

# PERCEPTION OF ARABIC LIQUIDS BY JAPANESE LISTENERS

Tomohiko Ooigawa

Phonetics Laboratory, Sophia University, Tokyo, Japan  
ooigawaferchichi@gmail.com

## ABSTRACT

The present research aims to identify Japanese listeners' perception patterns of non-native liquid contrasts. The study examines Japanese listeners' perception of Arabic liquids (/l/, /r/, /ll/ and /rr/). Japanese listeners showed poor performance on the Arabic /l/-/r/ discrimination and very good performance on the discrimination of the other liquid contrasts (/l/-/ll/, /ll/-/rr/, /l/-/rr/, /r/-/rr/ and /r/-/ll/). The listeners assimilated Arabic /l/ and /r/ to Japanese /r/, Arabic /ll/ to Japanese /Qr/, and Arabic /rr/ to Japanese /rur/. Of the four liquids, Arabic /l/ and /r/ were equally rated as closest to Japanese /r/, while Arabic /rr/ was rated as the least Japanese-like. The Arabic /ll/ stimuli were rated as intermediately close sounds between the singletons and /rr/.

**Keywords:** Arabic, Japanese, liquid, perception, PAM.

## 1. INTRODUCTION

In order to identify how native speakers of Japanese perceive non-native liquid sounds, the present study aims to examine Japanese listeners' discrimination, identification and goodness ratings of Arabic liquids, and to interpret the results under the Perceptual Assimilation Model [e.g. 3, 4].

### 1.1. Liquids

According to [15], the term "liquids" includes "laterals (l-sounds)" and "rhotics (r-sounds)." Laterals share a common manner of articulation (i.e. lateral) except for the vocalized realizations in some languages such as English and Portuguese [2, 28]. Rhotics are still not known to share any common articulation or acoustic cues. The only commonality of rhotics is to be written with the letter "r" that is derived from the Greek counterpart "P (rho)" [15, 16]. Cross-linguistic phonological commonalities of liquids have been discussed in a few studies, such as [6] and [22]. However, to my knowledge, no study has shown any convincing phonological commonalities of liquids.

In Japanese, the phoneme /r/ is usually realized as [r], yet the phoneme has various phonetic realizations, including rhotic and lateral sounds [1,

18, 24, 27]. In addition, Japanese has only a single qualitative liquid contrast, the plain-palatalized contrast (/r/ vs. /rj/). The language also has a quantitative liquid contrast for special words. In Japanese, the first segment of a pair of geminate consonants (except nasals) is called *sokuon* and the segment is usually transcribed as /Q/. No geminate liquid is found in native Japanese or Sino-Japanese words. However, in some loanwords and interjections, Japanese liquid can be geminated [13, 25, 27], and Japanese /Qr/ is usually realized as [l:], [13].

In Modern Standard Arabic (MSA), as well as many other dialects including Bahraini Arabic, there are two contrastive coronal liquids: /l/ and /r/ [7, 11, 12, 26]. In addition, almost all Arabic consonants have the geminate form. Therefore, four kinds of liquids (i.e. /l/, /r/, /ll/ and /rr/) are contrastive in intervocalic position in Arabic.

### 1.2. PAM

PAM (the Perceptual Assimilation Model) is a theoretical model accounting for how naïve listeners perceive non-native phonological contrasts [e.g. 3, 4]. The model posits that, when listening to an unfamiliar non-native phone, naïve listeners perceptually assimilate the non-native phone to the most articulatorily-similar native phoneme in their native language. If we know the perceptual assimilation patterns of non-native phones, PAM can predict the discrimination difficulties of non-native phonological contrasts as follows: Very good to excellent discrimination is predicted for Two Category (TC) assimilation, in which the two non-native phones are perceptually assimilated to acceptable tokens of two different native phonemes. Poor discrimination is predicted for Single Category (SC) assimilation, in which the two non-native phones are perceptually assimilated to equally good or poor tokens of the same native phoneme. Intermediate discrimination is predicted for Category Goodness (CG) difference, in which the two non-native phones are perceptually assimilated to tokens of the same native phoneme, but they differ in goodness of fit to the tokens of the native phoneme.

