

## The matched and mismatched interlanguage speech intelligibility benefit for listeners (ISIB-L): Chinese L2 talkers' production of English liquids

Joo-Kyeong Lee\*  
(University of Seoul)

Xiaojiao Xue  
(University of Seoul)

**Lee, Joo-Kyeong and Xiaojiao Xue. 2013. The matched and mismatched interlanguage speech intelligibility benefit for listeners (ISIB-L): Chinese L2 talkers' production of English liquids. *Studies in Phonetics, Phonology and Morphology* 19.1. 125-153.** This paper attempts to investigate the interlanguage speech intelligibility benefit for listeners (ISIB-L), focusing on Chinese talkers' production of English liquids and its perception of native listeners and non-native Chinese, and Korean and Japanese listeners. The English liquids /l/ and /r/ produced by Chinese talkers were considered in terms of positions (syllable initial and final), contexts (segment, word and sentence) and minimal/non-minimal pair contrasts to see if these factors play a role in the ISIB-L. Results showed that the initial /l/ was significantly more intelligible to native listeners than non-native listeners, eliciting no ISIB. The matched ISIB-L was observed for the other three target sounds (final /l/, initial /r/, final /r/), but not consistently with talkers' proficiency. The mismatched ISIB-L was found only for the low proficient talkers and reflected the L2 phonological/phonetic system of liquids. Korean listeners outperformed native listeners for the identification of the initial /r/, Japanese listeners' identification for the final /l/ was more accurate than that of native listeners, and both Korean and Japanese listeners performed better than native listeners for the perception of the final /r/. The matched ISIB-L occurred in word context rather than segment or sentence contexts and in the minimal, as opposed to non-minimal, pairs, when the stimuli were produced by low proficient talkers. To sum up, the success of recognizing foreign accented speech depends on talkers' proficiency and language background, context, and minimal/non-minimal pair contrast, supporting many previous studies (Bent and Bradlow 2003, Hayes-Harb et al. 2008, Lee and Xue 2011). **(University of Seoul)**

Keywords: intelligibility, English liquids, position effect, proficiency, context, minimal and non-minimal pairs

### 1. Introduction

This paper attempts to investigate the interlanguage speech intelligibility benefit for listeners (ISIB-L), focusing on Chinese talkers' production of English liquids and its perception of native English listeners and non-native Chinese, and Japanese and Korean listeners. The ISIB is the phenomenon that nonnative speech is as intelligible as or sometimes more intelligible to nonnative listeners than native listeners when the nonnative talkers and listeners share the same L1 (Bent and Bradlow 2003). Similar L2 phonological representations directly generate from the same L1 for nonnative talkers and listeners so that nonnative listeners take advantage of the same L1 nonnative talkers' L2 speech and perform a better

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\* Corresponding author.

comprehension of it than native listeners.

The ISIB has been divided into ISIB-T (talkers) and ISIB-L (listeners) depending on which L2 group, talkers or listeners, is compared with L1 group for intelligibility. More specifically, ISIB-T concerns the case that nonnative speech is more intelligible to nonnative listeners than native speech. ISIB-L, on the other hand, refers to the case that nonnative speech is more intelligible to nonnative listeners than it is to native listeners (Hayes-Harb et al. 2008). The ISIB is again classified into matched and mismatched, depending on whether the nonnative talkers and listeners share the same L1 or not (Bent and Bradlow 2003). It has been long suggested that non-native talkers may be more intelligible to non-native listeners from the same language background than they are to native listeners, namely the ISIB-L (Weinreich 1953, Hayes-Harb et al. 2008, Imai et al. 2005, Lee and Xue 2011, Munro et al. 2006, Smith and Rafiqzad 1979). There were comparatively fewer studies supporting the ISIB-T (Bent and Bradlow 2003, van Wijngaarden et al. 2002). The current work attempts to investigate the ISIB-L in the light of the recent tendency of the ISIB findings.

Many studies have showed that non-native talkers and listeners are more benefited than natives in L2 speech intelligibility (Bent and Bradlow 2003, Bent et al. 2007, Derwing and Munro 2001, Munro 1998, Munro and Derwing 1999, Hayes-Harb et al. 2008, Lee and Xue 2011, Major et al. 2002, Selinker 1972, Smith and Rafiqzad 1979, Smith et al. 2009, van Wijngaarden 2001, van Wijngaarden et al. 2002). Moreover, it is mediated by critical factors such as talker and listener proficiency in L2, contextual constraints, neighborhood density, certain acoustic properties of speech, etc. For example, high proficient talkers and listeners showed the ISIB-T effects in Bent and Bradlow (2003). They examined both ISIB-T and ISIB-L effects in their study where native listeners of English, Chinese, Korean, and a mixed group from various native language backgrounds performed a sentence recognition task with the English recordings from Chinese, Korean, and English talkers. Results showed that intelligibility of a high-proficiency nonnative talker from a same or different native language background was greater than or equal to the intelligibility of the native talker, suggesting for the matched and mismatched ISIB-T. Similarly, Lee and Xue (2011) explored the ISIB-L effects in their study on native and non-native high and low proficiency Chinese production of English liquids and their intelligibility for native, high and low proficiency Chinese and Korean listeners. The matched and mismatched ISIB effects held true only for high proficiency non-native Chinese and Korean listeners. They performed better than native listeners at identifying the English liquids produced by Chinese talkers. Furthermore, Smith et al. (2009) and Stibbard and Lee (2006) found evidence for the ISIB-T for their high proficient as opposed to their low proficient non-native talkers.

Hayes-Harb et al. (2008), on the other hand, demonstrated that ISIB-L was effective only for the low proficiency L2 talkers and listeners. More

specifically, native Mandarin low proficient listeners were more accurate than native English listeners at identifying the English word-final voicing contrasts produced by low proficient Mandarin talkers. A similar finding was reported by van Wijngaarden et al. (2002) that the ISIB-L held true for low proficiency listeners.

As such, the effects of talkers' and listeners' L2 proficiency on speech intelligibility still are not decisive but widely variable depending on the task, language background, etc. There has been marginally some work on the ISIB and its relation with contextual constraints and lexical density. Mayo et al. (1997) claimed that the contextual constraints influenced the intelligibility of nonnative speech in such a way that the advantage from the context was significantly greater for native and early nonnative listeners than nonnative listeners. Bradlow and Pisoni (1999) showed that word recognition by nonnative listeners was worse for low frequency words in high density neighborhoods than for high frequency words in sparse neighborhoods, which suggested that neighborhood density was a important contributor to the intelligibility. Imai et al. (2005) found that the non-native listeners outperformed the native listeners only for the words produced by non-native talkers that came from dense lexical neighborhoods. When the words have many similar surrounding neighbors, listeners can easily get confused.

Concerning the acoustic properties of speech mediating the ISIB, relatively much work has examined vowels rather than consonants due to the fact that the perception tasks associated with vowels are more convenient and permissive to L2 listeners than those of consonants (Lee and Xue 2011). Moreover, vowels were asserted to have a stronger effect than consonants to the speech intelligibility of non-native sentences (Fogerty and Kewley-Port 2009, van Wijngaarden 2001). Most of the studies on L2 consonant intelligibility used word final stop voicing (Hayes-Harb et al. 2008, Smith et al. 2009). What was common in their findings revealed that they did not show strong evidence for ISIB. That is, Hayes-Harb et al. (2008) observed that there were no ISIB-T effects, and Smith et al. (2009) even further contended that either ISIB-T or ISIB-L did not occur. This may be attributed to the fact that the ISIB identification tasks are concerned with a tiny local spectral portion and that listeners are relatively insensitive to stops rather than vowels because the perceptual energy is not sufficiently salient. The current work, therefore, examined the English L2 liquid sounds to extend the scope of the ISIB work to sonorant consonants. It should be tested if these results are confined to particularly stop consonants per se. It may be worth examining sonorants, for example, liquids, because they are perceptually more similar to vowels due to their formant energy. Along the same line, Lee and Xue (2011) examined Chinese talkers' intelligibility of English liquids /l/ and /r/ for native and non-native Chinese and Korean listeners. They conducted an Identification Task for the Chinese accented English /l/ and /r/ both in syllable initial and final positions. They differentiated non-native talkers' and listeners' proficiency into high and low to see if non-native

