A Categorical Perceptual Study on Mandarin Tones by native Dai language speakers in Dehong Autonomous Prefecture (Postprint)

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Abstract

This paper is intended to investigate how the Dai Dialect speaker in Dehong Autonomous Prefecture perceives Mandarin tones. Therefore identification and discrimination experiments are conducted of the four Mandarin tone continuums with Dai Language speakers. The results suggested that the Dai Language speaker' s perception mode of T1-T2 and T2-T4 continuums are Categorical Perception, but for T1-T3, T2-T3, T3-T4 and T1-T4 continuums are not. These findings indicate that Dai language tone system does have a significant influence on the perception of Mandarin tones.

Full Text

A Categorical Perception Study on Mandarin Tones by Native Dai Language Speakers in Dehong Autonomous Prefecture

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Abstract

This study investigates how native speakers of the Dai dialect in Dehong Autonomous Prefecture perceive Mandarin tones through identification and discrimination experiments conducted on four Mandarin tone continuums. The results indicate that Dai speakers exhibit categorical perception (CP) for the T1-T2 and T2-T4 continuums, but not for the T1-T3, T2-T3, T3-T4, or T1-T4

continuums. These findings demonstrate that the Dai language tone system significantly influences the perception of Mandarin tones.

Keywords– Categorical Perception; Dai language speakers; Mandarin tones

I. Introduction

Categorical perception has been one of the most extensively studied phenomena in speech perception for nearly 50 years, as it is believed to reflect fundamental aspects of speech sound processing [1]. Early CP research primarily focused on segmental features—consonants and vowels. Consonants were considered to be perceived categorically, meaning there is a clear linguistic boundary in the continuum between two consonants, whereas vowels were not [2, 3, 4]. Since the 1970s, increasing attention has been directed toward suprasegmental features, particularly lexical tones. Wang [5] and Francis et al. [6, 7] demonstrated that a continuum ranging from a high level tone to a high rising contour tone is perceived categorically by native speakers. Abramson and Francis et al. [6, 7] further noted that continuums between one or more level tones are not perceived categorically by native speakers.

Mandarin Chinese has four lexical tones that can be described phonetically as T1 (high level), T2 (high rising), T3 (falling-rising), and T4 (high falling), respectively. Although some controversy remains, the consensus view has been that the T1-T3, T1-T3, and T1-T4 continuums are perceived categorically, whereas the T2-T3 continuum is not [10, 11, 12]. Additionally, linguistic experience plays a crucial role in the development of CP. Wang [5] first demonstrated that native American English speakers (non-tone language) showed no linguistic boundary for tone contrasts. Since then, several studies on Mandarin tone perception have investigated the impact of language background, though most have focused on the contrast between native tone language and non-tone language subjects. However, different tone inventories may also influence tone perception in another language. As is well known, China has many tone languages, and some minority languages have even more tones than Mandarin. How, then, do these tone-language speakers perceive Mandarin tones? Will they establish CP patterns similar to native Mandarin speakers?

There remains a lack of research on whether and how different tone systems affect tone perception from a CP perspective. This study selects Dai language speakers in Dehong Autonomous Prefecture as subjects to examine their perception of Mandarin tones and the influence of their mother tongue. The Dai language used by the Dehong branch of the Dai ethnic group belongs to the Sino-Tibetan language family. According to previous studies [13, 14, 15], the Dai language in Dehong has nine tones for monosyllabic words: three level tones, four falling tones, and two rising tones, with tone values of 24, 35, 51, 54, 31, 44, 33, 55, and 41. This paper therefore conducted perceptual experiments on the four Mandarin tone continuums with Dai language speakers.

II. Experiment

A. Subjects

Thirty native speakers of the Dai language in Dehong (15 males, 15 females) participated in this experiment. They were similar in age and years of formal education. All participants were from Jiedong village, Ruili County, Dehong Autonomous Prefecture, and could also speak Mandarin. All exhibited normal hearing sensitivity and were compensated for their participation.

B. Stimuli

The stimuli were derived from the Mandarin syllable /da/ with four Mandarin tones (T1: da1, "take"; T2: da2, "reach"; T3: da3, "hit"; T4: da4, "big"), pronounced by a female native speaker. The four naturally produced /da/ syllables were normalized to a duration of 500 ms. Twelve pairs of tone continuums were then constructed by manipulating F0 from each of the four /da/ syllables to the other ones using Praat software (Boersma and Weenink 2009). Taking T1-T2 as an example: we first extracted 11 pitch points of F0 to plot the pitch contours of "da1" and "da2," then computed nine pitch contours between the two syllables' original F0 by dragging the 11 pitch points equidistantly. Since phonation cues also influence CP perception [10, 16], we used "da1" and "da2" as the original samples respectively. This means there were two continuum subgroups with the same F0 parameter changes but different phonation information in the T1-T2 group. Finally, 11 steps of stimuli in each of the 12 pairs of tone continuums were synthesized into new sound files in Praat. Figure 1 [Figure 1: see original paper] shows the schematic diagram of F0 manipulation for the 11 stimuli in each tone continuum pair.

