# The Effect of Min Proficiency on the Realization of Mandarin Tones in Mandarin-Min Bilinguals

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## Abstract

This study investigated how Min proficiency influenced the realization of Mandarin tones in Mandarin-Min bilinguals. Forty subjects recruited were divided into the high and the low Min proficiency groups. Isolated Mandarin syllables carrying one of the four Mandarin tones were recorded. Results showed that Min proficiency was roughly in negative correlation with pitch height for high tonal targets. Gender differences were also observed. Specifically, while the high Min proficiency males made a parallel shift downwards in register, the high Min proficiency females made used of a narrower tonal range. These indicated that Min proficiency did contribute to dialectal differences found in pitch height use in Mandarin tones though the nuance differences in how the effect of Min applied was determined by factors not identifiable at the present stage.

**Index Terms**: Mandarin tones, Mandarin-Min bilinguals, language proficiency

## 1. Introduction

Mandarin has four tones, which were first described by Chao (1968) as high-level, high-rising, low-dipping, and high-falling, respectively. While these descriptions have been widely acknowledged, they are, in fact, only representative of the tones used in the Beijing dialect of Mandarin, which is regarded as the standard form of Mandarin in Mainland China. In reality, Mandarin is spoken by a vast number of people, who have in turn developed their own Mandarin dialects.

Taiwan Mandarin happens to be one of them. According to Fon and Chiang (1999), the four Taiwan Mandarin tones are more accurately described as high-level, mid-dipping, low-dipping, and high-falling. It was also pointed out that Taiwan Mandarin used a narrower tonal range. A comparison made by Torgerson Jr. (2005) between the tones of Taiwan Mandarin and those of Mainland Mandarin showed that Mainlanders use a higher tonal register for their Mandarin tones compared with Taiwan speakers.

This phenomenon of utilizing lower tonal register for Taiwan Mandarin was suggested by Fon and Chiang (1999) to be due to the influence of Taiwan Min as Chiang (1967) noted that Taiwan Min was characterized by having more tones occupying the lower register of one's pitch range. To examine if Min was a direct cause of the differences found in the use of tonal height and to obviate the effect of dialectal differences, two groups of Taiwan Mandarin-Min bilinguals differing in Min proficiency levels were examined. Presumably, the more proficient one was in Min, the more influence Min would have on one's Mandarin (Mägiste, 1984).

Consequently, if the lowering of tonal register in Taiwan Mandarin was indeed triggered by influences of Taiwan Min, we should be able to discover a negative correlation between proficiency and tonal height. That is, the more proficient one is in Min, the lower one's Mandarin tones will be. If, however, the lowering of tonal register in Taiwan Mandarin was not due to the influence of Min, or that it was due to a collective influence rather than an idiosyncratic influence of individual Min proficiency, we should not be able to find any difference between groups of Taiwan Mandarin speakers differing only in terms of their Min proficiency levels.

## 2. Method

### 2.1. Subjects

Forty Mandarin-dominant Mandarin-Min bilinguals, aged 18 to 28, with males and females being balanced, were recruited. Participants were ethnically Min, born in either Taipei City or County, and resided in these areas till at least the age of 18. Subjects were controlled for their location of birth and residence to prevent the interference of dialectal differences as it has already been testified that the Mandarin spoken in the three biggest metropolises in Taiwan; namely, Taipei, Taichung, and Kaohsiung, were different (Huang, 2008).

Subjects were divided into two groups according to their Min proficiency, which was determined by two criteria. One was by a short screening interview conducted in Min by the experimenter prior to the experiment. The other was by subjects' self-ratings on language background questionnaires. Both ratings utilized a seven-point Likert scale where 1 represented the least proficient and 7 the most proficient. Those categorized as belonging to the high Min proficiency group had both ratings of Min either equal to or above the score of 5, whereas those regarded as belonging to the low Min proficiency group had both ratings of Min below 4. A three-way ANOVA with the between factors of Group (high or low Min proficiency groups), Gender (males or females), and Rater (self or experimenter) was conducted on the Min rating scores. Results only showed a main effect of Group [$F(1, 72)= 462.49$, $p < .001$].

