

THE EFFECTS OF LINGUISTIC EXPERIENCE ON PERCEPTUAL ASSIMILATION OF LEXICAL TONE

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ABSTRACT

This study examines the effects of L1 tone experience and L2 learning experience on tone assimilation. It has been proposed that perceptual assimilation of segments is tied to L1 and L2 contrasts at the phonetic level for listeners without L2 experience [1] but at both phonetic and phonological levels for those with L2 experience [2]. In this examination of perceptual assimilation of lexical tones, 80 native Mandarin and Thai listeners with or without L2 experience performed a mapping-rating assimilation task in which they first identified which L1 tone sounded most similar to the L2 tone they heard, and then rated its goodness on a 5-point scale. The inexperienced listeners assimilated L2 tones to L1 tones with the most similar phonetic properties, i.e., pitch height and direction. The experienced listeners were also influenced by phonemic tone sandhi changes in Mandarin. In other words, Mandarin rising tone and Thai low-falling tone were assimilated to the Thai and Mandarin falling-rising tone. These findings support the Perceptual Assimilation Model [1] and Perceptual Assimilation Model-L2 [2].

Keywords: tone assimilation, linguistic experience, Mandarin, Thai

1. INTRODUCTION

Speech assimilation has been used as an efficient method to indicate phonetic and phonemic contrasts in L1 and L2. It has been proposed in the current speech perception models, such as the Perceptual Assimilation Model (PAM, [1]) that the degree of the phonetic similarity between L1 and L2 phones may lead to a poor or excellent perceptual discrimination. Furthermore, L2 experience has been suggested to affect assimilation such that assimilation by L2 learners occurs at both phonetic and phonemic levels (PAM-L2, [2]).

In Mandarin, tones are used to distinguish word

meanings. There are four tones in Mandarin, namely, T1, T2, T3 and T4. In a tone sequence where a T3 precedes another T3, it becomes a T2 [3]. In other contexts where a T3 precedes the other three tones, it is realized with partial features of the original T3 [6]. This phenomenon of tone changes at the phonemic level is known as tone sandhi. Tone sandhi exists in some languages but not the others, such as Thai [4].

The current study investigated tone assimilation by listeners with or without L2 tone experience. The assimilation paradigm included a mapping task with goodness ratings. This approach has been widely used to examine the perceptual similarities between segments [7] but not yet to evaluate tone assimilation. The listeners were native in Mandarin or Thai, two tone languages with comparable numbers of level and contour tones [4].

The goal of the current study was to explore the effects of linguistic experience on tone assimilation. Based on the current perception models, we hypothesized that Mandarin/Thai listeners without L2 tone experience assimilated L2 tones to L1 tones depending on their phonetic similarities; while those with L2 tone experience also relied on the phonemic properties of L2 tones.

2. METHOD

2.1. Listeners

Eighty native listeners, 40 each of Mandarin and Thai, participated. In each group, half had 0.5-2 years of L2 learning experience in the target language countries while the other half had none. For native listeners of Thai, L2 was Mandarin and vice versa. According to their experience with L2 tones, the listeners were labeled as IM (Inexperienced Mandarin listeners), EM (Experienced Mandarin listeners), IT (Inexperienced Thai listeners), and ET (Experienced Thai listeners). The inexperienced listeners were monolingual speakers of Mandarin or Thai, 9 male and 11 female in the IM group, age 19-21 years; and 8 male and 12 female in the IT

group, age 19-24 years. In the experienced groups, the EM listeners were learning Thai at a Bangkok university (4 male and 16 female, 19-23 years), and the ET listeners were learning Mandarin at two Beijing universities (11 male and 9 female, 21-32 years). All the experienced listeners reported more L2 use than L1 use in the target language countries. All participants reported normal hearing and speech ability, and all were right-handed with no or limited musical training experience.

