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The Acquisition of Xiamen Tone Sandhi by Children

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Abstract

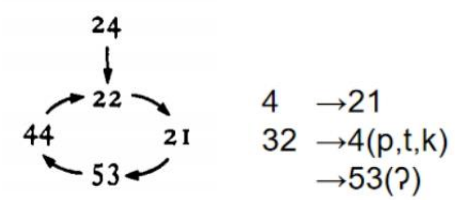
The focus of the present study is the child acquisition of tone sandhi patterns in the Xiamen dialect. The Xiamen dialect, which belongs to the Southern Min dialectal group, is well-known for having complex tone sandhi patterns. The tone sandhi patterns of free tones form a tone circle as there is an A→ B→A pattern. The checked tones' sandhi patterns are influenced by codas. Very little is known for how children acquire complex tone sandhi patterns. The present study tested children's ability to apply tone sandhi using a picture-naming task with both real words and semi-wug words. The results showed that both young and old children were able to apply tone sandhi to real words. Though the old children group had much better performance than the young children group in the semi-wug words, they failed to reach adult-like proficiency. Since the old children group in the present study was quite mature (9;2 - 12;2, M = 10;6), the acquisition of complex tone sandhi patterns seems to finish late.

Keywords: Xiamen dialect, tone sandhi, child acquisition

1. Introduction

1.1. Xiamen dialect's tone sandhi patterns

The Xiamen dialect has five free tones and two checked tones. Tone sandhi is a very common phonological phenomenon in the Xiamen dialect. The sandhi patterns of the free tones are shown in Figure 1a). The checked tones occur with obstruent codas /p, t, k, ʔ/ and they are shorter than the free tones. The sandhi patterns of checked tones are shown in Figure 1b). According to Chen [1] and Lin [2], the tone sandhi of the Xiamen dialect is right-dominant. Within the same tone sandhi domain, only the syllable on the right edge preserves the citation tone.



a) b)

Figure 1: The tone sandhi patterns in the Xiamen dialect [1]

1.2. Tonal acquisition by children

Earlier studies on child tonal acquisition generally agreed that tones are acquired very early and tonal acquisition is accomplished within a short period of time. In Mandarin, children were found to have acquired the lexical tones before the age of two [3]. 268 Cantonese-speaking children from 2-year-old to 6-year-old were tested by a picture-naming task. The children were found to have very few problems with tones [4]. But in more recent studies, children were found to be not mature enough in production task [5], [6]. The F0 contours were not adult-like. The 5-year-old children still failed to achieve adult-like performance. An age effect for a more adult-like performance was found [7]. Very few studies were done on the acquisition of tone sandhi. Early studies on spontaneous speech showed that the Mandarin T3 sandhi is acquired a bit later than lexical tones, but not later than age two [3]. In picture-naming tasks, Mandarin-speaking children were tested by both real and wug words. The results indicated that 6-year-olds still did not have adult-like accuracy [7].

1.3. The present study

Very few studies investigated children's ability on tone sandhi. The Xiamen dialect provides rich materials to test child acquisition of tone sandhi. The present study used a picture-naming task to elicit production of tone sandhi of real words and semi-wug words. There are mainly two research questions: 1) Do the children in the present study have the ability to apply tone sandhi in the Xiamen dialect? 2) Is there any significant difference between the performance of children of different ages, as compared to adults?

2. Method

2.1. Participants

The participants included both children (5;6 - 12;2, N = 29) and adults (19 - 57, N = 10). All children were Mandarin-Xiamen dialect bilingual speakers born and raised in Xiamen. The participants could be further divided into three groups according to their age: the young children group (Y) (5;6 - 8;1, M = 6;8, N = 15), the old children group (O) (9;2 - 12;2, M = 10;6, N = 14) and adults (A) (19 - 57, M = 39.6, N = 10). According to the language background questionnaire, all speakers had very little exposure of other languages, including English and other Chinese dialects. The children mainly spoken Mandarin at school, and the usage of the Xiamen dialect is limiteat home.