### 2.2. Stimuli

Ten isolated Mandarin syllables having either a CV or a CVN structure were used. The four Mandarin tones were mapped onto each type of syllable creating 10 quadruplets. For an example of a quadruplet, refer to Table 1.

Table 1: *An example of a quadruplet stimuli.* [1]

| Tone 1 | Tone 2 | Tone 3 | Tone 4 |
|---|---|---|---|
| 雞 | 級 | 擠 | 寄 |
| [tɕi] | [tɕi] | [tɕi] | [tɕi] |
| 'chicken' | 'level' | 'crowded' | 'send' |

[1] For ease of presentation, the high-level, mid-dipping, low-dipping, and high-falling tones of Taiwan Mandarin will be referred to as Tone 1, Tone 2, Tone 3, and Tone 4, respectively.

### 2.3. Procedure

Subjects were asked to a sound-proof booth to record Mandarin syllables presented to them via Powerpoint slides one at a time. They were told to read aloud what they saw at a normal speed and in a natural manner. Practice trials were done before the recording of the experimental stimuli, which were quasi-randomized. If false production or noises other than the responses to the stimuli were produced, subjects were asked to repeat the item again. When the recording came to an end, subjects were asked to fill out a language background questionnaire. The procedure of the experiment lasted for approximately ten minutes.

### 2.4. Measurements

Isolated Mandarin syllables were labeled and extracted of pitch with Praat (Boersma & Weenink, 2009). The part included in the labeling was the voiced proportion as it was the part of a syllable in which a tone was feasible of measurement and some scholars have proposed it to be the domain of Mandarin tones (Chao, 1968; Wang, 1967). Figure 1 illustrates the labeling of the starting and end points of a syllable.

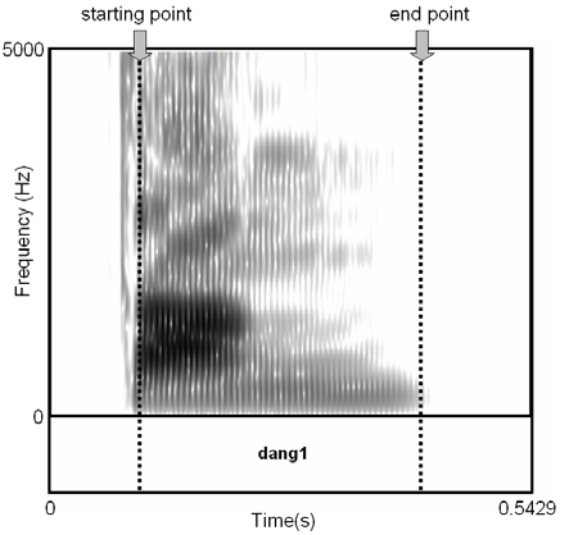


Figure 1: *An illustration of the labeling criteria.*

The labeled materials were subsequently fed to a Praat script for automatic pitch extractions. The outcomes of the pitch tracks were checked manually and corrected for tracking errors. Then, contours were smoothed and interpolated using Praat functions. Finally, the points that were said to have both phonological and phonetic significance were measured from the pitch tracks of the tones for analyses.

For Tone 1, as it manifested itself as a level tone, only the maximal $F_0$ was extracted to represent it. For Tone 2, as it manifested itself as a dipping tone, the initial and final maximal $F_0$ values, and the turning point of the dipping contour, which was the minimal $F_0$, were measured. For Tone 4, as it manifested itself as a falling tone, the initial maximal $F_0$ and the final minimal $F_0$ were measured. For Tone 3, as it had two forms of realizations, measurements were carried out depending on how Tone 3 was realized. In particular, if it was realized as a dipping tone, it would be measured of three points; namely, the initial and final maximal $F_0$ values and the middle minimal $F_0$. If Tone 3 came in the form of a falling tone, the maximal and minimal $F_0$ values were measured. The range of each tone except for Tone 1 was also calculated by subtracting the minimal point from the highest maximal point.

