

# A CROSS-LANGUAGE STUDY ON THE PERCEPTION OF SYNTHETIC SPEECH SOUNDS OF [r - l]

KATSUMASA SHIMIZU

Dept. of Languages  
Nagoya Gakuin University  
Seto city, Aichiken, Japan

MASATAKE DANTSUJI

Dept. of Linguistics  
Kyoto University  
Sakyoku, Kyoto 606 Japan

## ABSTRACT

The present study is concerned with the perception of synthetic speech sounds of [r - l] continuum by speakers of different languages. Specifically, the study examines how the differences of the linguistic function of liquids in English, Spanish, Japanese, Hindi, Korean, and Chinese affect the perception of the synthetic continuum and reports the results of identification and discrimination tests. The results indicate that different modes of perception appeared depending on the phonemic functions of liquids in each language. The boundary between /r/ and /l/ differed systematically in each language and the speakers having a phonemic function of /r/ and /l/ showed a categorical mode of perception and differences of linguistic experience cause those of perceptual modes.

## INTRODUCTION

It is generally known that speakers of different languages show some different characteristics in the perception of speech sounds. Among the cross-language studies on speech perception, the study on [r] and [l] has been of considerable interest among phoneticians since the /r/ - /l/ contrast has often been a choice to study the effect of linguistic experience and they have unique articulatory and acoustic features which can be defined as an intermediate between stop consonants and vowels. There have been several reports on the experiments of the perception of [r] and [l] using synthetic speech sounds. Miyawaki et al.[1] studied the effect of linguistic experience of English and Japanese in the perception of synthetic [r - l] continuum and mentioned that the difference of linguistic experience is specific to perception of speech mode. Furthermore, Mochizuki[2] and Shimizu and Dantsuji[3] carried out the experiments of speech perception to English and Japanese speakers by using natural and synthetic speech sounds and re-

ported that English speakers perceive the [r - l] continuum categorically, while Japanese speakers do it continuously, and the difference of the perception mode can be attributed to the one of the linguistic function of the liquids in these languages. It is well known that the /r/ - /l/ contrast is functional in English but not in Japanese and different function of the liquids in these languages cause some learning problem for Japanese speakers.

Although the difference between English and Japanese speakers in the perception of [r - l] continuum has been accepted, the experimental data on other language speakers are very scarce, and it will be necessary to examine other language speakers in order to clarify the relationship between linguistic experience and the mode of speech perception. Viewing from these points, the present study aims at examining how the difference in the linguistic function of liquids in other languages affects the perception of [r - l] continuum and how linguistic experience affects the mode of perception.

## EXPERIMENTAL PROCEDURE

### Subjects

The subjects composed of speakers from six language groups: English, Spanish, Japanese, Hindi, Korean, and Chinese.

English: 7 native speakers of American English took part in the experiment. They had lived in Japan for a certain period, ranging from three months to three years.

Spanish: 4 native speakers of Spanish took part in the experiment. They were undergraduate students at UCLA.

Japanese: 23 native speakers of Japanese were tested in a classroom. They were undergraduate students in an introductory phonetics class at Sugiyama Joshi Univ.

Hindi: 2 native speakers of Hindi took part in the experiment. They were graduate students in physics and journalism at UCLA.

Korean: 3 native speakers of Korean took part in the experiment. They were graduate students at Kyoto University. Chinese: 3 Chinese (1 from Hong Kong, 2 from Mainland China) took part in the experiment.

### Stimulus Materials

The stimulus were prepared on the OVE III synthesizer at Haskins Laboratories. The 10 step [ra - la] stimuli differed in the frequency values of F2 and F3 within the initial state portions and the transition portions. F2 values varied in almost equal step from 951 to 1404 Hz and F3 values from 1488 to 3246 Hz. F1 values were kept constant for 10 stimuli. The stimulus with 1404 Hz of F2 and 3246 Hz of F3 was a good /la/, while the one with 951 Hz of F2 and 1488 Hz of F3 was a good /ra/. The total duration was 377 msec.

