Articulatory Preference in Japanese Liquids and F3 in English: A Preliminary Report

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1 Introduction

While the phonetic realization of Japanese liquid phoneme /r/ is often described as apico-alveolar tap or flap /ɾ/, it is known to be highly variable (e.g. Akamatsu, 1997; Vance, 2008; Arai, 2013). In particular, recent articulatory studies have demonstrated that lateralization is one of the viable strategies employed by native speakers when producing the liquid consonant in Japanese. For example, in an EPG study, Tsuzuki and Lee (1992) found that palatalized laterals are employed in syllables such as /rja, rjo, rju/, while retroflexed laterals are employed in word-initial position, when preceding a non-high vowel. Through another EPG study examining both singleton and geminated liquids, Kawahara and Matsui (2017) observed weaker lateral constrictions for geminated liquids, as well as a lateral opening for the /ara/ condition. In an EMA study also considering singleton and geminated liquids, Morimoto (2020) observed that some speakers exhibit a preference toward lowering the side of the tongue, while others do not as much. Additionally, speakers who do not show such preference may often resort to side-lowering in high front vowel environments. In the current study, I examine whether such articulatory preference of a native Japanese speaker has any bearing on her English liquid productions.

As Kawahara and Matsui (2017) pointed out, the fact that (at least some) native speakers of Japanese are able to produce laterals and some other rhotics as variants of a Japanese phoneme /r/ may have some pedagogical implications. Many Japanese learners of English struggle to learn the distinction between English /l/ and /ɹ/ both perceptually and articulatorily (e.g. Best and Strange 1992; Bradlow et al. 1997; Moore et al. 2018), and drawing attention to the articulation of the variants within Japanese may be beneficial. In the meantime, it is still unclear how the inter-speaker differences in the production of Japanese liquids play out in the learning of English liquid contrast. For example, using a combination of articulatory data (obtained through EMA) and acoustic data (F3 difference between intended /l/ and /ɹ/), Moore et al. (2018) reported on a lower-intermediate Japanese learner of English who can only inconsistently apply appropriate articulatory strategies in his repertoire, failing to create a sufficient difference between /l/ and /ɹ/ in terms of F3. Another lower-intermediate learner, on the other hand, was more successful in acoustically differentiating the two, relying on two main strategies depending on the intended phoneme (though not as consistent as more advanced learners). The current study aims to propose that, along with many other possible reasons for this kind of inter-speaker differences (the obvious one being L2 proficiency), articulatory preferences within the native sound category is another possibility to be considered in the future.

In the following section, I summarize the nature of the data discussed in the paper. I will introduce two female native speakers of Japanese that have different articulatory tendencies for Japanese liquids. In section 3, I report on the F3 values for Japanese /r/, English /l/ and /ɹ/ for each speaker. The results, though preliminary, show that (a) simple preference for lateralization may not necessarily be advantageous in learning the English /l/-/ɹ/ distinction, and (b) there is room for further investigation regarding the application of native articulatory variability to the learning/teaching of a non-native contrast.

2 Method

2.1 *Data collection and processing* The current study reports on a small subset of the results of a production experiment conducted in 2016 in Tokyo.[1] In this experiment, eight native speakers of the Tokyo-area Japanese (age range 19~28, female=5) read aloud Japanese and English phrases in a sound-proof room.

The Japanese speech material consisted of 39 Japanese reduplicative mimetics in regular form (with singleton target consonant) and emphatic form (with geminated target consonant). The regular mimetics have the form CVCVCVCV (e.g. /garagara/ ‘empty’), and emphasizing them results in the gemination of the second consonant (which is the target consonant), as in CVC:VCVCV (e.g. /garragara/ ‘very empty’). They were embedded in a carrier phrase ‘konnnani <mimetic> nanowa hajimeteda (I’ve never experienced something so

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[1] More detailed methodology is available in Morimoto (2020).

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<mimetic>).' Each phrase was produced three times in total, in a randomized order. The target consonants were all alveolar consonants (/t, d, r, n, s/), and the surrounding vowels were varied.

The English speech material consisted of eight English words containing /l/ and /ɹ/ either word-initially or in a word-initial cluster, preceded by the word 'Okay, <word>.', following Moore et al. (2018). The English utterances were collected after all the Japanese words were produced, and each of them were produced three times in a randomized order.