proficiency had an effect on the ISIB-L. They found that non-native Chinese production of the English liquids was more intelligible for final /l/, initial /r/ and final /r/, but the ISIB was not observed in the initial position of /l/. In addition, the matched and mismatched ISIB was elicited only for high proficiency non-native Chinese and Korean listeners regardless of talkers' proficiency. It might be, however, their drawback that the mismatched ISIB was investigated only with one L1 background of listeners, Korean. It seems to be worth extending to another language of L2 listeners in order to induce more general and/or reliable results of the mismatched ISIB. The present study, therefore, attempts to evaluate the ISIB-L of Chinese accented English speech with a particular interest in whether different L1 backgrounds of L2 listeners may induce different patterns in the mismatched ISIB-L. Therefore, L2 listeners were varied in three languages: Chinese, Japanese, and Korean. What differs from Lee and Xue (2011) additionally is that the L2 listeners' proficiency was leveled to intermediate while the non-native listeners were high and low proficiency in their work.<sup>1</sup> That is, non-native listeners' language backgrounds were varied more extensively to Japanese in the current study while non-native listeners' proficiency was maximally differentiated into high and low in Lee and Xue's study.

There are two different interpretations about 'benefit' in ISIB studies. When Bent and Bradlow (2003) originally brought up the ISIB, they assumed that non-native listeners found non-native speech at least as intelligible as native speech. However, this definition has been recently questioned by Stibbard and Lee (2006) and Hayes-Harb et al. (2008). It was their contention that the word 'benefit' should be used only when performance by non-native listeners exceeded that of native listeners. In this paper, we follow the definition more strictly applied to 'benefit' like Stibbard and Lee and Hayes-Harb et al. The word 'benefit', literally implying a positive connotation, should be used for the case where non-native listeners outperform native listeners, that is, where non-native accented speech is more intelligible to non-native listeners than native listeners. In addition, nonnative accented speech is obviously less intelligible to native listeners than native speech, which may sometimes result in native listeners' poor comprehension (Munro 1998, Munro and Derwing 1995). Consider that non-native listeners listen to the same accented speech as native listeners. If their accented speech is as intelligible to non-native listeners as native listeners and non-native listeners' understanding is assumed to be as poor as that of native listeners, it may not be plausible to claim that the non-native listeners take the advantage of the interlanguage and that they perceive the accented speech more accurately than the native listeners.

As claimed in Mayo et al. (1997), contextual cues were satisfactorily utilized in native listeners' perception. The cues were, in the present study, varied from segment to word and finally to sentence to see if the ISIB might

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<sup>1</sup> Non-native talkers' and listeners' proficiency was determined through the identical Foreign Accentedness Task both in Lee and Xue (2011) and the present study.

be influenced by the degree of cue richness. More specifically, in the intelligibility perception task, listeners were asked to identify the English liquid sounds in different contexts: segment alone, within a word and within a sentence. Finally, the contrast of minimal and non-minimal pairs was also examined to see if perceptual confusion induced by minimal pair tokens might result in different ISIB patterns from non-minimal pair tokens in such a way that native listeners would be less accurate at identifying the target liquids than non-native listeners because they might be more confused with minimal pair targets. That is, L2 accented speech would be additionally deteriorated by the perceptual confusion caused by minimal pairs.

Four different language backgrounds of listeners, (American) English, Chinese, Korean and Japanese, differ in their L1 phonological structure and phonetic realizations of the liquid sounds. There are two kinds of liquid sounds in American English, namely, a lateral approximant /l/ and a post alveolar approximant or retroflex /ɭ/. There is no positional restriction to the English liquids, they appear in both initial and final position of a syllable. It has been assumed that the retroflex has its phonetic values [ɭ] in both syllable initial and final position, but the lateral has two different variations, light [l], syllable initially and dark [ɫ], syllable finally. Chinese also shows the phonological contrast between /r/ and /l/. However, the phonetic representation of /r/ varies from a retroflex approximant [ɭ] to a retroflex fricative [ʒ] in initial position of a syllable (Shimizu and Dantsuji 1987), and it is always preceded by /a, ə, u/ in the final position (Zhou 1990). The sound /l/ is actually an alveolar lateral approximant [l] in Chinese, but it appears only in the initial position because of the very restricted syllable structure in Mandarin Chinese (He 2001). In other words, Chinese liquids seem to be phonotactically restricted to some degree, when compared with English. That is, the lateral [l] is allowed only in the syllable initial position. The retroflex [ɭ] occurs both syllable-initially and finally, but it is occurs with a limited number of preceding vowels in the syllable final position. Japanese, on the other hand, has only one liquid sound, which is an apico-alveolar /r/, and it is phonetically more similar to flapped /t/ and /d/ in American English, namely [ɾ]. Due to the fact that CV structure is merely allowed in Japanese except when a nasal occurs in the syllable final position followed by a homorganic oral stop, [ɾ] appears only in syllable initial position. In the case of Korean, only one liquid phoneme /l/ exists, and there is no phonological contrast between /r/ and /l/. The phoneme /l/ never appears in word initial position, but changes to [n] or loses its phonetic substance.<sup>2</sup> The phoneme /l/ is, however, realized as [ɾ] in word medially syllable initial position as in /a.li.laŋ/ [a.ri.raŋ] ‘arirang’ and as [l] when preceded by another [l] as in /mul.li/ [mul.li] ‘physics’. It is realized faithfully as [l] in word final position in Korean. Table 1 compares phonological structure and phonetic variations of liquids in four different languages.

<sup>2</sup> /tʃo.lok/ [tʃo. **rok**] ‘green’ vs. /lok.sek/ [**nok**.sek] ‘green color’  
/ko.li/ [ko.**ri**] ‘high interest’ vs. /li.ik/ [l.**ik**] ‘interest’

**Table 1. Phonological/phonetic system of liquids  
in English, Chinese, Japanese and Korean**

	English	Chinese	Japanese	Korean
/l/ and /r/ distinctive?	Yes	Yes	No	No
initial /l/	[l]	[l]	None	[r] ~ [n] ~ [l] ~ [Ø]
initial /r/	[ɹ]	[ɹ] ~ [z]	[r]	None
final /l/	[l]	None	None	[l]
final /r/	[ɹ]	[ɹ] after [a, ə, u]	None	None

There has been much empirical work on L2 English liquids /l/ and /r/, but has mostly focused on Japanese talkers and listeners (Aoyama et al. 2004, Goto 1971, Guion et al. 2000, Takagi and Mann 1995, Takagi 1993). It may be because Japanese is more radically differentiated from English in terms of phonological and/or phonetic structure and patterns when compared with Korean or Chinese as shown in Table 1. Aoyama et al. (2004) demonstrated that native Japanese speakers more successfully acquired English /r/ than /l/. According to the Speech Learning Model, the more distant an L2 sound (phonetic segment) is from the closest of L1 speech sound, the more learnable the L2 sound will be (Flege 1987). English /r/ is perceptually more dissimilar from Japanese /r/ than English /l/ is for native Japanese speakers (Takagi 1993). That is, Japanese /r/, which is realized as the flap [r], is more likely to be perceived as English /l/. This similarity may invoke Japanese listeners' confusion when they perceive English /l/ rather than /r/. Therefore, a more distant liquid [r] is more readily perceived by Japanese listeners.

There are also many studies on training L2 Japanese adults on the English /ɹ/ and /l/ (Lively et al. 1993, Logan et al. 1991, McCandliss et al. 2002, Strange and Dittmann 1984). What they commonly found was that Japanese non-native subjects in the adaptive training group showed more native-like identification and discrimination functions along the trained continuum. For example, Logan et al. (1991) trained Japanese listeners to identify English /r/ and /l/ emphasizing variability among stimulus tokens. Results showed that the perception of /r/ and /l/ by Japanese listeners was improved using a simple laboratory training task which included the identification of an item from a minimal pair of English words.

