On the Learnability of Nuclear and Prenuclear Accents — Using Taiwan Mandarin Learners of English as an Example

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Abstract

This study examined the phonological choice and the phonetic implementation of nuclear and prenuclear accents in L2 English among Taiwan Mandarin learners. Twenty-two advanced Mandarin EFL learners and 22 native American English speakers read 21 English monosyllabic stimuli embedded in a declarative carrier sentence. The EFL learners also read an additional list of 21 sentences in which phonotactically-matched Mandarin stimuli were embedded. Results showed that there is only slight phonetic difference between native and nonnative speakers regarding the nuclear accent. The main difference lies in the prenuclear accent. L2 English speakers generally had a smaller tonal inventory at their disposal, and were less flexible in their placement of prenuclear accents compared to their native counterparts. As for the text-tune alignment, L2 speakers showed deviations of L+H* tone in a gender-dependent fashion, while their alignment of the H* tone was more comparable. This implies that nuclear accents are easier to acquire for L2 learners possibly due to their prominent status, while prenuclear accents pose a problem for even advanced learners. Analyses on Mandarin data showed that the difficulty might stem genuinely from challenges in L2 learning, and could not be easily explained away by a direct negative transfer from Mandarin.

Index Terms: prosody, pitch accent, L2 acquisition, tone type, tonal alignment

1. Introduction

Pitch accents are used in many prosodic systems to highlight information in speech. Based on the degree of structural prominence, the status of pitch accent can be either nuclear or prenuclear, with the former bearing greater phonological prominence than the latter (e.g. [1, 2]). The nuclear accent is the prosodic head of an intonational unit and is thus considered obligatory, while the prenuclear accent is more peripheral and optional [3]. The exact placement of nuclear and prenuclear accents within an intonational phrase is dependent on a combination of elements, including metrical [3, 4], syntactic (e.g. [5]), and pragmatic factors (e.g. [6, 7]), and is supported by perceptual and psycholinguistic evidence. Generally speaking, listeners find nuclear accents to be perceptually more prominent than prenuclear ones [1], and speakers show greater consistency in realizing nuclear than prenuclear accents (e.g. [8]).

Given the complex nature of pitch accents, it is not surprising that L2 learners generally regard mastering phrase-level prominence fairly challenging (e.g. [9]). Previous studies showed that L2 speakers tend to assign accents incorrectly (e.g. [10, 11]), over-accentuate (e.g. [12]), and deviate from the native norm in their peak alignment patterns (e.g. [13, 14, 15, 16]). In this study, we would like to focus on the potential difference between nuclear and prenuclear accents for L2 learners. The fact that native speakers make a clear distinction between these two accents implies that there is a fundamental difference between them in speech planning. As nuclear accents are perceptually more prominent and less variable in production, it is possible that they are easier to grasp for L2 learners than the less prominent yet more variable prenuclear accents. Although most of the previous studies on L2 pitch accent mainly focused on nuclear accents only (e.g. [14]), there is some evidence showing that there might be differential difficulties between the two types of accents for L2 learners. Chen and Fon [13] found that early Mandarin-English bilinguals tend to align accent peaks later than native English speakers only in prenuclear but not nuclear positions. Recently, Chien and Fon [17] also showed that advanced EFL learners made tonal choices that are fairly different from their native norms in prenuclear accents, but were rather unanimous with those in the nuclear position.

Mennen [18] argued that the learning process of prosody should mirror that of segments. L2 learners first learn the phonological representation of a sound before they can correctly implement the phonetic realization of a particular phoneme. Therefore, it is likely that for pitch accents, learners might also master the phonological aspects earlier than the phonetic details. In this paper, we investigated how Taiwan Mandarin learners of English realized their pitch accents in a declarative sentence. There are three aspects that we are mainly interested in, the placement of pitch accents, the choice of tone types, and the text-tune alignment patterns. Following Mennen's [18] arguments, we would predict that L2 learners would have less difficulty with the former two as they involve gross phonological categories, and would more likely show deviation in their alignment patterns. In addition, since many L2 studies tend to assume negative transfer to be the main culprit for deviations from the L1 norm (e.g. [14]), we would like to include Mandarin data of the L2 learners to see if such a transfer indeed exists in pitch accent learning.

2. Method

2.1. Participants

Two groups of speakers were recruited in this study. The first included 22 Taiwan Mandarin learners of English (11 males and 11 females), aged 18-30. All of them were considered advanced learners, as they were either English majors in college and/or had obtained an advanced level of CEFR B2 or C1 in an English proficiency test. The second group included 22 native American English speakers from the U.S. (11 males and 11 females), aged 18-30, who served as native controls. Both groups were recruited in Taiwan.