Two types of test were prepared: an identification test and an oddity test. In the former test, each stimulus was repeated 10 times, making the total presentation 100, and the stimuli were randomly arranged. The interstimulus interval was 1 sec. and the block interval was 10 sec. The oddity discrimination test consisted of 18 repetitions of each of 7 stimulus pairs (1-4, 2-5, 3-6, 4-7, 5-8, 6-9, and 7-10), totalling 126 trials in all. Stimulus pairs were arranged such that members were three steps apart along the 10 step stimuli. For each pair, trials were constructed by duplicating one member of the pair, and six permutations of each companion were included; i.e., for 1-4 pair, 1-4-4, 1-1-4, 4-1-1, 1-4-1, 4-1-4, and 4-4-1. All test materials were recorded on audio tape for presentation to subjects.

### Results

Results of the identification and discrimination tests can be shown in Figures 1 - 3.

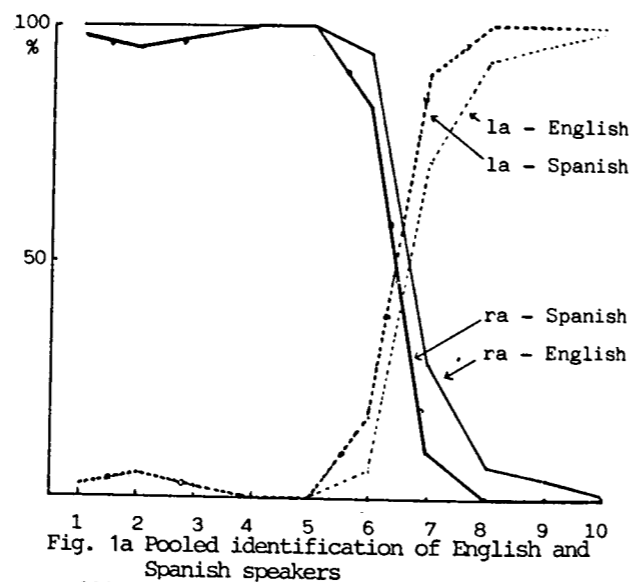


Fig. 1a Pooled identification of English and Spanish speakers

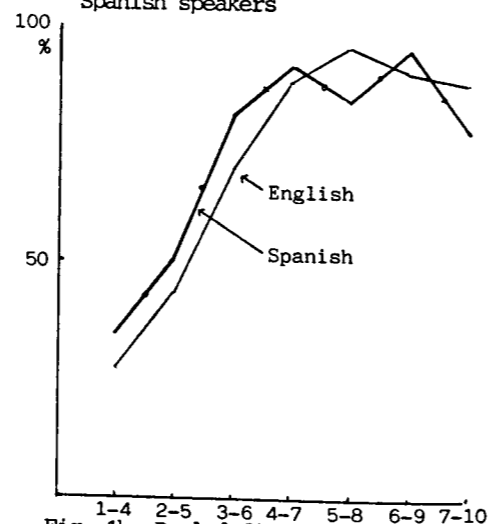


Fig. 1b Pooled discrimination of English and Spanish speakers

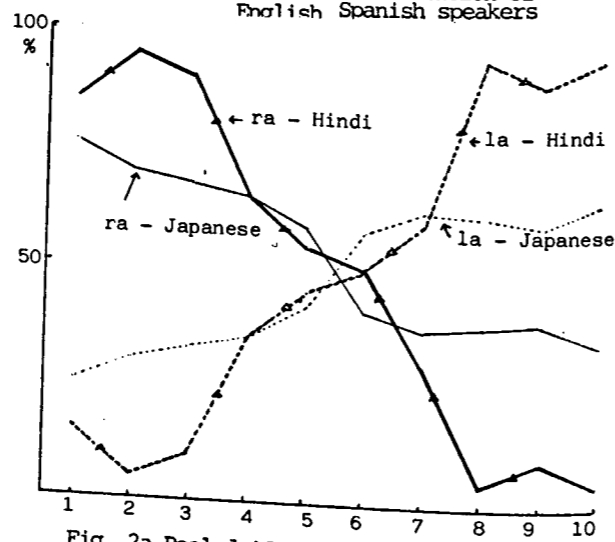


Fig. 2a Pooled identification of Hindi and Japanese speakers

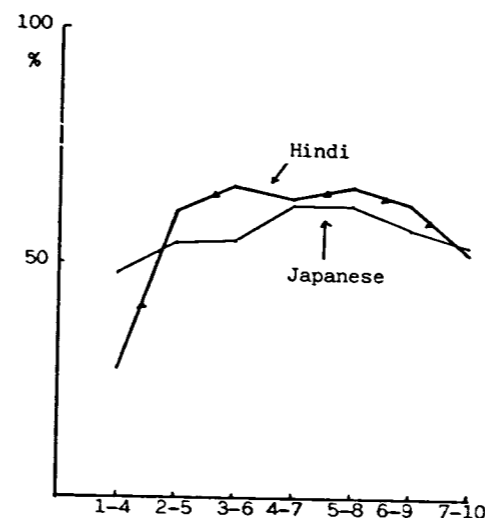


