A Contrastive Analysis of English and Chinese Intonation Systems: An Auto-segmental Metrical Framework

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Abstract: Intonation refers to the use of super-segmental features to convey pragmatic meanings at the sentence level in a linguistically structured way. The difference in intonation between the native language and a foreign language may influence second language learners' acquisition of intonation. The purpose of this study is to explore the similarities and differences at the level of phonological representation between English and Chinese intonation systems. This study investigated English and Chinese intonation systems, respectively, from both form and meaning under the Auto-segmental Metrical framework by referring to previous studies and illustrating examples. The results showed that in terms of form, there were notable differences in the structural elements and their inventories between the intonation systems of English and Chinese. In terms of meaning, assertions were represented by different structural elements in English and Chinese intonation systems; the types of structural elements in English intonation possessed the capability to convey complex and subtle meanings, contrasting with the comparatively simpler nature of Chinese intonation. The results indicate the potential effects of Chinese intonation on the acquisition of English intonation by Chinese learning English as a foreign language and provide evidence for explaining the challenges that they face in learning English intonation.

Keywords: acquisition of L2 intonation; Auto-segmental Metrical framework; Chinese intonation; cross-linguistic effects; English intonation

英汉语调系统对比研究-基于自主音段节律框架

摘要：语调指的是运用超音段特征以语言结构的方式传达句子层面的语用含义。母语和外语语调上的差异可能影响第二语言学习者语调的习得。本研究的目的是探索英汉语调系统之间音系表征层面的相似与差异。通过参考以往文献和举例，本研究在自主音段节律框架下，从形式和意义两个方面分别对英汉语调系统进行研究。研究结果显示：形式上，英汉语调系统在结构要素及其集合上存在很大差异　意义上，断言在英汉语调系统中由不同的结构要素表征；英语语调中的结构要素类型具有传递复杂而微妙含义的能力，与相对简单的汉语语调形成鲜明对比。研究结果揭示了汉语语调对中国英语学习者习得英语语调潜在的影响，为解释他们在英语语调学习中面临的挑战提供了证据。

关键词：二语语调习得　自主-音段节律框架　汉语语调　跨语言影响; 英语语调

1. Introduction

English pronunciation concerning the reception and transmission of information plays a critical role in English learning. It is generally composed of segmental features and suprasegmental features. The former usually refers to vowels and consonants, while the latter refers to suprasegmental phenomena, which include stress, rhythm, and intonation (Nunan, 2001). Second, language (henceforth "L2") learners may acquire segmental features with relative ease, while they may encounter various difficulties and yield a sense of frustration in acquiring suprasegmental features. For example, Hua Chen and Bi (2008) reported that suprasegmental patterns produced by Chinese learning English as a foreign language (henceforth "EFL") showed a non-linear trend with no significant improvement over a period of 4 years.

In English, intonation, as a component of suprasegmental features, is essential for communication. It can help a hearer understand which part of the linguistic information in an utterance is more critical. In addition, several studies have reported that it can suggest a speaker's mood or attitude (Hua Chen, 2008; Wells, 2006). In other words, when interacting with native English speakers, intonation patterns used help convey what a speaker intends to signify, and he may be perceived as "purposely, or deliberately being unkind, insistent, and, probably disagreeable" if wrong intonation patterns are used (Benrabah, 1990, p. 14).

However, plenty of studies, including Hua Chen (2008), Bi and Hua Chen (2013), Bu (2016), and A. Li et al. (2020) among others, have demonstrated that acquiring native-like use of English intonation is incredibly hard for Chinese EFL learners. For example, the results from Bu (2016) showed that the tone-related errors made by Chinese EFL learners were manifested in several ways, including the misplacement of the nucleus, the replacement of rise and fall-rise with a fall, the accenting of function words, and a high frequency of tone group. Hua Chen (2006) found that Chinese EFL learners performed well in the primary tones, namely falling, rising, and level tones. However, they struggled with the use of the secondary tones, which refer to the degree of rise or fall, to express attitude and mood. Their intonation errors also included the excessive use of level tones and falling tones. Given the challenges that Chinese EFL learners face in acquiring English intonation, a thorough investigation into the underlying causes is essential.

Recent investigations have demonstrated that the deviations observed in L2 learners' acquisition of intonation might be attributed to the interference from their native language's intonation (Albin, 2015; Mennen, 2007, 2015). For example, a significant analysis and discussion on the subject was presented by Albin (2015). The researcher examined the production of 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 final syllables. The results demonstrated that the frequencies of Japanese learners of English using these three kinds of intonation transfer were higher than those of the native English speakers, which indicated the effect of L1 intonation. Therefore, there is a need to conduct a cross-linguistic analysis of intonation, focusing on English and Chinese intonation systems.

According to the typological definition, the fundamental approach for classifying the world's languages is to distinguish the most significant attributes (Hagège, 1992). From the perspective of prosodic systems, an important attribute distinction is between intonation languages and tone languages. English is a typical representative of the intonation languages, while Chinese is a typical representative of the tone languages (Duanmu, 2004; Du & Yang, 2000; P. Zhang, 2000).

English is an intonation language, and its meaning is related to the use of intonation rather than the lexical meaning it conveys. In English, each word, phrase, or sentence can be pronounced with different intonation patterns to convey distinct meanings. For example, pronouncing the word "dog" with a falling intonation usually expresses a simple declarative meaning. However, pronouncing it with a rising intonation may indicate that a speaker is

asking a question, expressing doubt, or indicating uncertainty.

In contrast, Chinese is a tone language, and its meaning is related to the use of its lexical tones. In Chinese, there are four lexical tones: high level, high rise, low, and high fall. The tones attached to words or syllables are used to distinguish meanings. For example, the syllable "ma" has four different lexical tones, each conveying a distinct meaning, which are "mother", "hemp", "horse", and "scold". Therefore, the misuse of lexical tones will lead to misunderstanding. However, although Chinese is a tone language, it also has an intonation system. For instance, Chinese intonation primarily conveys a declarative or interrogative mood through the boundary tone at the end of an utterance (Z. Li, 2018).

The L2 intonation learning theory (henceforth "LILt") provides a theoretical basis for the comparison of intonation systems between two languages. This theory was proposed by Mennen (2015). It attempts to identify deviations that learners may produce in their L2 intonation learning. The Auto-segmental Metrical theory (henceforth "AM") has also facilitated the cross-language comparisons of intonation. In other words, if both languages can be analyzed using the AM theory, a systematic comparison of their intonation systems can be conducted.

Pierrehumbert (1980) first proposed the AM theory of English intonation. The main points of this theory can be elaborated from the following four aspects (Ladd, 2008) (1) Sequential tonal structure. Pitch contours are phonologically analyzed as sequences of discrete intonational events. In English, three types of such events are distinguished: (initial and final) boundary tones, pitch accents, and phrase accents. (2) Distinction between pitch accent and stress. The phonological element of a pitch contour that correlates with certain stressed syllables is called pitch accent. This element plays the part of perceptual cues to stress or prominence. (3) Analysis of pitch accent in terms of level tones. Pitch accent is the most critical phonological event, which is further analyzed as sequences of pitch targets or level tones, High (H) and Low (L). (4) Local sources for global trends. A sequence of localized phonological events generates global trends in pitch contours.

Both English and Chinese intonation systems can be analyzed from the AM perspective. After the introduction of the AM theory, it has been widely used in the analysis of English intonation (Graham & Post, 2018; Jun & Foreman, 1996; Meng & Wang, 2009). Moreover, this theory has also been applied to the study of Chinese intonation (H. Chen, 2006; A. Li, 2002; M. Lin, 2012). For example, some researchers hold that Chinese intonation is composed of accents and boundary tones (Jia, 2009; M. Lin, 2012; M. Lin et al., 2020).

In the LILt, Mennen put forward four dimensions of cross-language studies of intonation: the systemic dimension, the realizational dimension, the semantic dimension, and the frequency dimension. This paper, however, is confined to two of the four dimensions, namely the systemic dimension and the semantic dimension. The reasons for selecting these two dimensions are twofold. On the one hand, the systemic dimension involves different types of structural elements of intonation, which represent the phonological aspects of intonation. Research has indicated that the investigation of L2 intonation at the level of phonological representation is more imperative than that at the level of phonetic implementation (Chien & Fon, 2019; Mennen et al., 2010) since the former is often accompanied by changes in meaning. On the other hand, the semantic dimension is usually related to meaning, such as focus marking and interrogativity. Past research has shown that even when two languages share a phonological category, it is difficult to predict the relative difficulty that learners face in producing this category if the meanings they convey differ (Mennen, 1999, 2015).

The goals of this paper are threefold: (1) to investigate English and Chinese intonation systems, respectively, from both form and meaning at the level of phonological representation under the AM framework. (2) to summarize the similarities and differences in intonation systems between the two languages. (3) to discuss the potential effects of Chinese intonation on the acquisition of English intonation by Chinese EFL learners.

2. AM Analysis of English Intonation

In the 1970s, two essential phonological theories emerged: Autosegmental Phonology and Metrical Phonology (Goldsmith, 1976; Liberman, 1975; Liberman & Prince, 1977). Based on these two theories, Pierrehumbert (1980) developed the Autosegmental-Metrical (AM) theory for the analysis of English intonation. This theory holds that all the tunes are composed of pitch accents, phrase accents, and boundary tones. In this section, we will systematically analyze the three structural elements of English intonation from both form and meaning.

2.1 Form of English Intonation

2.1.1 Pitch Accents

Since the 1980s, the inventory of English pitch accents has undergone great changes. In Pierrehumbert's (1980) theory, there were seven pitch accent types: H*, L*, L*+H, L+H*, H*+L, H+L*, and H*+H. However, in an article co-authored by her and Beckman (Beckman & Pierrehumbert, 1986), the H*+H was removed from this inventory. They argued that its pattern was re-analyzed as "involving ordinary H* accents produced in an elevated but compressed pitch range" (Beckman & Pierrehumbert, 1986, p. 306).

