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The Effect of English Proficiency on the Production of English Intonation by Chinese EFL Learners

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ABSTRACT

English intonation is an integral component of English pronunciation teaching. However, as students' proficiency levels in English pronunciation improve, it remains unclear whether their intonation levels also develop. The present study, based on the second language intonation learning theory, aims to investigate the influence of English proficiency on Chinese EFL learners' production of English pitch accents, edge tones, and intonation patterns from the perspective of phonological representation. Two language groups of participants took part in a reading task: native English speakers (12) and Chinese EFL learners (36). The learners were classified into three groups based on their scores in the Chivox National Spoken English Test, ranked from high to low: the advanced, intermediate, and elementary groups. The reading task comprised 90 dialogue pairs. The participants were required to read part B of each dialogue pair aloud, but afterwards, only the Chinese EFL learners attended the semi-structured interview. The results showed that the native English speakers only demonstrated significant differences from each learner group in four of the ten intonation types involving the three aspects of English intonation, which may indicate regional variations in American English and difficulties distinguishing (H*) and (L+H*). In addition, there were no significant differences between the three learner groups in producing the ten intonation types, which maybe attributed to their similar learning experiences.

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INTRODUCTION

English intonation is a key element in pronunciation and refers to "the use of suprasegmental phonetic features to convey post-lexical or sentence-level pragmatic meanings in a linguistically structured way" (Ladd, 2008, p. 4). It conveys a speaker's linguistic information and influences their attitude (Chen, 2008). Moreover, it is an essential indicator of "speaker identity, reflecting the speaker's physical state, age, gender, psychological state, and sociolinguistic membership" (Mennen, 2007, p. 53). The recently published Teaching Guideline for English Majors has made requirements for English intonation in four core courses: oral English, comprehensive English, audio-visual-oral English, and English public speaking and debating, and has explicitly stated that students are supposed to master standard English intonation (Guidance Committee for English Major Teaching, 2020).

In the past two decades, a substantial body of empirical research has been done on the production of second language (henceforth "L2") intonation (e.g. Barto, 2015; Bi & Chen, 2013; Bu, 2016; Chen, 2008; H. Chien & Fon, 2019; S. Chien & Fon, 2020; Li, Qu, & Zhi, 2020; Lu & Miran, 2016; Meng & Wang, 2009; Nguyen & Dao, 2018; Xia & Mu, 2008). These studies cover various factors influencing learners' production of English intonation, such as English proficiency and first language (henceforth "L1") intonation. Among them, English proficiency is of great value to learners' production of English intonation. It can reveal their developmental processes of acquiring English intonation and provide references for future English intonation teaching.

Previous studies have identified that English proficiency influences learners' production of English intonation; however, the extent of this influence varies (Albin, 2015; Chen, 2006; Graham & Post, 2018; Liu & Chen, 2016; McGory, 1997; Nguyen & Dao, 2018). For example, Albin (2015) presented a significant analysis and discussion. The researcher investigated three kinds of intonation transfer among Japanese learners of English: L1-transferred phrasal H- (a high tone located at the left edge of a phrase, which is similar to English %H), use of low fundamental frequency (henceforth "F0") targets at prosodic boundaries, and simple boundary rise from the final syllable. The results indicated the effect of English proficiency only for the last one. In another major study, Graham and Post (2018) examined the production of English intonation with a narrow focus on late bilinguals of different L1 backgrounds. The effect of English proficiency was limited to the choice of plateau-type H* accent produced by Japanese learners of English. A third study by Nguyen and Dao (2018) investigated intonation patterns of statements and questions produced by Vietnamese speakers at two different proficiency levels. The results showed that most intonation patterns produced by the advanced learners were the same as those of the native English speakers. However, the beginners used a variety of patterns, some

of which were different from those of the native English speakers.

In contrast, there is one study in which the impact of English proficiency has not been found on the production of English intonation. Meng and Wang (2009) explored the characteristics of boundary tones in spoken English by Chinese EFL learners. They found no significant differences in the production of boundary tone patterns between the learners with high and low proficiency in English.

Through further analysis, we discover that these studies employ diverse methods to evaluate the English proficiency levels of learners, resulting in varying degrees of reliability in their classification. For example, in Albin's (2015) study, the researcher did not provide information regarding rates, nor did the researcher test the inter-rater reliability. The only measure the researcher took was that prior to evaluating the learners' recordings, the raters were implicitly encouraged to listen to a model speaker and establish a baseline. In Graham and Post's (2018) study, three native English speakers were instructed to score 1–3 (1, advanced; 2, basic; 3, other) based on their independent judgments. The participants classified into the advanced or basic groups by at least two of the three raters were included in their study. In Nguyen and Dao's (2018) study, the distinction between advanced learners and beginners was primarily based on whether they had any experience studying abroad. In Meng and Wang's (2009) research, the raters consisted of graduate advisors and their students and foreign teachers from Britain. The composition of the raters was complicated, and the reliability of the raters was not mentioned.

In addition, concerning the research on learners' production of English intonation, there are primarily three approaches: the British configurational approach, the American level approach, and the Auto-segmental Metrical (henceforth "AM") approach (Chen, 2009).[1] Researchers have consistently used the first and third approaches. With the in-depth investigation of L2 intonation, a theory based on the AM approach has emerged for cross-language analysis of intonation, offering valuable insights for a more profound explanation of the production of L2 intonation.

The L2 Intonation learning theory (henceforth "LILt") was proposed by Mennen (2015), which holds that deviations observed in the production of L2 intonation by learners are primarily influenced by their L1 intonation. In this theory, four dimensions for cross-language studies of intonation are proposed:

1. The inventory and distribution of categorical phonological elements ('systemic dimension')
2. The phonetic implementation of these categorical elements ('realizational dimension')

[1] The AM approach, developed by Pierrehumbert (1980), is characterized by the key perspective that an intonation contour consists of three structural elements: pitch accents, phrase accents, and boundary tones. Moreover, the three structural elements can be described by two pitch events, H and L (pitch accents, e.g., H*, L*; phrase accents, H- and L-; boundary tones, H% and L%).