### 1.3. Past studies

Naïve Japanese listeners assimilate both English /l/ and /r/ to Japanese /r/ [9, 10], although it depends on the position of the liquids in a syllable [14]. The assimilation pattern of English liquids by Japanese listeners is generally SC. The discrimination is predicted to be poor, and they do perform it poorly in tests [e.g. 8, 10, 14, 17, 21]. In the case of French liquids, the Japanese listeners assimilate French /l/ to Japanese /r/, and French /ʁ/ to Japanese /h/ or /g/, although it depends on the phonetic realization of French /ʁ/ [10, 20, 29]. The assimilation pattern of French liquids by Japanese listeners is generally TC. PAM would predict very good to excellent discrimination, and experimentation bears this out [10, 19, 29]. Spanish has a three-way liquid contrast (/l/, /r/ and /r̄/). In the case of Spanish liquids' perception, Japanese listeners assimilate Spanish /l/ and /r/ to Japanese /r/, and Spanish /r̄/ to Japanese double /r/ (i.e. /rur/) [21]. The assimilation pattern of Spanish /l/-/r/ by Japanese listeners is SC, and the patterns of Spanish /l/-/r̄/ and /r/-/r̄/ are TCs. The discrimination of Spanish /l/-/r̄/ is predicted to be poor, and the discriminations of Spanish /l/-/r/ and /r/-/r̄/ are predicted to be very good to excellent. These predictions are consistent with the results of a discrimination test in [21]. Russian has a four-way liquid contrast (/l/, /l̄/, /r/ and /r̄/). According to [23], the Japanese listeners performed very well in discriminating the Russian plain-palatalized contrasts (/l/-/l̄/ and /r/-/r̄/), while they poorly discriminated the lateral-rhotic contrasts (/l/-/r/ and /l̄/-/r̄/). Japanese listeners assimilated Russian /l̄/ and /r̄/ to Japanese /r̄j/, and that they assimilated Russian /l/ and /r/ to Japanese /r/. The assimilation patterns of the Russian plain-palatalized contrasts should be TCs for Japanese listeners, and those of the Russian lateral-rhotic contrasts should be SCs.

So far, wide-ranging research studies on Japanese listeners' perception of liquids (but mainly English liquids) have been carried out. However, as far as I know, there has been no previous research on Japanese listeners' perception of Arabic liquids. The language has a four-way liquid contrast of both quality (lateral vs. rhotic) and quantity (single vs. geminate).

## 2. EXPERIMENT

### 2.1. Listeners and stimuli

Two groups of monolingual native speakers of Japanese without difficulties in speaking and hearing (18-23 years old) participated in the experiment. One of the groups (36 listeners) completed a discrimination task, and the other group (34

listeners) completed identification and goodness rating tasks. All the listeners were Japanese university students, had never stayed outside Japan for more than one month, had never majored in linguistics or a foreign language and had never studied linguistics or foreign languages other than English.

A female native speaker of Arabic (24 years old, from Jidhafs, Bahrain) participated in the recording. She was a native speaker of her local dialect, and had learned Modern Standard Arabic (MSA). The recorded materials were tri-syllabic words /tʰa\_aqa/ in MSA (see, Table 1). The four liquids were realized as [l], [l:], [r] and [r], respectively. The carrier sentence was /'kataba " " bi'butʰ?/ 'he/it wrote " " slowly.' The words and carrier sentence were written in MSA orthography. The speaker was asked to produce the stimuli with the carrier sentence in a soundproof room, and to read the sentences along with some distracters in a random order at least 15 times. The utterances were recorded onto a digital recorder (PCM-M10) through a microphone (ECM-MS957) and digitized at 48 kHz with 16 bits. The target materials were extracted from the carrier sentences. For each target word, the most clearly produced two tokens were selected from the recorded materials as stimuli.

Table 1: List of the stimuli.

