*DISCRIMINATION OF LEXICAL TONES OF THE CHONGQING DIALECT BY MANDARIN SPEAKERS*

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**Abstract**

With an increasing interest in discovering the nature of lexical tone perception, many studies have examined various dimensions of acoustic cues (e.g. F0 onset, F0 direction, duration, turning point of pitch contour, etc.) for tone perception both cross-linguistically and cross-dialectally (Hallé *et al.*, 2004; Wu, 2005). However, most of these studies only focus on particular tones instead of the whole tone system of that language. Thus, this preliminary study intends to unfold how well the natives of tonal language (Mandarin) can discriminate tones within another tonal system (Chongqing dialect), which the future research into perceptual cues for tone perception could base upon.

**Key Words:** Tone Perception, Cross-dialectal Tone Discrimination, Mandarin Tones, Tones of Chongqing Dialect, AX Discrimination Experiment

## 1. Background

### 1.1 Tonal Systems of Mandarin Chinese and Chongqing Dialect

Chinese is a tonal language (Chen, 1999; Duanmu, 1999; Chen *et al.*, 2000; Duanmu, 2002; Yip, 2002; Zhiming, 2003; Lin, 2007). Apart from consonants and

vowels, tone is the third dimension of speech which could differentiate its meaning from morphemes (or syllables) bearing identical arrangement of segments (Chen *et al.*, 2000). Tone is manifested by the pitch of the voice which is determined by fundamental frequency (F0), a more acoustic phonetic property of voice describing the frequency of vocal folds vibration (Ladefoged, 2001). Therefore, a higher F0 and higher pitch will be perceived as a higher tone; a lower F0 and lower pitch will be as a lower tone. In order to describe the tonal system of a language, phoneticians calculate the relative pitch values of each tone by measuring the exact F0 of a tone. Thus the pitch values of tones not only indicate the pitch level of a tone, but also the direction or pitch movement of a tone. Tones have the same pitch values belong to the same tone category (Yang, 2010). In terms of pitch contour or pitch movement, there are two distinct types of tones: level tones and contour tones. The former means that the level of pitch remains stable while the later refers to the changes of the pitch level within a syllable (Lin, 2007: 92). Standard Chinese (Mandarin) has one high level tone termed T1 and three contour tones (T2, T3, T4) as underlying tones.

Chongqing dialect (CQ), a branch of Southwest Mandarin, also has four-tone system, but each tone differs in values compared to that of Mandarin. For comparison, the pitch values of each tone in tone systems of Chongqing dialect and Mandarin are illustrated through a carrier syllable [tʰi] in the following table.

| [tʰi] | Tone 1 (T1) | Tone 2 (T2) | Tone 3 (T3) | Tone 4 (T4) |
|---|---|---|---|---|
| Chongqing | 35 | 31 | 341 | 213 |
| Mandarin | 55 | 35 | 214 | 51 |
| English meaning | ladder | to carry | body | To replace |

*(Based on Liang and Meng, 2011: 1231; Lin, 2007: 93)*

## 1.2 Tone Perception

### 1.2.1 Categorical Perception

Categorical perception occurs when there is an abrupt change of perception along a physical continuum. In terms of speech sounds, they will be perceived as different categories if one or more dimensions of their phonetic properties cross the categorical boundaries, namely that sounds within a category have poor discriminative identity, whereas sounds belonging to separate categories carry perceptually distinctive phonetic cues (Studdert-Kennedy *et al.*, 1970).

### 1.2.2 Categorical Perception of Tone

Various dimensions of acoustic cues have been examined in the studies of tone perception. Pitch variations are the most consistently researched and believed to be the primary cues for the identification of tone categories, although duration and amplitude of tones might also contribute to tone perception (Norman, 1987). For example, Stagray and Downs (1993) have explored pitch height in the perception experiment on categorizing level tones. Gandour (1983) has used both pitch height and pitch direction as multi-dimensional scales to make a conclusion that the judgement of all four Mandarin tones relies on these two cues. However, Shen and Lin (1991) have introduced the turning point of the pitch contour which in turn has proved to be the dominant feature in the discrimination between Mandarin T2 and T3. Wu (2005) has re-tested their argument by comparison between the perception of the adjusted positions of the turning point of T2 and T3, and he has found that the shorter the part before the turning point is, the less chance that subjects could distinguish T3 from T2. But the problem is, as Yang (2010) criticizes, that it is hard to investigate categorical perception systematically and completely if merely focusing on those tone pairs that are distinctive in one or two phonetic dimension.