Subsequently, a standard prosodic transcription system, the Mainstream American English-Tones and Break Indices (henceforth "MAE-ToBI"), was developed (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. The four tiers are illustrated as follows.

1) The orthographic tier, for transcribing words;

2) The break-index tier, for transcribing boundaries between words (0, 1, and 2) and between prosodic phrases (3 and 4);

3) The tone tier, for transcribing tonal events, such as pitch accents, phrase accents, and boundary tones;

4) The miscellaneous tier, for recording additional observations, such as disfluencies and laughter.

In this system, there are two notable changes in the types of pitch accents: one is the assimilation of H*+L into H*, and the other is the change of H+L* to H+!H*. In other words, there are five pitch accent types in American English intonation: H*, L*, L*+H, L+H*, and H+!H*. Figure 2.1 displays the pitch contours of the five pitch accent types. Note that the recordings for Figure 2.1 (A-D) were obtained from two native English speakers studying at a university in the United States. The recording for Figure 2.1 (E) was obtained from Veilleux et al. (2006).

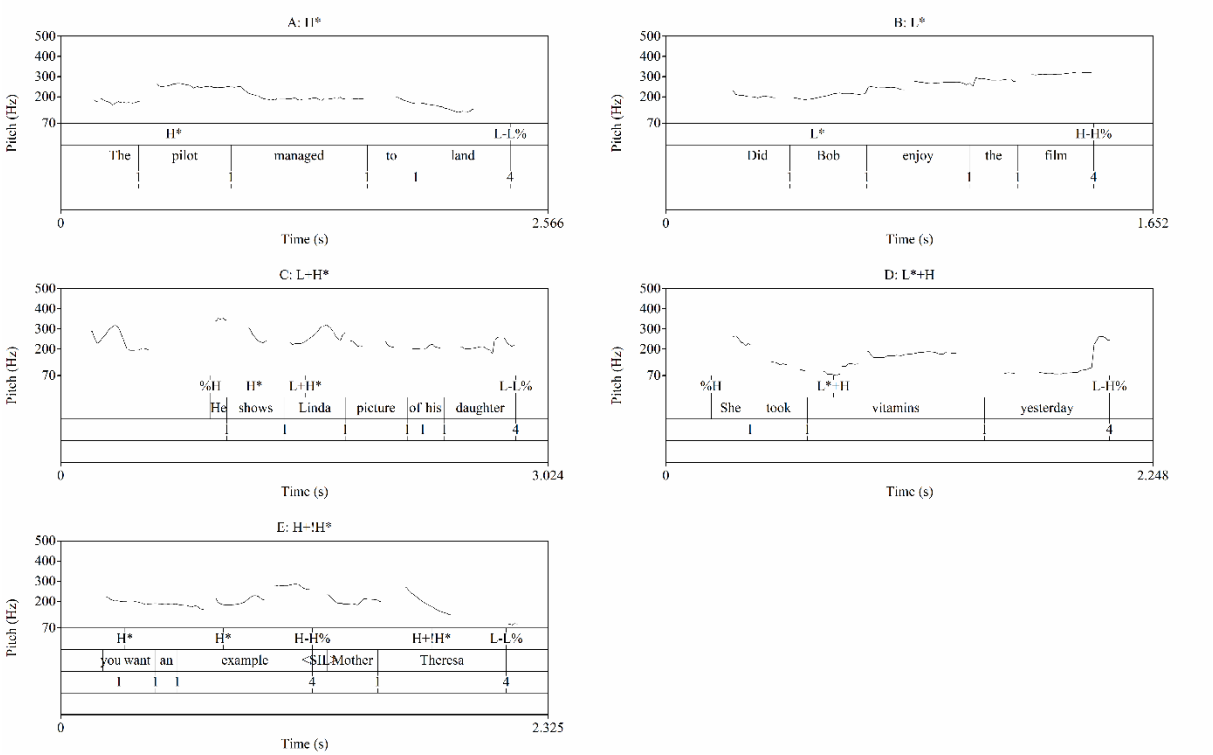

Figure 2.1 Pitch track representations of the five pitch accent types in English

Figure 2.1A shows a tone target on the accented syllable *pi* in "pilot" which is in the upper part of the speaker's pitch range (H*). Figure 2.1B illustrates a tone target on the accented syllable *Bob* in "Bob" which is in the lowest part of the speaker's pitch range (L*). A high tone target on the accented syllable *Lin* in "Linda" is preceded by a sharp rise from the lowest part of the speaker's pitch range in Figure 2.1C (L+H*). A low tone target on the accented syllable *vi* in "vitamins" is followed by a gradual rise to the upper part of the speaker's pitch range in Figure 2.1D (L*+H). A high pitch on the non-accented syllable *The* in "Theresa" is followed by a downstep to the accented syllable *re* in Figure 2.1E (H+!H*).

There is one special issue that should be noted. Grice (1995) distinguished between H+!H* and H+L* in British English[1]. He further proposed that Americans produced H+L*. For example, in (1), the tone sequence H+L*L-H% was used by speaker B to indicate that there was no reason for one to be concerned. However, whether H+L* is treated as part of American English intonation should be investigated further in the future. Thus, it was excluded from the current study.

(1) A: How on earth are you able to do it?
B: It's easy.
H+L*L-H% (Grice, 1995, p. 203)

2.1.2 Phrase Accents

Before discussing phrase accents, it is necessary to distinguish between two types of phrases: intermediate and intonational phrases. For example,

(2) Did John resign or retire?
H*H- H*L-L% (Bartels, 1999, p. 117)

[1] Grice (1995, p. 201) described H+!H* as a "high preaccentual pitch followed by a mid accented syllable", which is similar to the MAE-ToBI standards, while he described H+L* as a "high preaccentual pitch followed by a low accented syllable".

The example presented in (2) consists of only one intonational phrase, which is composed of two intermediate phrases, namely "Did you resign" and "or retire". Two types of phrase accents can be distinguished based on their positions in the sentence. The H- in H*H- is a nonfinal phrase accent, while the L- in H*L-L% is a final phrase accent. Below, we will use final phrase accents to illustrate the pitch characteristics of this type of phrase accent.

The starting points of phrase accents are usually located near accented words. A L- shows a fall in fundamental frequency (F0) to a low level, while a H- shows a rise in F0 to a high level. The former can be referred to in Figure 2.1 A, C, and D, and the latter can be referred to in Figure 2.1 B.

There are discrepancies among researchers regarding whether final phrase accents are absent in certain specific circumstances. Gussenhoven (1983) and H. Chen (2006) believed that in cases where phrase accents were identical to their following boundary tones (e.g., H*L-L%, H*H-H%), these phrase accents could be omitted. Levis (2002), however, indirectly rejected this view. He argued that the complete description of the two low-rising intonation patterns, L*L-H and L*H-H%, should be retained, or one may fail to interpret them. Furthermore, another justification is that final phrase accents have the function of influencing the assertions made by speakers (see examples (7 and 9) in section 2.2.1.1 B). If these phrase accents are deleted, their functions may not be readily apparent.

2.1.3 Boundary Tones

Boundary tones are divided into initial boundary tones and final boundary tones. The former occurs at the beginning of an intonational phrase, while the latter occurs at the end of an intonational phrase. Both of these boundary tones may be marked with a L or H tone, but their symbols differ slightly. %L and %H are initial boundary tones, whereas L% and H% are final boundary tones where the % indicates the location of the boundary. This study primarily focuses on the latter. The H% in example (1) and the L% in example (2) are the two types of final boundary tones.

Figure 2.1 also presents the pitch contours of the two boundary tone types. In Figure 2.1 A and C, the L%s demonstrate that F0 falls to a point low in the speaker's range, from a relatively low level. There are two ways to achieve a H%. The first one involves the rise of F0 to a point high in the speaker's range, from a relatively high point in F0 contour (see Figure 2.1 B). The second one involves the rise of F0 to mid-level or beyond, from a relatively low point in F0 contour (see Figure 2.1 D).

2.2 Meaning of English Intonation

The compositional theory of intonation meaning in American English was put forward by Pierrehumbert and Hirschberg (1990, henceforth"P&H") based on the AM theory of English intonation (Beckman & Pierrehumbert, 1986; Pierrehumbert, 1980). It holds that changes in meaning are realized by the structural elements of English intonation. In this section, we will draw upon the P&H theory as a foundation, while also referencing other research to discuss the meanings of pitch accents, phrase accents, and boundary tones.

2.2.1 Pitch Accents

2.2.1.1 Relationship between Assertion and Pitch Accent

A. Key theoretical perspectives

In the P&H theory, pitch accent is a critical element. First, the use of different types of pitch accents is linked to the status of information. Specifically, they are used to convey "information about the status of the individual discourse referents, modifiers, predicates, and relationships specified by the lexical items with which the accents are associated" (Pierrehumbert & Hirschberg, 1990, p. 286). For example, in (3), there are two H*s, which provide information about the two arguments represented by *George* and *pie* in the utterance.

(3) George likes pie.
H* H*L-L% (Pierrehumbert & Hirschberg, 1990, p. 289)

Second, the use of pitch accents can provide valuable information about whether a speaker is instructing a hearer's mutual beliefs regarding a particular proposition. An intonational phrase is formalized by P&H to elaborate their view. The logical form corresponding to an intonational phrase is regarded as an open expression in which variables are used to replace accented lexical items. For example, the logical form of (3) can be represented as (4):

(4) X likes y
x(H*), y (H*)
x=George, y=pie

The open expression of (4) is "x likes y". The instantiation of x is "George" and the instantiation of y is "pie". Both the two items are assigned an accent H*, which signifies new information in the utterance.

The theory posits the role of pitch accents based on the logical form---"intonational phrases whose accents are all H* appear to signal to H that the open expression is to be instantiated by the accented items and the instantiated proposition realized by the phrase is to be added to Hearer's mutual belief space" (Pierrehumbert & Hirschberg, 1990, pp. 289–290)[2].