Comparatively a small number of studies have investigated Chinese or Korean L2 production and/or perception of English liquids. He (2001) examined Chinese talkers' production of the English liquid /l/ and found that Chinese English learners performed English /l/ in different manners depending on syllable position. They did not have any difficulty producing the English /l/ in syllable initial position, but the error rates were extremely high for the syllable final /l/ and/or syllabic /l/. This was interpreted as stating that the phonemic status of /l/ was positively transferred when they

acquired English /l/. More specifically, the Chinese /l/ sound is acoustically similar to English /l/, but it occurs only syllable initially. This positional restriction facilitates relatively easy production/perception of the syllable initial English /l/ as opposed to the final /l/. Kelso et al. (1979) asserted that the positional imbalance in Chinese speakers' performance of English liquids was not elicited only from phonological influence but also from phonetic influence. That is, there is a time lag existing between two articulatory gestures (consonantal apical gesture and vocalic dorsal gesture) in the productions of the final /l/ and the syllabic /l/, and this might articulatorily induce more difficulty. The syllable initial /l/, on the other hand, involves two gestures occurring almost simultaneously. Therefore, the articulatory difficulty may result in Chinese L2 talkers' and listeners' poorer performance of the final and syllabic /l/.<sup>3</sup> This is not associated with the sound patterns specific to Chinese but rather a phonetically universal gestural coordination. Even native English speakers frequently adopt the strategy of vocalization to avoid articulatory difficulty of the final, no matter what kind of vowel precedes it. Furthermore, the preceding vowels /u/ and /o/ promote deletion of the final /l/ and also the modification to the retroflex /r/.

Heo and Lee (2005) reviewed how English liquids were produced and perceived within the phonological system of Korean and explored the role of its syllable structure in the adaptation of foreign words. They concluded that Koreans were apprehending foreign liquids in terms of syllable structure alignments than in terms of laterality. Moreover, apparent deviations from the general pattern are not due to perceptual variables, but to extraphonological factors such as misinterpretation of source language morphology, avoidance of the structure absent in the native language, influence of Japanese and pragmatics. Some studies also focused on the perception of English /l/ and /r/ by Korean listeners. Ingram and Park (1998) compared Japanese and Korean listeners' identification and discrimination of English liquids using a common set of minimal pair stimuli. The score pattern for the discrimination test, where Koreans performed better than Japanese, was similar to that of the identification test. Japanese listeners' poorer identification of /l-r/ in cluster position was attributable solely to the lower acoustic discriminability. The Korean listeners' responses were predominantly influenced by prior L1 phonological strategy (vowel epenthesis), which enabled them to deploy the Korean phonetic contrast between flaps and geminate liquids in medial position and to aid the perception of the English /l-r/ contrast in initial cluster.

There have been very few studies on the ISIB effects of non-native talkers' production of English liquids for native and non-native listeners. In fact, the languages with systematic phonological differences in liquids, such as

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<sup>3</sup> The articulatory difficulty with the sequential arrangement of the dorsal gesture followed by the apical gesture will cause non-native Chinese talkers' problem with producing the English final and syllabic /l/, which may lead to listeners' difficulty with perceiving them according to the Motor Theory (Liberman et al. 1967).

English, Chinese, Japanese and Korean, would show complex results upon the question of whether the non-native Chinese talkers' production of English liquids is more intelligible to non-native Chinese, Japanese, and Korean listeners than native English listeners (ISIB-L) and the question of whether Chinese non-native listeners are more accurate at recognizing the liquid sounds produced by Chinese talkers than Japanese or Korean non-native listeners (matched-ISIB-L) or the other way around holds true (mismatched-ISIB-L). The present study, therefore, focuses on how the phonological patterns and system affect the intelligibility of speech and how the differences and/or similarities in liquid phonotactics and phonetic realizations among English, Chinese, Japanese and Korean play a role in the ISIB-L. In addition, Chinese talkers' proficiency as well as Chinese, Korean and Japanese listeners' proficiency was determined from the Accentedness Judgment Task prior to the Identification Task. Previous research has shown a variety of different approaches to categorizing L2 learners' proficiency that may contribute to their intelligibility. For instance, Bent and Bradlow (2003) differentiated high from low proficiency talkers on the basis of their intelligibility to native listeners. van Wijngaarden et al. (2002) referred self-reports of general proficiency in L2. Hayes-Harb et al. (2008), Imai et al. (2005), and Stibbard and Lee (2006) all used an accentedness judgment task. The potential non-native participants were rated for their foreign accentedness by native listeners first, and those who received low/high accentedness ratings were considered more/less proficient in the L2 in the intelligibility experiment. Similar to their work, the present study assumed that L2 learners' proficiency, or more specifically phonological proficiency, functioned as accentedness. In consequence, a Accentedness Judgment Task was carried out to capture L2 talkers' and listeners' proficiency for the Identification Task.

## 2. Experiment 1: Accentedness Judgment Task

### 2.1 Subjects

40 non-native subjects (10 Chinese talkers, 10 Chinese listeners, 10 Korean listeners and 10 Japanese listeners) participated in the Accentedness Judgment Task. This aimed to sort out the same proficiency group prior to the Identification Task. The Chinese and Japanese participants were all exchange students at a university in Seoul, Korea. They had been staying in Korea less than a year. They began to study English between ages 8 and 13. Korean participants were also college students at the same university as the Chinese and Japanese subjects. They were commonly 18-26 years old and began to study English between ages 8 and 13. Thirty non-native subjects who participated in the Accentedness Judgment Task (except 10 Chinese talkers) would potentially serve as listeners for the Identification Task, but only those who belong to the identical accentedness rating range would be



sorted out.

## 2.2 Methods

Each of the 40 participants was asked to read 40 carrier sentences which would be used for the Identification Task in Experiment 2. The recordings were conducted at a sampling rate 44.1 kHz in Praat. Only 3 sentence productions were randomly selected from each subject for the Accentedness Judgment Task as presented in (1).

- (1) Three sentences used for the foreign accent judgment
  - A. Language is an instrument for communication.
  - B. He told rather a rude joke and everyone looked embarrassed.
  - C. They were watching a rugby match when I was cooking.

120 stimuli were randomized and given to five English speakers (1 male and 4 females) for accentedness rating. The English native judges were English instructors in a Korean college. The Accentedness Task was programmed in Superlab 4.0, and the judges rated the degree of foreign accent for each speech sample on a 9-point Likert scale (Hayes-Harb et al. 2008; 1= no foreign accent, 9= very strong foreign accent), marking its scale on the paper after they had heard it. Data were collected from all judges in a quiet setting. Subjects who got the accentedness scores higher than 7 were labeled as low proficiency, and who got the scores lower than 3 were labeled as high proficiency and who got the scores 4, 5, and 6 were categorized into intermediate proficiency.

## 2.3 Results

Figure 1 shows the relative accentedness of the 10 non-native Chinese talkers and 10 non-native Chinese 10 Japanese and 10 Korean listeners. The X-axis indicates the subject number, and the Y-axis shows the accentedness scales (0 to 9). No high proficient Japanese listeners were found. The Japanese group was categorized into 6 low proficient listeners and 4 intermediate proficient listeners. Both Chinese and Korean participants were divided into 3 high and 3 low and 4 intermediate proficiency listeners respectively. The proficiency levels common to all three language groups were intermediate and low, but this pair was rarely compared in L2 studies. Therefore, the proficiency was leveled to intermediate for all three language groups. We chose Chinese listeners 1, 3, 5, and 10, Japanese listeners 6, 7, 9, and 10, and Korean listeners 1, 5, 8, and 10 for intermediate proficiency as they gained the rating scores between 4 to 6, and they participated in the Identification Task.

Unlike the leveled proficiency for the listeners, the Chinese talkers who participated in the Accented Judgment Task were divided into 3 low

proficient talkers (1, 2, 10), 3 high proficient talkers (4, 5, 6), and 4 intermediate talkers (3, 7, 8, 9). In order to see the effect of the proficiency of talkers on ISIB-L and maximize it, we selected 3 high and 3 low proficiency Chinese subjects for the L2 talker group.