Acoustic and articulatory recordings were made simultaneously. For the articulatory data collection through EMA (Electromagnetic Articulography), we used the NDI Wave Speech Research System. Prior to the recordings, five sensors were attached to the tongue of each speaker in order to track the lingual movements (see Figure 1 for sensor configuration). In this study, we are concerned with the height difference between TB (Tongue Blade) sensor and the TR (Tongue Right) sensor as an index of lateralization (Ying et al. 2017). Higher value of the index indicates more side-lowering, and lower or negative value of the index indicates side-raising.

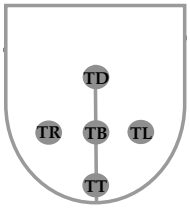

Figure 1: Tongue sensor configuration

After the articulatory data was head-corrected and rotated, extreme outliers in the articulatory signals were removed and filled using linear interpolation. We used the Mview package (Tiede, 2005) to visualize and identify articulatory landmarks such as articulatory onset and offset, or point of maximal constriction. Annotation of the acoustic signals and formant extraction were done with Praat (Boersma and Weenink, 2001). The F3 values reported below were obtained by first calculating the mean F3 value for each liquid production, and then averaging over the three utterances of each item. In order to enable a comparison between speakers and language, the following analysis will feature a small subset of the collected data: two Japanese items (regular and emphatic versions), two English items, produced by two speakers.

2.2 *The Items* The four items included in the current analysis are listed in Table 1 below. For a comparison of Japanese liquids and English liquids, /burebure~burrebure/ and 'blade/braid' were chosen. Additionally, in order to assess whether a speaker makes use of phonetic variants of Japanese liquids, an item with high front vowel environment, /puripuri~purripuri/, was also added.

Japanese	**Singleton**	**Geminate**	**Item ID**
/r/	burebure	burrebure	JR17
/r/	puripuri	purripuri	JR18
English			
/l/	blade		EL4
/ɹ/	braid		ER2

Table 1: Speech materials included in the present paper

2.3 *The Speakers* Based on the previously reported articulatory results (Morimoto 2019, Morimoto 2020), two female speakers were selected: S2 and S8. Among the eight speakers, S2 stood out as a highly lateralizing speaker. As illustrated in the positive lateralizing index in Figure 2, S2 has an overall tendency to lateralize while producing Japanese liquids (even if the liquid is not in a high front vowel environment; and increasingly so if the liquid is adjacent to a high front vowel). S2 was chosen to examine if an overall lateralizing tendency can be advantageous in the articulation of English /l/.

On the other hand, S8 maintains the tongue surface mostly flat or in a concave shape during the production of Japanese liquids. When a liquid is adjacent to a high front vowel, however, S8 appears to employ a different articulatory strategy that is closer to lateralization. S8 was chosen to explore if the presence of this intra-personal variability has any relevance to the production of English /l/ and /ɹ/.

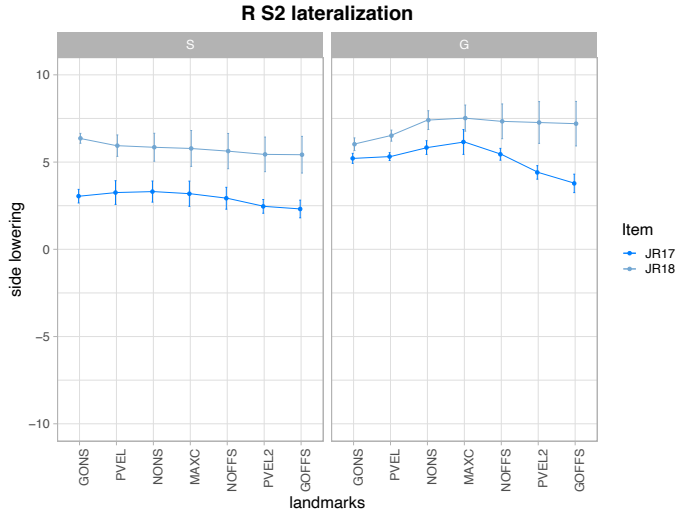

Figure 2: Lateralization index (the height of tongue center minus the height of the tongue side) for S2 over the course of the liquid production (starting with the onset of the preceding vowel and up to the offset of the following vowel) of burebure~burrebure (JR17) and puripuri~purripuri (JR18), for singletons (S) and geminates (G)