Lastly, the conveyed information varies depending on the types of pitch accents. Generally, the five pitch accent types in American English can be classified into two categories. One is that the starred tone is H (H* and L+H*), which indicates that the information is new and a speaker instructs a hearer to add an instantiated proposition to the hearer's mutual beliefs; the other is that the starred tone is L (L*, L*+H and H+!H*), which suggests that the information is not new and the accented items will not "be instantiated in the open expression that is to be added to H's mutual beliefs" (Pierrehumbert & Hirschberg, 1990, p. 291). The not new information refers to information that a speaker believes that a proposition has already existed in a hearer's mutual beliefs, even if the speaker mistakenly believes that the hearer knows the proposition that the speaker is trying to convey.

B. Controversial issues

In (3), P&H did not illustrate the relationship between the two H*s and the hearer's mutual beliefs. Though Truckenbrodt (2012) did not explicitly illustrate which of the two H*s was more important, some insights can be obtained from his examples, which are used to discuss declarative intonation. For example, in example (5), the speaker approaches a receptionist to determine whether he is in the right place for his appointment. Truckenbrodt argued that if the H*s in H*H-H% in these two examples are replaced by L*s, the speakers may convey that the information is part of the hearer's mutual beliefs. In other words, the final pitch accent is the one that affects the decision made by the speakers.

(5) My name is Mark Liberman.
H*H* H-H%
(6) I thought it was good.
H* H*H-H% (Truckenbrodt, 2012, p. 2048)

[2] Mutual beliefs: This term comes from Clark and Marshall (1981) and Joshi (1982). According to the P&H theory, it refers to "those beliefs that conversational participants come to believe to be shared among them as a direct result of the conversational interaction" (Pierrehumbert & Hirschberg, 1990, p. 285). Specifically, this term is used to express the notion of "one-sided mutual belief", which refers to "A's beliefs about what is mutually believed by A and B" (p. 285).

In addition to the issue in (3), there are other issues with this theory. These issues can be grouped into three cases as illustrated by the sample exchanges in (7-9): elements used to question a proposition, L* in declaratives and high-rise intonation in questions. In example (7), Hirschberg and Ward (1995) stated that this utterance could be understood as "I'm calling from Skokie. Have you heard of that place?" (p. 408). The meaning of the H*in H*H-H% is that the instantiated proposition is added to hearer A's mutual beliefs by speaker B. The H-H% is used to question this proposition (Pierrehumbert & Hirschberg, 1990). However, researchers have different views on what element has the function to question this proposition.

(7) A (Chicago radio station DJ): Good morning, Susan. Where are you calling from?
B (Caller): I'm calling from Skokie?
H* H* H-H% (Bartels, 1999, p. 230)
-proposition (henceforth "-pr."). I'm calling from Skokie.

The L* in L*L-H% in (8) indicates that the proposition to be conveyed has become the common knowledge of both the speaker and the hearer. However, the problem is that the speaker really instructs the hearer to add this proposition to the hearer's mutual beliefs, because this utterance is in the declarative mood and has a declarative form.

(8) Question about wishes for birthday presents, where the desire for a Pavoni espresso machine is already mutually believed.
Well, I'd like a pavoni…
L* L* L*L-H% (Pierrehumbert & Hirschberg, 1990, p. 292)
-pr. I'd like a pavoni.

Finally, in example (9), P&H believed that the difference between L* and H* in (9) was not so noticeable. However, the high-rise intonation (H*H-H%) in questions is usually used when a speaker expects the answer to the question to be "yes". In contrast, there is no such expectation for a low-rise intonation (L*H-H%). Therefore, they treated the intonational contour, rather than a structural element, as the source of this difference, which is quite different from other studies (Bartels, 1999; Truckenbrodt, 2012).

(9) A: (Showing B how to make a blouse) This is the left sleeve; and here is the right one.
B: Is there any difference between them?
H* H-H% (Bartels, 1999, p. 126)
-pr.: There is a difference between them.

C. Targeted recommendations

Since the emergence of the P&H theory, two approaches related to it have been proposed. One is that the intonational phrase accent L- is the element to carry an assertion and the difference between L* and H* is reduced to "to be evoked" and "already evoked" (Bartels, 1999, p. 56)[3].

The other is that an assertion of an intonational contour is assigned to H (Truckenbrodt, 2012). The H consists of the pitch accent H* and the final phrase accent H-. Detailed information is as follows:

[3] The term "assertion" refers to the declaration that "a speaker expresses an instruction to the addressee to reduce his context set by all those possible worlds incompatible with the speaker's commitment to that proposition" (Bartels, 1999, p. 54). Fundamentally, this term is similar to P&H's mutual beliefs.

> H* marks a salient proposition as new in the sense of an instruction by the speaker to add the proposition to the common ground of speaker and addressee[4].
> H- marks a salient proposition as put up for question by the speaker. (Truckenbrodt, 2012, p. 2049)

From the above demonstration, Truckenbrodt (2012) agrees with the P&H theory about the role of H*. However, he ascribes the function of questioning a proposition to H-.

In the following part, we attempt to use these two approaches to explain the issues in (7-8). In Bartels's view, a L- in (7) should be used, which is supported by the declarative syntax. However, although this utterance is appropriate as an assertion, it is a question because it conveys uncertainty about the hearer's ability to accept this proposition. As for why the L- is absent, he claimed that it is embedded in the H-. In other words, the proposition in this utterance is assertive (L-), and the question hidden in this utterance is non-assertive (H-). The result of the interaction between the L- and H- is that the H- is preserved and the L- is hidden, which makes her analysis complex. Truckenbrodt argued that H- implements the role of questioning a proposition, which is an alternative way to interpret (7). We argue that Truckenbrodt's proposal is in line with the P&H theory's original intention that different structural elements are utilized to convey distinct meanings.

The L- in Bartels's analysis is an essential cue to determine whether a proposition is asserted or not. In other words, both L*L- and H*L- can suggest an assertion in an utterance. Thus, the issue in (8) cannot be explained by this approach. Different from Bartels, Truckenbrodt believed that the L*L- sequence has the connotation of weak assertion, because the L- in L*L- lacks the capability to question this proposition. In short, acknowledging degrees of assertion appears to be an appropriate interpretation of (8).

In (9), according to Bartels, the phrase accent H- determines the non-assertive nature of the proposition made by the speaker. In other words, the attitude cue of the speaker towards the proposition is the phrase accent. However, the interpretation provided appears to fall short of fully conveying the information intended by the speaker.

We discussed Truckenbrodt's meaning of H with respect to statements provided earlier. When it comes to questions, the meaning of H will be different. The reason is that a proposition in statements can be obtained from the surface of an utterance, while propositions in questions need to be inferred. His main point is as follows:

> H* presupposes that the speaker adds a proposition to the common ground.
> H- presupposes that the speaker is putting up a proposition for question. (Truckenbrodt, 2012, p. 2053)

As for Truckenbrodt, the H* (in H*H-) in questions deals with the fact behind an implicature. Although the content of the implicature in (9) is that there is a difference between them, what the speaker intends to express is that I suppose that there is a difference between them. From the above analysis, we hold that Truckenbrodt's explanation is more reasonable.

2.2.1.2 Multiple Meanings of Pitch Accents

The meaning of a pitch accent type in English depends on the specific context in which it appears, which brings us to the notion of pitch accents in focus. Wells (2006, p. 116) defined focus as "the concentration of attention on a particular part of the message". A key distinction in focus is between broad and narrow focus (Cruttenden, 1997; Wells, 2006). Broad focus highlights everything in an intonational phrase and can serve to answer questions like "What happened?", as shown in example (10).

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[4] The term "common ground" is not defined clearly by Truckenbrodt. However, from his illustration, Stalnaker's (2002, p. 701) definition is closer to his viewpoint: Common ground refers to "the presumed background information shared by participants in a conversation". His understanding of common ground is roughly similar to P&H's mutual beliefs.

(10) A: What happened next?
B: Everyone burst out laughing. (Wells, 2006, p. 116)

However, narrow focus highlights only part of an intonational phrase and can serve to express meanings such as emphasis, as illustrated in example (11).

(11) A: Who brought the wine?
B: Mary brought the wine. (Wells, 2006, p. 117)

In this study, the "multiple meanings of pitch accents" refer to the meanings of accented words with different pitch accent types in narrow focus. For example, utterance B in (12) can be labeled as H*L-L%, in which the H* indicates emphasis (Veilleux et al., 2006).

(12) A: Who brought the wine?
B: Mary brought the wine.
H* L-L%

The L+H* in (13) suggests contrast or correction. Dennison (2010, p. 165) claimed that "the contrastive pitch accent evokes people's pragmatic knowledge of presupposition, where compatible alternative items must exist in the world under consideration, and the contrastive focus is applied to single out the target item against those alternatives".

(13) A: Bob made the marmalade.
B: No. Marianna made the marmalade.
L+H* L-L% (Veilleux et al., 2006)

In English, using L* can convey old or given information. In (14), even though speaker B replaces "Cathy" with "Mary", from the speaker's perspective, hearer A knows whether Mary works in a restaurant.

(14) A: Cathy works in a restaurant.
B: Does Mary work in a restaurant?
L* H-H%

The tone sequence L*+HL-H% was examined in detail by Ward and Hirschberg (1985). It can be utilized to express uncertainty related to a scalar value in a discourse. For example, in (15), speaker B conveys uncertainty about whether Anna is one of the people in their right mind. In other words, speaker B might wonder if a scale (Anna) is relevant in this context.

(15) A: Would anybody in their right mind marry Manny?
B: Anna may marry Manny.
L*+H L-H%

Besides uncertainty, this sequence can also convey incredulity (Ward & Hirschberg, 1986). For example, in (16), what speaker B intends to convey is that a value (ugly) on the temporal scale (a scale of attractiveness) is inappropriate.

(16) A: I bet I know why Mary isn't dating John anymore. He's ugly.
B: He's ugly!
L*+HL-H% (Ward & Hirschberg, 1986, p. 6)

However, P&H presented a different view on what element carries the meaning of uncertainty or incredulity. They argued that the primary cue of this pragmatic meaning was mainly achieved through this pitch accent, not the entire contour. Thereafter, the L-H% can be replaced by other edge tones, such as H-H% and H-L%.