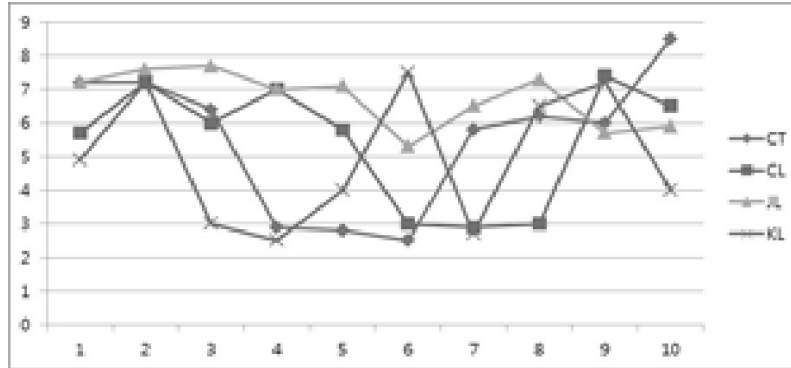


Figure 1. Mean accentedness ratings for talkers and listeners (CT: Chinese talkers, CL: Chinese listeners, JL: Japanese listeners, and KL: Korean listeners)

### 3. Experiment 2: Forced-choice Identification Task

#### 3.1 Subjects

Only 4 intermediate proficiency subjects from each group of Chinese, Japanese and Korean language backgrounds served as listeners in the Identification Task. Four native speakers, who did not conduct the accentedness judgment, served as native listeners in the Identification Task. They were also instructors in a college in Seoul, Korea and had been living in Korea for 1 to 2.5 years. They were between 29 and 36 years old.

#### 3.2 Methods

The speech stimuli for the Identification Task were elicited from three high and three low proficiency Chinese talkers in Experiment 1. The sentence stimuli consisting of 10 initial /l/ 10 initial /r/ 10 final /l/ and 10 final /r/ sounds were randomized and recorded at the sampling rate of 44.1 KHz. The 10 target stimuli for each target included 5 minimal pair words (e.g., read – lead) and 5 non-minimal pair words to see if the contrast of minimal and non-minimal pairs would have an effect on the ISIB-L. The stimuli used for the experiment are presented in the Appendix.

The liquid stimuli, both segments and words, were edited from the spectrogram with reference to their waveform. The liquids /l/ and /r/ generally show weaker formant energy when compared with vowels, once

the whole duration of a liquid was approximated in the spectrogram, the precise onset and offset points were determined where periodic waveforms changed in shape. In order to avoid listeners noticing the purpose of the experiment, another list of 40 sentences, called ‘fillers’, were randomly mixed with the target stimuli and recorded together. The filler sentences necessarily included sounds other than target liquids such as /t/ or /m/.

To prepare the speech stimuli for the Identification Task, different positions of /l/ and /r/, initial and final /l/ and initial and final /r/, were edited in three different contexts: segment alone, within a word and in a sentence. This was intended to investigate the contextual effect on ISIB-L. Sound edition was carried out in the Praat program. The total number of the target stimuli was 720 (4 liquids \* 10 sentences \* 3 contexts \* 6 talkers) with another 720 fillers available. It would invoke listeners’ fatigue and have a detrimental effect on the identification results if the listeners judge 1440 audio signals (720 targets and 720 filler stimuli). 120 target stimuli recorded by each of high and low proficiency (4 liquids \* 10 sentences \* 3 low or high proficiency talkers) were split into three sets, with each composed of 40 stimuli. Moreover, each set was manipulated to necessarily have 10 stimuli for initial /l/ and /r/ and final /l/ and /r/, that is 10 initial /l/ 10 final /l/ 10 initial /r/, and 10 final /r/ sounds were included in each set with the talkers randomized. Subsequently, each set consisted of 40 stimuli low Chinese talkers, 40 stimuli from high talkers and 40 filler stimuli. Those 80 target stimuli were available in both segment and word forms, but only 20 sentences as opposed to segments or words from each proficiency were embedded in each set to avoid a repetition of the same sentence. Since 10 different sentences were recorded for each positional liquid, one sentence would be repeated twice to a listener if 40 sentences were all used from both low and high talkers’ recordings. The total number of audio signals which a listener listened to was 300 per set, 80 target segments (40 from low talkers and 40 from high talkers) + 40 segment fillers + 80 target words (40 from low talkers and 40 from high talkers) + 40 word fillers + 40 target sentences (20 from low talkers and 20 from high talkers) + 20 sentence fillers. 16 listeners (4 listeners from Chinese, Japanese, Korean and native groups, respectively) were presented with a set of 300 speech stimuli.

The stimuli for the Identification Task were programmed in Superlab 4.0 in such a way that a subject listened to the audio signals in a sentence form first, and then a word form, and finally a segment. It was because they would have been otherwise able to appreciate the target sounds and readily recognize the intention of the experiment. Listeners were asked to wear a headphone and sit in front of a computer in a quiet room. When they identified the target words in the sentence context, each sentence with a blank popped up on the computer screen simultaneously as they listened to the sentence. This task was executed in a forced-choice method as it has been recently used in many speech intelligibility studies (Hayes-Harb et al. 2008, Smith et al. 2009 among others). Below the sentence were four choices of

examples shown with numbers 1, 2, 3, and 4.<sup>4</sup> The four choices were made up with similar sound combinations to the target word with no consideration of semantic or syntactic status of word choices in a sentence. For example, there were four choices of words, *limits*, *likes*, *rates*, and *ages*, for a given audio sentence 'He knows his own \_\_\_\_\_'.

In the word identification from a sentence, listeners were required to choose, for the blank, the same word that they had heard by pressing 1, 2, 3, or 4 in 10 seconds. The four choices were made up with two minimal pair words, if the target was from a minimal pair, and the other two words including one or two similar sounds to the target word like *store*, *stole*, *stick* and *smell*. Once their response was sent, the next sentence automatically popped up on the screen with its audio signal. In the word and segment identification, four different words or segments were shown with numbers 1, 2, 3 and 4 on the screen. Listeners were required to give their response in 5 seconds. Unlike the sentence stimuli, they had to wait for the next word or segment even after they hit their response. It was assumed that words, which were usually composed of one syllable, or segments were too short in duration so that the listeners would need some time to reset themselves for the next stimulus. It took approximately half an hour for each listener to complete the whole session of the Identification Task.

### 3.3 Results

#### 3.3.1 Intelligibility of four different positional liquids

The identification accuracy ratings for the different positional liquids produced by Chinese low proficient (LP) talkers are shown in Figure 2. The X-axis indicates the listeners arranged by their L1 backgrounds (CL – Chinese listeners, JL – Japanese listeners, KL – Korean listeners and EL – English listeners), and the Y-axis displays the percent (%) correctness for each liquid identification. The perception data were all submitted to a two-way ANOVA (analysis of variance) with the liquids in different positions and the listeners' language backgrounds as factors and accuracy ratings as a dependent variable. There were main effects of listeners' language backgrounds [ $F(3,48) = 638.48, p < 0.05$ ] and the liquids [ $F(3,48) = 2.04, p < 0.05$ ] and their interaction [ $F(9, 48) = 462.78, p < 0.05$ ].

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<sup>4</sup> A four-way forced choice task takes advantage over a two-way forced choice one in that the former can reduce the accidental rate of correctness. Listeners may be accidentally correct or incorrect when given only two choices

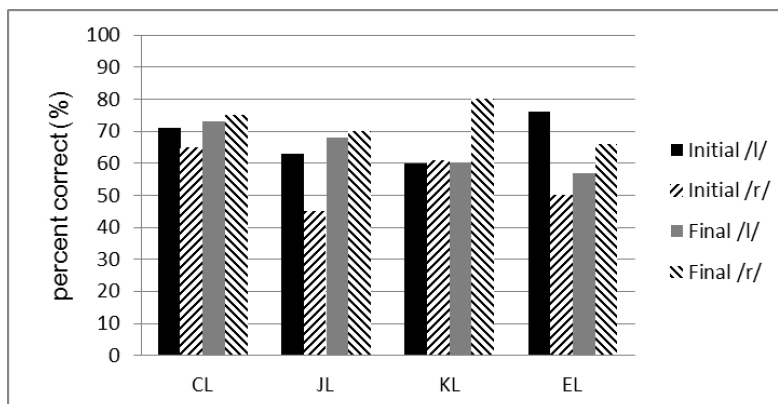


Figure 2. Identification accuracy for Chinese LP talkers by position

*Post hoc* pairwise comparisons (Tukey test) of listener groups' accuracy for each target liquid were conducted. English listeners (EL) were more accurate at identifying the initial /l/ than all the non-native listener groups as illustrated in the leftmost bar of each listener group ( $p < 0.05$ ). This suggests that the non-native listeners did not take advantage of the interlanguage whether their L1 was the same as the non-native Chinese talker's or not. Therefore, the results did not support the either matched or mismatched ISIB-L.

