A LOOK INTO THE PLOSIVE CHARACTERISTICS OF JAPANESE /r/ AND /d/

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1. INTRODUCTION

At first glance, two phonemes such as /r/ and /d/ do not seem likely candidates to share a great deal of phonetic similarity. In near-natural speech where articulatory reduction is expected, though, /d/ realized as [ɾ] (a flap/tap) is commonplace in a number of languages including Japanese. Japanese /r/, or more properly /ɾ/, is largely considered to be an alveolar or post-alveolar tap subject to a wide degree of phonetic variability (e.g. Vance 1987; Akamatsu 1997) . Alongside canonical [ɾ] realizations, variants of /r/ in Japanese can include the lateral flap [ɺ], lateral- and rhotic approximants [ɹ, l] (Okada 1999; Amanuma et al. 2004) as well as what Hattori (1951) calls a 'weak [d]' (or 'weak plosive' in Kawakami 1977; see also Vance, 1987). The weak plosive variant of /r/ is generally discussed as a positional variant, occurring word-initially or following a pause. This author's earlier auditory-phonetic work with a corpus of extemporaneous (Kansai) Japanese dialogue suggested (Magnuson 2008) that variation may also in part be individual. That is, in one conversational dyad each speaker's pattern of phonetic realization of /r/ differed widely. One speaker ('JFB') produced taps which included transients akin to the release bursts of stops (i.e., 'weak plosives'), while the other speaker ('JFA') produced a number of these alongside a variety of taps as well as lateral- and rhotic approximants.

This paper acoustically re-examines the same dataset to explore the hypothesis that the speaker who produced more plosive-like /r/s (JFB) would lengthen her phonetic realizations of /d/ so as to avoid neutralizing her /r, d/ contrast. The conclusion arrived at is that this speaker does use duration to augment the contrast, but she does so by reducing the length of /r/ as opposed to lengthening /d/.

2. METHOD

The speech data analyzed here consist of one approx. 30-minute telephonic conversation held between two female speakers of Kansai Japanese, JFA and JFB. This conversation is the last in a series of 10 such conversations between the same two speakers, recorded in separate acoustically-controlled environments as a subset of the JST/ATR ESP-C corpus of unscripted Japanese conversation (Campbell 2004, 2007).

Each speaker's side of the conversation (separate digital recordings) were analyzed using Praat. Tokens of /d/ and /r/ were segmented and labeled based on their acoustic properties as were visible in the sound spectrogram and waveform (see Fig. 1, overleaf). Plosive realizations of /d/ and /r/ were identified as those that featured a release burst followed by a short span of aperiodicity leading into a subsequent vowel. Although this sort of release phase is a defining characteristic of [d], it is not something normally associated with flaps/taps. Nonetheless, each speaker produced both plosive-like tokens (with release-like bursts) and flap-like tokens (with no burst but a general decrease in amplitude across a broad range of frequencies) as realizations of both phonemes. The start of the release phase of plosive-like realizations was identified as a brief spike in the waveform prior to the onset of the following vowel.

Only tokens of /r/ and /d/ which were directly comparable to one another were used in the present analysis of duration. That is, post-nasal and post-pausal tokens were excluded as their start-points could not be reliably determined acoustically; also, /r/ does not frequently occur in these positions in Japanese. Approximant realizations of /r/ and /d/ were also excluded as their precise durations could not be reliably determined. Thus, the tokens investigated here consist of both speaker's (phonetically) intervocalic /r/s and /d/s produced either as plosives or as flaps. Table 1 summarizes the tokens used in the acoustical analysis. Where appropriate, the statistical significance of differences in duration among the realizations (within and across speakers) were determined via single-sample t-tests using the mean value of the contrasting group as the test value.

Table 1. Plosive (p) & flap (f) realizations of /d, r/ by speaker.

	JFA	**JFB**	Total
	(p) 79	(p) 136	215
/d/	(f) 82	(f) 150	232
	161	**286**	**447**
	(p) 22	(p) 105	127
/r/	(f) 84	(f) 206	290
	206	**311**	**517**
Total	**367**	**597**	**964**