H+!H* implies that a speaker is familiar with earlier items and conveys that the previous proposition might be wrong (Grice, 1995; Hirschberg, 2006). One of its possible meanings is to serve as a reminder. For example, in (17), the meaning of this pitch accent is to remind hearer A that their viewpoint is wrong.

(17) A: No German has ever won the Luce Prize.
B: Joachim's from Germany.
H+!H* L-L%/L-H%

2.2.2 Phrase Accents

In the previous section, we discussed the meaning of final phrase accents as part of our discussion pitch accents. In this section, we will focus on nonfinal phrase accents. There are two types of nonfinal phrase accents: H- and L-. The H- suggests that the current phrase is treated as part of a larger unit with the subsequent phrase, while the L- indicates the separation of the current phrase from the subsequent phrase (Pierrehumbert & Hirschberg, 1990; Bartels, 1999). For example,

(18) Do you want apple juice or banana juice?
H* H- H* L-L%
(19) Do you want apple juice or banana juice
H* L- H* L-L% (Pierrehumbert & Hirschberg, 1990, p. 302)

The meanings conveyed in (18-19) are distinct, and the discrepancy arises from the use of nonfinal phrase accents. In (18), the use of H- indicates that, from the perspective of the hearer, there may be other types of juice in addition to "apple juice", whereas in (19), the use of L- conveys a sense of exhaustiveness.

2.2.3 Boundary Tones

The P&H theory emphasizes the relationship between two or more intonational phrases. The selection of a boundary tone reflects the relationship between the current intonational phrase and its preceding or subsequent intonational phrase. Specifically, a speaker expects a hearer to pay attention to the following utterance when an H% is used. For example, in (20), the H% can be interpreted as: utterance (a) is not the entire content of the discourse, and there may be other utterances, such as b, following it. However, the relationship does not exist between b and c.

(20) a. My new car manual is almost unreadable.
L-H%
b. It's quite annoying.
L-L%
c. I spent two hours figuring out how to use the jack.
L-L% (Pierrehumbert & Hirschberg, 1990, p. 305)

Unlike the above analysis, Bartels focuses on the meaning of boundary tone in a single intonational phrase. He differentiated between statements and questions. As far as statements are concerned, the choice of boundary tone indicates the presence or absence of continuation dependence. H% represents the attitudinal property of continuation dependence, leading to

various pragmatic inferences. However, L% itself is meaningless, only to satisfy the completeness of a prosodic structure. For example,

(21) a. I like Roy's granddaughter.
H* L-L%
b. I like Roy's granddaughter.
H* L-H% (Bartels, 1999, p. 60)

In (21), the two types of boundary tones are the only clue that causes a difference in meaning between these two utterances. The L% in utterance (a) is meaningless itself. However, the H% in utterance (b) indicates that the speaker has not fully expressed his thoughts, and this utterance is only part of what he intends to convey. For instance, one possibility is that I like Roy's granddaughter, but I couldn't care less about him.

The meanings conveyed by boundary tones may differ when they appear in questions. Alternative questions typically entail a detailed, closed, mutually exclusive set of options in which L% is usually utilized. Conversely, an open alternative list is often associated with H%. For example,

(22) a. Did Amy order mineral water, ice tea, or lemonade?
H* H- H* H- H* L-L%
b. Did Mary vote Democrat last year or Republican?
H* H- H+!H*L-H% (Bartels, 1999, p. 90)

In (22), the difference between the two utterances lies in the exhaustiveness of the listed items. The L% in utterance (a) indicates that there are only three items in the set, while the H% in utterance (b) indicates that there may be other items in addition to the two items mentioned.

There are two types of Yes-No Questions (henceforth "YNQs") in English: if-YNQs and whether-YNQs. The basis for this distinction is whether a YNQ is assertive or not. If-YNQs do not have the property of assertion and their propositions correspond to single propositions, while whether-YNQs have the property of assertion and their propositions correspond to alternative propositions. For example,

(23) A. Your roses are wonderful just now.
B. Would you like to take a few?
L* H-H% (Bartels, 1999, p. 124)
-pr.: you'd like to take a few. (if-YNQ)

(24) A: I'm sure of it. I have heard it said many times.
B: Yes, but did you see it yourself?
H* L-L% (Bartels, 1999, p. 127)
-pr.: you saw it yourself, or you didn't see it yourself. (whether-YNQ)

In (23), the default boundary tone is H%, which suggests the expectation to reduce speaker B's uncertainty. In contrast, in (24), the default boundary tone is L%, which means the lack of expectation from speaker B.

Wh-questions are divided into falling wh-questions and rising wh-questions. The presupposed proposition is assertive in falling wh-questions. In contrast, a speaker does not attempt to assert any proposition in rising wh-questions. The boundary tones of the two types of wh-questions may convey different meanings. For example,

(25) A: Where did you put my camera?

H* H-H%

-pr.: you put my camera somewhere.

B: In your daypack.

A: OK. (Bartels, 1999, p. 194)

(26) A: Fred didn't want to abandon it.

B: Fred didn't want to abandon what?

H*L-L% (Bartels, 1999, p. 127)

-pr.: Fred didn't want to abandon something.

The H% in (25) prompts the meaning of continuation dependence, emphasizing speaker A's expectation that hearer B will cooperate to reduce their uncertainty. In (26), the H*L- indicates an assertion, whereas the L% itself has no meaning.

2.3 Summary of Main Findings

In terms of form, English intonation is composed of three structural elements: pitch accents, phrase accents, and boundary tones. The types of each structural element are as follows:

Pitch accents: H*, L+H*, L*, L*+H, and H+!H*

Phrase accents: H- and L-

Boundary tones: H% and L%

In terms of meaning, two central claims can be made. First, assertions are primarily carried by pitch accents, and there are degrees of assertion. Second, the three structural elements of English intonation carry distinct meanings.

Pitch accents:

New or not new information: H* and L+H* (new),
L*, L*+H, and H+!H* (old/ given)

Emphasis: H*

Contrast/ correction: L+H*

Uncertainty/ incredulity: L*+H

Reminder: H+!H*

Phrase accents:

Final phrase accents: The questioning of a proposition

Nonfinal phrase accents: Relationship between two or more intermediate phrases

Boundary tones:

Relationship between two or more intonational phrases

Continuation dependence

Closed or open alternative list (alternative questions)

Expectation (Yes-No Questions, and wh-questions)

3 AM Analysis of Chinese Intonation

The AM theory has had a profound impact on the study of Chinese intonation. It has been applied to the study of intonation in Chinese and has yielded fruitful achievements (A. Li, 2002, 2004, 2021; M. Lin & Li, 2011; Peng et al., 2005). One of these achievements is the featured-based model of Chinese intonation (M. Lin et al., 2020; M. Lin & Li, 2011). In this part, we will first introduce this model, and then analyze Chinese intonation from both form and meaning based on this model.

3.1 Feature-based Model of Chinese Intonation

The model was proposed by M. Lin and Li (2011) with the purpose of serving the teaching of Chinese as a foreign language. However, prior to the proposal of this model,

researchers represented by Lin had already conducted extensive research in this field (H. Chen, 2006; M. Lin, 2004, 2005, 2007a, 2007b, 2011). Later on, this model was further refined and improved (M. Lin et al., 2020).

This model does not explicitly specify the tiers of prosodic analysis for Chinese. However, based on previous studies mentioned above, it involves three tiers, namely a syllable tier, a tones tier, and a break indices tier. Besides, a miscellaneous tier is required to record additional information.

Tones tier

This model posits that Chinese intonation is composed of two elements: accents and boundary tones. The realization of these two elements is based on the lexical tones in Chinese. Table 3 presents the feature-based model of Chinese intonation[5].

Table 3.1 Feature-based model of Chinese intonation (M. Lin et al., 2020, p. 27)

	Initial boundary tone	Accent	Final boundary tone
Narrow focus		[+RH] or [+LL]	
Broad focus		[-RH] and [+LL]	
Statements	LT%		LT%
Questions	RT%		RT %
Exclamation		[+RH▲]	
Imperative			RT *%

Notes: R, raise; L (the L in LT% and the first L in [+LL]), lower; H and L (the second L in [+LL]), high and low points of pitch contours; T, the pitch contour of a tone.

Accents

Accents associated with narrow focus are narrow focus accents, which manifest as raising one or two non-Tone3 syllables' high (H) points within a phrase relative to its preceding and succeeding syllables. This raising results in the expansion of their pitch range and an increase in their duration. Also, Tone 3's low (L) points within the phrase are lowered, further extending their pitch range and duration. In contrast, accents related to broad focus are broad focus accents that manifest themselves in the gradual lowering of the high points of each prosodic word and in the enlargement of the pitch range of the final prosodic word and an increase in its duration.

Boundary tones

The information conveyed in statements and questions is primarily carried by the last one or two stressed syllables in the final prosodic word of a phrase. Still, it can be conveyed by the first syllable of a phrase. The realization of boundary tones is to raise or lower the pitch relative to the lexical tones of these syllables.

PinYin tier

Canonical Pinyin and tone for each syllable are labeled in this tier. The four lexical tones are labeled 1, 2, 3, and 4, respectively. Also, the neutral tone is labeled as 0.

Break indices tier

This model distinguishes four prosodic units: syllables, prosodic words, prosodic phrases, and sentences. Prosodic words are groups of syllables that are considered closely linked by a hearer in a segmented listening experiment. Prosodic phrases contain two prosodic words, or one prosodic word and a compound prosodic word, or two compound prosodic

[5] This study focuses on accents in narrow focus and boundary tones in statements and questions to compare them with English intonation.

words. Compound prosodic words are usually made up of two prosodic words that are more closely combined with each other. When a pause occurs within a sentence, the sentence is segmented into two prosodic phrases. For the convenience of later annotation of Chinese intonation, we number these four prosodic units as 1-4, corresponding to syllables, prosodic words, prosodic phrases, and sentences, respectively.

Miscellaneous tier

Additional information, such as disfluencies and laughter, is recorded in this tier.