The correctness rate of the initial /r/ identification is illustrated by the second bars from the left in each group in Figure 2. Non-native Chinese and Korean listeners were significantly more correct than English native listeners, but English listeners performed better than Japanese listeners ( $p < 0.05$ ). That is, the shared phonological and phonetic knowledge between Chinese listeners and talkers seemed to facilitate the perception of the same L1 talkers' production of the initial /r/, matched ISIB-L held true. Similarly, Korean listeners were more accurate at identifying the initial /r/ than English listeners ( $p < 0.05$ ), this was the evidence of the mismatched ISIB-L effects. There seemed to be an interlanguage existing between non-native Chinese talkers and Korean listeners as far as the initial /r/ sound was concerned. Japanese listeners, on the other hand, did not establish the same kind of interlanguage with the Chinese talkers unlike Korean listeners.

The identification accuracy for the final /l/ is shown by the third bar from the left in each listener group. Chinese and Japanese L2 listeners were significantly more accurate than English listeners ( $p < 0.05$ ). The identification accuracy scores were not significantly different between Korean listeners and English listeners ( $p = 0.122$ ). Contrast to the results of the initial /r/ sound, Japanese listeners seemed to share an interlanguage with Chinese talkers while Korean listeners did not have common phonological/phonetic knowledge with Chinese L2 talkers. As for the final /l/,

the matched ISIB-L, therefore, was observed, but the mismatched ISIB-L occurred for Japanese listeners rather than Korean listeners.

The rightmost bars in each group indicate the accuracy for the final /r/ sound. All nonnative listeners outperformed English listeners ( $p < 0.05$ ). In other words, native listeners were less accurate at identifying the final /r/ sound produced by Chinese LP talkers than non-native Chinese, Japanese, and Korean listeners. The non-native listeners seemed to take advantage of the interlanguage irrespective of their L1 backgrounds. This suggests that both matched and mismatched ISIB-L held true.

Figure 3 displays the accuracy results of the target liquids in different positions produced by the Chinese high proficiency (HP) talkers. A two way ANOVA (analysis of variance) was executed on the identification accuracy scores, and there were significant effects of listeners' language background [ $F(3,48)=35.03$ ,  $p < 0.05$ ], target liquid [ $F(3,48)=397.7$ ,  $p < 0.05$ ], and their interaction [ $F(9, 48)=300.21$ ,  $p < 0.05$ ].

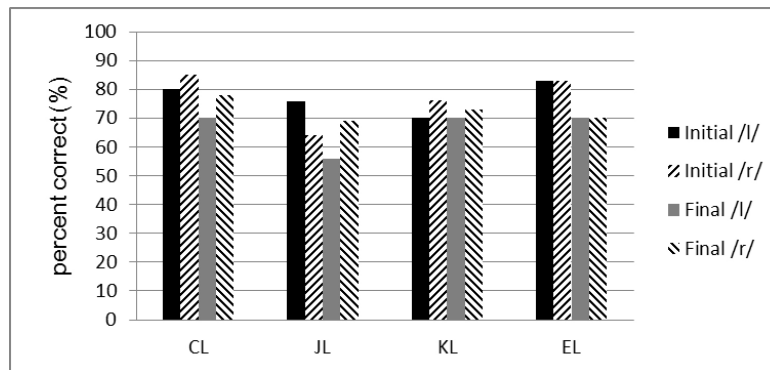


Figure 3. Identification accuracy for Chinese HP talkers by position

A Tukey test was carried out for *post hoc* pairwise comparisons at  $p < 0.05$ . The identification accuracy scores for the initial /l/ were not significantly different between Chinese and native listeners ( $p = 0.367$ ) (compare the leftmost bars in CL, JL and KL with that of EL). However, native listeners showed significantly higher accuracy scores than Korean listeners and Japanese listeners. That is, English native listeners outperformed both Japanese and Korean listeners when perceiving the English initial /l/ sound produced by Chinese HP talkers. In the case of Chinese listeners, they were as accurate as native listeners. Therefore, non-native listeners did not seem to be benefited from the interlanguage between nonnative listeners and talkers, either matched or mismatched ISIB-L did not occur for the identification of the initial /l/. There seemed to be no interlanguage built up between Chinese high talkers and non-native listeners regardless of their L1 backgrounds.

As for the identification of the initial /r/ produced by Chinese HP talkers,

the second bars from the left in each group compared its perception accuracy between native and non-native listeners. The performance of English listeners excelled that of both Korean listeners and Japanese listeners ( $p < 0.05$ ). However, there was no significant difference between English and Chinese listeners ( $p = 0.09$ ). This suggests that either matched or mismatched ISIB-L was found for the initial /r/ produced by Chinese HP talkers. This is also interpreted as stating that there was no shared sound knowledge linking with the English initial /r/ among non-native talkers and listeners.

Concerning the identification accuracy of the final /l/, the third bars from the left in each group show that the accuracy scores of English listeners were not significantly different from those of Chinese listeners ( $p = 0.12$ ) or Korean listeners ( $p = 0.99$ ), but that English listeners were significantly more accurate than Japanese listeners ( $p < 0.05$ ). That is, there were no non-native listener groups who outperformed native listeners, no ISIB-L was observed. Similarly to the cases of the initial /l/ and /r/ sounds, the non-native listeners did not take advantage of the intelanguage which might be shared with the non-native Chinese talkers.

Finally, the rightmost bars indicate that only Chinese listeners performed better than English listeners ( $p < 0.05$ ). Either Japanese or Korean listeners were not more accurate than native listeners at identifying the final /r/ sound produced by Chinese HP talkers ( $p = 0.6$  for JL,  $p = 0.39$  for KL). This indicates that only the matched ISIB-L held true for Chinese listeners but that the mismatched ISIB-L did not occur for either Japanese or Korean listeners.

### 3.3.2 ISIB-L in different contexts

Figure 4 exhibits the identification accuracy rates of the three different contextual liquid targets produced by the low proficiency Chinese talkers. According to a two way ANOVA, there were main effects of listeners' language background [ $F(3,35) = 559.2$ ,  $p < 0.05$ ], target sounds [ $F(2,35) = 3.14$ ,  $p < 0.05$ ], and their interaction [ $F(6,35) = 409.18$ ,  $p < 0.05$ ].

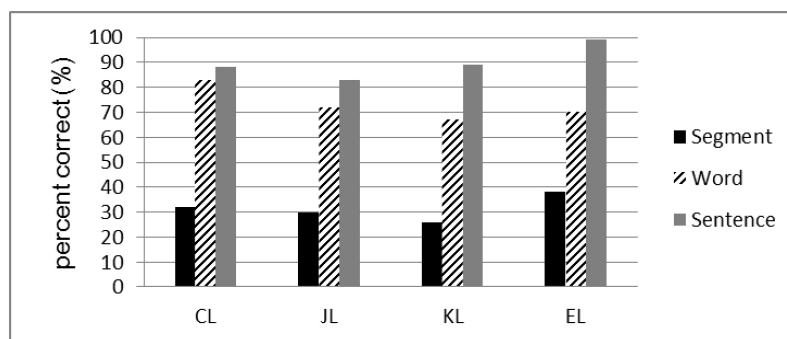


Figure 4. Identification accuracy for Chinese LP talkers in different contexts

According to a *post hoc* Tukey test, no statistically significant difference between English listeners and Chinese listeners ( $p=0.82$ ) was found. Moreover, both Korean and Japanese listeners showed a significantly lower accuracy scores than English listeners ( $p<0.05$ ). This shows that neither matched nor mismatched ISIB-L was observed. That is, non-native listeners did not take advantage over native English listeners when a lower level of sound information, namely segments, was provided

The mid bars in each category indicate the identification accuracy scores in word context. When the listeners were asked to identify the target sounds within a word, it was generally assumed that there were more contextual cues available than in the segments alone condition. Chinese listeners were more accurate at identifying the target liquids than English listeners ( $p<0.05$ ), but Japanese or Korean listeners were not significantly different from English listeners ( $p=0.08$  for JL,  $p=0.45$  for KL). The matched ISIB-L occurred for the Chinese listeners, but the mismatched ISLB-L did not hold true for either Japanese or Korean listeners.

