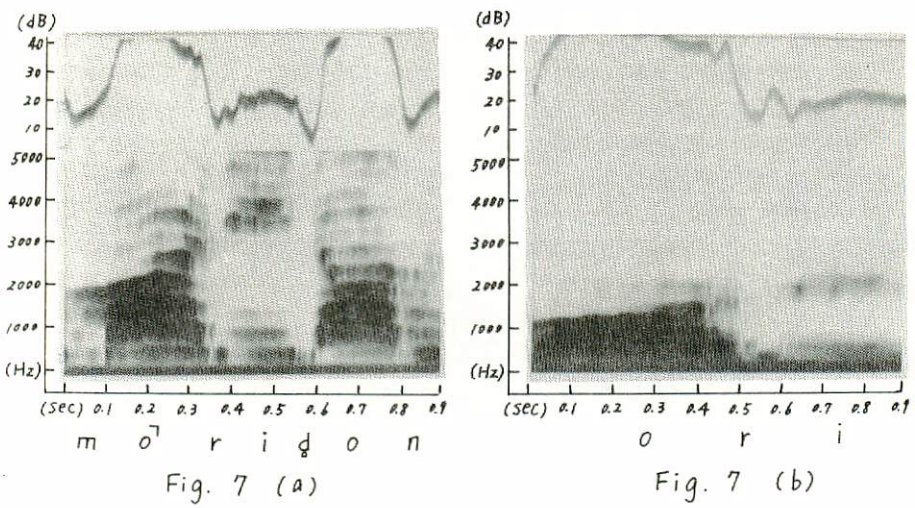

Fig. 7 *A spectrogram of [mo˥ ri d̥onde], reproduced at a tape speed of 19 cm/sec (a) and 9.5 cm/sec (b).*

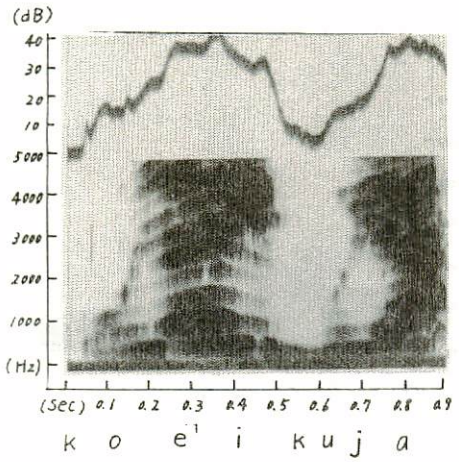

Fig. 8

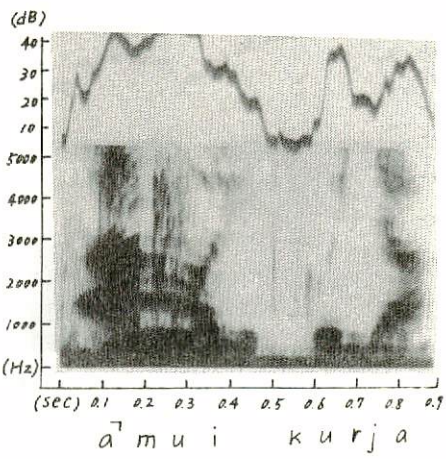

Fig. 9

Fig. 8 *A spectrogram of [koe¬ ikuja ↗].*

Fig. 9 *A spectrogram of [a¬ mu ikurja ↗]. Both at a tape speed of 19 cm/sec.*

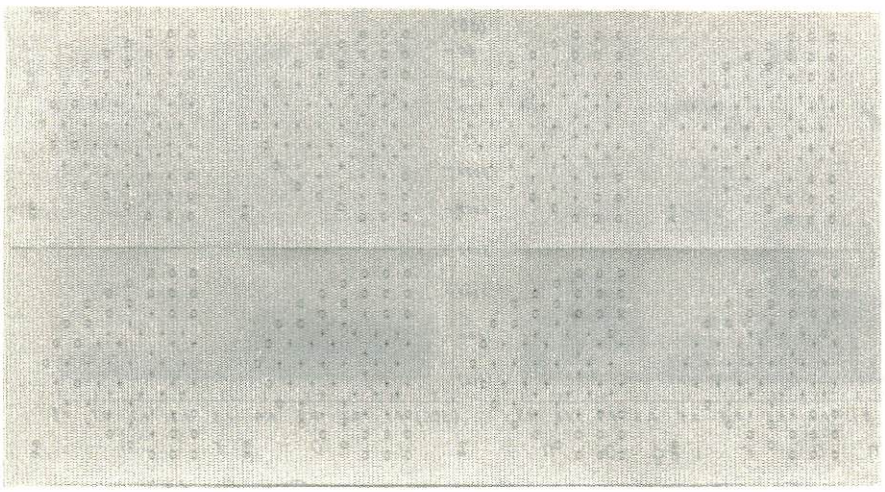

Fig. 10

Fig. 10 *Dynamic palatograms of [rja] and [ra].*