2.2. Material

The reading material included 21 English declarative sentences of a simple SVO structure in the form of *I know the word X*. Target stimuli of a CV or CVN syllable were embedded as the last word in the sentence. In addition, 21 Mandarin declarative sentences were included as part of the reading material for the L2 learners. These were comparable sentences of *Zhege zi nian X* 'This character reads X'. Phonotactically matched Mandarin monosyllabic target stimuli of Tone 4 (i.e., a high-falling tone) were embedded as the last word in the sentence. The sentences were printed on individual index cards for recording.

2.3. Equipment and recording procedure

A KORG DAT MR-1000 digital recorder along with a SHURE SM10A head-mounted microphone were used for recording. All participants were recorded individually in a soundproof room. The participants were asked to read aloud the sentences at a normal speed and in a natural fashion. They were asked to repeat if there was any pause, cough, or slip of tongue occurring in the middle of their production. The native speakers read only the English sentences while the L2 learners read the additional Mandarin sentences after they read the English sentences. In each session, all 21 sentences were randomized and each speaker had a different randomization order.

2.4. Measurement

The English sentences were labeled using the English ToBI system [19]. The placement of both nuclear and prenuclear accents in the sentence were identified, and their pitch peaks and valleys were extracted using Praat [20], as shown in Figure 1. Single high tones (H*) or bi-tonal combinations with an H element (L+H*, L*+H, and H+!H*) were labeled. Timing of tonal targets (pitch valleys for L and pitch peaks for H) relative to the relevant syllable onset was measured and was later transformed into percentages by using duration of the syllable as the denominator. Mandarin sentences were labeled according to the Pan-Mandarin-ToBI system [21] and pitch peaks of stressed syllables (mostly on *zi* 'character' and the target word) were extracted. Syllable boundaries were determined based on visual inspection of the spectrogram. All labels were cross-validated by both authors.
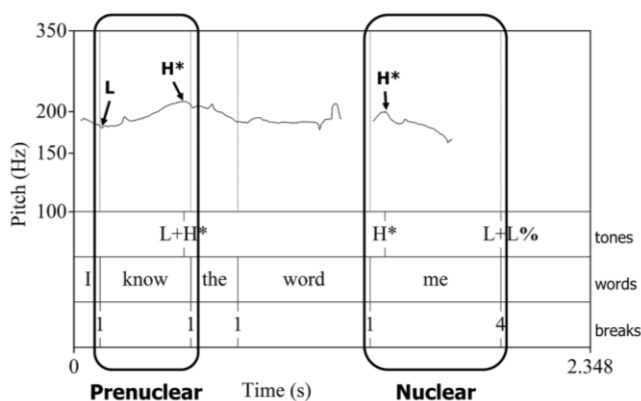

Figure 1: *Measurement of pitch peaks and pitch valleys in H* and L+H*.*

3. Results

3.1. Placement of pitch accents

For both native and L2 speakers, nuclear accents were consistently placed on the final target words in the sentences. However, differences were found in the case of prenuclear accents. Table 1 shows the words on which the prenuclear accents were placed among native and L2 speakers; occurrences were calculated in percentages. In general, native speakers showed more variability in their placement of prenuclear accents than L2 speakers. This is especially true for native females. It is also interesting to note that about 30% of the native sentences did not have any prenuclear accents, while only about 1% of the L2 utterances showed this lack.

Table 1: *Placement of prenuclear accents among native and L2 speakers. ("I": the prenuclear accent was placed on the word I; "know": the prenuclear accent was placed on the word know; None: no prenuclear accent at all)*

	"*I*"	"*know*"	None
Native Male	19 %	57 %	25 %
Native Female	29 %	39 %	33 %
L2 Male	16 %	83 %	1 %
L2 Female	2 %	97 %	1 %

3.2. Choice of tone types

Table 2 shows the tone type choices for nuclear accents between native and L2 speakers. It is clear that although there were three possible tone types for the native speakers (H*, L+H*, and L*), the choice was predominantly H* for both groups.

Table 2: *Tone type choices for nuclear accents.*

	H*	L+H*	L*
Native	97 %	1 %	2 %
L2	100 %	0 %	0 %

Table 3 shows the tone type choices for prenuclear accents on the word *know*. As in their accent placement, native speakers again showed high variability. Four possibilities, H*, L+H*, L*+H, and H+!H*, were found. However, one could see that the rising tone L+H* is the most favored across the four groups of speakers, in contrast to what was found in the nuclear position.