2.2. Talkers

The target stimuli were produced by four native speakers, two each of Mandarin and Thai, one male and one female, age 20-23 years.

2.3. Stimuli

Stimuli were syllables consisting of the four Mandarin tones labeled as MT1-MT4 and the five Thai tones TT1-TT5 superimposed on 10 monosyllables (Table 1).

The syllables represented both real and nonsense words in both languages with a variety of syllable structures. High quality recordings were made in a sound-absorbent room at the phonetics Lab in a university. To obtain a full representation of each tone as produced from a natural utterance [3], the Mandarin and Thai words were recorded in the final position of a carrier sentence: in Mandarin “我读一个___” (in English “I read a ___”) and in Thai “ผมอยากบอกว่า ___” by the male talker and “ฉันอยากบอกว่า ___” by the female talker (in English both sentences mean “I am going to read ___.”)

Table1: Syllables produced with Mandarin and Thai tones.

Syllable structure	Real words		Nonsense words
	Mandarin & Thai	Mandarin Thai	
CV(V)	/lau, paa, maa/	/fej, tuo/	/k ^b aa/
CVC		/fəŋ/	
CCV(V)		/sjau/	/pju/
CCVC			/kjɛn/

2.4. Procedure

The experiment was conducted in quiet rooms in Bangkok for the EM and IT listeners and in Beijing for the IM and ET listeners. Participants heard the stimulus words via AKA headsets. A practice session and an experimental session were run.

The listeners performed the mapping task followed by the rating task. Instructions were

displayed in the native language of the listeners. Listeners first heard a Mandarin/Thai (non-native) tone and then selected the Thai/Mandarin (native) tone which sounded most similar to the non-native tone by pressing a computer key labeled with Thai/Mandarin transcription. They then rated the similarity between the non-native and the native tones on a 5-point Likert scale from 1 “least similar” to 5 “most similar” by pressing one of the number keys. In the practice session, 10 non-native words were randomly presented for mapping and rating. Short breaks were provided between blocks. The experiment lasted for approximately 15 minutes and was self-paced, though the listeners were instructed to respond as fast as possible.

3. RESULTS

Results include not only the assimilation patterns with their ratings from the assimilation task, but also the acoustic properties of each tone in Mandarin and Thai collected for the current study to show the acoustic similarities and differences between the tones.

3.1. Acoustic analysis

Pitch height and direction (contour) were compared between the Mandarin and Thai tones, while other features were neutralized as tone is mainly characterized by pitch height and direction [4]. Intensity was equalized across all the tones and duration was normalized for each tone category across syllables.

The pitch of each token was converted from the original Hertz (Hz) to T value using formula (1). As previous studies suggest (e.g., [8]), the use of T (from 0 to 5 in pitch height) to replace the pitch level in Hz was expected to accommodate the difference in pitch range among the talkers, especially between the males and the females.

$$(1) \quad T = ((\log X - \log L) / (\log H - \log L)) * 5$$

X is pitch (in Hz) of any given point. L is the lowest and H is the highest pitch (in Hz) for a given speaker.

Five critical points separated by four intervals from one endpoint to the other (i.e., 0%, 25%, 50%, 75% and 100%) were selected for each tone to compare pitch height and direction. Mean ranges for the level tones, as well as the mean falling ranges and/or rising ranges for the contour tones, were calculated [8]. Results are shown in Table 2. As can be seen, based on pitch values of the critical points and their contours, the nine tones

can be categorized into level, falling and dipping tones. Of the dipping tones, Dipping-1 carries a short and slightly falling contour before turning to a long rising trajectory, contrasting with those labeled as Dipping-2, with a longer and deeper falling contour before a switch to the rising part. Furthermore, falling tones are differentiated by the T value in the initial position; high falling tones

start with a higher T value and low falling tones with a lower one. As a result, Mandarin has one level tone (MT1), one falling tone (MT4), one Dipping-1 (MT2) and one Dipping-2 (MT3) and Thai has one level tone (TT1), two falling tones (high falling: TT3 and low falling: TT2), one Dipping-1 (TT4) and one Dipping-2 (TT5).