Ortho.	Phoneme	Phone	Gloss.
طَلَّقَ	/'tʰalaqa/	[ 'tʰalaqa]	he/it let go
طَلَّقَ	/'tʰallaqa/	[ 'tʰal:aqa]	he/it divorced
طَرَّقَ	/'tʰaraqa/	[ 'tʰaraqa]	he/it knocked
طَرَّقَ	/'tʰarraqa/	[ 'tʰaraqa]	he/it hammered

### 2.2. Procedures

All the tasks were conducted in a Computer-Assisted Language Learning (CALL) classroom in a university in Japan. Praat Version 5.3.39 [5] was used as an interface. The listeners were asked to complete each task wearing headphones (CZ530-A). In all the tasks, the stimuli were presented in random order.

As to the discrimination test, an AXB task was conducted. In each trial, the participant listened to three stimuli (i.e. AAB, ABB, BBA or BAA) that were different tokens, but the second stimulus was the same word as the first, or the third stimulus. The listeners had to judge whether the second stimulus is more similar to the first, or to the third stimulus. The

discrimination task included 24 trials (6 contrasts × 4 AXB triplets).

For the identification and goodness rating tasks, in each trial, the participants listened to a stimulus and had to judge which button on the screen indicated the most similar Japanese transcription of the stimulus, and had to judge how close the stimulus was to the Japanese sound they chose. On the screen, six Japanese transcriptions in *katakana* letters were presented as options: “タラカ /taraka/,” “タツラカ /taQraka/,” “タルラカ /taruraka/,” “タルラカ /tarraka/.” The last option included a small ル (/ru/) letter that is not standard, but is sometimes used to indicate a foreign sound. The transcriptions were selected on the basis of the results of a preliminary study. The preliminary transcription test was carried out under the same condition as in the present identification test, except that six participants were asked to listen to the stimuli and to transcribe each stimulus in *katakana* on a sheet of paper.

In addition to the Japanese transcriptions, the five-point scale goodness rating options were presented on the screen (5 being the closest to Japanese). The identification and goodness rating tasks included 16 trials: 4 liquids × 2 tokens × 2 repetitions. The listeners were permitted to replay the recording up to three times by clicking the “Repeat” button for each trial.

### 3. RESULTS

#### 3.1. Discrimination

Figure 1: Results of the discrimination task.

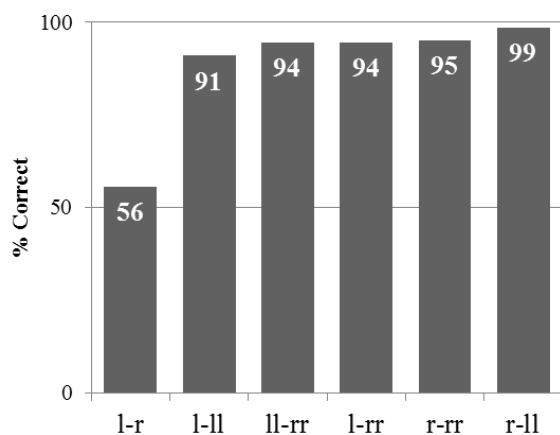


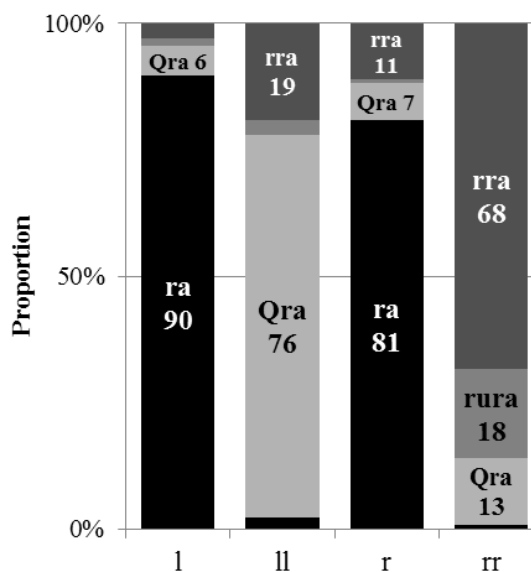
Figure 1 shows the mean rates of accurate discrimination of each contrast: /l-/r/ (56%), /l-/ll/ (91%), /ll-/rr/ (94%), /l-/rr/ (94%), /r-/rr/ (95%) and /r-/ll/ (99%). The rate of /l-/r/ (56%) is near to the chance level (50%), which indicates that the Japanese listeners were doing no better than they

would if they were simply guessing. A one-way repeated-measures ANOVA ( $F(5,175) = 54.931, p < .01$ ) and the multiple comparisons (Bonferroni) showed that the differences between /l-/r/ and the other contrasts were significant ( $p < .01$ ), and that the differences among /l-/ll/, /ll-/rr/, /l-/rr/, /r-/rr/ and /r-/ll/ were not significant ( $p > .05$ ). In summary, the Japanese listeners poorly discriminated Arabic /l-/r/, and discriminated the other liquid contrasts very well or almost perfectly.