Table 3: *Tone type choices for prenuclear accents on the word "know"*

	H*	L+H*	L*+H	H+!H*
Native Male	18 %	77 %	5 %	0 %
Native Female	8 %	57 %	7 %	28 %
L2 Male	45 %	54 %	1 %	0 %
L2 Female	31 %	60 %	9 %	0 %

3.3. Text-tune alignment

Figure 2 shows the timing of F_0 peak in H* in the nuclear position. Both groups had their H* peaks at about a quarter into the syllable, around 22-25%. However, L2 speakers aligned the tones slightly earlier than their native counterparts, and the difference was near-significant [$t(42) = 1.85$, $p = 0.07$]. The alignment of Mandarin H tones in L2 speakers was around 30%, and was significantly later than their English H* [$t(21) = 5.56$, $p < .0001$].
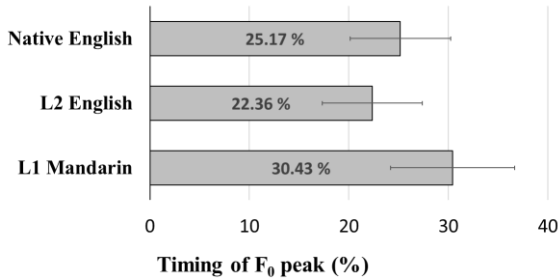

Figure 2: *Timing of F0 peaks of the H* tone relative to the total duration of the target syllable.*

For the prenuclear accent, alignment measurements were done on the most commonly chosen tone on the most commonly accented word, L+H* on *know*. Figure 3 shows the timing of the L and H* target relative to the onset of the word *know*. In the case of H*, percentages greater than 100% indicate that the peak of the H* target was not realized until the following syllable *the*, as in the example of Figure 4. In the case of L, negative percentages indicate that the valley of the L target occurred in the preceding syllable *I*.
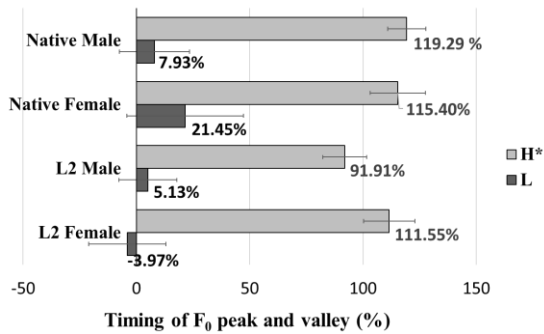

Figure 3: *Timing of F0 valleys (for L) and F0 peaks (for H*) in L+H* relative to the total duration of "know".*
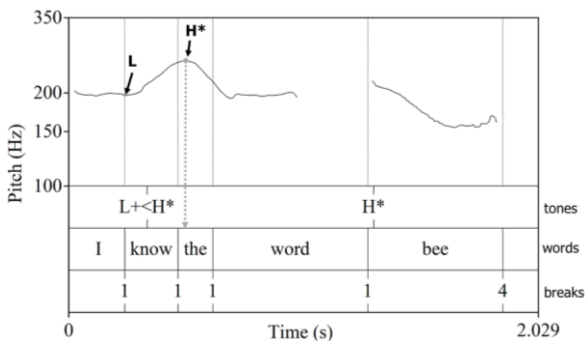

Figure 4: *Example of H* (in an L+H* tone) occurring in the following syllable "the."*

Interestingly, although both L2 males and females differed from the native norm, their deviations showed a gender-dependent pattern. For L2 males, while their timing of L targets was comparable to that of native speakers [$t(12) = 0.38$, ns.], their H* were aligned much earlier than their native counterparts [$t(13) = 5.89$, $p < .0001$]. On the other hand, L2 females showed alignment patterns similar to the native speakers for their H* targets [$t(10) = 0.59$, ns.], yet their L targets occurred earlier than the native norm [$t(8) = 2.06$, $p = 0.07$].