The rightmost bars in each category show the identification results in sentence context, whereby the listeners perceived the target liquids within a sentence. Intriguingly, English listeners excelled all of the nonnative listeners in identifying the liquids produced by Chinese LP talkers ( $p<0.05$ ). It seems that nonnative listeners, regardless of their L1 backgrounds, did not take advantage of a higher level of contextual information over native listeners when they identified Chinese accented English liquids. Consequently, no ISIB-L effects, either matched or mismatched, were supported in the sentence condition.

Considering the accuracy rate for each language background across the contexts, all listeners performed better in the word context than in the segment context ( $p<0.05$ ). Japanese and Korean nonnative listeners and English listeners were more accurate at identifying the target liquids in the sentence context than the word context ( $p<0.05$ ). However, this was not the case for the Chinese listeners ( $p=0.07$ ).

Figure 5 shows the identification accuracy of the three different contextual target liquids produced by Chinese high proficiency talkers. All the data were submitted to a two way ANOVA (analysis of variance), and there were main effects of listeners' language background ( $[F(3,35)=245.2, p<0.05]$ ), target sound ( $[F(2,35)=8.98, p<0.05]$ ), and their interaction ( $[F(6,35)=320.05, p<0.05]$ ).



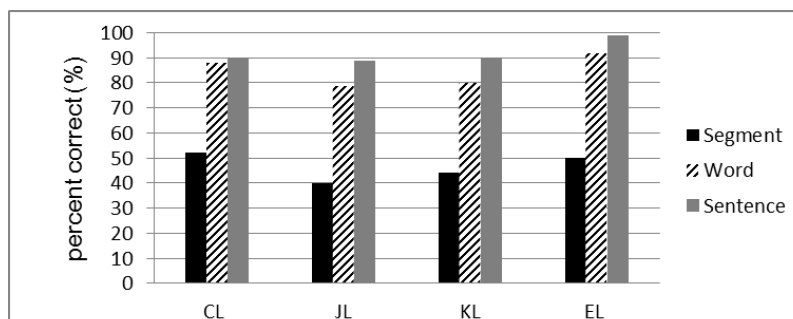


Figure 5. Identification accuracy for Chinese HP talkers in different contexts

A post hoc pairwise comparisons were executed through a Tukey test. When the leftmost bars in each group were compared, the identification accuracy was not significantly different between English and Chinese listeners ( $p=0.259$ ), but was statistically higher than that of Japanese listeners and Korean listeners ( $p<0.05$ ). That is, there were no ISIB effects, either matched or mismatched, were found. The interlanguage which might be shared by non-native talkers and listeners did not seem to play a beneficial role in the perception of the target liquids in isolation.

Similarly the accuracy scores for the identification in the word condition were not significantly different between Chinese and English native listeners ( $p=0.89$ ), and furthermore, Japanese and Korean listeners showed significantly lower scores than English listeners ( $p<0.05$ ). A word level of contextual information seemed to rather facilitate native English listeners' perception of the Chinese accented English liquids.

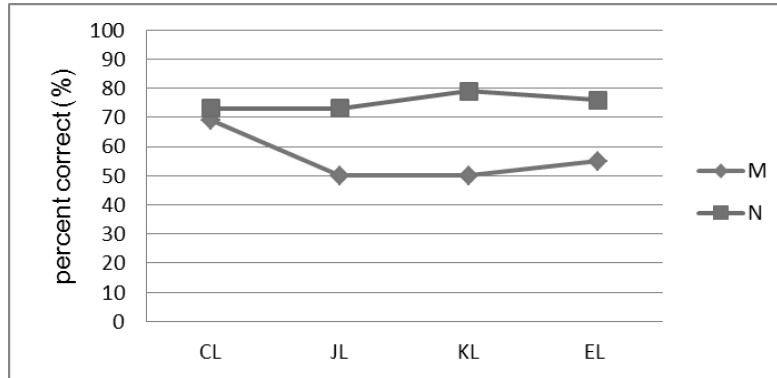
English listeners performed significantly better than all the nonnative listeners when they identified the target liquids in sentence context ( $p<0.05$ ). In consequence, there was no ISIB-L, native listeners rather took advantage of richer contextual cues over non-native listeners.

When comparing the results of the three contexts for each group of listeners, the accuracy scores were higher in word context than segment context ( $p<0.05$ ). Japanese, Korean and English listeners performed significantly better in sentence context than in word context ( $p<0.05$ ). However, this was not the case of Chinese listeners ( $p=0.31$ ).

### 3.3.3 ISIB-L in minimal and non-minimal pair contrasts

Minimal vs. non-minimal pair contrasts are only accessible at a higher level processing like word or sentence, therefore, the identification of /l/ and /r/ in the segment context was not considered in association with these contrasts. Figure 6 shows a comparison of the accuracy scores of the target liquid identification between minimal and non-minimal pairs. The results

were statistically analyzed by a two way ANOVA, there were main effects of listeners' language background [ $F(3,24)=162.2$ ,  $p<0.05$ ], minimal vs. non-minimal pair contrast [ $F(1,24)=3.78$ ,  $p<0.05$ ], and their interaction [ $F(3,24)=162.05$ ,  $p<0.05$ ].



**Figure 6. Identification accuracy for Chinese LP talkers in minimal vs. non-minimal pairs (M: minimal pairs, N: non-minimal pairs).**

In the case of minimal pair tokens, only Chinese listeners performed better than English listeners ( $p<0.05$ ), showing the matched ISIB-L. Japanese and Korean nonnative listeners, however, showed no significance difference from English listeners ( $p=0.59$  for JL,  $p=0.39$  for KL). This suggests that there is no evidence for the mismatched ISIB-L effects. For non-minimal pair stimuli, any groups of non-native listeners were not significantly more accurate than native listeners either ( $p=0.11$  for CL,  $p=0.08$  for JL,  $p=0.59$  for KL). That is, no ISIB-L was supported. The overall sketch of Figure 6 is that listeners performed better for non-minimal tokens than minimal pair tokens ( $p<0.05$ ) except Chinese listeners ( $p=0.18$ ).

Figure 7 shows the correct perception rates for the target liquids produced by Chinese HP talkers in minimal and non-minimal pair conditions. The results were analyzed by a two way ANOVA, and there were main effects of listeners' language background [ $F(3,24)=238.54$ ,  $p<0.05$ ], minimal vs. non-minimal pair contrast [ $F(1,24)=1.82$ ,  $p<0.05$ ], and their interaction [ $F(3,24)=210.05$ ,  $p<0.05$ ].

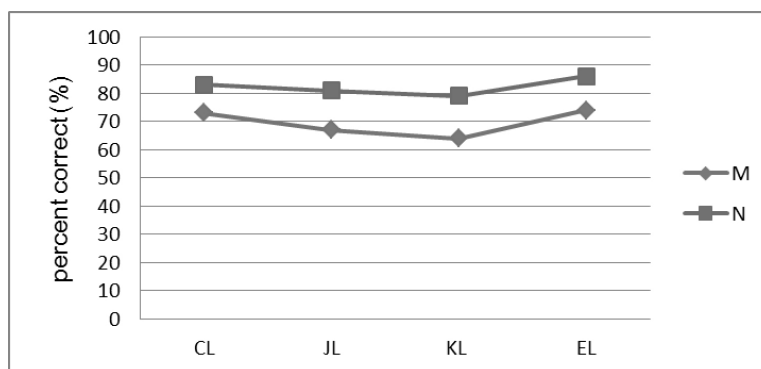


Figure 7. Identification accuracy for Chinese HP talkers in minimal vs. non-minimal pairs (M: minimal pairs, N: non-minimal pairs).