Table 2: T value of the five critical points for the four Mandarin tones (MT1-MT4) and the five Thai tones (TT1-TT5), their ranges, and description of each tone based on their contours.

Description	0% (SD)	25% (SD)	50% (SD)	75% (SD)	100% (SD)	Range (SD)	Falling range (SD)	Rising range (SD)
MT1 Level	3.8 (.3)	3.8 (.3)	3.8 (.2)	3.8 (.2)	3.8 (.3)	0.2 (.1)		
MT2 Dipping-1	3 (.5)	2.8 (.5)	3 (.4)	3.3 (.4)	3.5 (.9)		0.3 (.2)	1 (.2)
MT3 Dipping-2	2.6 (.9)	1.3 (1.2)	0.7 (.9)	2.3 (.7)	2.6 (.8)		2 (1)	2.4 (.9)
MT4 High falling	4.2 (.3)	4.1 (.2)	3.6 (.2)	2.6 (1)	1.9 (1.4)		2.7 (1.1)	
TT1 Level	3.4 (1)	3.2 (.9)	3.1 (.9)	3.1 (.9)	3.1 (.9)	0.3 (.2)		
TT2 Low falling	3.2 (1.1)	2.6 (.9)	1.7 (1.2)	1.7 (1.7)	1.2 (1.5)		2.6 (1.2)	
TT3 High falling	3.6 (1.1)	3.7 (1.1)	3.6 (1)	2.3 (.9)	1.6 (1.2)		2.2 (1.2)	
TT4 Dipping-1	3.4 (.9)	3.2 (.8)	3.3 (.8)	3.5 (.8)	3.7 (.7)		0.2 (.2)	0.6 (.1)
TT5 Dipping-2	2.8 (1.2)	1.6 (1.2)	1.2 (1.3)	2.9 (1)	3.7 (.8)		2 (1)	2.8 (.9)

Table 3: Tone assimilation (in %) between L1 and L2 tones and their ratings (1-5, 1 = least similar, 5 = most similar) by native listeners of Thai and Mandarin with (EM, ET) or without (IM, IT) L2 experience. L2 tones are the presented tones.

L2 tone	IM		IT		EM		ET	
	L1 tone	Rating	L1 tone	Rating	L1 tone	Rating	L1 tone	Rating
MT1			TT1 (59%)	4			TT1 (96%)	4.2
MT2			TT4 (61%)	3.6			TT5 (53%)	3.8
MT3			TT5 (51%)	4			TT2 (45%)	3.5
MT4			TT3 (55%)	4			TT3 (72%)	4
TT1	MT1 (99%)	4			MT1 (99%)	4.1		
TT2	MT4 (84%)	3.7			MT3 (88%)	4.1		
TT3	MT4 (95%)	4			MT4 (95%)	4.2		
TT4	MT2 (84%)	3.3			MT2 (55%)	2.7		
TT5	MT3 (78%)	3.7			MT2 (69%)	3.7		

3.2. Mapping-rating task

Table 3 shows the perceptual assimilation of L2 tones (column 1) to their perceived L1 categories and ratings (remaining columns). The assimilation patterns were based on the highest percent of responses despite the fact that the L2 tones were mapped to different L1 tones. Of the four Mandarin tones, MT1 was mapped into TT1 by both the inexperienced and experienced listeners of Thai with relatively high ratings (IT: 4 and ET: 4.2), despite a difference in mapping frequency (IT: 59% vs. ET: 96%). Consistency was also observed for MT4, which was mapped to TT3 by both groups (IT: 55% vs. ET: 72%) with a high rating (4). MT2 and MT3, known as the most confusing tone pair in Mandarin [5], however, were mapped to different Thai tones by the inexperienced and experienced listeners. The IT listeners mapped

MT2 to TT4 (mapping: 61%, rating: 3.6) and MT3 to TT5 (mapping: 51%, rating: 4) while the ET listeners mapped MT2 to TT5 (mapping: 53%, rating: 3.8) and MT3 to TT2 (mapping: 45%, rating: 3.5).