#### 3.2. Identification

Figure 2 shows the results of the identification task. For Arabic /l/, the listeners selected Japanese /ra/ (90%), /Qra/ (6%), /rura/ (1%) and /rra/ (3%). As to Arabic /ll/, the listeners selected Japanese /ra/ (2%), /Qra/ (76%), /rura/ (3%) and /rra/ (19%). For Arabic /r/, the listeners selected Japanese /ra/ (81%), /Qra/ (7%), /rura/ (1%) and /rra/ (11%). As to Arabic /rr/, the listeners selected Japanese /ra/ (1%), /Qra/ (13%), /rura/ (18%) and /rra/ (68%).

Figure 2: Results of the identification task.



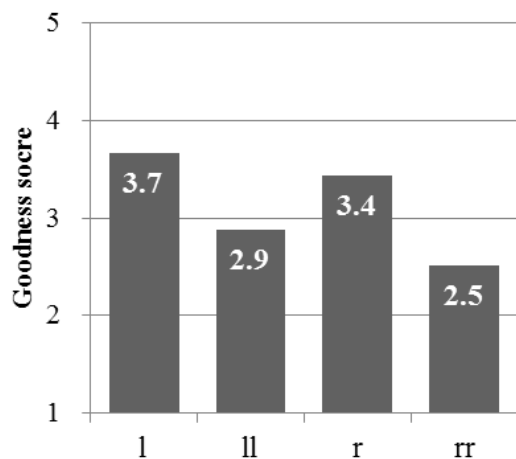
A chi-square test showed that there were significant differences in the frequencies of the selections among the four types of the stimuli ( $\chi^2(9) = 587.171, p < .01$ ). According to the residual analyses, for both Arabic /l/ and /r/ stimuli, the frequencies of Japanese /r/ selections were significantly higher than the expected values ( $p < .01$ ). As to the Arabic /ll/ stimuli, the frequencies of Japanese /Qr/ selections were significantly higher than the expected value ( $p < .01$ ), while the frequencies of Japanese /rur/ and /rrr/ selections for the Arabic /rr/ stimuli were significantly higher than the expected values ( $p < .01$ ).

The results of the identification task show that the Japanese listeners' assimilation patterns of Arabic /l/ and /r/ are very close (i.e. Arabic /l/ and /r/ → Japanese /r/). Meanwhile, the patterns of Arabic /ll/ and /rr/ are different from each other and from the singletons (i.e. Arabic /ll/ → Japanese /Qr/, and Arabic /rr/ → Japanese /rur/ or /rr/).

### 3.3. Goodness rating

Figure 3 shows the results of the goodness rating task. On a five-point scale (5 being the closest to Japanese sounds), the mean scores were 3.7 (/l/), 2.9 (/ll/), 3.4 (/r/) and 2.5 (/rr/). A one-way repeated-measures ANOVA ( $F(3,99) = 21.376, p < .01$ ) and the multiple comparisons (Bonferroni) showed that only the difference between /l/ and /r/ was not significant ( $p = .220$ ), and that the differences among the other pairs (i.e. /l/-/ll/, /ll/-/rr/, /l/-/rr/, /r/-/rr/ and /r/-/ll/) were significant ( $p < .01$ ). In summary, the Arabic /l/ and /r/ stimuli were rated equally and rated as closer to Japanese /r/ than Arabic geminate liquids. The Arabic /rr/ stimuli were perceived as the least Japanese-like sounds. The rating of Arabic /ll/ was intermediate between the singletons and /rr/.

Figure 3: Results of the goodness rating task.