3. The functionality of the categorical elements or tunes ('semantic' dimension)
4. The frequency of use of the categorical elements ('frequency' dimension). (Mennen, 2015, p. 173)

Moreover, this theory holds that when learners have limited experience with the use of L2 intonation, they will rely on their L1 intonation to produce L2 intonation. However, as learners' proficiency levels in L2 improve, their production of L2 intonation will be enhanced, at least in some of the four dimensions.

However, few previous studies have systematically investigated the effect of English proficiency on the production of English intonation under the AM framework. For example, in Albin's (2015) study, the researcher focused on three types of intonational transfer. Graham and Post's (2018) study centered on the pitch accent (L+)H* (H* and L+H*). In McGory's (1997) study, the researcher investigated two intonation patterns, H*L-L% and L*H-H%.

From the discussion above, we can draw the following conclusions: firstly, the methods utilized by the researchers to assess learners' proficiency levels in English pronunciation require further improvement; secondly, there is a lack of systemic research on L2 intonation production. Therefore, in this study, we will employ a relatively objective approach to assess learners' proficiency levels in English pronunciation. Furthermore, based on the LILt, we will investigate the effect of English proficiency on Chinese EFL learners' production of English intonation from the perspective of phonological representation, involving the systemic and semantic dimensions.[2] Specifically, the research questions are as follows: (1) Are there any significant differences in the production of English pitch accents, edge tones, and intonation patterns between the native speaker group and each of the three L2 learner groups? (2) Are there any significant differences in the production of English pitch accents, edge tones, and intonation patterns between the three L2 learner groups?

METHODS

This study obtained approval from the ethics committee of UPM [JKEUPM-2022-249]. The ethical review included assessments of ethical issues, an informed consent form, and scientific soundness. Prior to the survey, the participants were informed about detailed information related to the study and required to sign a consent letter.

Participants

The study participants were native English speakers and Chinese EFL learners. We recruited the participants using social media platforms such as WhatsApp and WeChat through a student studying in the United States and the first author's colleague. A total of 13 native English speakers and 50 Chinese EFL learners accepted our invitation.

[2] This study is limited to the phonological level of English intonation rather than the phonetic level, as the former may change the meaning of an utterance (H. Chien & Fon, 2019; Mennen et al., 2010).

We excluded one native English speaker and fourteen Chinese EFL learners based on the following criteria. Firstly, we excluded one native English speaker who was not born in Ohio, USA. According to Kretzschmar (2004), the state of Ohio is often regarded as a model for the "General American." In addition, we excluded 4 Chinese EFL learners who were non-Han Chinese from the Yunnan Chinese dialect regions to ensure homogeneity among the participants. Yunnan is a multi-ethnic province. In addition to the Han ethnic group, there are 24 ethnic minorities. Lastly, 46 Chinese EFL learners took an English proficiency test. Based on the test results, we selected 36 from the learners, 12 for each English proficiency level.

The 12 native English speakers were all undergraduates from a university in Ohio, USA. They consisted of seven female and five male students. The ages of these participants ranged from 20 to 22. They were all born in Ohio, USA. Two of the participants received training in English pronunciation.

The 36 Chinese EFL learners were English majors from a provincial university in Yunnan Province in southwest China. There were 34 female and 2 male students. They were Han Chinese from the Yunnan-Chinese dialect regions. Their ages ranged from 18 to 23. They had no experience of living abroad. They reported that they had normal hearing and no issues with language expression.

Chivox National Spoken English Test

The Chivox National Spoken English Test (henceforth "CNSET") is China's first oral English proficiency test. It uses artificial intelligence speech technology for scoring and relies on big data corpus technology to comprehensively assess candidates' pronunciation, pragmatic, and expressive abilities. The marks of this test can be used to compare a candidate's oral ability at different stages and to compare candidates' abilities in other areas at the same stage (China Information Association, 2021).

This test is hierarchical. Levels 1-2, 3, and 4 correspond to elementary school students, junior high school students, and senior high school students, and level 5 corresponds to college students. Level 5 has six aspects: paper reading, listening and repeating, listening and retelling, listening and answering, listening and summing up, and thinking and speaking. We used the level 5 test materials to assess the learners' English proficiency levels.

The test process and the selection of participants in this study were carefully arranged. Before the test, the participants were given 10 minutes to familiarize themselves with the test's question types. After getting these participants' scores, the researcher sorted their results and selected 12 participants with the highest, 12 with the middle, and 12 with the lowest scores.[3] The ten participants who fell outside the three groups were excluded from the study.

A one-way ANOVA was performed for their scores to examine the extent of the differences between the three groups. The test was significant at 0.5, $F(2,$

[3] We select 12 students for each group to compare with native English speakers. This method may effectively examine the differences between the three learner groups.

33)=67.316, p=0.000, η^2=0.803. Also, post-hoc analysis with Bonferroni correction revealed significant mean differences between the three groups (all p<0.001). To be specific, the mean score of the advanced group (M=68.16, SD=4.23) was significantly higher than that of the intermediate group (M=58.13, SD=2.06), which was significantly higher than that of the elementary group (M=45.98, SD=6.62).

Semi-structured Interview Questions

A semi-structured interview can provide an in-depth understanding of interviewees' views, experiences, and attitudes. Compared to a questionnaire, it can better explore interviewees' true feelings and thoughts because they have more opportunities to explain and clarify what they said (Safrudiannur, 2020).

We used this semi-structured interview to know the learners' learning of English pronunciation and intonation and interpret their actual performance. We designed the interview questions by referring to previous studies (Benrabah, 1990; McGory, 1997; Zárate-Sández, 2015) and taking into account the actual situation of learners. The questions consisted of three parts: 1) questions 1-3 examined the learners' experiences of English learning, 2) question 4 assessed the learners' knowledge of English pronunciation, and 3) questions 5-9 evaluated the learners' knowledge and the use of English intonation.