2.2. Stimuli

The stimuli can be divided into four kinds: monosyllabic real words (Stimuli M); disyllabic real words elicited by 1 picture (Stimuli D1); disyllabic real words elicited by 2 pictures (Stimuli D2); and disyllabic semi-wug words elicited by two pictures (Stimuli W). Stimuli W are called semi-wug word because they were made of real characters, but the resultant disyllabic words do not exist. Previous studies used wug words, i.e. non-existent syllables. To make sure that the

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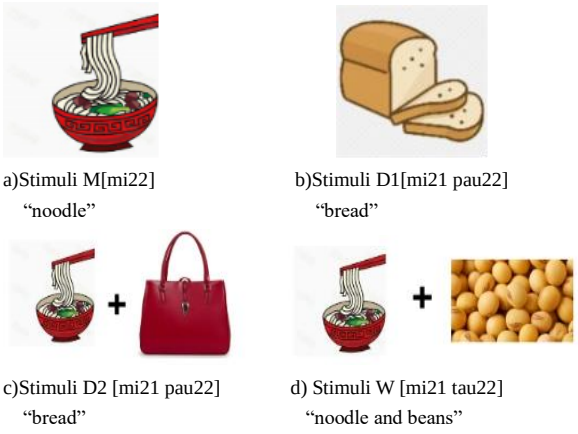
speakers would treat the stimuli as speech materials and apply tone sandhi, and that the stimuli would go through the mental lexicon, the present study used semi-wug words. Examples of stimuli could be found in Figure 2.



a)Stimuli M[mi22] "noodle"

b)Stimuli D1[mi21 pau22] "bread"

c)Stimuli D2 [mi21 pau22] "bread"

d) Stimuli W [mi21 tau22] "noodle and beans"

Figure 2: Examples for the Stimuli M, D1, D2 and W

2.3. Procedure

The participants were asked to sit in a quiet room with the experimenter. They were asked to look at a screen of an iPad showing the stimuli in pictures, and to say what they had seen. Their speech was recorded by a solid-state recorder. The adults had 3 repetitions and the children only had 2 repetitions of the stimuli because of the limited attention of the children.

3. Results

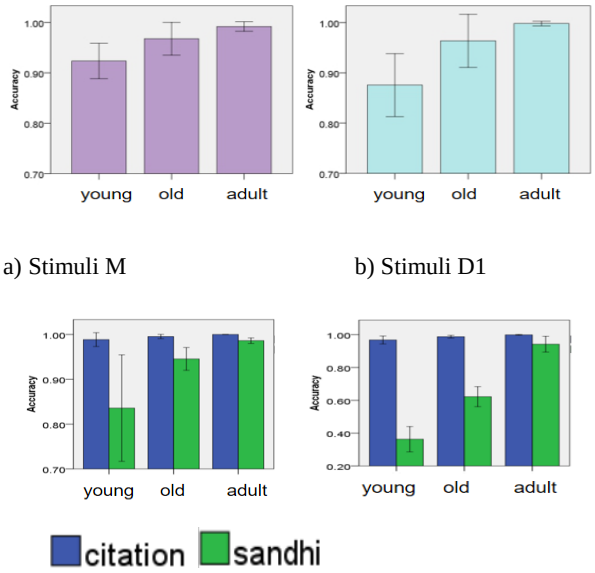
3.1. The tone sandhi application accuracy

Two adult native judges (two females, one is 26-years-old and the other is 54-years-old) received some trainings on the Xiamen dialect tonal system beforehand. They did two tasks: firstly, they decided which tones they had heard; secondly, they decided whether they had heard the correct tones. The following analysis was based on the judgements of these two native speakers.

A one-way ANOVA was conducted to test the effect of Group on the accuracy of Stimuli M. The result reported a significant effect of Group ($F(2, 35) = 5.67$, $p = 0.007$). As shown in Figure 3a), the young children group ($M = 90.36\%$, $SD = 0.061$) was found to have a significantly lower accuracy than the adult group ($M = 99.2\%$, $SD = 0.013$, $p = 0.008$). Another one-way ANOVA also reported a significant effect of Group on the accuracy of Stimuli D1 ($F(2, 35) = 6.62$, $p = 0.004$). As shown in Figure 3b), the accuracy of the young children group ($M = 87.57\%$, $SD = 0.109$) was significantly less accurate than the old children group ($M = 96.4\%$, $SD = 0.091$, $p = 0.033$) and the adults ($M = 99.8\%$, $SD = 0.006$, $p = 0.005$). In general, the young children group had significantly worse performance than the other two groups in both Stimuli M and D1, but the accuracy was not very low (over 85%).