## 3. Result

### 3.1. Tone 1

Figure 2 (a) and (b) show the Mandarin Tone 1 produced by the bilingual males and females, respectively, grouped as high Min proficiency or low Min proficiency speakers.

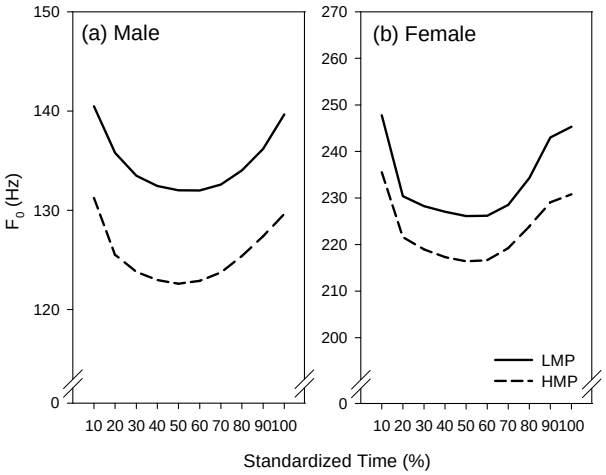


Figure 2 (a) and (b): *Mandarin Tone 1 produced by the high and the low Min proficiency bilingual males and females.*

For males, an independent *t* test was conducted to see if a difference existed between the maximal points of Tone 1 for the high and low Min proficiency bilinguals. Results revealed that the low Min proficiency group manifested significantly higher maximal $F_0$ values for their Mandarin Tone 1 compared with the high Min proficiency group [$t(198)= -4.29$, $p < .001$]. For females, an independent *t* test also indicated similar results by showing that the low Min proficiency group used a higher maximal $F_0$ value for their Mandarin Tone 1 compared with the high Min proficiency group [$t(198)= -3.05$, $p < .05$].

### 3.2. Tone 2

Shown in Figure 3 (a) and (b) are the Mandarin Tone 2 produced by groups of bilingual males and females who were either proficient or not proficient in Min.

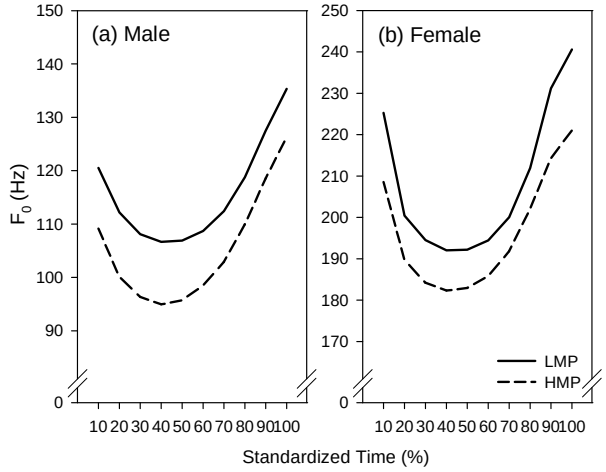


Figure 3 (a) and (b): *Mandarin Tone 2 produced by the high and the low Min proficiency bilingual males and females.*

Planned comparisons were carried out on the following: (1) the initial maximal $F_0$, (2) the minimal $F_0$, (3) the final maximal $F_0$, and (4) the range. For males, independent *t* tests showed that all points produced by the low Min proficiency group were higher in $F_0$ values compared with those produced by the high Min proficiency group [Initial maximal $F_0$: $t(195)= -7.21$, $p < .001$; Minimal $F_0$: $t(195)= -8.38$, $p < .001$; Final maximal $F_0$: $t(163.36)= -3.61$, $p < .001$, adjusted for equality of variances with the Levene's Test]. However, in terms of the range, no difference was found.