Materials

The materials used in this study consisted of 90 dialogue pairs. There were two primary sources of these dialogue pairs. One was from previous literature (Benrabah, 1990; Grice, 1995; Li, Wan, et al., 2020; Lian et al., 2013; Ward & Hirschberg, 1985; Wells, 2006; Works, 1985); the other was from dialogue pairs designed by the researcher. These materials were designed to examine the participants' production of English intonation. After completing these materials, we invited a native English speaker to review their grammatical issues, and he made minor revisions to five dialogue pairs.

The materials of this study were divided into five parts, which involved the three structural elements of English intonation and their combinations presented below (Bartels, 1999; Hirschberg & Beckman, 1994; Pierrehumbert, 1980; Pierrehumbert & Hirschberg, 1990; Truckenbrodt, 2012).

Pitch accents:
H* (emphasis), L+H* (correction/ contrast), L* (given information), L*+H (uncertainty)

Edge tones:
L-L% (not questioning a proposition), H-H% (putting up a proposition for question), L-H% (continuation dependence)

Intonation patterns:

H*L-L% (statements), L*H-H% (yes-no questions), H*L-H% (statements and non-finality)[4]

[4] In this study, the three structural elements and their combinations are summarized into three aspects: pitch accents, edge tones, and intonation patterns. Furthermore, each of the three aspects includes different types, and we selected the more representative ones.

We provide some examples below to better illustrate the use of these items in the materials.[5]

(1) A: Who arrived with the salad?
B: Robbie arrived with the salad.
H*, L-L%, H*L-L%

(2) A: Bob made the salad.
B: No. Bill made the salad.
L+H*

(3) A: Mike loves his family.
B: Does Molly love her family?
L*, H-H%, L* H-H%

(4) A: Would anybody in their right mind marry Manny?
B: Anna may marry Manny. (Uncertainty about whether Anna is one of the people in their right mind.)
L*+H

(5) A: Who voted for Oliver?
B: Gail voted for him, but she did not like him.
L-H%, H*L-H%

Data Collection

To accurately reflect the learners' production of English intonation, we extracted a part of a native speaker's recording to elicit the targeted sentences. Before the survey, we invited two native English speakers (male and female) to read all the dialogue pairs aloud. We chose the male speaker's recording based on its audio quality and its suitability for our purposes. Part A of each dialogue pair was extracted from his recording, and then both the extracted sounds and the accompanying texts were integrated into presentation slides.

We provided this guidelines to the participants in the reading task to achieve the research objectives: (1) to familiarize the specific requirements of the reading task using the five dialogue pairs in the slides, (2) to listen to the recordings of Part A and then read B aloud at their normal speed, (3) to pay attention to the hint(s) in the bracket (if any), (4) to read Part B with the intonation patterns that they believe were appropriate, and (5) to read Part B at least twice, with the final reading being fluent.

Setting the location for the reading task and configuring the recording tool parameters were essential aspects of this investigation. This task was conducted in quiet classrooms at the universities where the participants were enrolled. The location was equipped with several laptops. The study's recording software was Audacity 1.3 Beta (Unicode), with a sampling frequency configured at 44100Hz. The sound file was saved as a mono soundtrack in WAV format.

After the recordings were completed, the learners were required to attend the semi-structured interview. First, we introduced the materials and the objectives of the interview. The interview comprised nine questions about their experiences learning English pronunciation and intonation. Second, we conducted individual interviews. Individual interviews contribute to a comprehensive understanding of participants' perspectives

[5] Since the use of pitch accents in English involves different contexts, we limit the scope of the study to English intonation with a narrow focus.

and protect their privacy. Finally, after obtaining their permission, we recorded the interview.

Data Analysis

We followed the Mainstream American English-Tones and Break Indices (henceforth "MAE-ToBI") convention in annotating English intonation (Beckman & Elam, 1997; Beckman et al., 2006; Hirschberg & Beckman, 1994; Silverman et al., 1992). This system has four tiers: an orthographic tier, a tone tier, a break-index tier, and a miscellaneous tier. Using Praat 6.2.14, we can easily identify and annotate the items mentioned above. Figure 1 provides some examples of using this system to annotate English intonation.

Figure 1(A-D) illustrates the four mentioned pitch accent types: H*, L+H*, L*, and L*+H. The pitch target H refers to the upper part of a speaker's pitch range, while the L refers to the lower part. The asterisk (*) following these pitch events indicates the position of the accented syllables. Unlike the other three pitch accents, the H in L*+H is situated on the syllable following the accented one rather than within the accented syllable. Figure 1(E) shows that the H* is preceded by the symbol "!", indicating that the H* in this syllable is realized at a lower pitch compared to the preceding accented syllable.

Figure 1 also illustrates three edge tone types: L-L% (A and B), H-H% (C), and L-H% (D and E), in which the H- and L- are phrase accents, typically found near the accented syllables and the H% and L% are boundary tones, typically located at the end of intonational phrases.

Intonation patterns are composed of pitch accents and edge tones. In Figure 1(A, C, and E), we can observe three distinct intonation patterns, namely, H*L-L%, L*H-H%, and H*L-H%, respectively.

Participants committed a variety of errors in producing English intonation. We classified these errors and illustrated their corresponding pitch contours, as depicted in Figure 2.

Figure 2 provides examples of error types in the production of pitch accents by speakers when conveying given information and emphasis. In Figure 2(A-C), the speakers are expected to use L* on the targeted word "volleyball," but they use H*, L+H*, and L*+H, respectively. In Figure 2(D), the speaker is supposed to use H* on "name" but use L* instead. In Figure 2(E), the expected accent on "name" is absent, resulting in the pitch accent error type Na.