### 1.2.3 Non-native Speakers and Native Speakers' Tone Perception

In more recent cross-linguistic studies, native speakers of tonal languages are reported to perceive tones categorically or near-categorically, whereas non-tonal language speakers (e.g. English or French as first language) use other strategies; they tend to perceive tones in a psychophysical way (Francis *et al.*, 2003; Hallé *et al.*, 2004; Wu, 2005; Xu *et al.*, 2006). When examining tonal language speakers' perception of another tonal language, research has shown that although both the subjects in Thai and English have no learning experience of Mandarin, the former group performed much better than the later in Mandarin tone perception, which is indicating that learning experience or the exposure to tone languages could to some extent influence the perception of tones of another language (Wu and Lin, 2008). However, Lee *et al.* (1996) have found that Mandarin speakers do not take advantage in the discrimination of Cantonese tones compared to English speakers. On the contrary, Cantonese speakers outperformed English native speakers in Mandarin tone discrimination. This leads them to claim that language experience affects the perception of another tonal language, but since Cantonese tonal system is more complicated and delicate, Cantonese tones seem to be more difficult to be judged. Subsequently, Li and Zhang (2010) have investigated the role of different pitch dimensions in Mandarin tone perception between Mandarin and Cantonese speakers. The results have revealed that Mandarin speakers are more dependent on F0 direction regardless of F0 height, while Cantonese speakers rely more on F0 onset. It is explained that Cantonese has tonal contrasts between level tones which are not included in Mandarin, and that is part of the reasons why the two groups of listeners use different dimensions as perceptual cues.

## 2. Aims and Research Questions

To sum up, all these studies mentioned above have implied a significant role of language background in tone perception which is shaped by the number and nature of the tone systems (Li and Zhang, 2010). This inspires the purpose of this research, that is what if two dialects of a tone language, Mandarin vs. Chongqing dialect, have the same number of tones, and neither of them has tone contrast in level tones but only differ in pitch contour. Do the natives of Mandarin have difficulties in distinguishing tones of Chongqing dialect? Therefore, the aims of this paper are to examine:

a. Whether Mandarin speakers can discriminate tones of Chongqing dialect?

b. How well can they distinguish Chongqing tones when compared with native speakers of Chongqing dialect?

c. What types of tones are the hardest to distinguish and what are the easiest?

Unlike the studies mentioned above which only focus on particular tones that are supposed to be the hardest ones to be distinguished, it is claimed that only when attain a comprehensive knowledge of how well natives of tone language can distinguish tones of another system, could it be justified to further construct the overall mechanism of categorical tone perception (Chen, 2012).

## 3. Methodology

### 3.1 Participants

A total of 14 students studying in Newcastle University took part in this project. Ten of them are native speakers of Mandarin, including 5 male and 5 female with an

average age of 24.2 (SD=0.87). None of the informants had learning experience of Chongqing dialect, nor had been consistently exposed to this dialect. The remaining four including 2 male and 2 female were born and grown up in Chongqing. Their age ranged from 21 to 25 with a mean of 23 (SD=1.41). All of the participants have normal hearing and vision.

## 3.2 Stimuli

In order to achieve the aims of this study, the stimuli contain all types of tones in Chongqing dialect carried by monosyllables [pʰi], [pʰa], [tʰi], and [tʰa]. Considered that the literature on the pitch values of Chongqing tones are controversial (See Zhai, 1996; Fu, 2009; Wu, 2009; Liang and Meng, 2011) and only Liang and Meng (2011) have done acoustic measurements of F0 from different age groups of Chongqing natives, the recording of tones produced by the researcher in the speech lab were synthesized manually by Praat 5.3.50, which means that the values of the onset, turning point, and offset of each type of tones were revised to the mean values of all the productions. Moreover, the duration of each type of the tones were kept identical in which tone 1 and tone 2 were 55ms and tone 3 and tone 4 were 59ms, because the latter two types are inherently longer than the first two (Zhai, 1996). The final version of the pitch values of each tone were: T1=193.1-241.4Hz, T2=202.4-166.6Hz, T3=188.5-198.5-166.2Hz, T4=177.6-154.4-199.2Hz. These were almost consistent with the results in Liang and Meng (2011: 1231) in which the tone value of Chongqing dialect are normalised as T1=35, T2=31, T3=341, T4=213.