## 4. DISCUSSION

According to the results of the identification task, both Arabic /l/ and /r/ were assimilated to Japanese /r/, Arabic /ll/ was assimilated to Japanese /Qr/, and Arabic /rr/ was assimilated to Japanese /rur/ or /rr/, which was consistent with the results in the past study of the perception of Spanish liquids, [21]. The results of the goodness rating task of the present study were also consistent with those of the identification task. Both Arabic /l/ and /r/ were perceived as equally close to Japanese /r/, while the

goodness scores of Arabic geminate liquids were different from each other.

Representative allophones of Japanese /r/ may be similar to the realizations of Arabic /l/ ([l]) and /r/ ([r]). Consequently, it is reasonable that Japanese listeners perceptually assimilate Arabic /l/ and /r/ to Japanese /r/. One of the common characteristics of the first segment of Japanese geminates (i.e. *sokuon*) is to maintain the closure between the articulators, so the realization of Japanese /Qr/ is usually [l:], which may be a very close realization to Arabic /ll/ ([l:]). Therefore, it is natural that Japanese listeners perceptually assimilate Arabic /ll/ to Japanese /Qr/. As to Arabic /rr/ ([r]), Japanese /r/ can be realized as [r], yet it occurs in very limited socio-/para-linguistic context [27]. A trill is an unnatural realization as Japanese geminates, because *sokuon* should not be released. All Japanese geminate stops are articulated with a longer closure and a single release. Japanese /Qr/ is usually realized as a lateral, not as a tap or trill. As a trill sound has plural releases, it may be perceived as plural short morae for Japanese listeners.

Under the framework of PAM, Japanese listeners' assimilation pattern of the Arabic /l/-/r/ contrast is Single Category assimilation, and the patterns of the other liquid contrasts (i.e. /l/-/ll/, /ll/-/rr/, /l/-/rr/, /r/-/rr/ and /r/-/ll/) are Two Category assimilations. Poor discrimination for Arabic /l/-/r/, and very good to excellent discriminations for the other liquid contrasts are predicted. In the experiment, the Japanese listeners discriminated the /l/-/r/ contrast poorly, and they discriminated the other liquid contrasts very well or almost perfectly. Therefore, PAM offers an appropriate prediction of naïve Japanese listeners' perception of Arabic four-way liquid contrast.

## 5. CONCLUSION

The present research reported the results of Japanese listeners' discrimination, identification and goodness ratings of Arabic liquids, and confirmed that the Perceptual Assimilation Model [e.g. 3, 4] accounts for the perception. The conclusion is that the discrimination of the Arabic /l/-/r/ contrast is difficult and the discriminations of the other liquid contrasts (i.e. /l/-/ll/, /ll/-/rr/, /l/-/rr/, /r/-/rr/ and /r/-/ll/) are easy for Japanese naïve listeners because of the perceptual assimilation of Arabic /l/ and /r/ to Japanese /r/, that of Arabic /ll/ to Japanese /Qr/, and that of Arabic /rr/ to Japanese /rur/ or /rr/.