In addition, in Figure 2(A-C and F), the speakers are supposed to use H-H%, but they use P, L-H%, L-L%, and H-L%, respectively. In Figure 2(A), the speaker accents the words "popular" and "at" after the targeted word "volleyball," leading to the edge tone error type P. In Figure 2(D), the speaker is anticipated to use L-H%, but he uses H-H%. In Figure 2(E), the speaker does not accent the targeted word "name," resulting in the edge tone error type NP.

The transcription of English intonation consisted of two steps. One was that the researcher was in charge of the words tier, the breaks tier, and the misc. tier. In

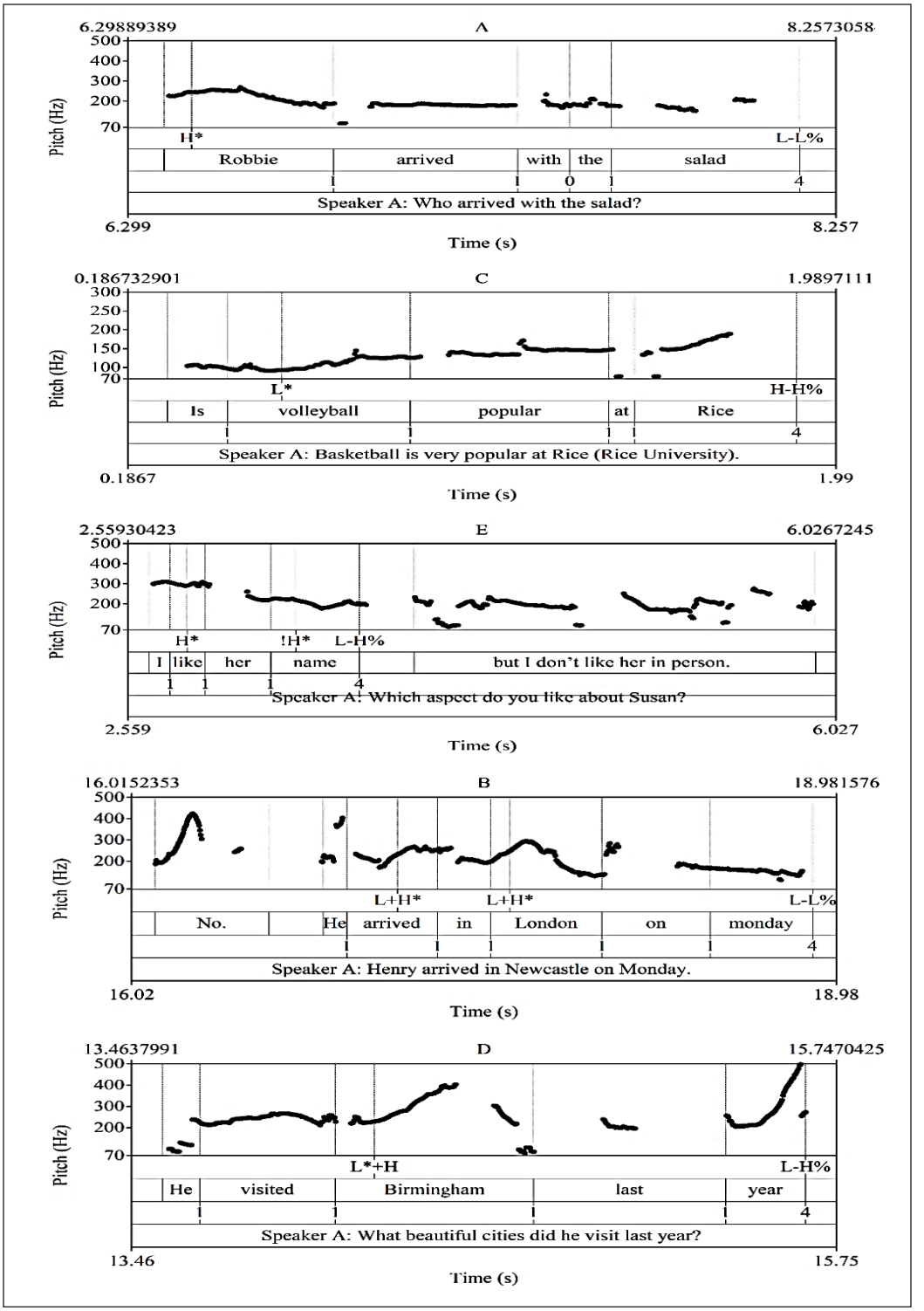

Figure 1. AM analysis of English intonation (*Source:* Authors' work)