This model contributes to understanding Chinese intonation. It proposes that Chinese intonation consists of accents and boundary tones and discusses their realization in detail, which serves to teach Chinese as a foreign language. Also, this model provides a basis for comparing English and Chinese intonation systems. However, this model has several limitations. For example, there are still controversies regarding the use of the term "pitch accent" and the carrying unit of boundary tone. We will address these issues in the next section.

3.2 Form of Chinese Intonation

3.2.1 Lexical Tones

Chinese is a tone language (Duanmu, 2004). To analyze Chinese intonation using the AM theory, it is necessary first to describe the lexical tones in Chinese using the AM theory's norms. This is because Chinese intonation is heavily reliant on its lexical tones.

There are four lexical tones in standard Chinese. When read individually, their standard tonal values are 55 for high level, 35 for high rise, 214 for low, and 51 for high fall (M. Chen, 2004; A. Li, 2002; Z. Li, 2018; T. Lin, 1989). Some researchers, such as Yip (2002), have attempted to use H and L to describe Chinese lexical tones. See Table 3.2 for details.

Table 3.2 AM description of Chinese lexical tones (Yip, 2002, p. 180)

Tone	Description	Tone letter	Tonal feature
Tone 1	High level	55	H
Tone 2	High rise	35	LH
Tone 3	low	21(4)	L
Tone 4	High fall	53	HL

Table 3.2 demonstrates the AM representation of Chinese lexical tones. According to the description of Tone 1, 2, and 4, they are marked as H, LH, and HL, respectively. Though the pitch value of Tone3 is 21(4), it is appropriate to describe it as "L". Shi (2020) argued that the essential tones in standard Chinese are tones in continuous speech. He provided three justifications to support his argument: "(1) the continuous tones are closer to native tone; (2) the monosyllabic tone has boundary elements; (3) continuous tones are closer to actual language communication". Consequently, he described Tone 3 in standard Chinese as 11 or 21. However, if Tone3 occurs in the final position, its value will be 114 or 214. Figure 3.1 presents pitch contours for different lexical tones of "ma"[6].

[6] We refer to H. Chen (2008) for the reading material of Figure 3.2 and M. Lin (2012) for the reading material of Figure 3.3. The recordings for Figure 3.1-3 are obtained from a male speaker, who had passed level 2B in the Putonghua proficiency test.

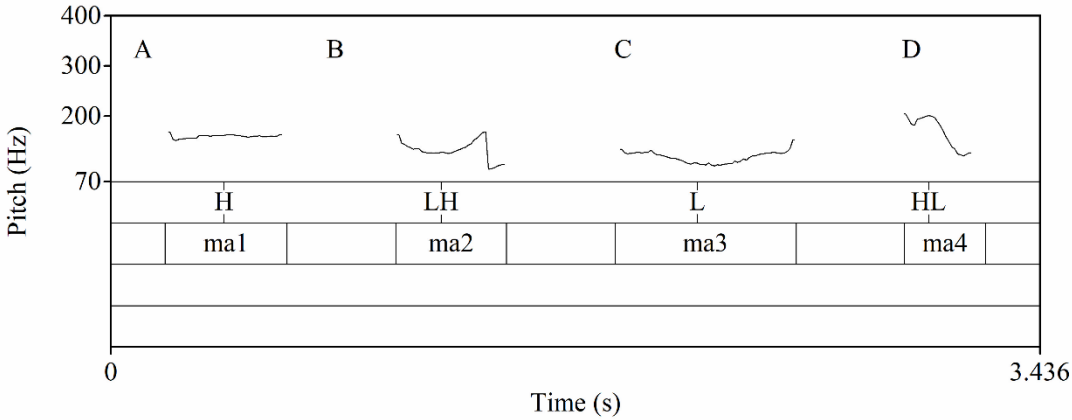

Figure 3.1 Pitch track representations of "ma" with different lexical tones

In Figure 3.1A, "ma1" can be represented by a high pitch event, located in the upper part of the speaker's pitch range. In Figure 3.1C, "ma3" is represented by a low pitch event, located in the lower part of the speaker's pitch range. In Figure 3.1B, "ma2" involves two pitch events, one low (L) and one high (H), thus forming a pitch contour that rises from low to high. In Figure 3.1D, "ma4" also involves two pitch events, one high (H) and one low (L), forming a descending pitch contour.

3.2.2 Pitch Accents

3.2.2.1 Use of the Term "Pitch Accent"

The term "pitch accent" was first used in Chinese intonation by M. Lin (2004). Referring to H. Wang's (2004) term "accent", he proposed that Chinese intonation has two variables: pitch accent and boundary tone[7]. In Lin's view, a prosodic word is an F0 variation group, in which one or two syllables are more prominent than others. Also, he proposed that the Chinese pitch accent is hierarchical: prosodic word, prosodic phrase, and intonational phrase. For example, in (27), the utterance "ma3 chang3 zhang3 mai3 wu3 ba3 hao3 yu3 san3 (Mr. Ma, who is in charge of a factory, bought five good umbrellas)" has three types of pitch accents.

(27) a.ma3 chang3 zhang3/ mai3 wu3 ba3/ hao3 yu3 san3.
b.ma3 chang3 zhang3/ mai3 wu3 ba3 hao3 yu3 san3.
c.ma3 chang3 zhang3 mai3 wu3 ba3 hao3 yu3 san3. (M. Lin, 2004, p. 59)

The utterance consists of three prosodic words (a): ma3 chang3 zhang3, mai3 wu5 ba3, hao3 yu3 san3. The syllables, chang3, mai3, and yu3 are the pitch accents of these prosodic words. These three prosodic words can be further grouped into two minor phrases (b). The syllables, chang3 and mai3 are the pitch accents of the two minor phrases. The utterance (c), ma3 chang3 zhang3 mai3 wu5 ba3 hao3 yu3 san3, is an intonational phrase. The syllable, mai3, was the pitch accent of this intonational phrase.

The use of pitch accent in Chinese also appears in his other articles (M. Lin, 2005, 2007a, 2007b). However, in his subsequent articles (M. Lin, 2011, 2012, 2015; M. Lin & Li, 2016; M. Lin et al., 2020), he has rarely used this term, and his research has shifted towards focus accents, including broad and narrow focus accents. He also argues that narrow focus accents bear many similarities to pitch accents in English. For example, in (28), the four syllables marked with an underscore bear the narrow focus accent in the four utterances.

[7] Wang stated that the term "accent" which is a perceptual definition refers to prominence in prosody. The primary cues of its acoustic property include strong intensity, high pitch, long duration, etc.

(28)a.Hua1 er0 gan1 si3 le0.
"The flowers have withered."
b.Wo3 ji2 si3 le0.
"I'm extremely anxious."
c.Li3 shi1 fu4 jiang3 le0 yi1 bian4.
"Master Li explained it once."
d,Di4 di4 kan4 le0 yi1 bian4.
"My younger brother looked at it once." (M. Lin, 2012, pp. 160-161)

Lin's viewpoint is substantiated by other researchers. H. Chen (2006) used this term in his thesis, which corresponds to Chinese lexical tones in narrow focus. Though Jia (2009) did not utilize this term, she followed British tradition and regarded narrow focus accents in Chinese as nucleus and pre-nucleus accents, which have roughly the same connotation as pitch accents.

Some researchers, however, have directly denied this term (Cao, 2010; Duanmu, 2004). Duanmu refuted the use of this term when examining the difference between Chinese and English words from a functional perspective. For example,

(29)a.Meat-ball [8]
H*
b.Rou-wan "meat ball"
H*L-LH (Duanmu, 2004, p. 906)

In (29a), the first word has a pitch accent, while the second does not. Duanmu explained that "one pitch accent (plus boundary tones) is enough to express contextual meanings" (Duanmu, 2004, p. 907). In (29b), Chinese shares a similar stress pattern with English, with the difference being that the second syllable in Chinese retains its tone. Based on this fact, he argued that the tones in Chinese could not be substituted with pitch accent to convey contextual meaning, as they were lexically contrastive.

In addition, Cao held that pitch accent in English corresponded to Chinese sentence stress. In other words, he disputed that every prosodic word was characterized by a pitch accent. Also, he argued that there was no need to refer to Chinese "sentence stress" as "pitch accent".

The causes presented by those who hold opposite views can be summarized as two perspectives: for one thing, can the lexical tones in Chinese convey contextual meanings? From the previous studies (H. Chen, 2006; Z. Li, 2018), Chinese lexical tones in narrow focus can convey contextual (pragmatic) meanings, despite carrying the same meanings, such as emphasis and contrast. For another thing, is it necessary to call narrow focus accents in Chinese pitch accents? For reasons of contrast with English intonation, using similar terms is more reasonable. Therefore, Chinese accents used in narrow-focus contexts can alternatively be referred to as pitch accents.

3.2.2.2 Types of Pitch Accents

In section 3.1, we elaborated on the property of pitch accent. For the sake of comparison, utilizing the forms that correspond to the AM theory is necessary. Previous research has seen attempts by some researchers. H. Chen (2006) employed H* and L* to depict the characteristics of pitch accent, which correspond to Lin's [+RH] and [+LL]. Jia (2009)

[8] The annotation system used by Duanmu appears to be the IViE (Grabe et al., 1998), not the MAE-ToBI. Besides, in b, we added a star * to illustrate that the first word had the primary stress.

superimposed the properties of Chinese narrow focus accents on the four lexical tones, thus forming four types of narrow focus accents: H*, L*, LH*, and H*L. From the above analysis, it can be seen that Jia's proposal is more intuitive and similar to English intonation. Therefore, we adopt Jia's approach and identify four types of pitch accents in Chinese, namely H*, L*, LH*, and H*L. Figure 3.2 illustrates the pitch contours of the four types of pitch accents.