For females, results of the independent *t* tests executed on the three phonologically and phonetically significant points of Tone 2 were in accordance with those of males; that is, the low Min proficiency group utilized higher pitch values for all points of Tone 2 compared with the high Min proficiency group [Initial maximal $F_0$: $t(185.52)= -5.49$, $p < .001$, adjusted for equality of variances with the Levene's Test; Minimal $F_0$: $t(173.76)= -3.51$, $p < .05$, adjusted for equality of variances with the Levene's Test; Final maximal $F_0$: $t(196)= -4.55$, $p < .001$]. Yet, unlike males, females showed a range difference. An independent *t* test revealed that the low Min proficiency females had larger tonal ranges for Tone 2 compared with the high Min proficiency females [$t(196)= -3.65$, $p < .001$].

### 3.3. Tone 3

As Taiwan Mandarin speakers produced Mandarin Tone 3 interchangeably as a dipping or a falling tone, the two variants were analyzed separately in this study.

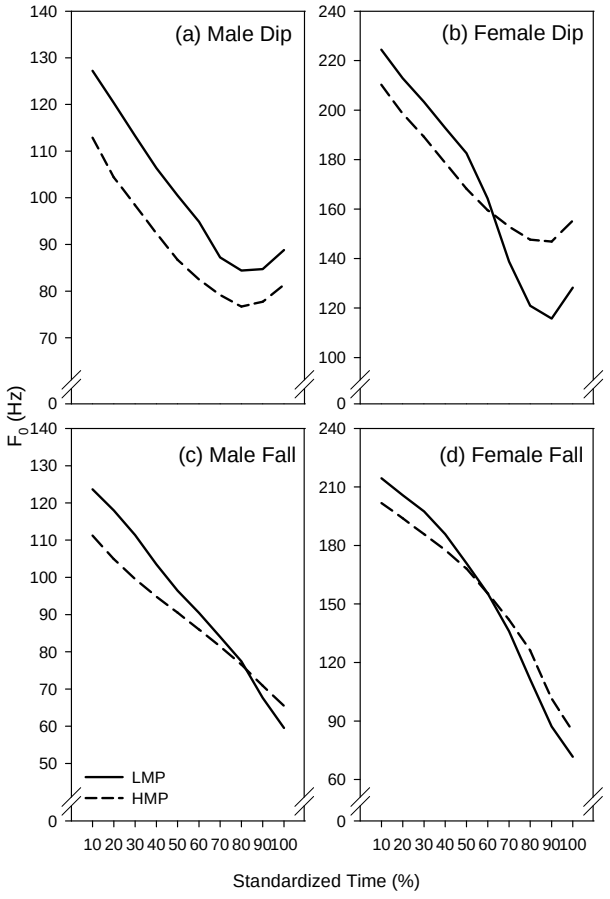


Figure 4 (a), (b), (c), and (d): *The dipping and falling variants of Mandarin Tone 3 produced by the high and the low Min proficiency bilingual males and females.*

#### *3.3.1. Dipping Variant*

Displayed in Figure 4 (a) and (b) are the dipping variants of Tone 3 produced by the bilingual males and females being either proficient or not proficient in Min. Planned comparisons were again conducted on the following elements: (1) the initial maximal $F_0$, (2) the minimal $F_0$, (3) the final maximal $F_0$, and (4) the range.