There was no evidence for the ISIB-L in either minimal or non-minimal tokens. More specifically, when the listeners were provided minimal tokens, native listeners performed with no difference from Chinese listeners ( $p=0.73$ ) and even better than Japanese listeners and Korean listeners ( $p<0.05$ ). Similarly, there was no statistical difference in identifying non-minimal liquid tokens between Chinese and English listeners ( $p=0.13$ ). The English native listeners were even better than Japanese listeners and Korean listeners ( $p<0.05$ ). All listeners were more accurate at identifying non-minimal pair tokens than minimal pair tokens ( $p<0.05$ ).

### 3.4 Discussion

We have shown the speech intelligibility of Chinese accented English liquids for non-native Chinese, Japanese and Korean listeners and native English listeners in connection to word positions, listeners' L1 backgrounds, and talkers' proficiency. Moreover, we examined the effects of contextual cues and minimal vs. non-minimal pair contrasts on the ISIB-L. The results presented in Figures 2 and 3 are summarized in Table 2 below.

Table 2. A Summary of the ISIB-L

	Chinese LP talkers			Chinese HP talkers		
	CL	JL	KL	CL	JL	KL
Initial-/l/	×	×	×	×	×	×
Initial-/r/	√	×	√	×	×	×
Final-/l/	√	√	×	×	×	×
Final-/r/	√	√	√	√	×	×

(√ indicates that the ISIB-L occurs, and × indicates that no ISIB-L occurs.)

Concerning Chinese talkers' proficiency, the ISIB-L dominantly occurred for Chinese LP talkers than HP talkers. There was only one ISIB case found for HP talkers, Chinese listeners were more accurate at identifying the final /r/ sound than native listeners. On the other hand, the ISIB-L was mostly observed for Chinese LP talkers except the initial /l/. Unfortunately, the effects of listeners' proficiency could not be examined in the current study, since non-native listeners' proficiency was all confined to the intermediate level. Chinese LP talkers' speech was more intelligible to non-native listeners than HP talkers' speech. This is consistent with Hayes-Harb et al. (2008). They found that ISIB-L effects were held only for the low phonological proficiency speech.

Since less proficient talkers' speech is usually more accented and presumably entails more L1-like phonological and phonetic features, the speech intelligibility may be more easily facilitated to nonnative listeners through the interlanguage existing between nonnative listeners and talkers. Inversely, high proficient talkers' speech, which is less accented, has relatively a less number of L1 and a greater number of L2 sound features in their interlanguage. Thus it may not serve sufficient information successfully to nonnative listeners. It may rather enhance the speech intelligibility for native listeners, finally leading to their outperformance over non-native listeners. The LP talkers who were judged as having the strongest foreign accents were more intelligible than the HP talkers. These mixed findings with respect to phonological proficiency/accentedness and intelligibility are consistent with findings reported in Munro and Derwing (1999) in that non-native speech intelligibility and accentedness are not necessarily correlated, and may thus be related to at least partially independent phenomena.

When the effects of word position on the ISIB-L are considered, native listeners exceeded nonnative listeners in the identification of the initial /l/ sound. Either matched or mismatched ISIB-L was elicited. As seen in Table 1, the initial /l/ among four different positional liquids in Chinese is the most similar to the English initial /l/ sound both phonetically and phonotactically (Shimizu and Dantsuji 1987, He 2001). He (2001) also reported that Chinese learners' production of the English initial /l/ was acoustically 100% accurate. Therefore, the Chinese accented /l/ in this position may entail very similar or even the same features as English talkers' initial /l/ so that native listeners can plausibly identify it relatively better than the other liquids [ $F(3, 36)=31.07, p<0.05$ ]. That may be the reason why no ISIB-L exists. This does not mean that nonnative listeners' accuracy for the initial /l/ was poorer than that of the other target segments but means that native listeners were simply more accurate than non-native listeners. As illustrated in Figure 2, the accuracy scores of non-native listeners for the initial /l/ were not considerably lower than those for the other liquids. The native listeners seem to have performed better, which might be attributed to Chinese L2 talker's more L2-like and intelligible production of the initial /l/. In other words, it should be more beneficial to native listeners than Chinese listeners, if

everything being equal, due to the fact that the speech stimuli of the initial /l/ were English rather than Chinese.

Unlike initial /l/, the intelligibility of initial /r/ and final /l/ and /r/ was more complicated depending on the listeners' native languages. In Figure 2, the Chinese listeners were always more accurate than native listeners at identifying the Chinese LP talkers' initial /r/ and final /l/ and /r/. This matched ISIB-L can be explained by the fact that non-native speech production and perception are both systematically linked to native language sound structure (Bent and Bradlow 2003, Best 1994, 1995, Flege 1992, 1995, Kuhl and Iverson 1995, Strange 1995 and many others). Chinese liquids are drastically different from English liquids except the initial /l/ as shown in Table 1. The initial /r/ is phonetically realized as either the retroflex approximant or the retroflex fricative and the latter is absolutely not attested in English. The final /l/ is not allowed in Chinese and the final /r/ is always followed by /a, ə, u/ in Chinese, which may give rise to a deviant production of final /r/ in other vowel environments in L2 English speech. Native listeners would identify any sound which is different from this phonetic representation as accented or sometimes unintelligible. Chinese low proficient talkers' liquids, presumably very distinct from English liquids in these positions, should contain more L1 features and less L2 features, and this may cause native listeners' confusion in the identification of the Chinese-accented initial /r/ and final /l/ and /r/.

Chinese HP talkers' production was, on the other hand, more intelligible to native listeners than Chinese listeners except for the final /r/ sound as recalled in Figure 3. That is, Chinese listeners did not seem to take advantage of the interlanguage, no ISIB occurred. Chinese HP talkers' speech, which is less accented, involves a smaller number of L1 and a greater number of L2 sound features, therefore, it is highly intelligible to English native listeners. However, Chinese HP talkers did not seem to share much of phonological/phonetic information with the Chinese intermediate listeners in their interlanguage. That is, more L2-like speech produced by HP talkers was not sufficiently intelligible to the intermediate listeners.

Concerning the final /r/, Chinese listeners performed better than English native listeners, resulting in the matched ISIB-L. This is also interpreted as the fact that Chinese talkers' performance of the English final /r/ is poorer than that of other liquids because it is the most dissimilar from the English final /r/ due to its phonotactic restriction. The retroflex [r] is only preceded by /a/, /ə/, /u/ in Chinese, therefore, it may be very difficult for Chinese talkers to produce it in other vowel environments. Consequently, it is not sufficiently intelligible to native listeners while Chinese listeners take advantage of its L1-like phonological properties in their interlanguage.

Considering the mismatched ISIB-L effects, it is worth noting that Korean listeners outperformed native listeners in the identification of Chinese LP talkers' production of initial /r/ and final /r/. It is not quite surprising that Korean listeners were more accurate at identifying Chinese accented English

/r/ in the word final position. As mentioned above, the final /r/ in Chinese seems to be extremely dissimilar from the one in English, which will decrease the intelligibility of the Chinese-accented English final /r/ sound to native listeners. Korean listeners, however, seemed to be benefited from Chinese talkers' considerably accented and highly deviant production of the final /r/, because there might not be retroflex-like phonetic features in Korean listeners' interlanguage either. This is attributed to the systematic difference of Korean liquid sounds from English, /r/ does not have a phonemic status or even show an allophonic realization of /l/ in the word final position in Korean. As asserted in Bent and Bradlow (2003), the mismatched ISIB-L results from the talker's and listener's shared knowledge of the structure of the target language in conjunction with the influence of general strategies that listeners and talkers applied when learning to produce and perceive a foreign language.<sup>5</sup> Due to far distinct phonological and phonetic characteristics of Chinese and Korean liquids from English, Chinese LP talkers share more L2-dissimilar sound information in relation with the English final /r/. This will bring about the mismatched ISIB-L of Chinese LP talkers for Korean listeners. These results were not, however, observed consistently in Korean listeners' perception of Chinese HP talkers' final /r/. Presumably, less accented HP talkers did not seem to share much phonological/phonetic knowledge with Korean listeners in their interlanguage. Consequently, the mismatched ISIB-L did not occur for Chinese HP talkers contrary to LP talkers.