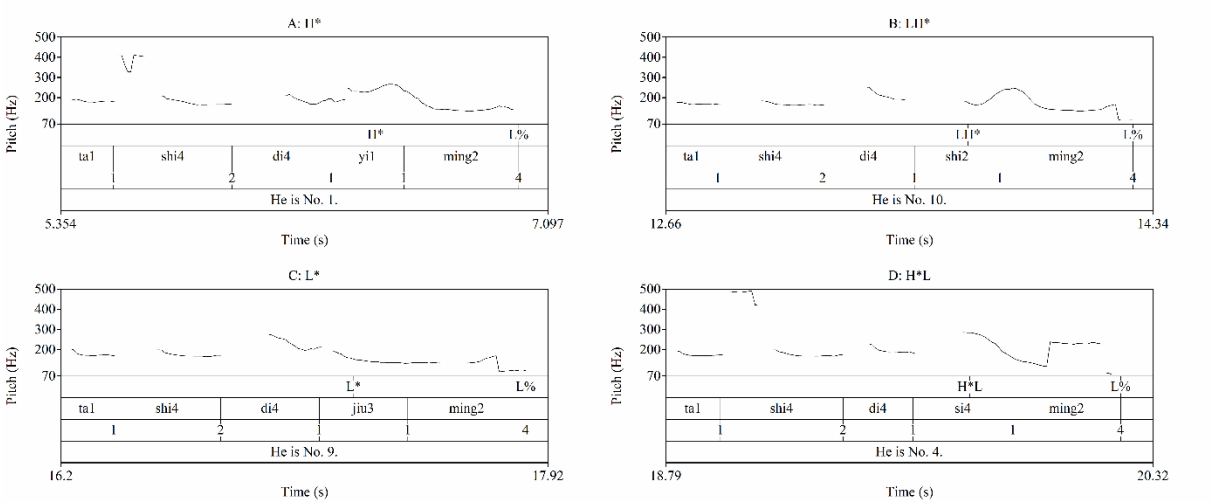

Figure 3.2 Pitch track representations of the four pitch accents in Chinese

Each of the four utterances is separated into two prosodic words, ta1 shi4, and di4 yi1/shi2/jiu3/si4 ming2. The second prosodic word exhibits a larger pitch range and a higher level compared to the first prosodic word. In these four utterances, the second prosodic word's second syllables are characterized by a longer duration and a higher/lower pitch level. Therefore, these syllables constitute the accent of these phrases. Regarding the H* (Figure 3.2 A), LH* (Figure 3.2 B), and H*L (Figure 3.2 D), their realization involves raising the H points of the corresponding syllables. Conversely, for the L* (Figure 3.2 C), it is primarily achieved by lowering the L point of the syllable.

3.2.3 Phrase Accents

In section 2.1.2, we mentioned that English has two types of intermediate phrases: nonfinal and final intermediate phrases. Both of these phrases have the same two types of phrase accents. The absence of final phrase accents in Chinese has become a consensus in the field of Chinese linguistics. The issue regarding phrase accents in Chinese lies in nonfinal phrase accents. Many studies have suggested that Chinese has minor prosodic phrases similar to intermediate phrases of English (H. Chen, 2006; Li, 2002; Peng et al., 2005). However, only H. Chen (2006) claimed that Chinese has such phrase accents and distinguishes between L- and H-.

With respect to nonfinal phrase accents, we hold a different position from Chen's viewpoint. As mentioned above, there must be at least one pitch accent preceding nonfinal phrase accents in English, and nonfinal phrase accents in English have an effect on an utterance's meaning (Bartels, 1999; Pierrehumbert & Hirschberg, 1990). However, H. Chen did not justify the existence of the two phrase accents in Chinese. Therefore, we claim that phrase accents are absent in Chinese.

3.2.4 Boundary Tones

3.2.4.1 Carrying Unit of Boundary Tone

According to Lin's demonstration on boundary tone (see section 3.1), three carrying units can be identified: the last stressed syllable in the final prosodic word of a phrase, the last two stressed syllables in the final prosodic word of a phrase, and the first syllable of a phrase.

However, there is disagreement between studies in this aspect. The main issue is whether the first syllable of a phrase, the final neutral syllable of a phrase, and the penultimate stressed syllable of a phrase have the function of differentiating between statements and questions. To solve this issue, we will first show how Lin reached his conclusion.

There are two experiments involving the first syllable of a phrase (M. Lin, 2006, 2012). One is the segmented listening experiment, in which utterances are divided into several parts. For example, the utterance "X xian1 sheng0 yao4 qu4 xi1 an1?" (Mr. X is going to Xi' an?) is divided into four parts:

(30) a.X xian1 sheng0 (Mr. X)
b.X xian1 sheng0 yao4 qu4 (Mr. X is going to)
c.X xian1 sheng0 yao4 qu4 xi1 (Mr. X is going to Xi)
d.X xian1 sheng0 yao4 qu4 xi1 an1 (Mr. X is going to Xi'an) (M. Lin, 2012, p. 225)

After listening to the stimuli, the experiment required participants to judge whether each component of the echo question was a question or not. The results showed that the last stressed syllable of the phrase was the primary cue that distinguished between questions and statements according to two speakers' data (94% and 86%, respectively). Also, the first syllable of the phrase (21% and 20%, respectively) and the penultimate stressed syllable of the phrase had some effect on the interrogative mood of the discourse (25% and 30%, respectively).

The other is the discrimination experiment. It was mainly carried out by changing the slope of the pitch contour at the first syllable of the phrase and the last stressed syllable of the phrase[9]. The results showed that the declarative mood was expressed when the slope was reduced to a certain degree. Therefore, Lin provided a favorable assessment of the function of the first syllable of a phrase.

Limited research has been conducted on the first syllable of a phrase. H. Chen (2006) did not find the effect of this syllable in the identification experiment, which might be caused by his research method. He simply interchanged the first syllables of declarative and interrogative sentences. Jia (2009) employed two boundary tones, H% and L%, to mark changes in pitch on initial and final boundary tones. To conclude, the first syllable of a phrase can distinguish between statements and questions. However, as noted by Lin, its use conveys a weak interrogative mood and its functional role is restricted.

Although Lin did not mention the neutral syllable in his demonstration, he cited Sun's (2006) results and acknowledged its function (M. Lin, 2012). Sun reported that when a neutral syllable appeared at the end of an interrogative sentence, it lost its neutral nature and became accented by raising the starting point of the F0 contour and enlarging its slope. In addition, Cao (2010) also supported the above point from the perspective of grammar. Therefore, the neutral syllable in the final prosodic word is also an important carrying unit to distinguish between statements and questions.

From the segmented listening experiment, the penultimate stressed syllable of a phrase can be treated as the carrying unit of boundary tone. However, this syllable has not caught the attention of other researchers. One possibility is that M. Lin (2003) attributed raising the F0 contour on this syllable to F0 coarticulation. The other is that it is not the primary carrying unit, just as Lin found in his study.

3.2.4.2 Types of Boundary Tones

Though different symbols are used among researchers to represent Chinese boundary tones, their underlying interpretations are fundamentally consistent. H. Chen (2006) utilized

[9] In cases where the interrogative mood is expressed by the first syllable of a phrase, it tends to convey a weak interrogative mood.

H% and L% to label boundary tones, which correspond to Lin's [RT] and [LT]. Other researchers, such as Jia (2009), A. Li (2002), and Peng et al. (2005), used H% and L% to label boundary tones. To facilitate the comparison between Chinese and English boundary tones, H% and L% were employed in this study to represent the two types of boundary tones in Chinese. Figure 3.3 shows the pitch contours of the two types of boundary tones in Chinese[10].

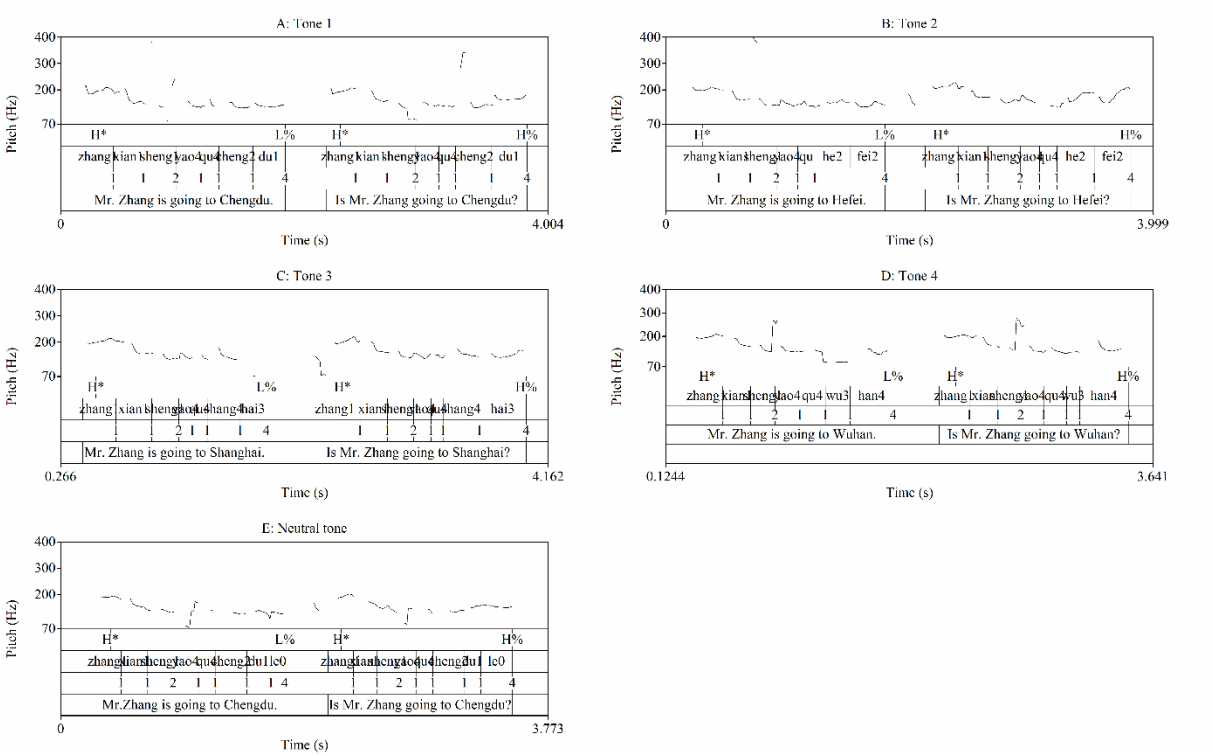

Figure 3.3 Pitch track representations of the boundary tones in Chinese

From Figure 3.3 (A-E), each of these utterances consists of one prosodic word (zhang1 xian1 sheng1) and a compound prosodic word (yao4 qu4 cheng2 du1/ he2 fei2/ shang4 hai3/ wu3 han4/ cheng2 du1 le0). The latter has two prosodic words, yao4 qu4, and cheng2 du1/ he2 fei2/ shang4 hai3/ wu3 han4/ cheng2 du1 le0. By observing the pitch contours of these utterances, it can be seen that the primary unit of this distinction between statements and questions is located at the final syllable of the last prosodic word. Furthermore, the realization of boundary tones involves modifying the pitch contour of the final syllable of a phrase by either raising (H%) or lowering (L%) it concerning its lexical tone[11].