Then the stimuli of each syllable were paired in the following way:

T1-T1        T2-T1        T3-T1        T4-T1

| T1-T2 | T2-T2 | T3-T2 | T4-T2 |
| T1-T3 | T2-T3 | T3-T3 | T4-T3 |
| T1-T4 | T2-T4 | T3-T4 | T4-T4 |

Each of these pairs was repeated three times. Therefore, the total number of the pairs was 16x4x3=192. The interval between two tones was 2 seconds.

## 3.3 Procedure

All participants were settled down in a quiet room with a laptop. They were instructed orally by the researcher in their native language (Lee *et al.*, 1996: 530). The tone pairs were randomly displayed. They were required to discriminate whether the two tones were the same or different as soon as possible by clicking the button of 'same' or 'different' on the screen, then moved to the next pair by clicking 'next' button until they finished. Before the experiment, they were allowed to practice several trials extracted from the target stimuli. During the practice stage, they could adjust the volume into a comfortable level.

## 3.4 Data analysis

The answers of each participants captured by Pratt were edited into SPSS. Four independent variables (subjects, gender, language background, types of tone pairs) and one dependent variable (accuracy) were analysed descriptively. One-way ANOVA was used to analyse the different performance between speakers from Chongqing and Northern parts, and between male and female.

## 4. Results and Discussion

### 4.1 Results and discussion of the overall accuracy of tone pair discrimination

The overall performances of Chongqing natives and Mandarin natives are presented in table 1.

Table 1: The accuracy of discrimination of all types of tone pairs

|  | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| Chongqing | 4 | 91.41% | 0.019 | 90% | 94% |
| Mandarin | 10 | 85.83% | 0.052 | 73% | 91% |
| Total | 14 | 87.43% | 0.052 | 73% | 94% |

(N=number of subjects, SD=standard deviation)

It is not surprisingly to find that Chongqing natives' overall accuracy of discrimination of tones is apparently higher than the Mandarin group (91% vs. 86%). And the performance of each individual in Chongqing group is quite similar (SD=0.02) ranging from 90% to 94% whereas the ability of discrimination of each in Mandarin group is of significant gap with minimum of 73% but maximum of 91%. However, the difference between two groups is not significant at 0.05 level (F (1, 12)=4.129, p<0.065), which is indicating that although the overall performance of native speakers' seems better than non-natives, it is not as significant as to conclude that non-native speakers of Chongqing dialect have much lower accuracy of discrimination compared with native speakers. But instead, in most of the cases, Mandarin speakers can distinguish Chongqing tone pairs correctly. This needs to be further elaborated in the process of this paper by exploring which types of tone pairs are harder than others for Mandarin speakers.

Table 2 displays the overall performances of male and female from both groups.

Table 2: The accuracy of discrimination of all types of tone pairs by male and female subjects

| | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| **Female** | 7 | 86.98% | 0.067 | 73% | 92% |
| **Male** | 7 | 87.87% | 0.036 | 82% | 94% |
| **Total** | 14 | 87.43% | 0.014 | 73% | 94% |

(N=number of subjects, SD=standard deviation)

Similarly, the difference between male and female subjects is not significant at 0.05 level (F (1, 12)=0.097, p<0.76). But the slight divergence of the discrimination ability can be told through the mean, minimum and maximum accuracy of the two groups. In general, male speakers performed slightly better than females with 0.9% mean higher accuracy and the worst performance in male group (82% accuracy) was better than the worst in female (73% accuracy), which means that he judged correctly 19 pairs more than she did. The best performance in male group was also better than the best in female (94% vs. 92%). This result is inconsistent with a previous study on tone discrimination, as Chen (2012) has found that female listeners perform an obvious better discrimination than male listeners in all types of Mandarin tone pairs. Since the difference between male and female speakers is not significant, the following analyses of the accuracy of each type of tone pair will not be compared between genders.

**4.2 Results and discussion of the mean accuracy of each type of tone pairs**

The following graphs reveal the mean accuracy of the identification of each type of tone pairs by Chongqing dialect speakers and Mandarin speakers.

