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Second language identification of Vietnamese tones by native Mandarin learners

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Abstract

In this study, we examined native language phonological and phonetic factors in identification of second language (L2) tones by learners with different learning experience. Results show that when L2 tones were Categorised with high percent choice and goodness ratings into native categories, it can be accurately identified. Uncategorised L2 tones tend to be mis-identified as other L2 tones that were assimilated into overlapping native response categories. L2 tones with unique phonetic characteristics can be easily identified even though they were Uncategorised. Thus, our research has theoretical implications for L2 speech learning models and ramifications for L2 lexical tone teaching and learning.

Index Terms: Vietnamese, Mandarin, lexical tones, second language perception

1. Introduction

Native language (L1) experience affects non-native perception of consonants, vowels, and lexical tones, which renders some non-native categories more difficult to perceive than others. In addition, increased experience with a second language (L2) can facilitate perception of some L2 categories. Most cross-language research has focused on perception of non-native consonants and vowels and by listeners with no L2 experience [1], [2]. Only a few studies have investigated how L1 affects L2 perception of lexical tones, and they tested L2 learners of non-tonal languages, such as English [3]. These learners do not have native phonological categories for lexical tones and are likely to differ qualitatively from L2 learners of other tone languages. Thus, it remains unresolved how L1 experience and varying L2 exposure affect perception of L2 tones particularly by listeners of other tone languages.

1.1. Native language influences

Several theoretical models have been proposed to account for variations of non-native speech perception as affected by native language experience, each with a different theoretical focus. The Speech Learning Model (SLM) [4] and the Native Language Magnet model (NLM) [5] focuses more on individual phonetic categories rather than on phonological contrasts. The Perceptual Assimilation Model (PAM) [6] and the Second Language Linguistic Perception model (L2LP) [7] consider both individual categories and contrasts. While L2LP mainly explores perception of vowels with predictions based on acoustic similarities, PAM elaborates on how native phonological and phonetic properties affect perceptual assimilation of non-native phones into native categories, and how perception varies for non-native categories of different assimilation patterns. PAM was selected as the main theoretical framework and other theories will be discussed wherever relevant.

According to PAM, a non-native phone can be (1) Categorised, i.e., perceived as a good or poor exemplar of a native phoneme, or (2) Uncategorised, i.e., not perceived as like any single native phoneme but still falling within the native phonological space, or (3) Non-Assimilated, i.e., perceived as a non-speech sound.

The original PAM focuses on naïve listeners' performance when they perceive an unfamiliar language for the first time. As their experience with the non-native language accumulates, they gradually develop a common L1-L2 system as depicted by PAM-L2 [8]. According to PAM-L2, no further perceptual learning will occur for a L2 phone that is *phonologically* Categorised as a native category and as a *phonetically* good exemplar of that category. A new category will be formed for the L2 phone that is *phonologically* Categorised but *phonetically* deviant from the native category, or *phonologically* Uncategorised but assimilated to different L1 phones. However, if two L2 phones are perceived as similar to the same set of L1 categories, a single new phonological category that merges the two phones will be formed.

1.2. L2 tone perception

Most L2 speech learning studies on lexical tones either compare non-tonal language learners of different proficiency levels [3], [9], [10] or comparing tonal and non-tonal learners [11]. The former group of studies find that more experienced learners are better at perceiving some L2 tones and show more native-like perceptual patterns than those with less L2 experience or lower proficiency. For example, Hao examined discrimination of Mandarin vowels and tones by L1 English learners of Mandarin at different learning stages: naïve, beginning, advanced [3]. Both beginning and advanced learners perceived /li–ly/ and T1 (high level)–T4 (high falling) tones more accurately than the naïve listeners as expected. In addition, naïve listeners were more accurate in discriminating non-native vowel than tone contrasts, which are absent in their native phonological system, whereas advanced learners increased their sensitivity to tonal distinctions, resulting in equally good discrimination of both contrasts. However, there was no difference between beginning and advanced learners in discriminating the selected Mandarin vowel and tone contrasts. The author attributed this to the fact that the beginning learner group had had more than one year experience with Mandarin and thus had already developed the ability to distinguish basic phonological contrasts.