3.3 Meaning of Chinese Intonation

3.3.1 Pitch Accents

3.3.1.1 Relationship between Assertion and Pitch Accent

The results in section 2.2.1.1 showed that the pitch accent in English serves the function of asserting a proposition. We will attempt to analyze whether the pitch accent in Chinese also serves a similar function.

(31) A: ta1 xi3 huan1 shen2 me0 yan2 se4?
"What colour does he like?"
B: ta1 xi3 huan1 hei1/ lan2/ zi3/ lu¨4 se4.

[10] The lexical tones of the final syllables in the five sentences mentioned in Figure 3.3 are as follows: 1, 2, 3, 4 and 0.

[11] If the final syllable of a phrase is a neutral syllable, the boundary tone may be influenced by the tone of its preceding syllable (H. Chen, 2006).

H* LH* L* H*L L%

"He likes black/ blue/ purple/ green."

-pr.: He likes black/ blue/ purple/ green.

From (31), the four pitch accent types convey new information. In other words, pitch accents in Chinese do not differentiate between new and not new information, which leads to the conclusion that Chinese pitch accents lack the function of assertion. This conclusion is also supported by the following example.

(32) A:zen3 me0 le0?

"What happened?"

B:ta1 de0 shou3 biao3 diu1 le0.

L%

"He lost his watch."

-pr.: He lost his watch.

The utterance B in (32) is declarative in nature and is marked by a broad focus accent; therefore, no pitch accents are present. Nevertheless, in this dialogue pair, speaker B clearly instructs hearer A to add the proposition "He lost his watch" to the hearer's mutual beliefs. Hence, the assertion made by the speaker is unrelated to Chinese pitch accents.

3.3.1.2 Multiple Meanings of Pitch Accents

Similar to English intonation, we analyze the meanings of Chinese pitch accents. In general, the meanings of pitch accents in Chinese are relatively simple: all pitch accents are used to express the same meanings, such as emphasis and contrast. For example, in (31), the four pitch accent types indicate emphasis, while in (33), the four pitch accent types indicate contrast.

(33) A: ta1 de2 le0 di4 wu3 ming2.

"He won the fifth place."

B: bu4. ta1 de2 le0 di4 yi1/ shi2/ jiu3/ si4 ming2.

H* LH* L* H*L L%

"No. He won the first/ tenth/ ninth/ fourth place."

The L* in English can convey given information. However, according to (34), all pitch accents can convey given information in Chinese.

(34) A: xiao3 wang2 ming2 tian1 lai2 zhe4 er0.

"Xiao Wang will come here tomorrow"

B: xiao3 zhou1/ qian2/ li3/ zhao4 ming2 tian1 lai2 zhe4 er0?

L* H* LH* L* H*L H%

" Xiao Zhou/ Qian/ Li/ Zhao will come here tomorrow."

The meanings of uncertainty and reminder in English are conveyed through pitch accents. How are these meanings conveyed in Chinese? In (35), speaker B intends to convey uncertainty about whether Zhang/ Wang/ Li/ Zhao Ting is one of the interesting people. The pitch accents here indicate that, from speaker B's perspective, Zhang/ Wang/ Li/ Zhao Ting is one of the interesting people. As a result, the meaning of uncertainty is not conveyed through pitch accent. In (36), the pitch accents here imply that speaker B would like to remind hearer A that the person mentioned was not busy throughout the entire month.

(35) A:You3 na3 xie1 you3 qu4 de0 ren2 lai2 can1 jia1 le0 ju4 hui4.

"What interesting people came to the party?"
B:Zhang1/ wang2/ li3/ zhao4 ting2 lai2 le0?
H* LH* L* H*L LH* H%
"Zhang/ Wang/ Li/ Zhao Ting came to the party."

(36) A:Ta1 mang2 le0 yi1 zheng3 ge4 yue4.
"He was busy for a whole month"
B:Ta1 xiu1 xi0 le0 qi1/ shi2/ wu3/ si4 tian1.
H* LH* L* H*L H* L%
"He took a rest for seven/ ten/ five/ four days."

3.3.2 Boundary Tones

3.3.2.1 Relationship between Assertion and Boundary tone

In section 3.3.1.1, we denied the claim that pitch accent serves the function for assertion. To verify whether boundary tones can play an assertive role, we propose a preliminary alternative hypothesis: boundary tones can suggest the presence or absence of an assertion in statements.

(37) A ni3 xi3 huan0 shen2 me0 yan2 se4?
"What colour do you like?"
B: wo3 xi3 huan0 lan2 se4.
LH* L%
"I like blue."
-pr.: I like blue.

In (37), the L% can indicate an assertion made by speaker B. In other words, speaker B instructs hearer A to add the proposition to the hearer's mutual beliefs. Therefore, the above hypothesis has been verified. Then, another alternative hypothesis is posited: boundary tone can suggest the presence or absence of an assertion in questions.

(38) A: zhang1 san1 xi3 huan0 zhe4 bu4 dian4 ying3.
"Zhang San enjoyed the film."
B: zhu1 xi1 xi3 huan0 zhe4 bu4 dian4 ying3?
H* H* H%
"Did Zhu Xi enjoy the film?"
-pr.: Zhu Xi enjoyed the film.

(39) A: Ni3 jin1 tian1 xiang3 qu4 na3 li3 wan2 er0?
"Where do you want to go play today?"
B: ni3 xiang3 qu4 gong1 yuan2 hai2 shi4 shang1 chang3 ?
H* LH* H* L* L%
"Do you want to go to the park or the mall?"
-pr.: You want to go to the park or the mall.

(40) A: ni3 neng2 jie4 gei3 wo3 ni3 de0 shou3 biao3 ma0?
"Could you lend me your watch?"
B ni3 yao4 gan4 ma0?
L%
"What do you need it for?"
-pr. You need it for something.

The H% in (38) means that speaker B argues that this proposition has become part of

both speaker B and hearer A, and speaker B questions hearer A about this proposition. However, the L% in (39-40) shows speaker B's intention to make an assertion on the proposition. Therefore, we propose that the L% in Chinese intonation is the primary cue for a speaker to assert a proposition, while the H% is used to question a proposition.

3.3.2.2 Multiple Meanings of Boundary Tones

In section 3.3.1.2, the results showed that the pitch accent in Chinese does not give rise to uncertainty. Then, is there any relationship between this meaning and boundary tone in Chinese? By observing (35), we can see that the boundary tone used is H%, indicating the meaning of uncertainty, which has been confirmed by existing research (L. Wang, 2019; J. Xu, 2000; Yan, 2017). The H% in Chinese can convey a sense of suspense, which is comparable to the continuation dependence in English. Prior research has indicated that when attempting to express suspense, the H% may be utilized (Zhao, 2002, 2005). For example, in (41), there are two intonational phrases in the discourse. The H% is assigned to the last syllable of the first intonational phrase.

(41) wo3 xing4 lu4, ni3 xing4 wang2[12].
H%
"My family name is Lu, but your family name is Wang." (Zhao, 2005, p. 28)

It should be noted that there are various ways in which Chinese boundary tone is realized according to the specific lexical tone used. When the lexical tone is Tone 2 (LH), the boundary tone is realized by raising the H point of this syllable. For example,

(42) ni3 xing4 wang2, wo3 xing4 lu4.
H%
"Your family name is Wang, but my family name is Lu." (Zhao, 2005, p. 28)

However, the use of Chinese boundary tones is also constrained by different contexts. In the following example, a H% should not be used, or the meaning conveyed by the speaker might be changed.

(43) A: shui2 tong1 guo4 le0 qi1 mo4 kao3 shi4?
"Who passed the final exam?"
B: zhou1 Yun2 tong1 guo4 le0 qi1 mo4 kao3 shi4,
H* LH* L%
Dan4 shi4 ta1 dui4 zi4 ji3 de0 biao3 xian4 bing4 bu4 man3 yi4.
"Zhou Yun passed the final exam, but she wasn't satisfied with her performance."

3.4 Summary of Main Findings

In terms of form, Chinese intonation consists of two structural elements: pitch accents and boundary tones. First, narrow focus accents in Chinese can be referred to as pitch accents. There are four pitch accent types: H*, L*, LH*, and H*L. Second, the final syllable of a phrase, regardless of whether it is stressed or neutral, can be utilized as the fundamental unit for distinguishing between statements and questions. There are two boundary tone types: H% and L%.

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[12] (41) serves as an example of a contrastive focus and may involve two cases: a double contrast or a single contrast (Wells, 2006). The former involves the contrast between "ni3" and "wo3" as well as "lu4" and "wang2". The latter involves the contrast between "ni3" and "wo3", or "wang2" and "lu4". (42) exhibits a similar case to (41). Considering the above situation, we do not mark their pitch accent types in these two examples.

In terms of meaning, three central claims can be made. First, pitch accents in Chinese carry the same meanings regardless of the context in which they appear. Second, the assertion made by a speaker is realized through boundary tone. Lastly, the boundary tone H% is associated with conveying the meaning of uncertainty, while the choice of boundary tones for expressing suspense varies depending on different contexts.