Figure 1: Mean accuracy of the discrimination of each tone pair by Chongqing natives
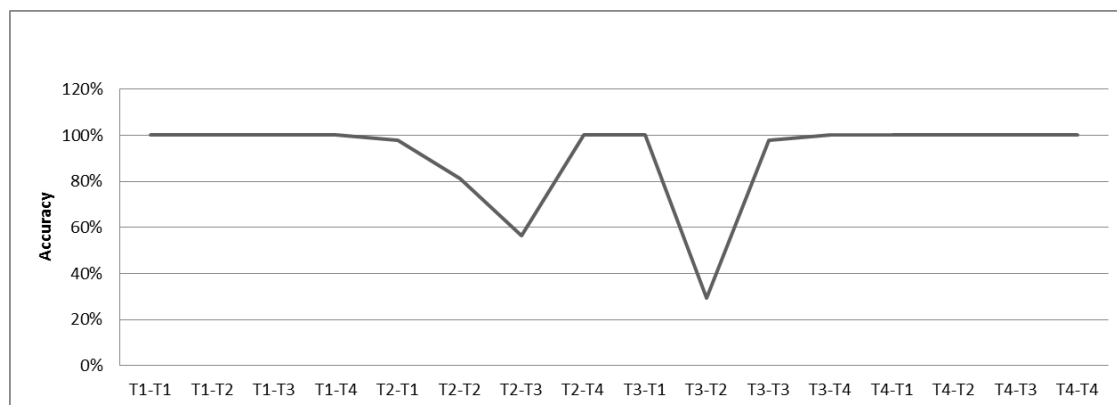
Shown by figure 1, eleven out of sixteen types of tone pairs were perfectly identified by natives of Chongqing dialect; they were: T1-T1, T1-T2, T1-T3, T1-T4, T2-T4, T3-T1, T3-T4, T4-T1, T4-T2, T4-T3, and T4-T4, which is suggesting that these paired tones are perceived categorically distinct by native speakers. An interesting finding is that although T1 and T2 could be identified as different tones in the sequence of T1-T2, but when they were swapped, there existed some difficulties in discrimination between the two. Considered the limited number of the incorrect answers, it is hard to conclude that there is a systematic tendency of unrecognizing T1 and T2 when they were displayed as T2-T1. Also in a few cases, T3-T3 were identified as different tones by some subjects. More cases of misidentification of same tones happened to T2-T2. Nearly 20% of the occurrences of this type of tone pair were perceived as different rather than identical tones. The most difficult tone pair for discrimination is T3-T2. Even though for native speakers of Chongqing dialect, in almost 70% of the time they perceived T3 and T2 as the same tone. Results got better when the sequence of playing the two was changed, but the accuracy rate was still very low (below 60%).

Figure 2: Mean accuracy of the discrimination of each tone pair by Mandarin speakers
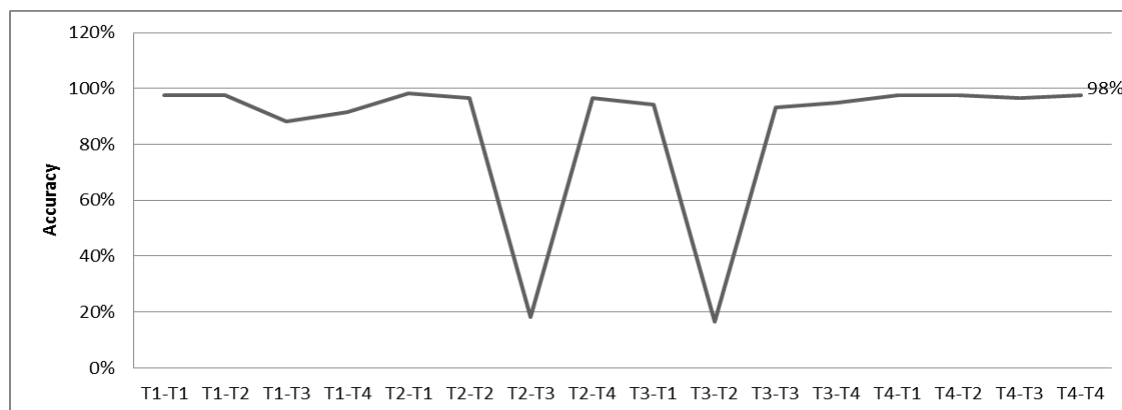
As figure 2 shows, for speakers of Mandarin, the general pattern of the mean accuracy of identification of all types of tone pairs seems very similar to that of native speakers. Although not a single type was distinguished perfectly, a total of thirteen types of tone pairs were of very high degree of discrimination (more than 90%); they were: T1-T1, T1-T2, T1-T4, T2-T1, T2-T2, T2-T4, T3-T1, T3-T3, T3-T4, T4-T1, T4-T2, T4-T3, and T4-T4. T1-T3 had slightly lower rate of correct identification but it still reached 85% of the time. As same as native speakers, T2-T3 and T3-T2 were the two types of the most difficult tone pairs to be distinguished. But in this group, no matter what sequence of playing the two tones, they seem to be indistinguishable with a very low correctness rate of less than 20%, which could imply that for Mandarin speakers, T2 and T3 are perceived as the same category. It needs to be mentioned that the 'same' tone pairs: T1-T1, T2-T2, T3-T3, and T4-T4 were all not perfectly discriminated as identical tones, but instead, in some cases, they were perceived as distinctive.

