PROCESSING OF JAPANESE PITCH ACCENT BY NATIVE JAPANESE AND ENGLISH LISTENERS

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1. INTRODUCTION

1.1 Background

It is generally believed that the left hemisphere is dominant for phonemic processing and the right hemisphere is more involved in processing prosodic features [1, 2, 3]. More recent studies [4, 5, 6], however, indicate that lateralization of different levels of prosody varies with their functional load as well as listeners' linguistic experience. For example, whereas processing of monosyllabic lexical tone is left hemisphere dominant for native, but not non-native listeners; that of emotional intonation in phrasal or sentential length is right hemisphere dominant for both native and non-native listeners. The processing of Japanese pitch accent poses an interesting question, since pitch accent in Japanese, same as lexical tones in Mandarin, is used to differentiate word meanings. The domain where pitch accent realizes, however, is usually larger than Mandarin tones; thus reduces its functional load [4].

1.2 The current study

To investigate the effects of language background on processing of pitch accent, the current study includes not only native listeners of a pitch accent language, Japanese, but also nonnative listeners without pitch accent language background, English. A dichotic listening paradigm is adopted to examine how pitch accent in Japanese is processed in the brain by Japanese and English listeners. A right ear advantage (REA, i.e., left hemisphere dominance) is expected for the Japanese listeners, whereas for the English listeners, a left ear advantage (LEA, i.e., right hemisphere dominance) is anticipated.

2. METHOD

2.1 Participants

A total of 32 young adults participated in this experiment, including 16 native Japanese and 16 native English listeners. The Japanese listeners all had no other tonal language experience. The English listeners had no knowledge of Japanese and any other tonal languages. All participants were right-handed. None of them had hearing impairment.

2.2 Stimuli

The stimuli were 30 Japanese disyllabic words with three pitch accent patterns: H*L, LH* and LH[2]. Among them, 24 were minimal triplets, superimposed to eight sets; and the other six were minimal pairs, superimposed to three sets. Dichotic pairs were created such that in each pair, the two words have the same segment but differ only in the pitch accent pattern, e.g. H*L and LH* pairs such as /hana/ (H*L) 'a female name' and /hana/ (LH*) 'flower' or LH* and LH pairs such as /hana/ (LH*) 'flower' and /hana/ (LH) 'nose.' These dichotic pairs were constructed and edited using Audacity 1.2.6 where one word in each pair was imported into the left channel and the other into the right channel. Each pair was normalized for intensity and duration.

2.3 Procedure

There were three sections of the test: familiarization, identification, and dichotic listening. First, all the participants were familiarized with the 3 different pitch accent patterns. In the identification test, they were requested to identify the pitch accent pattern for 21 disyllabic words presented binaurally and no feedback was given after each response. Only those participants whose accuracy of responses was higher than 60% could continue to take the dichotic listening test. In the dichotic test, the stimuli were randomized into 4 blocks (i.e. 4 repetitions), with 21 dichotic pairs of tokens each. Each pair was presented to the participants simultaneously, one to the left ear and the other one to the right ear. The participants were asked to identify both stimuli.

2.4 Data analysis

Two measures were calculated in this study: one is the % errors of identification of each pitch accent pattern in each ear, and the other is the percentage of errors (POE), defined as [PL/ (PR+PL)]*100, where PL is percentage of errors in the left ear and PR is percentage of errors in the right ear [6]. If the percentage of errors for left ear exceeds 50% (equivalent to no ear preference), it indicates that the listener shows an REA and vice versa.

3. RESULTS

3.1 Percentage of Errors

The distribution of left ear errors and right ear is shown in Figure 1. The average POE for the Japanese listeners was 47%, whereas that for English listeners was 42%. One-way ANOVA, with POE as the dependent variable (DV) and Listener Group (English and Japanese) as the independent variable (IV):, showed that the difference in ear preference between the English and Japanese listeners was not statistically significant [$F(1, 30) = 3.632$, $p > .066$]. The left ear errors are significantly less than right ear errors for both groups [Japanese: $F(1, 30) = 4.826$, $p < .036$, and English: $F(1, 30) = 29.948$, $p < .001$].