Figure 5 is a comparison of the tonal alignment of prenuclear H* tones in English between the native and L2 speakers. The high tone of the Tone 4 word *zi* in the Mandarin carrier sentence *Zhege zi nian X* was also included as a reference. In general, L2 speakers tended to align the peaks for H* slightly earlier than their native counterparts, although the difference was not significant, likely due to larger variability [$t(15) = 1.05$, ns.]. In contrast, there was a big difference in the F_0 peak alignment between English and Mandarin for L2 learners. Their English peaks were aligned much later than their Mandarin ones [$t(12) = 5.84$, $p < .0001$].
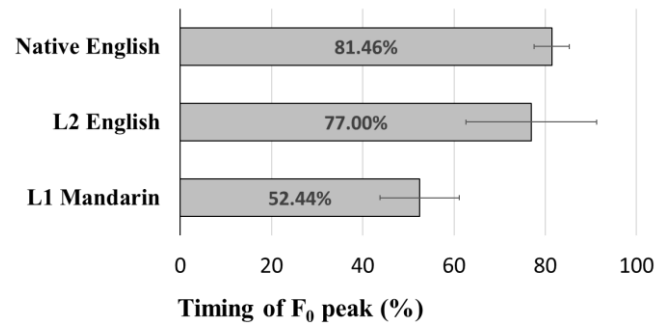

Figure 5: *Timing of F0 peaks of the English H* tone and Mandarin H tone relative to the total duration of the prenuclear syllable*

4. Discussion and conclusion

The results in this study showed that English prenuclear accents indeed pose a greater challenge to L2 speakers than nuclear accents, which is similar to what was found in the literature [13, 17]. L2 speakers' nuclear accents were fairly comparable to those of native speakers in tone type, accent placement, and text-tune alignment to a lesser extent. However, their prenuclear accents diverged from the native norm both phonologically and phonetically.

On the phonological level, L2 learners were less flexible than native speakers in their placement of prenuclear accents and choice of tone types. This implies that they might be more comfortable following a fixed pattern when assigning pitch accents, and they might have access to a smaller tonal inventory. This is likely due to their L2 input, which mainly occurred in an EFL environment, and might not have included the same range of variability as that of natural speech. However, it is crucial to note that displaying less variety than the native norm does not necessarily mean their L2 productions were "incorrect". In fact, most of the tones they used were identifiable as (mimics of) the native targets. Therefore, at least for this group of advanced speakers, tonal assignment errors did not occur as often (cf. [10, 11]).

Another interesting observation is that the L2 subjects in this study rarely lacked prenuclear accents. For a simple, short declarative sentence, it is natural for native speakers not to place any prenuclear accent before the nuclear accent. However, this is rarely the case for L2 speakers. This finding mirrors the "over-accentuation" phenomenon reported in previous L2 studies, in which L2 speakers were reported to produce more pitch accents than native speakers (cf. [12]).

On the phonetic level, L2 speakers diverged from the native norm in their alignment of the prenuclear rising L+H* tone in a gender-dependent fashion. For L2 males, their timing of the L target was comparable to that of native speakers. However, their H* targets were aligned much earlier. While the other three groups had their H* occurring unanimously in the following syllable, L2 males aligned their H* near the syllable end and seldom crossed over the syllable boundary. Given that the alignment pattern in Mandarin is syllable-bound and tonal targets are reported to align with syllable ends [22], this deviation may result from a negative transfer from their L1 Mandarin. For L2 females, their L target was aligned earlier than the native norm, which implies that they might need more time to prepare for the "rise" in the L+H* tone. Given that female speakers in general have a wider pitch range (e.g. [23]) and therefore require a steeper rise in a rising tone type, it is likely that such a shift in the L target reflects an accommodation for articulatory difficulty.

Contrary to the L+H* tone, the alignment pattern of the H* tone was more similar between native and L2 speakers. For both nuclear and prenuclear accents, L2 speakers tended to align the tone slightly earlier (around 3%) than their native counterparts. They also showed more variability in alignment in the prenuclear position. However, compared to the L+H* tone, these deviations were relatively minor. In other words, whether L2 speakers are able to implement (near-)native phonetic alignment patterns seems to be dependent on the tone type and the accent position. Bi-tonal accents and prenuclear positions are more difficult to master than mono-tonal accents and nuclear positions. For mono-tonal accents, advanced learners seemed to have less trouble mimicking the English way and were more likely to be on the target in the nuclear position, despite the fact that their Mandarin adopts a completely different text-tune alignment rule.

This study showed that pitch accent realization is indeed a challenge to L2 learners of English. However, it is a challenge that is not completely unsurmountable. Nuclear accents are more easily mastered than prenuclear ones, possible because they carry greater prominence, and are less variable. However, most of the prenuclear accents produced by L2 learners are identifiable as (mimics of) native targets. It is thus possible that learners could still fine tune themselves to grasp the nuances of prenuclear accents as they plod along the course with more input.

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