On the other hand, those that compare tonal and non-tonal learners have found that perception and learning difficulties can be caused by either absence of a functional tone tier in native phonological system in the case of non-tonal language learners or presence of specific native tone categories that interfere with L2 tone development in the case of tone language learners. For

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example, Hao tested identification of Mandarin tones by native Cantonese and English learners [11]. Both groups had problems in distinguishing Mandarin Tone 2 and Tone 3. Additionally, the Cantonese group had difficulties in distinguishing Mandarin Tone 1 and Tone 4, which were assimilated into overlapping Cantonese tone categories. This indicates native tone system interfered with L2 tone perception. But the study did not compare Cantonese speakers of different proficiency and thus it remains unknown how native influence is modulated by second language experience.

To examine how L2 experience modulates L1 phonological and phonetic factors in lexical tone perception, it is desirable to test native tone language learners at different learning stage via both assimilation and identification/discrimination task within a single study. Unfortunately, most studies so far tested L2 discrimination and identification but not assimilation, except for two [11], [12]. However, the former study did not test L2 learners of different proficiency levels and the latter did not include a test of identification. The present study addresses this issue by testing perceptual assimilation and identification of Vietnamese tones by L1 Mandarin learners of different Vietnamese experience.

1.3. Lexical tones in Vietnamese and Mandarin

In this section, descriptions of Vietnamese and Mandarin lexical tones are provided. We relied on existing Chao transcriptions [13] to provide an initial approximation of the *phonetic* characteristics of the tones. Chao transcriptions are based on perceived pitch within speakers' vocal range, in which 5 represents the highest and 1 the lowest pitch in that range. In addition, we distinguished between the specific, concrete f0 properties as shown in Figure 1 and more abstract *phonological* features, which include perceived abstract pitch contours, i.e., level, rising, falling, rising-falling, falling-rising and heights, i.e., high, mid, low.

Vietnamese in the standard/Northern dialect has six tones [14]: two phonologically level tones, high-level V44 (or *ngang* in Vietnamese), and low-level V22 (*huyền*); and four phonologically contour tones, i.e., rising V35 (*sắc*), falling V21 (*nặng)*, which appears to have a modest final rise, and two falling-rising tones, NV214 (*hỏi*), and NV415 (*ngã*).

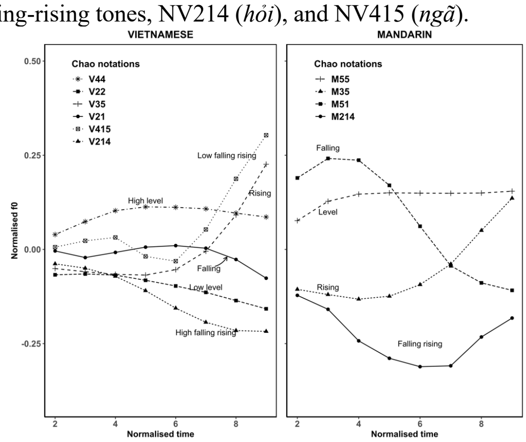

Figure 1: *Time- and Lobanov-normalised [15] f0 contours of Vietnamese and Mandarin. The legends in each panel show the Chao notations for the tones of the respective languages*.

Mandarin (M) has one *phonologically* level and three *phonologically* contoured tones in their citation forms [16]: a high-level tone M55 (or Tone 1 in Mandarin); a rising tone M35 (Tone 2); a falling-rising tone M214 (Tone 3); and a falling tone M51 (Tone 4).

In this paper, we report two experiments that examined phonological and phonetic factors in perception of Vietnamese tones by two groups of Mandarin-native learners with different lengths of Vietnamese L2 learning. The first experiment used a perceptual assimilation task to provide predictions on identification accuracy to be tested in the second experiment, which examined if/how native language influences as indicated in perceptual assimilation patterns was modulated by L2 learning experience in L2 tone perception.

2. Experiment 1 Perceptual assimilation

Experiment 2 (identification) was run first to avoid the assimilation-task-induced L1 influence. But we first reported the assimilation experiment as a background for explaining native influences.