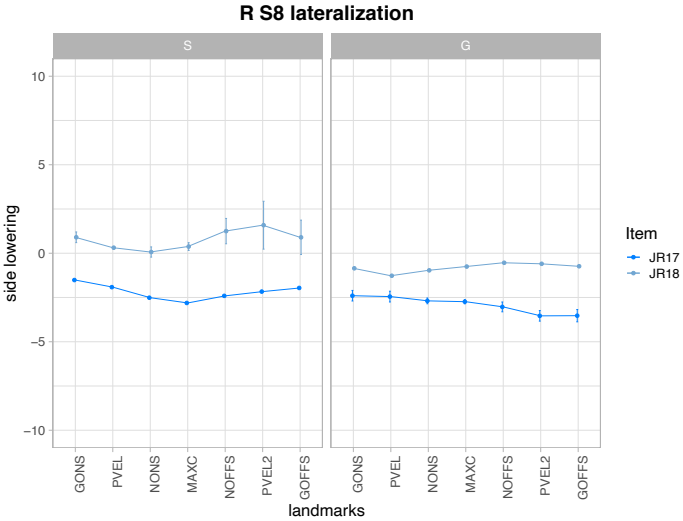

Figure 3: Lateralization index (the height of tongue center minus the height of the tongue side) for S8 over the course of the liquid production (starting with the onset of the preceding vowel and up to the offset of the following vowel) of burebure~burrebure (JR17) and puripuri~purripuri (JR18), for singletons (S) and geminates (G)

3 Results on F3

3.1 *Japanese F3 analysis* Table 2 presents mean F3 values (in Hz) for each Japanese Item as produced by S2 and S8. As expected from the lateralization profile in the previous section, S2 maintains relatively high F3 values across vowel environments. There is a slight tendency in which geminated liquids have higher F3. In contrast, F3 is higher in /puripuri~purripuri/ than in /burebure~burrebure/ for S8, which seems to suggest the effect of the high front vowel environment.

Speaker	Word	Singleton	Geminates	Overall mean
S2	burebure	2950	3164	3057
	puripuri	2900	3237	3069
S8	burebure	2943	3049	2996
	puripuri	3378	3290	3334

Table 2: Mean F3 for Japanese liquid consonants (Hz)

3.2 *English F3 analysis* Table 3 presents mean F3 values (in Hz) for each English Item. Overall, both S2 and S8 are in line with previous reports on the acoustics of English liquids (e.g. Delattre and Freeman, 1968; Kent and Read, 2002) in that they realize lower F3 for /ɹ/ compared to /l/. However, S2's F3 values for English /ɹ/ are still relatively high, and is even higher than that of S8's /l/. While S2 is quite successful in realizing laterals, which can be a challenge for many speakers (Moore et al., 2018), her overall tendency to lateralize appears to be transferring to the rhotics as well, in an undesirable direction. On the other hand, while S8's F3 for /l/ is not as high as S2, S8 is successful in making a clearer distinction between /l/ and /ɹ/ of over 600 Hz in terms of F3. Given that the /puripuri/ result above has shown that S8 is capable of producing a lateralized liquid with F3 at over 3000 Hz, there may be room for further articulatory instructions for establishing a more robust distinction between the two categories.

Speaker	Mean F3 for /l/	Mean F3 for /ɹ/	Mean difference
S2	3204	2968	236
S8	2954	2260	695

Table 3: Mean F3 for English liquid consonants (Hz)

4 Discussion and conclusion

The main aim of this paper was to explore the role of articulatory preferences in Japanese liquids in the learning of English liquid contrast. Through a case study of two speakers with different articulatory preferences, two things became clear. First, while lateral production of Japanese liquids may be beneficial in producing English /l/, which is difficult to some learners, a general and strong preference may not necessarily be advantageous unless the speaker acquires articulatory strategies for lowering F3 for the production of /ɹ/. The case of S2 provides support for the Perceptual Assimilation Model (PAM; Best, 1995), illustrating the hardship of learning two distinct categories that can be mapped onto a single category in one's native language. Second, the behavior of S8 suggests that a speaker may not always automatically exploit the full extent of their native articulatory ability, when they speak in a non-native language. This leaves room for further investigation and for potential pedagogical application. Given that S8 prefer lateralized liquids in high front vowel environments, it would be especially interesting to see if F3 difference would be boosted in items such as 'bleach' vs. 'breech'.

Meanwhile, it should be noted that the findings in this paper remain anecdotal given the very restricted data and coarse methodology. In order to examine the role of articulatory variants and preferences in the learning of non-native articulations, further acoustic, articulatory, and perceptual research are in order, while taking into account the complex nature of liquids (F2-F3 relations, consonantal duration, articulatory timings and syllable position, etc.)

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