Fig. 2b Pooled discrimination of Hindi and Japanese speakers

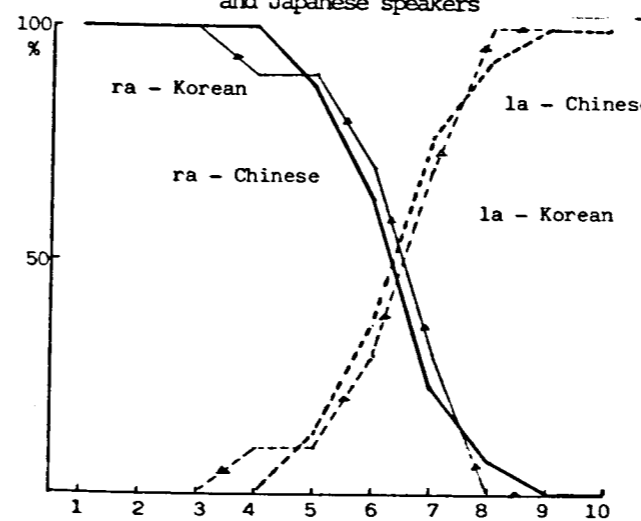


Fig. 3a Pooled identification of Korean and Chinese speakers

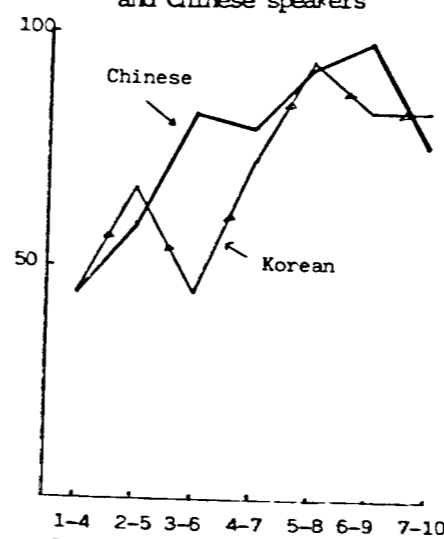


Fig. 3b Pooled discrimination of Korean and Chinese

Figure 1a shows the results of the pooled identification for English and Spanish speakers. Both subject groups show a similar pattern of identification curve. Subjects in both groups identified stimuli 1 to 5 as /ra/ and stimuli 8 to 10 as /la/, and showed an abrupt shift of the curve in the stimulus range from 6 to 8. The boundaries lie between stimuli 6 and 7, though there are slight discrepancies in both groups of subjects. Figure 1b shows the results of a pooled discrimination for both groups, and both subject groups show similar patterns in accuracy. The accuracy was below at 1-4 pair, but sharply rose to about 90% accuracy at the pairs which are considered to be in the phonetic boundary between /r/ and /l/. That is, both groups of subjects discriminated very well between stimuli drawn from different phonetic categories but very poorly between stimuli from the same phonetic category. Both identification and discrimination curves show that both subject groups identify the [r - l] continuum categorically.