3.2 Individual pitch accent pattern

Table 1 displays the mean % errors of identification of each

[1] The first two authors have made the same contributions to this study.
[2] H and L stand for high and low pitch, respectively; and '*' stands for accent.

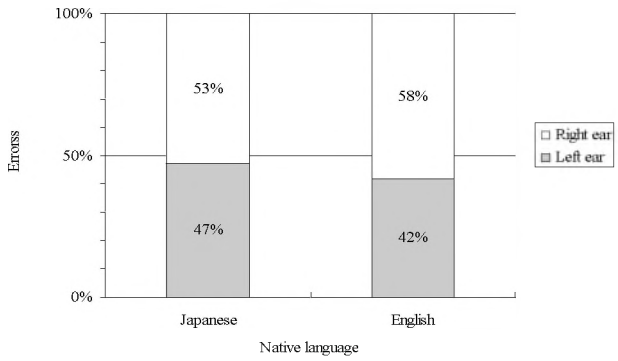

Fig.1. Distribution of left ear errors and right ear errors (in %) by the native Japanese (n=16) and native English (n=16) listeners.*: The difference in right-ear and left-ear error is significant at $p < .05$.

pitch accent pattern in each ear for each group. Overall, the English group made more errors than the Japanese group. Among the three patterns, LH* is the hardest for the Japanese listeners, and LH is the most difficult for the English listeners, whereas H*L is the easiest for both groups. A three-way ANOVA (DV: % errors; IV: Group*Ear*Pitch accent pattern) shows a significant interaction of group, ear, and pitch accent pattern [F (2, 2676) =3.851, p<.021]. One-way ANOVA (DV: % errors; IV: Ear) shows that identification of pitch accent pattern 1 (H*L) in the left ear is better than that in the right ear for both the Japanese group [F (1,446), p<.040], and the English group [F (1,446) =41.348, p<.001], indicating a right hemisphere dominance. Identification of pitch accent 2 (LH*) in the left ear, however, is significantly poorer than that in the right ear for the native Japanese group [F (1, 446) = 8.656, p < .003], indicating a left hemisphere dominance, but no ear preference was found for the non-native English group. For pitch accent pattern 3 (LH), no significant effects on ear were found for either group.

Table 1: Mean % errors of identification of each pitch accent pattern in each ear (Left, Right) for the Japanese and English groups.

	Japanese			English		
	Left	Right	Pooled	Left	Right	Pooled
H*L	28	35	31	31	48	40
LH*	56	46	51	50	45	47
LH	44	46	44	60	56	58

4. DISCUSSION AND CONCLUSIONS

The overall results show that for both the Japanese and English listeners, the percentage of errors for the left ear exceeds that for the right ear, indicating an LEA (i.e., right hemisphere dominance). The English group shows a greater degree of LEA than the Japanese group.

The native Japanese group did not reveal left hemisphere dominance for pitch accent, as previously found for linguistic tone processing by native listeners [6]. This finding supports Van Lancker's (1980) [4] "functional hypothesis," exhibiting that the functional load of pitch accent is lower than that of lexical tone for the native listeners. Therefore, the Japanese listeners revealed LEA instead of REA.

Although an overall LEA was obtained for both groups in the identification of pitch accent pattern H*L, REA was found only in the Japanese group when perceiving pitch accent pattern LH*, the hardest among the three patterns. This echoes Wang et al. (2004) [6] in that the native listeners tended to have REA in the perception of harder lexical prosodic features. It implies that native listeners relied more on the analytic linguistic information carried by harder prosodic features than that by easier ones. The nonnative group did not show a similar perception pattern, i.e. no REA was obtained when perceiving the pitch accent pattern, LH, which was the hardest for them. Thus, this study proposes that the difficulty of prosodic feature affects lateralization for native listeners.

These findings suggest that linguistic function differentially affects the hemispheric specialization of different domains of prosodic processing. Unlike lexical tone, pitch accent in Japanese has lower functional load which leads to LEA for the native listeners. Nevertheless, in certain situation where a prosodic feature is hard to distinguish by its acoustic properties, an REA is likely to occur. In contrast, the non-native listeners showed stronger LEA than the native listeners due to the lack of pitch accent language background. Therefore, linguistic function of target prosody interacting with listeners' language experience affects lateralization of Japanese pitch accent by native and non-native listeners.

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