A 3*2 repeated measure ANOVA was conducted to test the effects of Group and Position on the accuracy of disyllabic real words elicited by two pictures (Stimuli D2). The results in Figure 3c) showed that there was a significant interaction between the two factors ($F(2, 23) = 8.34$, $p = 0.002$). The results of posthoc one-way ANOVAs showed that in the citation position, Group did not influence accuracy ($F(2, 23) = 2.62$, $p = 0.09$). But in the sandhi position, significant effect of Group was found ($F(2, 23) = 9.12$, $p = 0.001$). The young children group ($M = 83.57\%$, $SD = 0.128$) were significantly less accurate than the old children group ($M = 94.55\%$, $SD = 0.007$, $p = 0.011$) and the adults ($M = 98.63\%$, $SD = 0.007$, $p = 0.001$).

A 3*2 repeated measure ANOVA was conducted to test the effects of Group and Position on the accuracy in semi-wug words (Stimuli W). The performance of Stimuli W can be found in Figure 4d). The interaction between Group and Position was significant ($F(1, 35) = 67.25$, $p < 0.001$). Results of posthoc one-way ANOVAs showed that in the citation position, the Group effect was significant ($F(2, 35) = 4.24$, $p = 0.022$), but significant difference was only found between the young children group ($M = 96.8\%$, $SD = 0.042$) and the adults ($M = 99.9\%$, $SD = 0.003$, $p = 0.024$). Group effect was also significant in the sandhi position ($F(2, 35) = 81.74$, $p < 0.001$). Significantly differences were found among all three groups. The results indicated that the sandhi position in semi-wug words is indeed a difficult position for children. Though the old children group had significantly better performance than the young children group in real words, the old children group failed to achieve adult-like accuracy in the sandhi position in semi-wug words.



a) Stimuli M

b) Stimuli D1

b) Stimuli D2

d) Stimuli W

Figure 3: The accuracy of Stimuli M, D1, D2 and W

3.2. The accuracy of each tone sandhi rule

To get rid of the frequency influence, this section only examines the performance of semi-wug words. The Xiamen dialect contains five free tone sandhi rules: 24>22, 22>21, 21>53, 53>44 and 44>22 and three checked tone sandhi rules: 4>21, 32(p,t,k)>4 and 32(ʔ)>53 (Figure 1), which may pose different levels of acquisition difficulty to children. Different analyses were run on the free tones and the checked tones. For the five free tones, three repeated measure ANOVAs with tone sandhi rule as a within-subject factor were conducted on each group. The details can be found in Figure 4. A significant effect of tone sandhi Type was found in the young children group ($F(4, 52) = 6.54$, $p < 0.001$). The pairwise T-tests reveal that 44>22 ($M = 53.71\%$, $SD = 0.314$)) had

significantly higher accuracy than 53>44 (M = 15.57%, SD = 0.216, $p < 0.001$). A significant effect of tone sandhi Type was also found in the old children group ($F(4, 52) = 6.04$, $p < 0.001$). The pairwise T-tests revealed that the accuracy for 44>22 (M = 79.71%, SD = 0.230) was significantly higher than 21 > 53 (M = 40.79%, SD = 0.211, $p = 0.001$) and 53 > 44 (M = 43.21%, SD = 0.321, $p = 0.002$). For the adult group, no significant effect of tone sandhi Type was found ($F(4, 36) = 1.381$, $p = 0.26$). For the checked tones, three repeated measure ANOVAs with the three checked tone sandhi rules as a within-subject factor were conducted on the three groups. No significant effect was found.