There was another mismatched ISIB for Korean listeners observed from Chinese LP talkers' production of the initial /r/. This can be also explained in a similar manner to the final /r/. Due to systematic differences between Chinese and English initial /r/ as presented in Table 1, Chinese LP production may be considerably deviant or accented. Similarly, the retroflex /r/ does not phonotactically exist in word initial position in Korean. More L2-dissimilar features from English may constitute more common or shared phonological/phonetic features in Chinese and Korean interlanguage as far as the initial /r/ is concerned. This may facilitate the ISIB-L effects for Korean listeners.

The ISIB-L for Japanese listeners was all observed in final position. That is, the intelligibility of final /l/ and /r/ sounds for Japanese listeners exceeded that of native listeners. This might be attributed to the interlanguage shared by Chinese LP talkers and Japanese listeners, whereby more dissimilar characteristics from L2 final liquids are accessed. Japanese does not allow a

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<sup>5</sup> Foreign accented speech, regardless of its L1 background, is inevitably distorted to some degree and deviated from the norm of native speakers, which may contribute to establishing an interlanguage shared by L2 learners of different L1 backgrounds. Their interlanguage may consist of more dissimilar phonological/phonetic features from the target language (L2). For example, a voiceless alveolar stop of English /t/ may be accented and distorted to dental by Korean talkers or retroflex by Hindi talkers in their interlanguage, but the common feature of the accented /t/ which is shared by Korean and Hindi learners is that /t/ is no longer alveolar.

consonant in final position except a nasal, therefore, Japanese listeners may not be well equipped to perceive English liquids in this position accurately, but comprehend better the acoustic-phonetic features of the speech of a mismatched non-native Chinese talker. That is, similar features of Chinese accented and Japanese accented English may serve to facilitate the perception of English speech between native Chinese talkers and native Japanese listeners. More specifically, due to the restricted phonotactic distributions of /l/ and /r/ in Chinese and Japanese as mentioned in Introduction, Chinese talkers' production of strongly accented /l/ and /r/ in the final position may lead to facilitating intelligibility to Japanese listeners.<sup>6</sup> The same kind of ISIB-L for Japanese listeners did not occur in the case of Chinese HP talkers. Similarly to the account of the ISIB-L for Korean listeners, more L2-like and less accented speech of Chinese HP talkers enhanced native listeners' comprehension, thus, the mismatched ISIB was not elicited.

The mismatched ISIB-L patterns of Chinese accented English liquids are substantially different between Korean and Japanese listeners. The initial and final /r/ sounds contributed to the ISIB for Korean listeners while the final /r/ and /l/ invoked the ISIB for Japanese listeners. Such differences are attributed to L1's phonological and phonetic structure or systems concerning liquids.

Recall Figures 4 and 5, in which contextual effects on speech intelligibility were exhibited. As asserted in Mayo et al. (2002) and Lee and Xue (2011), the identification accuracy would increase due to accessibility to semantic information, which can predicate that the identification accuracy ratings increase as contextual cues are richer from segment alone to word and from word to sentence. Furthermore, higher level contextual cues are more easily accessed by higher proficient listeners. It is then predicted that native listeners, who are assumed to be sufficiently high proficient, will perform better than non-native listeners in the identification of the target liquids in the order of sentence > word > segment contexts. The ISIB will be consequently more likely to occur in lower level context stimuli. The results in this study, however, demonstrated no ISIB-L in any contexts and in either LP or HP talkers' speech except the LP talkers' word stimuli. It suggests that contexts do not affect the ISIB, which is not consistent with the previous findings of Mayo et al. or Lee and Xue.

When the effects of the minimal vs. non-minimal pair contrast on ISIB-L were taken into consideration, the ISIB-L was found merely in one single case, Chinese listeners outperformed native listeners in the identification of the Chinese LP talkers' minimal pair stimuli. Imai et al. (2005) found that non-native listeners outperformed native listeners for the words produced by

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<sup>6</sup> As already mentioned in Introduction, Chinese does not allow /l/ to appear in final position and delimits /r/ in this position only when preceded by /a, ə, u/. Similarly, a final consonant is not allowed in Japanese except for the nasals homorganic to the following consonant.

the non-native talker that came from dense lexical neighborhoods (i.e., words that can easily be confused). Similarly, Bradlow and Pisoni (1999) reported that word recognition by non-native listeners were worse for hard words (low frequency in high density neighborhood) than for easy words (high density words in sparse neighborhoods). The results illustrated in Figure 6 were consistent with the previous findings such that only the Chinese listeners were more accurate at identifying the targets from the minimal pair stimuli. That is, they took advantage of the Chinese talkers' matched L1, more specifically, commonly shared phonological/phonetic features existing in their interlanguage. Native listeners were rather more confused with non-native/accented speech plus dense neighborhoods when listening to minimal pair stimuli.

#### 4. Conclusion

This study demonstrated that the positional effects on the matched and mismatched ISIB-L systematically reflected the phonological/phonetic structure and phonotactic patterns of both L1 and L2. This is consistent with the finding of Bent and Bradlow (2003) that L2 speech production and perception are linked to native language sound structure. The ISIB-L seemed to be closely related with talker's proficiency, low proficient talkers were more intelligible to non-native listeners of both matched and mismatched L1 than native listeners. Additionally, there were no contextual effects on the ISIB-L observed in the current study, but the contrast between minimal and non-minimal pairs influenced the ISIB-L in such a way non-native listeners with the matched L1 can identify minimal pair tokens more correctly than native listeners, that is, more confusing words were more intelligible to non-native matched listeners.

The success of recognizing foreign accented speech seems to be closely associated with talkers' proficiency, phonological/phonetic structure of L1, and minimal/non-minimal pair status, and this is consistent with many previous studies (Bent and Bradlow 2003, Hayes-Harb et al. 2008, Lee and Xue 2011 and many others).

#### Appendix

Sentence stimuli: bold faced words are target liquids, and underlined sentences include minimal pairs of /r/ and /l/.

##### *Initial //*

1. He knows his own **limits**.
2. One **leg** of the chair is missing.
3. **Language** is an instrument for communication.
4. I wish you **luck**!



5. It is **logical** to assume that they will attend.
6. What they did was against the **law**.
7. The **late** storm did much damage to the crops.
8. They set off at first **light**.
9. I left the key in the **lock**.
10. The temperature is very **low** today.

*Initial /r/*

1. They worked without **result**.
2. He is **ready** for the trip.
3. He told a rather **rude** joke, and everyone looked embarrassed.
4. The **reason** for her absence was that she was ill.
5. They were watching a **rugby** match when I was cooking.
6. All the **raw** materials are imported.
7. The employment **rate** is different now in that country.
8. She was **right** in her answer.
9. He likes playing **rock** music.
10. The woman told the children to stand in a **row**.

*Final /r/*

1. He was **real** sorry for what he did for you.
2. He remained **cool** before the enemy.
3. The **tall** guy was arrested last week.
4. He awoke to the ringing of an electric **bell**.
5. No one can deny her **beautiful** face.
6. He might have not found the **file**.
7. In the school play, she played the important **role**.
8. Mary admitted that she **stole** the money.
9. He fastened the photo to a **wall**.
10. He left without paying the **bill**.

*Final /r/*

1. The sound of music is pleasant to the **ear**.
2. My mother was used to be a social **worker**.
3. Do you need some **sugar**?
4. My **car** has stopped working since last month.
5. You may spend two **or** three days in that country.
6. He asked his men to **fire**.
7. I heard a **roar**.
8. I bought many apples at the nearest department **store**.
9. They were fighting a just **war**.
10. I would like to drink **beer**.

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Joo-Kyeong Lee  
Department of English Language and Literature  
University of Seoul  
163 Siripdaero (90 Jeonnong-dong), Dongdaemun-gu, Seoul  
Korea 130-743  
e-mail: jookyeong@uos.ac.kr

Xiaojiao Xue  
Department of English Language and Literature  
University of Seoul  
163 Siripdaero (90 Jeonnong-dong), Dongdaemun-gu, Seoul  
Korea 130-743  
e-mail: jiao0409@naver.com

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