2.1 Participants

Two groups of Mandarin-native learners of Vietnamese participated (beginning leaners: N = 27, M_{age} = 18.41 years, SD_{age} = 0.69, 23 females; experienced leaners: N = 26, M_{age} = 20.35 years, SD_{age} = 0.98 years, 20 females). The participants were born and raised in various regions in China (i.e., Guangxi, Hunan, Yunnan, Zhejiang, Hubei, Guizhou) but were all educated in Mandarin from early childhood through high school, and they used Mandarin on a daily basis. In future research, more homogeneous groups of participants would be desirable, e.g., recruiting only Beijing Mandarin speakers. For practical reasons, however, strict control of dialect background of L2 Vietnamese learners in China was not possible because Vietnamese programs are offered only at a few Chinese universities recruiting a limited number of students each year. With this said, the possible effect of dialect background differences adds potential variation to the assimilation patterns. In the present study, we used participants' assimilation patterns to directly predict and account for variations in their identification accuracy. In this way, dialect effects should be consistent across assimilation and identification tasks. None of the participants had more than two years of formal musical training, which is known to influence tone perception (Gottfried et al., 2004). All reported normal hearing. All participants gave informed consent form prior to testing. The experiments were approved by the Human Research Ethics Committee of School of Foreign Languages, Shanghai Jiao Tong University (approval 2111S1102).

2.2 Stimulus materials

Two consonant–vowel syllables (/ma/ and /mi/, meaningful free or bound morphemes in Vietnamese and Mandarin) that were recorded in a previous study [1] were used here with permission. Two female native Northern Vietnamese informants who were born and raised in Hanoi (M_{age} = 21.5 years) each produced 96 tokens in total (2 syllables × 6 tones × 8 repetitions). A perceptual evaluation experiment was run to select the tokens with the best quality. Two other female native Northern Vietnamese speakers (M_{age} = 20.5 years), who were born and raised in Hanoi and Hai Duong respectively, were presented with these tokens and identified the tones and rated the quality of pronunciation (1= poor, 7 = excellent). The tokens were blocked by each informant and presented randomly within each block. 48 tokens, i.e., 6 tones × 2 informants × 2 vowels

(/a/ and /i/) × 2 tokens that were identified correctly by both native judges and with the highest averaged goodness ratings were selected as the stimuli.

2.3 Procedure

Due to COVID-19 social distancing policy at the time of the experiments, participants were tested online via Psychopy (version 2021.1.3, Peirce et al., 2019) and were required to do the test in a quiet environment with headphones. Intensity of all auditory stimuli was normalised at 70 dB via Praat [18]. Before the test session, participants completed 12 practice trials to familiarise them with the task and were asked to adjust the volume of sounds trial. The stimuli in the practice trials were produced by a third informant that were not used in the test session. No feedback was given in either the practice or test session.

On each trial, a stimulus token was presented, and listeners first made a forced-choice categorisation (assimilation) judgment to their native tones in four Pinyin options via mouse clicks as quickly as possible. Immediately after their categorisation response, they rated category goodness of the token as compared to their chosen native category on a 7-point scale via mouse clicks: 1 = poor, 7 = perfect. Each participant categorised and rated 144 trials in total, i.e., 2 informants × 2 syllables (/ma/ and /mi/) × 2 tokens × 6 tones × 3 repetitions.

2.4 Results

According to PAM, a non-native phone can be a *phonetically* excellent to poor fit (gradient) to a native *phonological* category (categorical). Phonological influence is generally strong for Categorised assimilations and is weaker for Uncategorised assimilations. In addition to those phonological constraints, listeners will nevertheless display some residual sensitivity to the within-category *phonetic* discrepancies of L2 phones from their native categories. Residual native phonetic sensitivity is often quantified by percent choice and goodness ratings of the chosen categories. Following previous studies [1], [2], we divided percent choice of the native tones above chance into three ranges: Low, Medium and High. For the present study with four Mandarin tones, Low covered 25–49% of choices, Medium 50–75%, and High 76–100%. For the category-goodness ratings, we also divided the scale into three ranges: Low = 1–2.9, Medium = 3–4.9, and High = 5–7. These ranges reflect strong, moderate, and weak residual phonetic effects respectively.

Table 1 shows the mean percent choice of categorisation to Mandarin tones and goodness of fit ratings for each Vietnamese tone. Instead of a fixed threshold (e.g., 50% or 70%) for determining Categorised assimilation, we followed statistically-based criteria used in previous studies [1], [2], which are sensitive to variations among different native tone systems. First, a native tone must be selected significantly above chance level (i.e., 25%) by *t*-tests. Second, that native category must be chosen significantly more often than any other response categories. To test this, we fitted the data using two linear mixed-effects models (one for each learner group) with percent choice as the dependent variable, native categories as a fixed factor, and subjects as the random intercept. To calculate the *p*-values for the fixed effects, we used the Kenward-Roger approximation to estimate the degrees of freedom, as recommended by [19], and the *Anova* function from the *car* package [20] in *R* [21], with test specified as "*F*". We then ran multiple comparisons between native response categories using the *R*-package *lsmeans* [22].