## 6. REFERENCES

- [1] Arai, T. 2013. On why Japanese /r/ sounds are difficult for children to acquire. *Proc. 14th INTERSPEECH* Lyon, 2445-2449.
- [2] Barbosa, P. A., Albano, E. C. 2004. Brazilian Portuguese. *Journal of the International Phonetic Association* 34(02), 227-232.
- [3] Best, C. T. 1995. A direct realist view of cross-language speech perception. In: Strange, W. (ed), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research*. Baltimore, MD: York Press, 171-204.
- [4] Best, C. T., Tyler, M. D. 2007. Nonnative and second-language speech perception: Commonalities and complementarities. In: Bohn, O.-S., M. J. Munro (eds), *Language Experience in Second Language Speech Learning: In honor of James Emil Flege*. Amsterdam: John Benjamins, 13-34.
- [5] Boersma, P., Weenink, D. 2013. Praat: doing phonetics by computer [Computer program] (Version 5.3.39).
- [6] Dickey, L. W. 1997. The phonology of liquids. Doctoral Dissertation, University of Massachusetts Amherst, Amherst, MA.
- [7] Embarki, M. 2013. Phonetics. In: Owens, J. (ed), *The Oxford Handbook of Arabic Linguistics*. Oxford: Oxford University Press, 23-44.
- [8] Goto, H. 1971. Auditory perception by normal Japanese adults of the sounds "L" and "R". *Neuropsychologia* 9(3), 317-323.
- [9] Guion, S. G., Flege, J. E., Akahane-Yamada, R., Pruitt, J. C. 2000. An investigation of current models of second language speech perception: The case of Japanese adults' perception of English consonants. *The Journal of the Acoustical Society of America* 107(5), 2711-2724.
- [10] Hallé, P. 2000. Traitement phonétique et reconnaissance des mots chez le jeune enfant et chez l'adulte. HDR thesis, Paris 5 René Descartes, Paris.
- [11] Holes, C. 1990. *Gulf Arabic*. London and New York: Routledge.
- [12] Holes, C. 1995. *Modern Arabic: Structures, Functions and Varieties*. London and New York: Longman.
- [13] Kawakami, S. 1977. *Outline of Japanese Phonetics [written in Japanese as "Nihongo Onsei Gaisetsu"]*. Tokyo: Oofuu-sha.
- [14] Komaki, R., Akahane-Yamada, R., Choi, Y. 1999. Effects of native language on the perception of American English /r/ and /l/: Cross-language comparison between Korean and Japanese [written in Japanese]. *Technical Report of IEICE* SP99-45, 39-46.
- [15] Ladefoged, P., Maddieson, I. 1996. *The Sounds of the World's Languages*. Oxford, OX, UK; Cambridge, Mass., USA: Blackwell Publishers.
- [16] Lindau, M. 1985. The story of /r/. In: Fromkin, V. A. (ed), *Phonetic Linguistics: Essays in Honor of Peter Ladefoged*. Orlando, FL: Academic Press, 157-168.
- [17] Miyawaki, K., Jenkins, J. J., Strange, W., Liberman, A. M., Verbrugge, R., Fujimura, O. 1975. An effect of linguistic experience: The discrimination of [r] and [l] by native speakers of Japanese and English. *Perception & Psychophysics* 18(5), 331-340.
- [18] Okada, H. 1991. Japanese. *Journal of the International Phonetic Association* 21(02), 94-96.
- [19] Ooigawa, T. 2008. Discrimination de /l/-r/ en français et en anglais chez les auditeurs natifs japonophones. MA thesis, Sophia University, Tokyo.
- [20] Ooigawa, T. 2009. Individual differences in production of voicing of French /R/ sounds and the perception by Japanese adult listeners. *Proceedings of the CIL 18 (the 18th International Congress of Linguists)*, 1094-1111.
- [21] Ooigawa, T. 2013. Perception of /l/ and /r/ in English, French and Spanish by Japanese Listeners. *Sophia Linguistica* 61, 49-68.
- [22] Proctor, M. 2009. Gestural Characterization of a Phonological Class: the Liquids. Doctoral Dissertation, Yale University, New Haven, CT.
- [23] Smith, J., Kochetov, A. 2009. Categorization of non-native liquid contrasts by Cantonese, Japanese, Korean, and Mandarin listeners. *Toronto Working Papers in Linguistics* 34, 1-15.
- [24] Sugai, K. 2002. Realization of /r/ Sound in Standard Japanese: An Acoustic and Phonological Analysis. MA thesis, Sophia Univ., Tokyo.
- [25] Tanaka, S. 2007. Italian geminate consonants and the formation of sokuon (Japanese geminates): Focusing on the types and the occurrence position [written in Japanese]. *Proc. 134th General Meetings of the Linguistic Society of Japan (LSJ)*, 252-257.
- [26] Thelwall, R., Sa'Adeddin, M. A. 1990. Arabic. *Journal of the International Phonetic Association* 20(02), 37-39.
- [27] Vance, T. J. 2008. *The Sounds of Japanese*. New York: Cambridge University Press.
- [28] Wells, J. C. 1982. *Accents of English*. Cambridge: Cambridge University Press.
- [29] Yamasaki, H., Hallé, P. A. 1999. How do native speakers of Japanese discriminate and categorize French /r/ and /l/? *Proc. 14th ICPHS* San Francisco, 909-912.