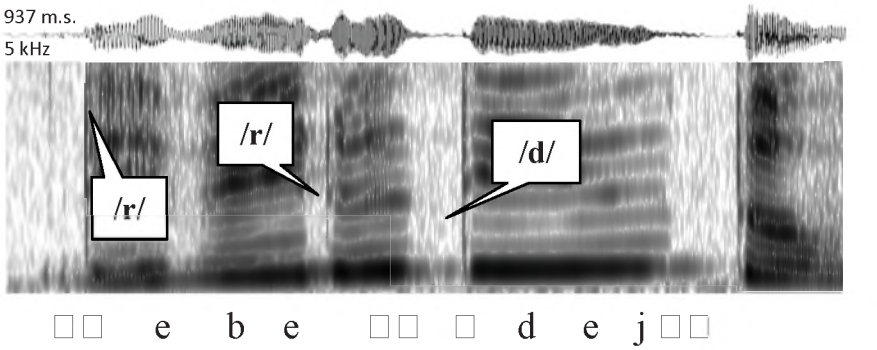

Fig. 1. A spectrogram and narrow transcription of *reberu-de iu-to* ('in terms of level'), spoken by JFB. A burst-like element is apparent in the 1st post-pausal /r/ (not included in the analysis). Note the comparative durations and presence of bursts among the 2nd /r/ and /d/. Both /r/s are transcribed as raised flaps ([□□]) to reflect a robust articulatory closure.

3. RESULTS

It is worth mentioning that, with respect to /r/, the dataset analyzed here reflects only a subset of the phonetic variety produced by the two speakers during their conversation. Both produced lateral- and rhotic approximants with varying degrees of articulatory reduction, in addition to lateral flaps (which have been grouped together here with non-lateral flaps/taps). That said, the tokens of /r/ analyzed here account for 68.7% of JFA's 300 total /r/s and 83.6% of JFB's 372 total /r/s. JFB produced substantially more plosive-like realizations for /r/, which comprised 28.2% (N= 105) of her total /r/s as compared to JFA, for whom plosive-/r/s constituted 7.3% (N= 22) of her total productions.

The hypothesis tested here is that JFB, for whom plosive-like realizations of /r/ were more frequent than JFA, would lengthen her /d/s so as to avoid confusion with her /r/s. This hypothesis would be supported if JFB's /d/s were significantly longer than JFA's. As it happened, the hypothesis was not supported; however, there were indications that JFB phonetically differentiated her /r/s from her /d/s via a different strategy. Specifically, JFB's /r/s (plosives and flaps alike) were significantly shorter than JFA's. These results are summarized in Fig. 2 below.

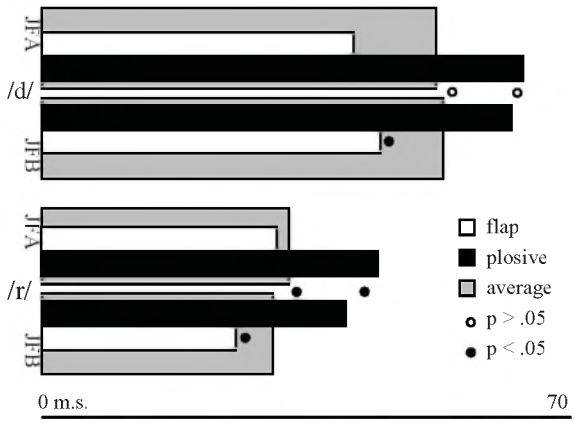

Fig. 2. Duration of both speakers' plosive and flap realizations of /d/ (upper) and /r/ (lower). Averaged flap (white) and plosive (black) duration is depicted in grey. Significance based on one-sample, two-tailed t-tests.

Either speaker's overall duration for /d/ (JFA: 52.2 m.s., JFB: 53.1 m.s.) and for plosive-/d/ (63.7 and 62.2 m.s.) did not differ significantly although JFB's flapped-/d/ duration was longer (44.8 versus 41.2 m.s.; $t = 3.64$, $p < .001$, mean difference = 3.65 m.s.). JFB's duration for both plosive- and flapped-/r/ were significantly shorter than JFA's: 40.2 and 25.7 m.s. versus JFA's 45.0 and 31.1 m.s. (Plosives: $t = -4.57$, $p < .001$; mean diff. = -4.71 m.s. Flaps: $t = -8.52$, $p < .001$; mean diff. = 5.41 m.s.). JFB's combined mean duration for /r/ was also shorter than JFA's: 30.6 versus 32.6 m.s. ($t = -2.95$, $p = .003$; mean diff. = -1.98 m.s.).

4. DISCUSSION

Taken together, these results suggest that speaker JFB exploited the duration of her /r/s in such a way as to maintain the phonological contrast with /d/. Since a duration distinction was also apparent between her flapped-/d/s and /r/s ($t = 7.59$, $p < .001$; mean diff. = 11.06 m.s.), I interpret JFB's use of duration for /r/ as a strategy for maintaining or enhancing her /r, d/ contrast. Much more study is needed to ascertain whether this is a pervasive influence on how /r/ is realized by speakers of Japanese.

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