In previous cross-dialectal studies on tone perception, it is assumed that Mandarin speakers depend more on pitch direction to categorically perceive tones irrespective of pitch height, namely F0 onset (Lee *et al.*, 1996; Li and Zhang, 2010). But in this research, results have shown that people spoken in Mandarin did not flawlessly perceive Chongqing T1 and T3, T1 and T4 categorically, although both pairs

differ in F0 direction (T1=35, T3=341, T4=213). On the contrary, for native speakers of Chongqing dialect, they perfectly conceived T1, T3, and T4 as acoustically distinctive tones. The uncovered different performances in tone discrimination by Mandarins and natives of Chongqing dialect could be partially explained by the influence of native tone languages which are of disparate pitch contours although the whole system of the two dialects are similar (the same number of tones and the same pitch range).

The difficulties in distinguishing T2 and T3 for both groups have drawn the researcher's attention. References on Mandarin tone perception have found that no matter for non-tonal language speakers or native tonal language speakers such as Cantonese and Thai, T2 (35) and T3 (214) are the most difficult ones to be discriminated due to their similar acoustic features (F0 direction and longer duration compared with T1 and T4). Likewise, T2 and T3 in Chongqing dialect carry the similar F0 direction but slightly differ in duration. Tone 3 with the pitch value of 341 has a trivial convex at the beginning of the pitch movement whereas tone 2 moves from value of 3 directly to 1. Shen and Lin (1991) and more recently Wu (2005) claim that the turning point of the pitch contour is the primary cue for the identification of Mandarin T2 and T3. They have tried to change the timing of the turning point by several scales along the movement of the pitch and found the perceptual category boundary between T2 and T3. Additionally, there is an inter-correlation between the loci of the turning point and the degree of initial fall which could be a supplementary categorically perceptual cue. Based on these arguments, it is plausible that the fixed pitch value and the exact position of the turning point of tone 2 and tone 3 in this study might not cross the category boundary of tone 2 and tone 3 which is attributed to explain why they were not

detectable for both groups. But it should be noted that for native speakers of Chongqing dialect, the detectability for T2-T3 was much higher than that for T3-T2, thus it hypothesizes that the longer duration of T3 is more likely to be perceived as a cue for helping discrimination when it is presented before T2, but it needs to be further researched.

## 5. Conclusion

Based on the descriptive analyses of the data gathered from this experiment, the research questions initiated have been addressed properly. First, in general, Mandarin speakers have a high level of accuracy in discriminating Chongqing tones, even though not as high as native speakers of Chongqing dialect have. Particularly in the judgement between tone 1 and tone 3, tone 1 and tone 4, the accuracies nearly reached a hundred per cent. Second, Mandarin speakers as well as native speakers of Chongqing dialect do have severe problems in the identification of tone 2 and tone 3, but the difference is that Chongqing native speakers have more than half of the chance to identify tone 2 and tone 3 when tone 2 precedes tone 3. This leaves an open question to future research which could attempt to identify the category boundary between tone 2 and tone 3 of Chongqing dialect and whether there exists different boundary for natives and non-natives. Moreover, tone duration could also be considered as a cue for tone perception in the further research since in some cases in this study, changing the sequence of the tones leads to obvious diverse performance in discrimination. Last but not least, the relatively small number of subjects, particularly for native speakers, might to some extent limit the reliability of the generalisation of the performance in tone perception by both groups.

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