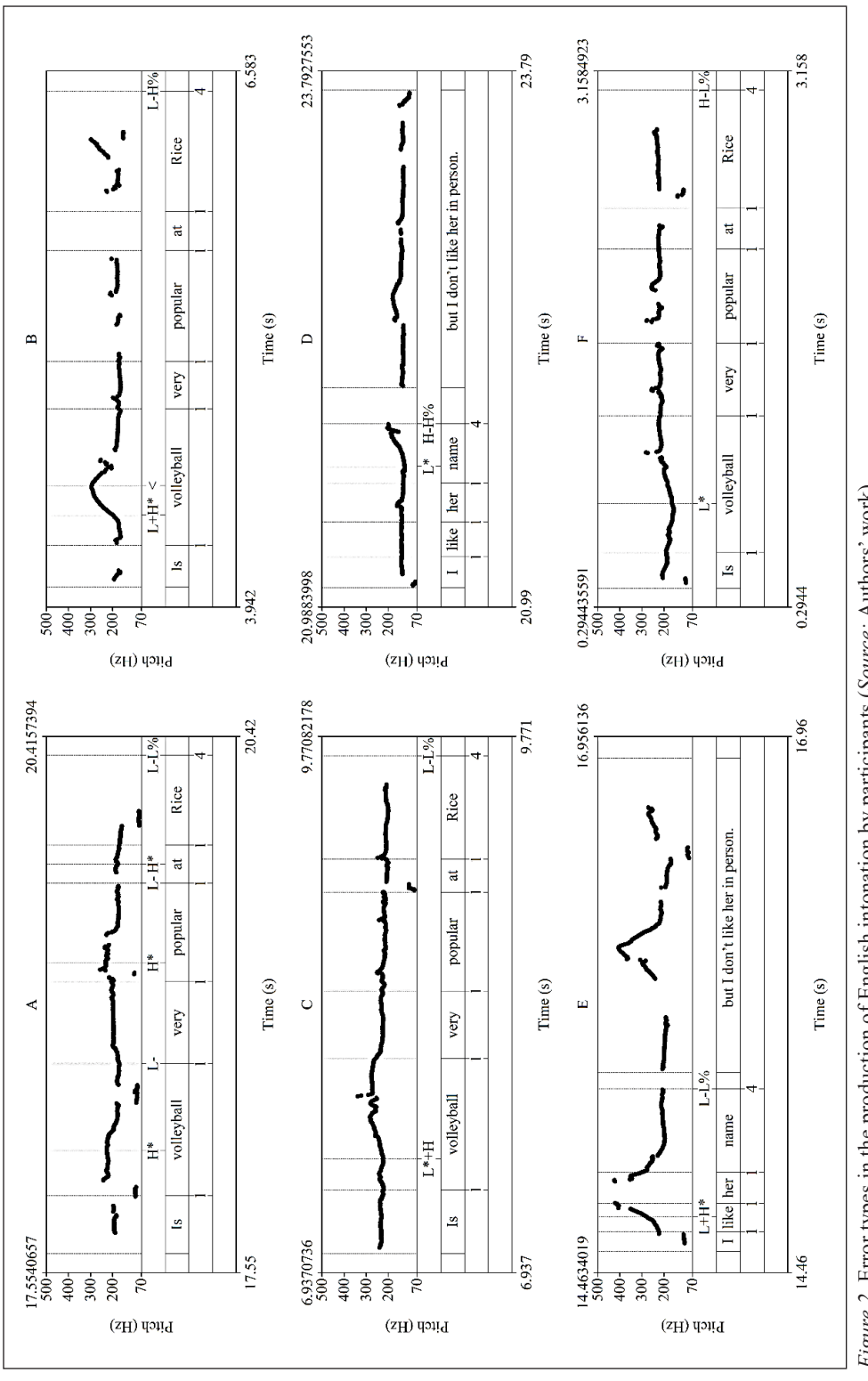

Figure 2. Error types in the production of English intonation by participants (*Source:* Authors' work)
Note. Na is where targeted words are not accented; P is where other accented words follow the targeted words; NP is the case of edge tone caused by Na, with or without accented words following it

addition to these tiers, he was responsible for determining the location of the accented words. In this process, a native English speaker was invited to identify the words the researcher was unsure whether they were accented. The other was that the researcher and his colleague annotated the tones independently. After the end of the annotation, the two raters discussed different tones between them by reviewing previous materials and seeking suggestions from four experts in the field. These experts have a wealth of experience in annotating English intonation. They reviewed the annotated materials we provided and offered detailed explanations.

To ensure the accuracy of the annotations, we tested the inter-reliability between the raters. We first converted the annotated tones into numbers 1 and 0, representing agreement and disagreement with the American model.[6] Subsequently, based on the ratings of the two raters, one-fourth of the recordings (12/48) were selected for a reliability test.[7] The test selected was Fleiss' Kappa. The results showed that the values of pitch accents, edge tones, and intonation patterns were 0.868, 0.8765, and 0.756, respectively. All the values were above 0.75, which suggested a high inter-rater reliability.

For the analysis, we conducted both descriptive and inferential statistical analyses. English proficiency was used as the independent variable, whereas the accuracy scores of pitch accents, edge tones, and intonation patterns were used as the dependent variables. The results of the descriptive statistics for the variable, English proficiency, were offered. A Shapiro-Wilk test of normality was conducted to establish which statistical test should be used. A choice was made between a one-way ANOVA and a Kruskal-Wallis test, depending on whether the data presented a normal distribution and whether the homogeneity of variances test was met (if normally distributed; Cohen, 1988; Green & Salkind, 2014).

RESULTS AND DISCUSSION

Table 1 displays the means and standard deviations of ten types of intonation scores for the four participant groups. The results showed that the native English speaker group achieved higher scores than each of the three learner groups in the ten intonation types except for H*. Moreover, the differences between the learner groups were small for the ten intonation types.

Table 1 also provides the results from the normality tests. The tests revealed the presence of normal distribution for L+H*, L-L%, H-H%, H*L-L%, and L*H-H%. Nevertheless, the homogeneity of variances tests showed significant values of more than 0.05 for L-L% (p=0.158) and H*L-L% (p=0.301) for Levene statistic, but not for

[6] Figure 1 illustrates cases where the participants produced tones consistent with the American model, indicated by a value of 1. However, considering that H-L% in American English is considered a variant of H-H% (Bartels, 1999), we assign a value of 1 to H-L%. On the contrary, Figure 2 displays cases of different tones from the American model, marked with a value of 0.

[7] In Hua's (2019) study, after two raters had rated the recordings, one-fifth of the recordings were used to test the reliability between them.

Table 1
Descriptive statistics and normality test results of ten types of intonation scores for the four participant groups

Types	Group 1			Group 2			Group 3			Group 4		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
H*	10.1	3.6	**0.045**	12.2	2.2	0.113	11.7	2.8	0.406	10.9	2.2	0.583
L+H*	6.4	4.5	0.606	4.3	2.3	0.055	4.9	2.2	0.213	4.6	3.2	0.668
L*	14.4	3.7	0.075	6.2	2.4	0.834	4.7	4.5	**0.039**	4.3	2.1	0.486
L*+H	2.8	3.5	**0.014**	1.7	2.0	**0.016**	0.3	0.7	0.000	0.9	1	**0.028**
L-L%	13.9	1.8	0.635	9	1.7	0.350	7.9	2.8	0.135	8.7	1.7	0.149
H-H%	13.3	3.9	0.060	3.3	1.9	0.779	2.1	1.6	0.363	2.4	1.4	0.811
L-H%	2.1	2.5	**0.008**	1.3	1.5	**0.015**	0.2	0.4	0.000	0.8	1	**0.005**
H*L-L%	9	3.2	0.129	7	2.3	0.100	6.3	2.9	0.928	6.1	2.1	0.294
L*H-H%	12.7	4.6	0.193	3.3	1.9	0.779	1.7	1.4	0.082	2.3	1.2	0.495
H*L-H%	0.8	1.2	**0.001**	0.4	0.7	**0.000**	0.1	0.3	**0.000**	0.2	0.4	**0.000**