C. Procedure

1) Identification Task

In the identification task, participants listened to stimuli from the 12 continuums in random order. The 11 stimuli of each continuum were repeated twice in the entire identification session, forming a total of 132 trials. During each trial, two Chinese characters appeared on the computer screen, and subjects were instructed to press the left or right mouse button to select which character corresponded to what they heard. Once a response was collected, the next stimulus was presented automatically. Participants could press a "pause" button to take a self-controlled short break.

2) Discrimination Task

In the discrimination task, stimuli were presented in pairs with a 500-ms interstimulus interval. A total of 324 pairs were presented in random order. Of these pairs, 216 consisted of two different stimuli separated by two steps of the continuum, in either forward (1-3, 2-4···9-11) or reverse order (11-9, 10-8 ···3-1). The remaining 108 pairs contained one of the middle nine stimuli of the continuum paired with itself (same pairs: 2-2, 3-3···9-9). There were two occurrences per stimulus pair. After hearing each pair, participants judged whether the two stimuli were the same or different, responding by pressing a mouse button (left = "same," right = "different"). Participants could also press a "pause" button to take a self-controlled short break.

D. Data Analysis

CP has the following characteristics [17]: In the labeling function, there is a sharp boundary between two categories; in the discrimination function, accuracy peaks at the category boundary but is at or near chance level within categories; and the discrimination function can be predicted from the identification function. However, the third characteristic is controversial, so we obtained individual results for each subject based on the first two essential characteristics of CP: category boundary position and width, and corresponding discrimination peak.

1) Identification Scores

The identification score was defined as the percentage of responses with which participants identified a stimulus as being either 'Sound1' or 'Sound2.' Boundary position and boundary sharpness were measured by applying logistic regression analysis as in Xu, Gandour, and Francis [1]. The boundary position was defined as the 50% crossover point, and the boundary width was defined as the linear distance between the 25% and 75% crossover points as determined by the mean and standard deviation obtained from probit analysis.

2) Discrimination Scores

In the discrimination task, hit rates for "different" responses to different pairs and correct rejection rates for "same" responses to same pairs were calculated. The discrimination score was defined as the mean of these two rates.

III. Results and Discussion

The category boundary position and width obtained by probit analysis of the 12 groups are presented in Table 1 . These parameters and the discrimination scores were used to plot the identification and discrimination curves in Figure 2 [Figure 2: see original paper]. Results of repeated measures ANOVA showed that continuum subgroups based on the same F0 parameter changes but different phonation information in the T2-T3 and T3-T4 groups were perceived significantly differently [$F(1,654) = 9.124$, $p<0.001$; $F(1,654) = 24.952$, $p<0.001$], whereas the phonation effect in other groups was not significant ($p>0.001$), meaning that phonation information only contributed to the perception of Mandarin Tone 3 in this study. Therefore, we merged the data of each pair of subgroups with the same F0 parameter changes but different phonation information.

TABLE 1. Derived Categorical Boundary Position and Width
(Table content would appear here)

For the identification results, the category boundary was clear and sharp for all continuums, as shown in Table 1 and Figure 2 [Figure 2: see original paper].

The boundary width of T2-T4 was the narrowest, while T2-T3 was the widest.

For the discrimination results, one-way ANOVA revealed that discrimination scores were significantly different among the nine stimulus pairs of the T1-T2, T2-T4, and T1-T4 continuums [$F(8,261) = 10.299$, $p<0.001$; $F(1,654) = 13.093$, $p<0.001$; $F(8,261) = 18.438$, $p<0.001$], but not significantly different in the T1-T3, T2-T3, and T3-T4 continuums [$F(8,261) = 2.556$, $p>0.001$; $F(1,654) = 1.597$, $p>0.001$; $F(8,261) = 3.636$, $p>0.001$]. This means discrimination peaks could be found clearly in the perception results of the T1-T2, T2-T4, and T1-T4 continuums, whereas there were no discrimination peaks in the perception results of the T1-T3, T2-T3, and T3-T4 continuums. Additionally, the discrimination peak of the T1-T4 continuum did not correspond to its category boundary, as shown in Figure 2.

In summary, steep categorical boundaries and corresponding discrimination peaks were only found in the perception results of the T1-T2 and T2-T4 continuums, indicating typical CP for Dai speakers in Mandarin T1-T2 and T2-T4 contrasts. However, CP was not successfully established for T1-T3, T2-T3, and T3-T4, which may be due to the lack of a contour tone similar to Mandarin Tone 3 in the Dehong Dai language. Furthermore, Dai speakers also could not perceive T1-T4 categorically, perhaps because there are many more falling and level tones in Dehong Dai than in Mandarin, which may make subjects more sensitive to the change from level to falling in Mandarin tones.

IV. Conclusion

In this study, we examined the influence of Dai language experience on the perception of Mandarin tones within the framework of CP. From the identification and discrimination experiments, we see clearly that Dai speakers in Dehong perceived the contrast between level vs. rising and level vs. falling tones in Mandarin categorically, while they did not establish categorical perception for the contrast of level vs. falling-rising or falling-rising vs. other tones. These results were shaped and constrained by the different tone inventories of the Dai language in Dehong.

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Note: Figure translations are in progress. See original paper for figures.