SPATIAL CONFIGURATIONS OF ENGLISH FRICATIVES FOR JAPANESE LEARNERS

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ABSTRACT

This study investigates how spatial configurations of English fricatives change for Japanese learners in advanced, intermediate and pre-intermediate levels, in comparison to that of native speakers. The perceptual representations obtained from Multidimensional Scaling analysis on similarity judgements showed clear sibilance/nonsibilance division for advanced and intermediate learners, but place of articulation feature was not observed. The perceptual configuration of pre-intermediate level students showed strong L1 phonological influence. The results show that the spatial modelling of similarity data can provide an alternative to the conventional approaches to cross language perception.

Keywords: spatial representation, MDS, perception, fricatives, L2 learning

1. INTRODUCTION

In the previous study [1], Japanese learners of false-beginner level and native English speakers listened to a set of English voiceless fricatives /f θ s ʃ h/ and judged the similarities between the sounds. The perceptual configurations obtained from Multidimensional Scaling (MDS) analysis did not correspond well to their physical configurations based on spectral analysis. This was contrary to the result obtained for L1 perception in which perceptual, physical and phonetic domains showed highly significant correlation between them. The result from Japanese learners implied that L2 perception was not based on the acoustic properties of signals, but largely influenced by the learners' native language phonological structure.

This is a novel approach in that most previous second-language perception experiments concentrate on minimal pairs whereas this study examined a set of consonant inventory of a target language as a whole. The spatial modelling enables us to identify key factors involved in each domain of speech processing, without recourse to predetermined set of acoustic cue evaluations, and to establish correlations across the different domains.

In this study, we will investigate whether the spatial approach can adequately model perceptual changes for L2 learners in different stages of the second language acquisition and its implications on cross-language perceptual theories.

The following section describes the results of a native-language perception for English fricatives. Section 3 is about the spatial representations of L2 perception in different levels. Finally section 4 summarises the results and the implications on cross-language speech processing.

2. L1 PERCEPTION

2.1 Materials and procedure

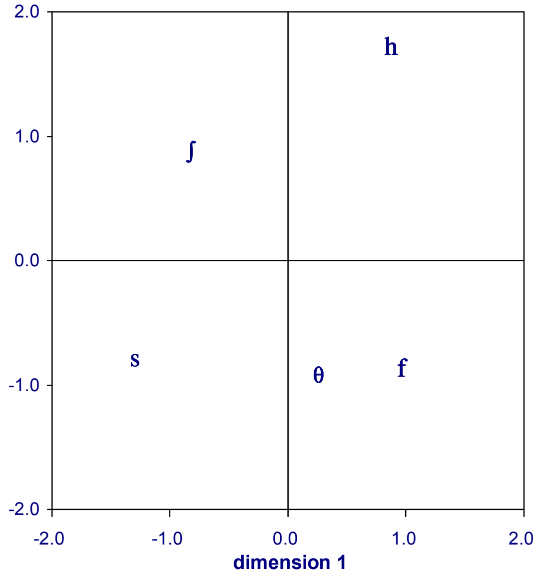
A female RP speaker produced voiceless English fricatives, /f θ s ʃ h/, followed by the vowel /ɑ/. The recording was made in an anechoic room onto a Sony DTC-1000ES digital audio tape recorder. They were digitised with a 20kHz sampling frequency and 16-bit quantisation. The fricatives were then excised and normalised in their intensity with respect to the RMS level.

The fricative stimuli were paired into AB AC, and each time listeners had to choose more similar sounding pair. 20 students of University College London were paid to listen to stimuli pairs. A perceptual similarity matrix was constructed from the responses of each subject. A weighted MDS analysis with the square matrix option was carried out on the similarity matrices.

2.2 Result

The resulting L1 perceptual map is shown below. Dimension 1 clearly separates the sibilants /s ʃ/, from nonsibilants, /f θ h/, while dimension 2 places the fricatives according to their place of constriction. The dimensions also corresponded quite closely to spectral properties of 'peakiness' – the maximum distance to mean amplitude – and the centre of gravity of the average spectra (see [2] for further details).

Figure 1. The perceptual space of English fricatives based on similarity judgements of 20 native listeners.



3. L2 PERCEPTION

3.1 Subjects and procedure

30 Japanese learners of English listened to the stimuli. They were second-year students of Seikei University, in Tokyo. They studied English for 6 years at secondary and high schools. This class, taught by the author, was selected for the perceptual test as they show different stages of second language development: advanced, intermediate and pre-intermediate levels (11, 12, 7 students, respectively). According to the questionnaire about their English education background, all advanced learners had experience living abroad in English speaking countries at different periods of their development. The rest had never been abroad.

The experiment was conducted in a quiet classroom in the university. The same /C/+/ɑ/ stimuli used in section 2.1 were played through speakers equipped in the room, and students had to select more similar sounding pair in the answer sheet.