Note. Group 1, the native speaker group; Group 2, the advanced group; Group 3, the intermediate group; Group 4, the elementary group; M, Mean; SD, Standard deviation; p, Shapiro-Wilk sig.
Source: Authors' work

L* (p=0.013), H-H% (p=0.029), L*H-H% (p=0.000). Therefore, two different tests were used to evaluate the relationship between the four participant groups and the ten types of intonation scores: L-L% and H*L-L%, a one-way ANOVA test, and H*, L+H*, L*, L*+H, H-H%, L-H%, L*H-H% and H*L-H%, a Kruskal-Wallis test.

The tests showed that no significant differences were found among the four groups for H*, $\chi2$ (3, N=48) = 2.855, p=0.415, L+H*, F(3, 44) = 1.090, p=0.363, and L*+H, $\chi2$ (3, N=48) = 6.777, p=0.079, and H*L-H%, $\chi2$ (3, N=48) = 6.668, p=0.083. However, there were statistically significant differences for L*, $\chi2$ (3, N=48) = 25.399, p=0.000, $\eta2$=0.54, L-L%, F(3, 44)=21.364, p=0.000, η^2=0.593, H-H%, $\chi2$ (3, N=48) = 28.210, p=0.000, $\eta2$=0.6, L-H%, $\chi2$ (3, N=48) = 9.801, p=0.020, $\eta2$=0.21, H*L-L%, F(3, 44)=2.886, p=0.046, η^2=0.164, L*H-H%, $\chi2$ (3, N=48) = 28.212, p=0.000, $\eta2$=0.6.

Post-hoc analyses using pairwise comparisons were conducted with a Bonferroni correction. The results of the tests showed significant differences between the native speaker group and each of the three L2 learner groups for L*, L-L%, H-H%, and L*H-H%, and between the native speaker group and the intermediate group for L-H%. However, no significant differences were found between the groups for H*L-L%. For specific details, see Table 2.

Based on the results of these tests, there were significant differences in four of the ten intonation types between the native speaker group and each of the L2 learner groups. There were also no significant differences between the three learner groups in the ten intonation types.

Table 2
Pairwise comparisons of L, L-L%, H-H%, L-H%, H*L-L% and L*H-H% scores for the four participant groups*

Pairs	L*	L-L%	H-H%	L-H%	H*L-L%	L*H-H%
	***p*(adj.sig.)**	***p***	***p*(adj.sig.)**	***p*(adj.sig.)**	***p***	***p*(adj.sig.)**
Group 1 vs. Group 2	0.015	0.000	0.004	1.000	0.455	0.013
Group 1 vs. Group 3	0.000	0.000	0.000	0.018	0.117	0.000
Group 1 vs. Group 4	0.000	0.000	0.000	0.829	0.067	0.000
Group 2 vs. Group 3	1.000	1.000	1.000	0.128	1.000	0.416
Group 2 vs. Group 4	1.000	1.000	1.000	1.000	1.000	1.000
Group 3 vs. Group 4	1.000	1.000	1.000	0.829	1.000	1.000

Note. Group 1 is the native speaker group; Group 2 is the advanced group; Group 3 is the intermediate group; and Group 4 is the elementary group. p is the mean difference, which is significant at the 0.05 level; *p*(adj. sig.) is the significance level, which is 0.05, and significance values have been adjusted by the Bonferroni correction for multiple tests.
Source: Authors' work

Differences Between the Native English Speaker Group and Each of the Three Learner Groups

To explain the results comprehensively, we examined three main aspects: error types made by the native English speakers, results from the semi-structural interviews conducted with the learners, and previous studies.

Table 3 summarizes the error types of the four-pitch accents produced by native English speakers. Regarding H*, there were two main error types. One was that the native English speakers did not distinguish between H* and L+H* when expressing emphasis. The proportion of cases where H* was replaced with L+H* was 27%. The other was that the targeted words were not accented, which accounted for 13% of the total tokens. With respect to L+H*, the native English speakers did not distinguish between L+H* and H* when expressing contrast. A higher frequency of H* was used in comparison to L+H*, accounting for 55% and 36%, respectively. With regard to L*, though the native English speakers may use other pitch accents, they were not as high in proportion. Regarding L*+H, associating

Table 3
Types of errors in the production of pitch accents in different contexts by native English speakers

Types	Percentages of pitch accents produced and error types (%)				
	H*	L+H*	L*	L*+H	Na
H*	56	27	1	3	13
L+H*	55	36	1	2	7
L*	7	6	80	2	4
L*+H	38	29	10	16	8

Note. The numbers highlighted in grey refer to the percentages of correct responses from the participants; Na refers to the cases where targeted words are not accepted.
Source: Authors' work

this pitch accent with the meaning of uncertainty appeared to pose a challenge for the native English speakers. In this case, alternative pitch accents, H* (38%), L+H* (29%), and L* (10%) were used to substitute for this pitch accent.

The above results show that the native English speakers did not distinguish between H* and L+H* when expressing emphasis or contrast. It was consistent with Bartels's (1999) and Ladd and Schepman's (2003) claims. Bartels merged L+H* and H* into a single H*.