For males, independent *t* tests implemented to investigate the differences between groups revealed again that the low Min proficiency males used higher pitch values for all three points measured in the dipping variant of Tone 3 compared with the high Min proficiency males [Initial maximal $F_0$: $t(44.06)= -5.72$, $p < .001$, adjusted for equality of variances with the Levene's Test; Minimal $F_0$: $t(81)= -3.77$, $p < .001$; Final maximal $F_0$: $t(62.33)= -3.16$, $p < .05$, adjusted for equality of variances with the Levene's Test]. Differences were also discovered in the tonal range. Specifically, the low Min proficiency group had a larger tonal range compared with the high Min proficiency group [$t(81)= -2.22$, $p < .05$].

For females, independent *t* tests showed that while the initial maximal $F_0$ was higher for the low Min proficiency group [$t(93)= -2.37$, $p < .05$], the pitch heights were lower for their minimal $F_0$ [$t(69.18)= 2.80$, $p < .05$, adjusted for equality of variances with the Levene's Test] and final maximal $F_0$ [$t(69.40)= 1.99$, $p < .05$, adjusted for equality of variances with the Levene's Test]. It was also discovered that the low Min proficiency females used larger tonal ranges compared with the high Min proficiency females [$t(65.57)= -4.83$, $p < .001$, adjusted for equality of variances with the Levene's Test].

#### *3.3.2. Falling Variant*

Figure 4 (c) and (d) display the falling variants of Tone 3 produced by the bilingual males and females, respectively, grouped according to whether they belonged to the high or the low Min proficiency groups. Planned independent *t* tests were implemented to compare the following: (1) the maximal $F_0$, (2) the minimal $F_0$, and (3) the range.

For males, the following results were reported: For the maximal $F_0$, the low Min proficiency group had higher $F_0$ values compared with the high Min proficiency group [$t(115)= -5.29$, $p < .001$]. However, for the minimal $F_0$, no pitch height difference was found. With regards to the tonal range, a larger magnitude was used for the low Min proficiency group compared with the high Min proficiency group [$t(115)= -4.92$, $p < .001$].

For females, independent *t* tests revealed similar results: For the maximal $F_0$, the low Min proficiency group made use of higher $F_0$ values compared with the high Min proficiency group [$t(89.76)= -3.29$, $p < .05$, adjusted for equality of variances with the Levene's Test]. Also like the males, no pitch height difference was observed for the minimal $F_0$. In terms of the tonal range, it was also the low Min proficiency group that had a significantly larger magnitude compared with the high Min proficiency group [$t(103)= -3.31$, $p < .05$].

### 3.4. Tone 4

Figure 5 (a) and (b) are the Mandarin Tone 4 produced by the two groups of bilingual males and females differing in Min proficiency. Planned independent *t* tests were carried out to compare the following: (1) the maximal $F_0$, (2) the minimal $F_0$, and (3) the range.

For males, the low Min proficiency group produced higher $F_0$ values for both their maximal $F_0$ [$t(198)= -4.25$, $p < .001$]

and minimal $F_0$ [$t$(181.31)= -4.19, $p$ < .001, adjusted for equality of variances with the Levene's Test], but no difference was found between groups in their use of tonal range.

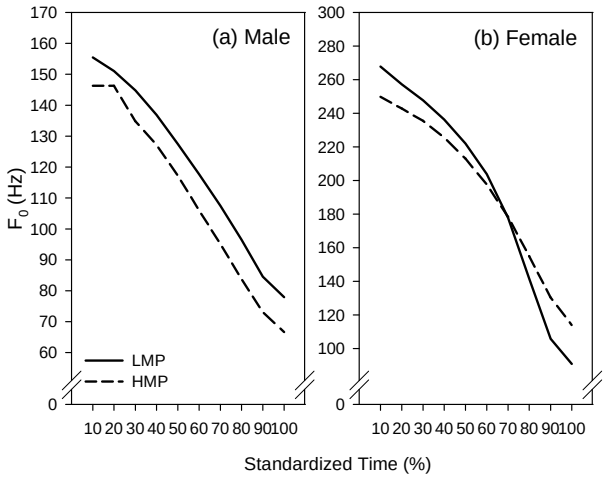


Figure 5 (a) and (b): *Mandarin Tone 4 produced by the high and the low Min proficiency bilingual males and females.*

For females, while the low Min proficiency group had a higher $F_0$ value for the maximal point [$t$(198)= -4.48, $p$ < .001], they manifested a lower $F_0$ value for their minimal point [$t$(198)= 2.98, $p$ < .05]. They were also shown to use a wider tonal range compared with the high Min proficiency group [$t$(198)= -5.07, $p$ < .001].