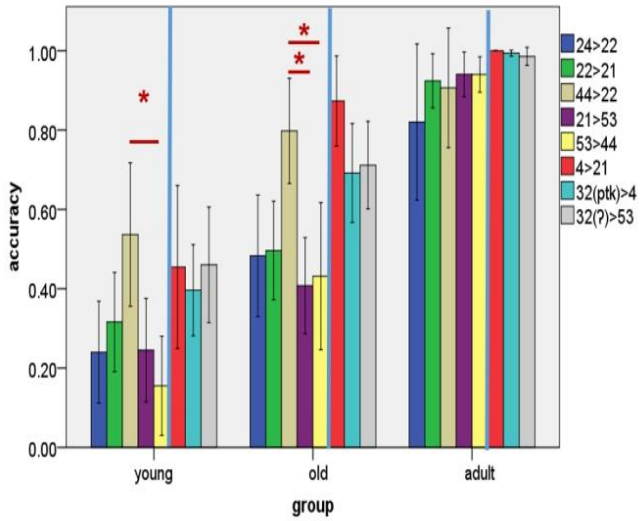


Figure 4: The accuracy of each tone sandhi rule in Stimuli W

3.3. Tonal errors

The suprasegmental errors that the participants made could be divided into two types: sandhi error and irrelevant error. The sandhi error refers to errors that the speaker produced a citation tone in a sandhi position or produced a sandhi tone in a citation position. The irrelevant error refers to errors that speaker produced a totally irrelevant tone in either position.

A 3*2*2 repeated measure ANOVA with Group as a between-subject factor, Position and error Type (sandhi error and irrelevant error) as within-subject factors, was conducted to test the error rate patterns (see Figure 5). The interaction among Group, Error type and Position was not significant ($F(2, 36) = 0.28$, $p = 0.76$). The results reported no significant effect of Group ($F(2, 36) = 1.78$, $p = 0.18$). But there was a significant effect of Position ($F(1, 36) = 196.71$, $p < 0.001$). The citation position (M = 12.60%, SD = 0.19) had significantly fewer errors than the sandhi position (M = 87.23%, SD = 0.86). There was also a significant effect for error Type ($F(1, 36) = 663.46$, $p < 0.001$). The participants had significantly more sandhi error (M = 92.74%, SD = 0.82) than the irrelevant error (M = 7.28%, SD = 0.15). The general pattern is that the sandhi error in the sandhi position was the most common error for each group.

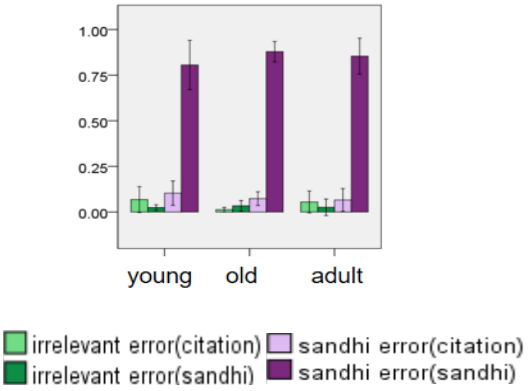


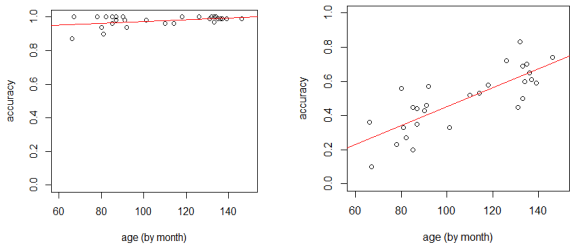
Figure 5: The error patterns

4. Discussion

4.1. The accuracy of tone sandhi

The present study used well-controlled materials to elicit production of semi-wug words. In general, the results shows that the acquisition of phonological rules like the Xiamen dialect's tone sandhi is a protracted process, as the old children group did not reach adult-like accuracy in tone sandhi application in semi-wug words.

For the real words, including the Stimuli M, D1 and D2, they all had very high accuracy in both citation and sandhi positions. The high accuracy indicated that the children had mastered both citation and sandhi tones in real words. But for the semi-wug words, though the citation position maintained high accuracy, the accuracy sharply dropped in the sandhi position. In Figure 3b), the accuracy in citation position of the three groups was all over 95%. But for sandhi position, the mean accuracy was 36.29% for the young children group and 62.21% for the old children group. Though the old children group had significantly higher accuracy than the young children group, they still failed to achieve adult-like accuracy (M = 94.2%, SD = 0.067). In all, throughout the whole experiment, the most difficult part for the children was the sandhi position in semi-wug words. The ability to apply tone sandhi to semi-wug words seemed to develop late in child acquisition. As shown in Figure 6a), even the young children had very high accuracy in the citation position (over 90%). Figure 6b) revealed the accuracy in the sandhi position increased as a function of age. Compared with the citation position, the sandhi condition had a much steeper slope. It is reasonable to believe that the children would reach adult-like accuracy in another few years.



a) The citation position (y = 0.0005x + 0.9222)

b) The sandhi position (y = 0.006x – 0.09862)

Figure 6: The effect of age (by month) on tone sandhi application accuracy in 2 positions in Stimuli W