> One further simplification I will introduce here without extensive justification is transcribing all high-pitch accents without trailing tones as H*, whether they might be argued to show a leading L tone. In other words, there will be no distinction between H* and L+H*. The difference between these two patterns may not be a categorical one in phonology; the relatively greater perceptual prominence of L+H* may simply be a function of the relatively higher H* tone (Bartels and Kingston 1995). As to interpretation, any context in which L+H* might be used as a nuclear accent might also display the less emphatic H*, though the former is naturally more likely to promote inferences of 'contrast' arising from ostensibly greater speaker involvement (Bartels, 1999, pp. 19-20).

Ladd and Schepman (2003, p. 104) regarded H* and L+H* as "instances of a single accent category," which were described as (L+H)*.

> The F0 level of the F0min and the second H* accent is affected by the number of syllables intervening between the two accented syllables in a way that is not predicted by Pierrehumbert's "sagging transition" model, which is central to the distinction between H* and L+H*. We, therefore, argue that in both H* and L+H*, there are distinct L and H targets and that the two should be regarded as belonging to a single accent category (Ladd & Schepman, 2003, p. 81).

With regard to the issue above, we consulted with Nanette Veilleux (Professor, Computer Science and Informatics Program, Simmons University, personal communication, 2022/1/1) about the necessity of distinguishing between these two pitch accents. She replied that "Native English (either British or MAE) speakers can hear a distinction. Labelers usually describe hearing the Low tone throughout the beginning of the accented syllable, rising to a high tone later. Other labelers describe hearing the "scoop" or "rise" over the accented syllable."

To sum up, although the results showed that the native English speakers did not differentiate between these two pitch accents, it was still necessary to differentiate them due to their distinct meanings in American English.

The second issue related to pitch accents was L*+H. The results of this study did not receive support from other research (Ward & Hirschberg, 1985, 1986; Veilleux et al., 2012). One possible reason for this difference was that the researcher did not intentionally prompt the native English speakers to produce this pitch accent. As mentioned earlier, the researcher simply instructed the native English speakers to read Part B of each dialogue pair based on Part A and the information in parentheses. Moreover, during the recording, the researcher did not interfere with the participants to gain insight into their real use of English intonation.

To gain an in-depth understanding of the use of L*+H by the native English speakers, we conducted a statistical analysis of the frequency with which different native English speakers employed this pitch accent. Table 4 shows the use of L*+H by the 12 native English speakers.

This table shows that some participants used L*+H multiple times, such as 11, 7, and 6. It indicates that these individuals were more inclined to use this pitch accent when expressing uncertainty. On the other hand, some participants used this pitch accent sparingly or not at all, like 2, 1, and 0, suggesting that these individuals were not familiar with the use of this pitch. The results may imply individual differences among native English speakers.

In addition, we found that pronunciation training may potentially impact the use of this pitch accent by native English speakers. In this study, the number of L*+H produced by the two native English speakers who received pronunciation training was 11 and 4, respectively.

Previous research has already established the existence of regional variants in American English (Arvaniti & Garding, 2007; Burdin, 2016; Burdin et al., 2018, 2022; Clopper & Smiljanic, 2011; Kelly, 2012; McLarty, 2018; Reed, 2020). Since the native English speakers in this study were all from Ohio, this result may be attributed to regional differences in American English.

Table 5 shows the error types of the four edge tones produced by the native English speakers. In terms of L-L%, NP and P were the primary error types, accounting for 22% of the total tokens. In relation to H-H%, in addition to NP and P, native English speakers may also use other edge tones, L-H% (8%) and L-L% (4%). Regarding L-H%, the percentage of L-L% was the highest, with a ratio of 59%. The percentages of P and NP accounted for 23%, making them the main error types.

According to the above description, the native English speakers exhibited some error types when producing L-L% and H-H%. Overall, their pronunciation

Table 4
L+H frequency analysis in the 12 native English speakers*

Frequency of occurrence	Participants
0	P02, P05, P09, P10
1	P11, P12,
2	P06, P07
4	P08
6	P04
7	P03
11	P01

Source: Authors' work

Table 5
Types of errors in the production of edge tones in different contexts by native English speakers

Types	Percentages of edge tones produced and error types (%)						
	L-L%	H-H%	H-L%	L-H%	!H-L%	P	NP
L-L%	77	0	0	0	0	9	13
H-H%	4	74	0	8	0	9	4
L-H%	59	3	3	12	0	9	14

Note. The numbers highlighted in grey refer to the percentages of correct responses from the participants. P refers to cases where other accented words follow the targeted words, and NP refers to edge tone caused by Na, with or without accented words following it.
Source: Authors' work

aligned with the American English model (Bartels, 1999; Hirschberg & Beckman, 1994). Nevertheless, there was a substantial deviation from the American English model due to the frequent use of L-L%.

Through further analysis, we found that L-L% was a potential edge tone of continuation for the native English speakers. Empirical findings from both perception and production studies revealed that among native speakers of British English, a notable prevalence of falling tone was observed (Hudson et al., 2019, 2022; Mok et al., 2016; Puga et al., 2017, 2018). In the perceptual experiment, falling tone reached 58%, while rising or level tone accounted for 42%. In the production experiments, the proportion of falling tones was 40%, while the proportion of rising or level tones was 60%. However, we also needed to recognize that this choice may be influenced by regional variations in American English for the same reason as L*+H.

From the discussion above, it can be observed that the native English speakers did not distinguish between H* and L+H*, and they rarely used L*+H and L-H%. These differences may be due to the influence of regional variations in American English, which could be considered a significant factor affecting the differences between the native English speakers and the learners with varying levels of English proficiency.

Differences between the Three Learner Groups

The results of this study were not in line with previous studies (Albin, 2015; Bi & Chen, 2013; Graham & Post, 2018; Nguyen & Dao, 2018). This inconsistency was partly related to the methods used to analyze their results. Most studies had typically relied on frequency rather than inferential statistical analyses. In the study by Meng and Wang (2009), they used inferential statistics, and the results did not show the effect of English proficiency. We analyzed their interview recordings to identify the causes for the mismatch between the learners' performance in English intonation and pronunciation. As a result, we argued that the results could be attributed to their identical or similar learning experiences. In the following part, we will elaborate on this conclusion from four aspects.