Perceptual data were accumulated over trials by assigning 1 scores for the fricative pairs selected as more similar, and 0 scores for the pairs which were not selected. An example of a similarity matrix for the five fricatives is given below.

Table 1. Similarity matrix for a Japanese learner who rated the English fricative pairs.

	f	θ	s	ʃ	h
f		3	0	1	2
θ	3		1	0	2
s	2	1		2	1
ʃ	0	1	3		2
h	3	2	1	0	

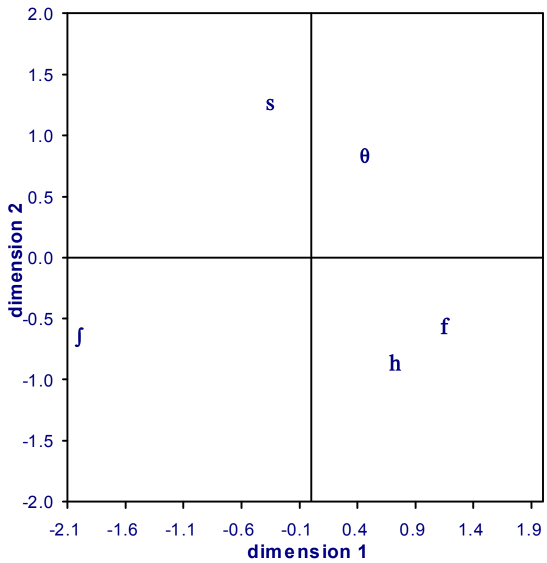
The similarity matrices obtained from each of the listeners were typically not symmetrical. Thus, the square matrix option was used in a 3-way MDS analysis (ALSCAL program, SPSS Windows version 12.0). The blank entries were given an appropriate large number for the distance conversion.

3.2 Results and discussion

In each learner group, the badness-of-fit curve and the interpretability of spatial arrangements suggest that 2-dimensional solutions are most appropriate to model the data. The three L2 perceptual spaces are compared with L1 perceptual map, which is given in Figure 1.

3.2.1 L2 Perceptual map of pre-intermediate learners

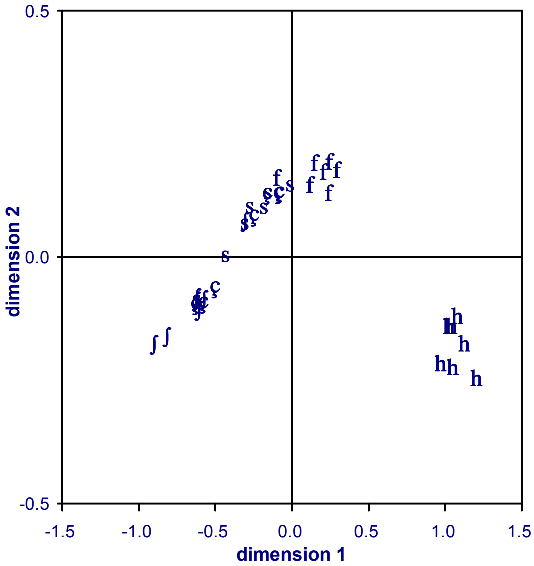
Figure 2. The perceptual space of English fricatives for 7 Japanese learners; pre-intermediate level.



Each fricative is distinct. The 'sibilance' property was maintained but the 'place' property is not. /f/ and /h/ are closer than /f/ and /θ/. This can be explained by their neutralised position before the vowel /u/ in Japanese word like *fujisan* "Mt. Fuji". /h/ is pronounced as a bilabial fricative, /ɸ/, before /u/[3]. The Japanese bilabial fricative is somewhat like a cross between the English phoneme /f/ and /h/. This may sometimes contribute to the Japanese mispronunciation of English words like "who". Compare this with English fricative result. /f/ and /θ/ are quite distinct because /θ/ is not in Japanese phoneme inventory. /θ/ in English loan word "thank you" is often pronounced as "sank you", so the perceptual configuration in the map reflects this characteristic Japanese pronunciation.

/s/ and /ʃ/ are relatively distinct reflecting the native language interference. Figure 3, from the previous study [4], is the perceptual map of Japanese fricatives judged by Japanese listeners.

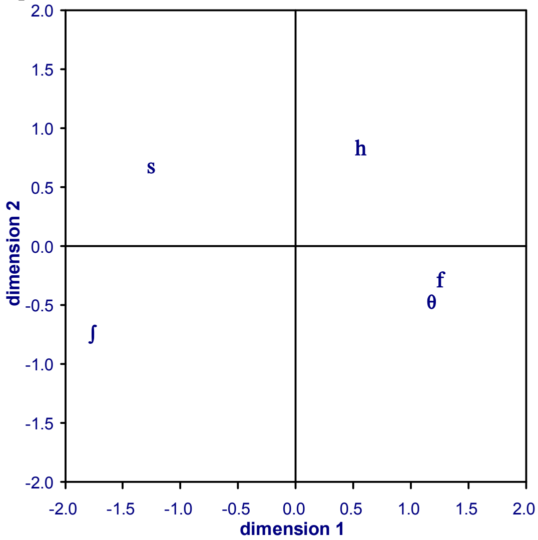
Figure 3. The perceptual maps of Japanese voiceless fricatives, / f s ʃ ç h /, heard by seven individual listeners, plotted on the common axes.