4 English and Chinese Intonation Systems: A Contrast

In this section, we compare the similarities and differences between English and Chinese intonation systems in terms of pitch accents, phrase accents, and boundary tones, both in form and meaning. We also attempt to predict the potential effects of Chinese intonation on the acquisition of English intonation by Chinese EFL learners.

4.1 Similarities and Differences between English and Chinese Intonation Systems

A. Pitch accents

Before comparing the pitch accents of the two languages, a crucial matter is to determine the similarity of a pitch accent between the two languages. The equivalent classification (Flege, 1995; Flege & Bohn, 2021), a general cognitive mechanism to classify acoustically different sounds in L1 and L2 as categorically identical, provides a good reference for our study. This mechanism has also been employed by some researchers in cross-language analysis of intonation (Albin, 2015; Mennen, 1999; Mennen, 2015). For example, in examining the acquisition of Greek intonation by native speakers of Dutch, Mennen (1999) used it to identify whether a pitch accent between the two languages was similar or not.

> In the case of prenuclear accents, it is quite straightforward to determine the degree of similarity between Greek and Dutch intonation patterns. Both Dutch and Greek prenuclear accents can be analysed as instances of a H* accent. That is, in Flege's terminology the prenuclear Greek accent is seen as 'similar' to the Dutch prenuclear accent. (Mennen, 1999, p. 86)

From the illustration above, Mennen perceived both L1 and L2 prenuclear accents phonetically as instances of a H*, thus identifying them as similar. Z. Li and Lin (2018) stated that this mechanism might also be applied to phonetic units other than segments, such as the lexical tones and intonation in Chinese. Specifically, pitch accents in English correspond to lexical tones in Chinese or their combinations at the sentence stress level.

The two languages exhibit both similarities and differences in pitch accent types. The inventory of English pitch accents consists of H*, L*, L+H*, L*+H, and H+!H*, while that of Chinese pitch accents consists of H*, L*, LH*, and H*L. There are three pitch accents in English that are similar to Chinese, namely H*, L*, and L+H*. L*+H in English is similar to the combination of L*+LH in Chinese. However, it should be noted that the former can also occur on a single syllable, which is different from the latter. As for H+!H* in English, it is different from H*L in Chinese, because the former involves two syllables, while the latter involves one syllable.

There exist great differences in the meanings of pitch accents between English and Chinese. First, the pitch accents in English can distinguish between new and not new information. However, the pitch accents in Chinese do not serve this function. Second, the pitch accents in English can be used to represent whether a proposition is asserted or not. The assertive effect of pitch accents can be strong or weak. To be specific, H*L- is stronger than L*L- in declaratives. In contrast, there are no such functions for Chinese pitch accents. Lastly, each pitch accent type (in narrow focus) in English has its distinct meaning, while all pitch accents in Chinese have the same meanings, such as emphasis and contrast.

B. Phrase accents

Nonfinal and final phrase accents are distinguished in English intonation, each

comprising two types of phrase accents, H- and L-. These two types of phrase accents carry different meanings depending on their position in an intonational phrase. However, the two types of phrase accents are absent in Chinese intonation.

C. Boundary tones

Both English and Chinese intonation systems have two boundary tone types, namely L% and H%. However, there exist great differences in meaning between them. The boundary tones in English can convey various meanings, including the relationship between two or more intonational phrases, continuation dependence, exhaustiveness of items in alternative questions, and a speaker's expectation. In contrast, the two boundary tones in Chinese are associated with assertion. Specifically, L% is used to assert a proposition, while H% is used to question a proposition. Also, H% can convey meanings of uncertainty and suspense, but the latter is context-dependent.

4.2 Potential Effects of Chinese Intonation on the Acquisition of English Intonation

Before analyzing the effect of Chinese intonation on the acquisition of English intonation by Chinese EFL learners, we need to determine how to predict the relative difficulty of learners' acquisition of L2 intonation. The present study is based on the L2 intonation learning theory. One of the main points of this theory is that the cause for learners' deviations in acquiring L2 intonation is the differences in intonation systems between L1 and L2. Though Mennen does not explicitly demonstrate whether similar or different categories between L1 and L2 are more difficult to acquire, it can be inferred from his examples that L2 learners have difficulty acquiring different categories between two languages (Mennen, 2015, pp. 175-179). Therefore, when discussing the influence of L1 intonation, we tend to believe that the different categories between the two languages are more difficult for Chinese EFL learners to acquire.

A. Pitch accents

There are obvious differences between English and Chinese pitch accents, which can be summarized into two cases: one is pitch accents that have the same form but different meanings; the other is pitch accents that differ in both form and meaning. For the former, learners may have difficulty distinguishing between the four pitch accents when producing them. Specifically, due to the influence of their native language, learners may use all four pitch accent types when producing each of the four pitch accent types in English. For example, when producing L* in English, learners may use H*, L+H*, L*, and L*+H. For the latter, learners may encounter more difficulty producing H+!H*. Since there is no equivalent pitch accent in Chinese, learners might use other English pitch accents as a substitute for this one.

B. Edge tones

Researchers investigating the acquisition of English intonation usually consider edge tone as an element, which comprises phrase accent and boundary tone (Hirschberg & Beckman, 1994). Therefore, we will discuss the potential effects of the similarities and differences in phrase accents and boundary tones between the two languages on the acquisition of English edge tones by Chinese EFL learners.

1) L-L%

In English declarative sentences, the pitch contour following narrow focus pitch accents exhibits a decline, which resembles that observed in Chinese declaratives (Jun & Foreman, 1996; Lin, 2011; Liu & Xu, 2005; Y. Xu, 1999). Therefore, L-L% in English is similar to L% in Chinese. An anticipated result is that learners may relatively easily produce the edge tone L-L% in English declaratives.

2) L-H%

There are three situations related to this edge tone. First, in English declaratives, L-H% indicates continuation dependence. On the contrary, in Chinese declaratives, L% is typically employed for this purpose[13]. In addition, the edge tone following the L*+H is L-H% in English, and it occurs in declarative sentences. In contrast, H% in Chinese is typically used in interrogative sentences to convey uncertainty or incredulity (Tang, 2003; L. Wang, 2019; J. Xu, 2000; Yan, 2017)[14]. Lastly, the edge tone after the H+!H* in English is L-L% or L-H%. In (17), Hirschberg (2006) does not provide the edge tone used in this example, but she uses L-L% in another instance in her article. However, from examples given by Grice (1995), L-H% is used. Due to the limited literature on this case, we cannot make a reliable conclusion. Therefore, further investigation is needed regarding the selection of this edge tone. On the contrary, in Chinese, the L% is used in this context. Based on the above analysis, it can be predicted that learners may produce L-L% when expressing continuation dependence and reminder, while they may produce L-H% when expressing uncertainty or incredulity.

3) H-H%/ H-L%

In English, the pitch contours following narrow focus pitch accents in interrogative sentences typically rise, resulting in H-H% (Jun & Foreman, 1996; Liu, 2009) or H-L% (a variant of H-H%) (Bartels, 1999), while in Chinese, it shows a sharp drop (Liu, 2009; Liu & Xu, 2005; Qadir & Wang, 2013), followed by a H%. One possible prediction is that when learners produce these two edge tones, they may actually produce L-H%.

C. Intonation patterns

In the former sections, we have introduced some typical intonation patterns in English, namely H*L-L%, L+H*L-L%, L*H-H%, L*+HL-H%, H+!H*L-L%/L-H%, and H*L-H%. Due to the differences in pitch accents and edge tones between the two languages, it can be predicted that acquiring these intonation patterns may pose a challenge for Chinese EFL learners. However, learners may have varying degrees of difficulty when producing these intonation patterns. Generally, they are likely to produce H * L - L % and L + H * L - L % with the highest probability, followed by L*+HL-H%, H*L-H%, and L*H-H%. Their performance may be poorest on H+!H*L-L%/L-H%.

5. Conclusion

In the present study, we have investigated four topics: the AM analysis of English intonation, the AM analysis of Chinese intonation, the similarities and differences between English and Chinese intonation systems, and the potential effects of Chinese intonation on the acquisition of English intonation by Chinese EFL learners. Through an examination of English and Chinese intonation systems in terms of form and meaning, we have identified considerable differences between the two languages in both aspects. These differences may potentially result in deviations in the acquisition of English intonation (pitch accents, edge tones, and intonation patterns) by Chinese EFL learners.

The findings of the study have important theoretical values. This study provides new insights that enrich the L2 intonation learning theory by addressing the gaps in the literature regarding the similarities and differences in form and meaning between English and Chinese intonation systems. Also, the findings can be used in linguistic studies. We present an approach for comparing the intonation systems of two languages, in which more insightful

[13] The situation described here only applies to the example presented in (43).

[14] According to our observations, when applying H% in Chinese to the production of English intonation, the H% is similar to the L-H% in English.

results might be obtained.

The findings of the study also have significant practical values. Firstly, the AM analysis can be used in the study of the acquisition of English intonation by Chinese EFL learners. This approach provides a framework for analyzing English and Chinese intonation systems, under which their structural elements can be displayed and compared, thus helping students to understand, identify, and master the structure and function of English intonation. Secondly, this theory and its approach can be applied to teaching and learning second language intonation. English teachers can demonstrate and explain English intonation, evaluate students' actual performance, and urge them to strengthen their practice in English intonation. Lastly, this study predicts the errors that Chinese EFL learners may make due to the influence of Chinese intonation. English teachers should remind students and correct their errors to avoid negative transfer from Chinese intonation.

However, there are certain limitations in this study. One limitation is that though we take a theoretical contrast between English and Chinese intonation systems, it lacks empirical research to support the results of the study. There may also be variations in different varieties of Englishes spoken in the world, and as found in segmental studies, there could be influences from other language systems used by the speakers as well (de Leeuw et al., 2012; Mennen et al., 2014). Given that this topic has not been extensively studied, some attempts have been made in the study to investigate the potential effects of Chinese intonation on the acquisition of English intonation by Chinese EFL learners, hoping that more researchers interested can participate in it.

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