For the beginning learners, four Vietnamese tones were Categorised to Mandarin tone categories. V44 and V35 was Categorised as M55 and M35 respectively with percent choices and goodness ratings in the high range. V21 was also Categorised as M51 with medium-range percent choices and ratings, indicating moderate residual phonetic sensitivity in phonological categorisation to the only falling tone in the native system and strong residual sensitivity to phonetic deviation of V21 from M51 in terms of height and range of falling.

Table 1: Assimilation of Vietnamese tones into Mandarin tone categories by beginning and experienced learners.

		Vietnamese stimulus					
Groups		V44	V22	V35	V21	V415	V214
Beginning	M55	**97 (5.6)**	26 (5.0)		8 (3.1)		
	M35			**90 (5.3)**		**59 (3.7)**	
	M214		21 (4.3)	8 (3.4)	13 (3.5)	39 (3.1)	**48 (4.8)**
	M51		**52 (5.2)**		**75 (3.6)**		47 (4.7)
Assim		C	C	C	C	U-$_{f}$	U-$_{c}$
Experienced	M55	**94 (5.9)**	24 (4.8)		12 (3.6)		
	M35			**93 (5.6)**		**52 (3.9)**	
	M214		**38 (4.6)**		25 (4.2)	36 (3.8)	**65 (5.1)**
	M51		35 (4.8)		**60 (3.9)**	10 (3.4)	32 (4.8)
Assim		C	U-$_{f}$	C	C	U-$_{f}$	C

Note: Categories in bold are choices that were significantly above chance (25%); underlined categories are Categorised. Assimilations: C = Categorised, U-$_{f}$ = Uncategorised$_{\text{-focalised}}$, U-$_{c}$ = Uncategorised$_{\text{-clustered}}$ Rating: 1 = poor, 7 = perfect; mean ratings are displayed. "-" = no response or response < 5%.

V22 was also Categorised as M51 with percent choices in the medium range, suggesting medium residual phonetic sensitivity in phonological categorisation to the falling tone in the native system. Given that both V22 and V21 were Categorised as M51, we further compared their goodness of fit ratings. The *t*-test indicated that there was a significate difference in goodness ratings, $t = 3.63$, $df = 38.99$, $p < 0.001$, and thus the V22-V21 contrast was a Category-Goodness assimilation contrast. V415 assimilation was Uncategorised$_{\text{-focalised}}$ because only M214 was selected above chance level. V214 assimilation was Uncategorised$_{\text{-clustered}}$ and split between M51 and M214, both selected significantly above chance level.

For the experienced group, assimilation of V44, V35, V21 and V415 showed the same pattern as that of the beginning learner group. The assimilation of V22 changed from being Categorised to being Uncategorised-$_{\text{focalised}}$ as only M214 was selected significantly above chance level. In addition, V214 changed from being Uncategorised to being Categorised as M214, with percent choices in the medium range and goodness rating in the high range, suggesting reduced residual phonetic sensitivity to phonetic deviation of V214 from M214 compared with beginning learners.

3. Experiment 2 Identification

The participants and tone stimuli in Experiment 2 were the same as in Experiment 1.

3.1 Procedure

On each trial, a stimulus token was presented, and listeners made a forced-choice identification via mouse clicks. They were instructed to click the responding options as quickly as possible after hearing the stimuli and rated its category goodness on a 7-point scale: 1 = poor, 7 = perfect.

3.2 Results

Figure 2 shows the mean percent choice of each Vietnamese tone identifications. We fitted the data using a linear mixed-effects model with identification accuracy as the dependent variable, and learning experiences (beginning versus experienced learners), and tones (V44, V22, V35, V21, V415, V214) as fixed factors, and participants as a random intercept. We calculated the *p*-values for the fixed effects as indicated before. There was a significant main effect of tones, $F(5, 233) = 163.06$, $p < .001$, but no main effect of learning experience nor significant learning experience by tone contrast interaction.