4.2. The accuracy of tone sandhi rules

Previous studies on Taiwanese (very similar to the Xiamen dialect) found that different tone sandhi rules had different productivity. In Zhang's study on adult speakers [9], the tone sandhi rule 55>33 and 24>22 had significantly higher accuracy in wug words. Previous studies on Taiwanese used phonetic constraints, phonological opacity and frequency effect to explain the productivity of tone sandhi. For instance, according to the phonetic constraints, the duration reducing 53>44 should not be productive, which is supported by Zhang's findings. Phonological opacity predicts that 24>22 should be of high accuracy, because no tone takes 24 as sandhi tone. Since no one would hear Tone 24 in the sandhi position, the possibility of applying this rule should be high. It is also true that the Taiwanese adults had high accuracy for 24>22. The frequency effect partially explains the productivity. For instance, the high frequency of 55>33 supported the high productivity for this tone sandhi rule [8]–[10]. But there are contradictions among these explanations. When there is contradiction between different criteria, it is hard to predict speakers' performance, because we do not know how the speakers weight these factors in their mind. For example, the phonetic constraint predicts that the duration increasing 53>44 is unproductive while the frequency effect predicts that the high frequency 53>44 should be productive. The phonetic constraint predicts that the duration-reducing 22>21 should be productive while the frequency effect predicts that 22>21 should be unproductive. Though the results of the present study support that 53>44 and 22>21 are unproductive, there is no way to explain why the phonetic constraint wins in the 53>44 case while the frequency effect wins in the 22>21 case.

Taiwanese has very similar tone sandhi patterns with the Xiamen dialect. The findings in the Taiwanese studies should also be found in the Xiamen dialect. However, the findings of the present study challenged these explanations. As shown in Figure 4, for the free tones, the young children group were found to be more accurate in 44>22 than in 53>44. For the old children group, 44>22 was found to be more accurate than 21>53 and 53>44. The phonetic constraint predicts that the duration-reducing 22>21 should be more productive than the duration increasing 53>44. It was true that 53>44 had low accuracy, but a high accuracy for 22>21 was not found. The phonological opacity predicts that 24>22 should be productive, but high accuracy of 24>22 was not found. In fact, 24>22 was found to be the lowest in adults, though it was not significant. The frequency effect was also violated. Because the checked tones in the present study was found to be of higher accuracy than the free tones, though checked tones are less frequent than the free tones [11]. Also, neither of these explanations could explain the high accuracy for 44>22 in both children groups. Further studies are needed to explain the factors that influence the productivity of tone sandhi rules.

There may be several reasons for the late and imbalanced development of ability on tone sandhi application. First, tone sandhi may be difficult in language acquisition. The acquisition of Mandarin tone 3 was found to be not finished at the age of 6 [7]. Second, the tone sandhi of the Xiamen dialect may be more difficult than Mandarin. The tone sandhi patterns of the Xiamen dialect are very complex as shown in Figure 1. Moreover, the tone sandhi is influenced by syntax [1,2]. To master tone sandhi in the dialect, children need the knowledge of syntax. These all pose great acquisition difficulties. Third, all children were bilingual speakers, and the Xiamen dialect was less dominant for children according to the information on the questionnaire finished by their parents. In all, the late acquisition of the Xiamen tone sandhi seemed to be the result of multiple reasons.

5. Future studies and conclusion

The present study had some limitations. First, the children showed imbalanced ability on different tone sandhi rules. None of the present theory could explain why certain tone sandhi rules had higher or lower accuracy. Second, though semi-wug words were used to avoid the influence of word frequency, the present study could not get rid of the influence of individual character/syllable frequency because the semi-wug words were combinations of real syllables. In future study, the character frequency can be considered in the stimuli design. Third, longitudinal study is needed to see how children develop ability on tone sandhi application, and when they will reach adult accuracy.

The present study used a picture-naming to test the ability of tone sandhi application in the Xiamen dialect. There were two main findings of the present study. First, the tone sandhi acquisition of the Xiamen dialect finishes late. Different tone sandhi rules are not acquired at the same time. And the productivity in the present study could not be explained by any of the present theories. Second, the young children group were significantly less accurate than the old children group in applying tone sandhi rules. More research is needed in order to elucidate the complex patterns of tone sandhi acquisition.

6. References

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