In this figure, each fricative area is less distinct, which reflects their neutralised pronunciations. /si:/ in English becomes /ʃi:/ in Japanese loan words like /ʃi:so:/ "seesaw" and /ʃi:zun/ 'season'. /ʃ/ and /ç/ also tend to merge particularly for Tokyo dialect speakers. They pronounce /çidoi/ "terrible" as /ʃidoi/. The subjects in this experiment were all standard Japanese speakers, but mainly from the Greater Tokyo area. These neutralized pronunciations between /si/, /ʃi/ and /çi/ in Tokyo dialect may also affect the perceptions of these fricatives before other vowels. Therefore, English /s/ and /ʃ/ seem to cause less confusion for Tokyo dialect speakers.

3.2.2. L2 Perceptual map of advanced learners

Figure 4. The perceptual map of English fricatives for 11 Japanese students; advanced level.

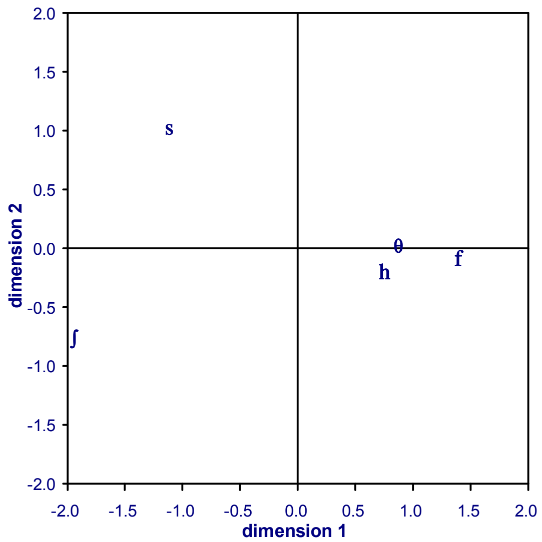


This L2 perceptual map shows clear 'sibilance/nonsibilance' distinction, but not the 'place' property of fricative constriction. These students, who have language experience in English speaking countries, show less L1 phonological influence in making the similarity judgements between /s/ and /θ/, or /h/ and /f/. However, the configuration is still rather different to the native language perceptual map (See Figure 1).

This is congruent to previous cross-language studies (e.g. [5]) in that subjects, who began learning English as children in English speaking environments, show additional perceptual learning over time but never match English monolinguals due to the continued influence of the L1 phonetic systems .

3.2.3. L2 Perceptual map of intermediate learners

Figure 5. The perceptual space of English fricatives for 12 Japanese learners; intermediate level.



This last group of L2 listeners show a perceptual configuration which might be expected of late learners. The sibilance property of /s/ and /ʃ/ is clearly discernable for this group, which was same as the advanced learners and native listeners. For non-sibilance consonants, /f/ /θ/ and /h/, Japanese allophonic property of /f/ and /h/ is still manifest. However, /θ/ is no longer confused with /s/, and it is placed close to /f/; /f/ and /θ/ share similar acoustic spectral properties in English.

4. CONCLUSIONS

The above results indicate that perceptual mapping of L2 speech sounds becomes closer to L1 perceptual configurations with increasing exposure to L2 sounds. Most of the advanced level students in this study had bilingual experience before a critical period [6]. Accordingly, this group shows the least L1 interference. The intermediate level students were exposed to L2 speech sounds after a critical period, but their perceptual map supports the assumption that it is possible for late learners to establish partly a native-like spatial mapping, although it is probably less likely than early learners.

The result of pre-intermediate students shows the strongest L1 interference and this may be explained by cross-language perception theories like the Native Language Magnet Model [7]; the easiest sounds to acquire in a second language are those in which the prototypes are almost identical in both languages. L2 sounds that are outside the L1 acoustic space are somewhat harder or slower to learn, but even harder are those sounds that are non-prototypical instances of an L1 sound. Therefore, English /s/ and /ʃ/ before the vowel /a/ almost coincide with Japanese /s/ and /ʃ/, while English /θ/ does not exist in Japanese. But English /f/ seems to be the non-prototypical instances of Japanese /ɸ/, resulting in the proximity in the perceptual map with /h/.

In summary, this study has shown that spatial approach based on similarity judgements of a set of consonants is capable of explaining the perceptual development of L2 learners. Also, spatial configurations could adequately model complex L1 interference in the second language acquisition and development. However, the results are not conclusive and it would be interesting to obtain spatial maps for learners with more varied L2 input in terms of their age, the amount and quality of exposure and the contexts of usage in future.

5. ACKNOWLEDGEMENTS

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