

Perception of American English /r/ and /l/ by Mandarin speakers: Influences of phonetic identification and category goodness

Feng-Ming Tsao, Michael D. Hall, Richard Eyraud, and Patricia K. Kuhl

Department of Speech and Hearing Sciences, University of Washington, Seattle, Washington 98195

Abstract: This study examined Mandarin speakers' perception of American English /r/ and /l/. Eighteen /ra/ and /la/ tokens were used that varied in F2 and F3 onset frequencies. Stimuli were identified as the /u/, /m/ or /l/ of Mandarin, and were rated for goodness. The similarity of pairs of stimuli was also evaluated. Multi-dimensional scaling (MDS) analyses of similarity ratings revealed that perception differed substantially from American speakers listening to the same stimuli, indicating the use of native-language representations in the perception of a non-native language.

Young infants are able to discriminate phonemic contrasts of both their native language and non-native languages. With continued linguistic experience, sensitivity to non-native contrasts weakens, while sensitivity to native language contrasts is enhanced (1). Language-specific experience not only influences the perceptual organization at the boundaries between speech categories, but within categories as well (2, 3, 4). Specifically, in the vicinity of a category's best exemplar or prototype, listeners demonstrate reduced sensitivity, a phenomenon referred to as the "perceptual magnet effect."

The current study addressed the non-native perception of American English /r/ and /l/ by Mandarin speakers. The /l/ in American English is acoustically and phonetically similar to that of Mandarin. In contrast, /r/ is not a phoneme in Mandarin. Therefore, Mandarin speakers were expected to rely on representations of phonemes in their native language to perceive this non-native sound. The nature of these representations, and whether perception of /l/ is similar to that of Americans, remained questions for the research to answer, thereby providing an example of the perceptual impact of linguistic experience.

METHOD

Stimuli were 18 synthetic /ra/ and /la/ tokens from American English which varied in F2 and F3 onset frequencies in 200-mel steps. Twenty-one native speakers of Mandarin, students in Taiwan, participated in two sessions. In the first session, the initial phoneme of each token was identified and rated for goodness on a 7-point scale. Pilot work revealed that Mandarin speakers classified the tokens as Mandarin /la/, /ua/, and /ma/, so identification was restricted to these phonemes. In the second session, participants rated the similarity of paired tokens on a 7-point scale. Similarity ratings were submitted to MDS to create a perceptual map where the distance between any two tokens corresponded to perceived similarity. [For additional details about procedures and stimuli, see Iverson and Kuhl (5).]

RESULTS AND DISCUSSION

Identification performance and goodness ratings (top), as well as MDS solutions (bottom), are summarized in Figure 1. Identification performance indicated two groups of listeners: those who identified nearly all tokens as /l/ (all-/l/ group) and those made few /l/ identifications (few-/l/ group). Separate analyses were conducted for each group. Results of the all-/l/ group (n=8) are summarized in the left panel of Figure 1. The panel (top) reveals that the best /l/ contained relatively high F2 and F3 onset frequencies. A two-dimensional MDS solution was obtained (stress of 0.1; $R^2 = 0.91$). The primary perceptual dimension was F2 onset. Consistent with a perceptual magnet effect, perceptual distances appear to be minimized near the best exemplars of /l/ and maximized near poor exemplars.

The right panel of Figure 1 displays results for the remaining listeners (n=13) who perceived 20 percent of the stimulus set as /u/. Identification as Mandarin /l/ or /u/ was primarily determined by F2 onset frequency (top). The best /l/ token was identical to that reported by listeners who perceived only /l/; the best /u/ token was at the lowest level of F2 onset and a moderate level of F3 onset. Similarity ratings provided a two-dimensional MDS solution (stress = 0.1; $R^2 = 0.95$). Note that perceptual distances between categories are maximized while within-category distances are minimized near best exemplars.

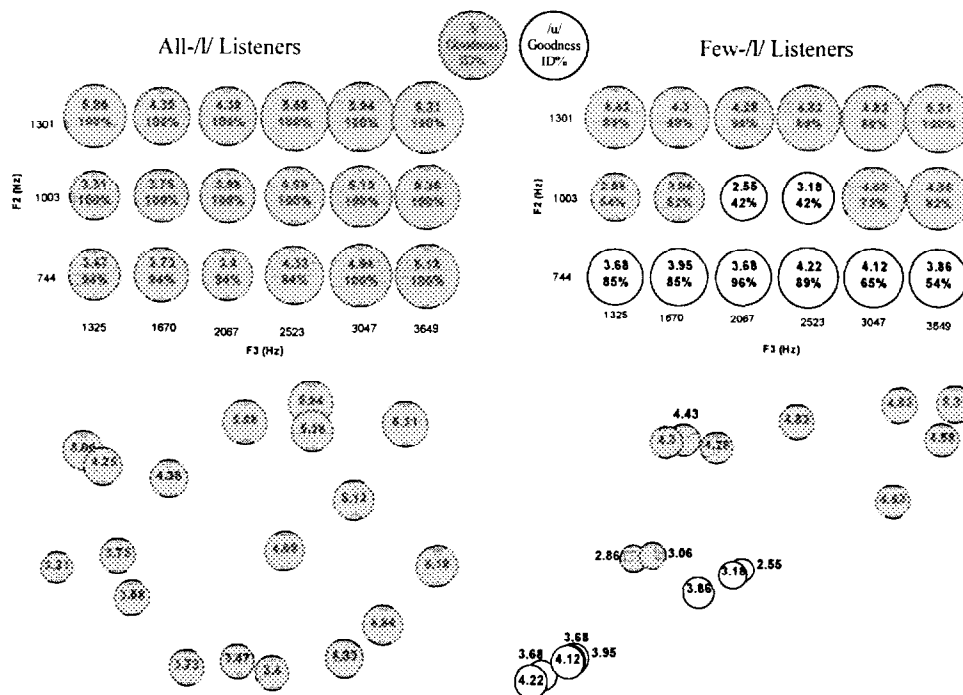


FIGURE 1. Summary of results for all-/l/ (left) and few-/l/ (right) listeners. Identification percentages and goodness ratings are included (top), as are MDS solutions based on similarity ratings (bottom) with reference to goodness.

Additionally, for both groups of listeners regression analyses revealed that the similarity of /l/ tokens was more strongly predicted by goodness (all-/l/, $p < .001$; few-/l/, $p < .001$) than by phoneme identification (all-/l/, $p > .05$; few-/l/, $p > .05$). Thus, since perceptual distance was primarily determined by within-category perceptual variation, the MDS results appear to reflect internal representation of the /l/ category, rather than simply categorization.

Category representations for Mandarin speakers differed markedly from those of American English speakers (5). American /r/ and /l/ are distinguished by F3 onset, whereas Mandarin listeners were more sensitive to F2 onset. Despite differences, all Mandarin listeners appear to perceptually organize these non-native categories in a predictable way: perceptual distances near the best exemplars of a category were minimized compared to poor exemplars. These results indicate the strong influence of linguistic experience on perception. Ongoing work is extending this analysis to languages that differ in the degree to which categories are similar to American /r/ and /l/.

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