Figure 2a shows the identification curves for Japanese Hindi speakers. Unlike the results in figure 1a, both Japanese and Hindi speakers showed a gradual shift of identification curve as the stimulus shifts from 3 to 8. Japanese subjects identified stimuli 1, 2 and 3 as /ra/ and stimuli 8, 9 and 10 as /la/ with 60 - 70% of identification rate, while Hindi speakers identified these stimuli with much higher rate than Japanese speakers. Figure 2b shows the discrimination curves for both language groups. Both subject groups discriminated the stimuli with an accuracy rate ranging from 50 to 70% across the continuum of stimulus set from the 2-5 pair. Although there was a moderate increase in discrimination of stimulus pairs 3-6, 4-7 and 5-8, there is no noticeable change in the accuracy percentage in both groups within and between categories. It can be said that these results indicate that Japanese and Hindi speakers perceive the [r - l] continuum continuously.

Figure 3a shows the identification curves for Chinese and Korean speakers. The curves are similar to the ones of English and Spanish speakers, but with less abrupt shift. The boundary between /r/ and /l/ lies between stimuli 6 and 7 for both groups of subjects. Figure 3b shows a pooled discrimination for the two groups. Both groups show sharp rise at the pairs of 5-8 and 6-9. Examining these results, it can be said that Chinese and Korean speakers perceive the [r - l] continuum with near categorical manner.

## DISCUSSION

We have examined how speakers of six languages perceive the [r - l] continuum and how the differences of linguistic experience affect the mode of speech perception. Examining the results of identification and discrimination tests, it has become clear that the speakers of six different languages show different patterns of performance. It can be said that familiarity with the [r - l] distinction has an impact on the perception of the continuum.

English and Spanish speakers show a peak of accuracy at the point where stimuli from different phonetic classes are being contrasted. Japanese and Hindi speakers are unable to discriminate [r] and [l] over the continuum. The results on Japanese subjects conform with the previous studies (Miyawaki et al. [1]) and are in harmony with what is known about linguistic function of the liquid in Japanese. The finding that Hindi speakers can not discriminate [r] and [l] over the synthetic continuum indicates that stimuli are not similar to the phonetically realized forms of the Hindi contrast of lateral and tap.

As shown in figures 3a,b, Korean and Chinese speakers discriminate the continuum in a near categorical manner. It is known that Korean has no phonemic contrast of /r/ and /l/ and has only one phonemic /l/, but /l/ has allophonic variations of [l] or tap in some phonetic environments. The finding that both groups of subjects can discriminate [r] and [l] indicates that the stimuli are similar to the allophonic variations of liquids in both languages.

These results of experiments indicate that different perceptual modes appeared depending on the phonemic functions of liquids in each language. The boundary between /r/ and /l/ differed systematically in languages, and the speakers having a phonemic contrast of /r/ and /l/ showed a clear categorical mode perception. It can be said, therefore, that the differences of linguistic experience cause those in the perceptual modes.

## REFERENCES

- [1] Miyawaki, K. et al. "An effect of linguistic experience: The discrimination of [r] and [l] by native speakers of Japanese and English," Percep. & Psych., 1975, 18(5).
- [2] Mochizuki, M. "The identification of /r/ and /l/ in natural and synthesized speech," J. Phonetics, 1981, 9.
- [3] Shimizu, K. and Dantsuji, M. "A study on the perception of /r/ and /l/ in natural and synthetic speech sounds," Studia Phonologica, 1983, 18.