Firstly, the learners were only exposed to native English speakers in college. The native English speakers mainly undertook the task of oral English teaching, with the purpose of cultivating the learners' ability in English communication. However, they rarely taught the learners knowledge of English intonation or corrected their problems in English intonation.

Secondly, they all took an English pronunciation course. The School of Foreign Languages offered this course when they were freshmen, and two Chinese English teachers undertook it. It covered all aspects of English pronunciation, such as English vowels, consonants, weak forms, stress, rhythm, and intonation. It may last for one or two semesters.

Thirdly, their knowledge of English intonation was limited. (1) Although English intonation is an integral part of this course, English teachers did not dedicate time and effort to teaching English intonation. There were only 2 or 4 lessons for this part. (2) The textbook introduces seven tones and their usages: high fall, low fall, low rise, high rise, level, fall-rise, and rise-fall (Zhu, 2003).[8] However, English teachers did not provide detailed explanations of these tones. (3) Though English teachers provided dialogues, passages, and songs to train the learners' English intonation, they focused on only two intonation patterns: rise and fall.

Fourthly, in addition to the textbook, they had a handbook of English pronunciation exercises (Zhang, 2010). There are many materials about English intonation in it, including simple sentences, combined sentences, question tags, vocatives, parentheses, and reporting phrases. However, English teachers did not address these aspects in their pronunciation teaching.

Lastly, they had not developed the habit of using English intonation. (1) Most learners (55%) only remembered two tones, rise and fall, and associated using the two tones with sentence patterns, such as declarative and interrogative sentences. (2) A small number of learners (22%) could recall that a rising tone conveyed the meaning of uncertainty or continuation dependence. (3) Almost all the learners (97%) argued that English intonation was important and that English intonation had an impact on a speaker's meaning, attitude, or emotion. However, they reported that they had limited knowledge of English intonation. (4) Most learners (83%) seldom practiced oral English. They occasionally imitated what they heard while watching English movies or TV series or doing listening exercises.

Due to the similar learning experiences of the learners with varying levels of English proficiency, the extent to which their native language influenced them was also comparable. Chinese is a tone language. However, it has its own intonation system (Lin et al., 2020). There are significant differences between Chinese and English intonation systems, which may be a crucial

[8] English intonation presented in this textbook follows the standards of British English. In British English, no differentiation is made between H* and L+H* phonologically (Grabe, 1998; Grabe et al., 1998).

factor contributing to the poor performance of the learners with different English proficiency levels (Bartels, 1999; Lin et al., 2020; Lin & Li, 2011; Pierrehumbert & Hirschberg, 1990; Truckenbrodt, 2012).

CONCLUSION

In this study, we investigated the impact of English proficiency on the production of English pitch accents, edge tones, and intonation patterns by Chinese EFL learners under the AM framework. The results showed significant differences in four of the ten intonation types (L*, L-L%, H-H%, and L*H-H%) between the native English speaker group and each of the three learner groups, which may be related to the failure of the native English speakers to distinguish between H* and L+H* and the regional variations in American English (L*+H and L-H%). Furthermore, there were no significant differences between the three learner groups. However, we observed that the differences in mean scores varied between the three learner groups in the ten intonation types. The differences presented a complex situation where the influence of English proficiency was presented in H*, L*, and H*L-L% but not observed in other intonation types. One significant factor contributing to this result may be that the learners were not consistently exposed to English intonation.

Implication to Theory and Practice

The results of the study have significant theoretical and pedagogical implications. The theoretical implications can be demonstrated from two aspects. (1) This study reflects the independence between the learners' proficiency in spoken English and their proficiency in English intonation. In other words, the improvement of the learners' spoken English is not consistent with the enhancement of their intonation proficiency. It reflects the uneven development in learners' English pronunciation. (2) This study enriches the L2 intonation learning theory. As the learners at different proficiency levels have not gained enough experience in English intonation, they may be similarly influenced by their L1 intonation, resulting in no significant differences in the production of English intonation between the three learner groups.

The following suggestions on pedagogical implications may be considered based on insights from the findings and the interviews with the study participants. English teachers should consider making learners aware of the complexity of English intonation produced by native English speakers. Despite possible regional variations in the production of H*, L+H*, L*+H, and L-H% among native English speakers, we still recommend that learners strive to master these standard forms. It complies with the Teaching Guideline for English Majors (Guidance Committee for English Major Teaching, 2020) and contributes to understanding native English speakers' speech and expressing learners' viewpoints. It may also be helpful to increase learners' awareness of regional differences and differences in non-native varieties of

English. Also, English teachers should be encouraged to fully realize the importance of English intonation. Teaching is the main channel through which learners acquire English intonation knowledge. Therefore, English teachers should fundamentally understand the crucial role of English intonation in language communication to enhance learners' performance in English intonation. English teachers may need further training to ensure that they understand the similarities and differences between English and Chinese intonation systems so that they can transfer this awareness more effectively to learners. Moreover, English teachers should provide equally systematic English intonation instruction to learners of different proficiency levels, and they should adjust their instruction according to learners' varying degrees of difficulty in different intonation types. Last but not least, the textbooks may need to be updated to include the necessary components to increase learner awareness of the complexity of English Intonation. These textbooks should reflect the new changes in intonation research and provide more comprehensive practice materials.

Limitations and Recommendations for Future Research

This study has some limitations. We regarded the production of L*+H and L-H% by native English speakers as regional variations in American English. However, this conclusion still lacks direct evidence. Future studies should take into account the use of these intonation types among native English speakers in other regions to obtain a more comprehensive understanding of the production of English intonation by native English speakers.

In addition, there are great differences between Chinese and English intonation systems in terms of the structural elements and their meanings. However, we did not explore the specific L1 negative transfer. Future studies should systematically compare English and Chinese intonation systems to understand the potential impact of Chinese intonation on learners' production of English intonation.

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