## 4. Discussion

In this study, we examined Mandarin tones produced by speakers of the same dialect, but who differed in terms of their Min proficiency. We have done so to see whether Min would indeed pose an influence on how Mandarin tones were realized. The results obtained gave an affirmative answer to this question. As a rule of thumb, it was found in the present study that those who were more proficient in Min tended to produce lower pitch values for their Mandarin tones regardless of gender, especially when a high tonal target was involved. As we controlled for dialectal differences in this study, such a finding could only have stemmed from the influence of Min. This showed that Min was indeed at play in distinguishing Mainland Mandarin from Taiwan Mandarin.

However, if the differences in pitch height used between Mainland Mandarin and Taiwan Mandarin only stemmed from idiosyncratic differences in how one was influenced by Min, would a Taiwanese with little knowledge of Min utilize similar tonal heights as those of a Mainlander? Or would this type of Taiwan speaker still have a lower tonal register compared with a Mainlander? If the former held true, pitch height differences may no longer be a reliable cue in telling apart Mainland Mandarin from Taiwan Mandarin as there should be situations where one could find a Taiwan speaker that does not know any Min and thus produces Mandarin tonal heights in a manner which resembles those of a Mainlander. Under such conditions, Min proficiency would be a sole predictor of the tonal heights used in Mandarin regardless of the dialect spoken. If, however, the latter held true, it would mean that while individual Min proficiency does play a part, other factors such as a collective influence of Min should also be at play. If there was indeed a collective influence of Min, we would expect Taiwan Mandarin to be lower than Mainland Mandarin in its use of tonal height regardless of individual Min proficiency differences. Further studies that compare Taiwan speakers with little knowledge of Min to Mandarin speaking Mainlander will help unsnarl the unsolved enigma aforementioned.

While it was found that the low Min proficiency speakers tended to have higher pitch heights for their high tonal targets compared to the high Min proficiency speakers regardless of gender, males and females manifested discrepancies in the lower tonal targets that did not meet the bottom of one's pitch range. As shown from Figures 4 and 5, while the low Min proficiency males tended to have higher minimal $F_0$ values for Tone 4 and the dipping variant of Tone 3, it was the high Min proficiency females that had higher $F_0$ values for the minimal points of these tones. This indicated that males and females probably relied on different ways to arrange their Mandarin tones. For males, the high Min proficiency speakers tended to have a parallel shift downwards for their Mandarin tones compared with the low Min proficiency speakers. Females, on the other hand, did not apply such a strategy. Instead of making a parallel shift downwards for all points in a tonal contour, they tended to narrow the tonal range if the tone produced encompassed a large range, especially one that involved the crossing from higher tonal heights to lower ones.

Though it remains unclear why males and females would apply different strategies, both strategies used were consistent with what was said in previous studies. Specifically, males' pattern of making a register shift was more like what Torgerson Jr. (2005) found, whereas females' narrowing of range was in line with what Fon and Chiang (1999) observed.

## 5. Conclusion

In this study, it was found that Min proficiency was an index to whether one used higher or lower pitch heights to produce their Mandarin tones. The findings suggested that the more proficient one was in Min, the lower the $F_0$ values would be for the Mandarin tones produced. The other interesting finding of this study was that males and females manifested differences in how Min posed its influence on them. Specifically, proficient Min speaking males used a lower register for their Mandarin tones, whereas proficient Min speaking females used a narrower range.

## 6. Reference


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