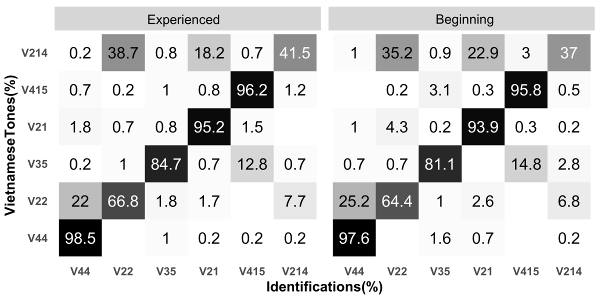

Figure 2: *Identification of Vietnamese tones by L2 learners.*

To further examine the tone type main effect, we ran pairwise multiple comparisons (*t*-tests) with Tukey adjustments for the six tones. These results reflect the following pattern for identification accuracy (from being good to poor): V44 = V21 = V415 > V35 > V22 > V214.

4. General discussion

First, native language affected identification of non-native tones. V44 was Categorised as M55 with percent choices and goodness ratings in the high range by both learner groups. As we expected, it was identified with highest accuracy as facilitated by the native tone category.

Similarly, V21 was Categorised as M51 with percent choice in the medium range and goodness ratings in the low range. Given that M51 is the only falling tone in the native language and L2 learners showed strong residual sensitivity to phonetic deviation of V21 from M51 in terms of height and range of falling, we speculated that a new falling category with modification of M51 has been established for V21 as indicated by the relatively good identification.

V415 was assimilated as Uncategorised$_{\text{-focalised}}$ with goodness ratings in the medium range, suggesting moderate residual sensitivity to phonetic differences between V415 and native tones. This tone was identified with high accuracy, indicating that learners have established a new category in the common L1-L2 perceptual space for this tone.

V35, on the other hand, was Categorised as M35 with percent choices and goodness ratings in the high range by both learner groups. It was identified with high accuracy but not as high as V415. We speculate that better identification of V415 could be explained by its unique phonetic features, i.e., a glottalization in the middle of the tone that can range from a strong laryngealisation to a full glottal stop. This phonetically salient feature can aid its identification.

V22 was percieved as either Categorised or Uncategorised by beginning and experienced learners respectively. In both cases, percent choice of the closest native category was in a medium range, suggesting moderate phonetic sensitivity to the differences between V22 and native categories. The confusion matrices of both groups indicate that V22 was often mis-identified as V44. This is understandable because Mandarin does not have a contrast of height for level tones. Our identification results also suggest that a seperate new category has not been formed for the L2 level tone, V22.

V214 was percieved as Uncategorised by beginning learners and as Categorised by experienced learners. In both cases, the percent choice of the closest native category was in the low-to-medium range suggesting moderate-to-strong phonetic sensitivity. It is likely that learners will modify M214 to accommendate V214 in the common L1-L2 perceptual space. However, our experienced learners have not yet established a stable category for V214 and kept mis-identifying it with other L2 tones, such as V22 and V21, which were assimilated into overlapping native response categories with V214.

Although we did not find significant overall differences between beginning and experienced learner groups in identification, slightly higher identification accuracies for each tone indicate some level of improvement. We speculated that there are some reasons for this lack of significant effects. First, given the importance of tones in Vietnamese, beginning learners need to make use of all the available information in the target tones and their native tones to quickly learn to identify each tone before they can acquire other higher level linguistic units. This is especially true for identification of L2 tones with counterparts in L1, such as V44 or V35, which may be acquired very rapidly in the early stage of learning. Identification of other tones, such as V415, can be aided by their salient phonetic features (i.e., laryngealisation). Second, for some difficult Vietnamese tones, such as V22 and V214, our experienced learner group has not shown much improvement in their identification. This could be attributed to the fact that these learners only had two years of formal classroom-based learning experience rather than natural exposure to Vietnamese in communicative settings.

5. Conclusion

Our current findings demonstrate that native language phonological and phonetic factors affected L2 identification of lexical tones. Categorised tones with high percent choice and goodness ratings can be accurately identified. Uncategorised L2 tones are likely to be mis-identified with other phonetically similar L2 tones with overlapping native response categories in assimilation, with the exception of tones bearing unique phonetic characteristics, such as laryngealisation.

6. Acknowledgements

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7. References

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