Of the five Thai tones, TT1 was mapped to MT1 and TT3 to MT4 by the Mandarin listeners of both groups with relatively high ratings (TT1→MT1, IM: 99%, 4; EM: 99%, 4.2 and TT3→MT4, IM: 95%, 4 and EM: 95%, 4.2). In addition, the inexperienced and experienced listeners of Mandarin also mapped TT4 to MT2 (IM: 84%, EM: 55%) but with relatively lower ratings (IM: 3.3, EM: 2.7). Inconsistency between the two groups was observed for TT2 and TT5, as TT2 was mapped to MT4 (mapping: 84%, rating: 3.7) and TT5 to MT3 (mapping: 78%, rating: 3.7) by the IM listeners; whereas TT2 was mapped to

MT3 (mapping: 88%, rating: 4.1) and TT5 to MT2 (mapping: 69%, rating: 3.7) by the EM listeners.

To summarize, for IT and ET listeners, MT1 and MT4 were mapped to TT1 and TT3, respectively. For IT listeners, MT2 was mapped to TT4 and MT3 to TT5; while for ET listeners, MT2 was mapped to MT5 and MT3 to TT2. For the Mandarin listeners, TT1, TT3 and TT4 were mapped to MT1, MT4 and MT2, respectively. IM listeners mapped TT2 to MT4 and TT5 to MT3 while EM listeners mapped the two tones to MT3 and MT2, respectively.

4. DISCUSSION

Results of the current study, on one hand, suggest tone assimilation is based on phonetic similarities. For example, the level tones and falling tones in L2 were mapped to tones in L1 from the same categories by all the listeners. On the other hand, the results also indicate discrepancies between the assimilation results and phonetic similarities. For instance, Dipping-1 and Dipping-2 were mapped to those belonging to different categories by the experienced listeners with relatively high ratings. For Mandarin tones, ET listeners assimilated either a Dipping-1 (MT2) into a Dipping-2 (TT5) or a Dipping-2 (MT3) into a low falling tone (TT2). For Thai tones, EM listeners assimilated a low falling tone (TT2) to a Dipping-2 (MT3) or a Dipping-2 (TT5) to a Dipping-1 (MT2). Thus, compared with the inexperienced listeners, tone assimilation by the experienced listeners was not based exclusively on the phonetic similarities.

As discussed in previous research [5], Dipping-1 and Dipping-2 in Mandarin, i.e., MT2 and MT3, are most confusable for native listeners due to their partially overlapping phonological status. Since the tone change is perceived only by native listeners, assimilation of MT2 to TT5 by the ET listeners suggests a native-like confusion between Dipping-1 and Dipping-2.

Another aspect of tone change in Mandarin is that MT3, a Dipping-2, is realized as a low-falling tone (also called “half MT3” as MT3 starts with a relatively low pitch [6]), if followed by MT1, MT2, and MT4. The current results showed that the EM listeners mapped TT2, a low falling tone, to MT3, indicating confusion between the two categories for the native listeners of Mandarin. This result was also observed for the ET listeners as they assimilated MT3 to TT2. Nevertheless, the assimilation between Dipping-1 and Dipping-2 as

well as between Dipping-2 and a low-falling tone was not observed for the IM or IT listeners, indicating greater influence of phonetic similarities on tonal assimilation by the inexperienced listeners.

In conclusion, the findings of the current study support previous research with data from a tonal assimilation paradigm indicating L2 speech assimilation is based on phonetic similarities between L1 and L2; whereas for listeners with L2 experience, it is also affected by L2 phonemic variations.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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