

## The Interlanguage Speech Intelligibility Benefit for Listeners (ISIB-L): The Case of English Liquids

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### ABSTRACT

This study attempts to investigate the interlanguage speech intelligibility benefit for listeners (ISIB-L), examining Chinese talkers' production of English liquids and its perception of native listeners and non-native Chinese and Korean listeners. An Accent Judgment Task was conducted to measure non-native talkers' and listeners' phonological proficiency, and two levels of proficiency groups (high and low) participated in the experiment. 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 lexical density (minimal vs. nonminimal pair) to see if these factors play a role in ISIB-L. Results showed that both matched and mismatched interlanguage speech intelligibility benefit for listeners occurred except for the initial /l/. Non-native Chinese and Korean listeners, though only with high proficiency, were more accurate at identifying initial /r/, final /l/ and final /r/, but initial /l/ was significantly more intelligible to native listeners than non-native listeners. There was evidence of contextual and lexical density effects on ISIB-L. No ISIB-L was demonstrated in sentence context, but both matched and mismatched ISIB-L was observed in word context; this finding held true for only high proficiency listeners. Listeners recognized the targets better in the non-minimal pair (sparse density) environment than the minimal pair (higher density) environment. These findings suggest that ISIB-L for English liquids is influenced by talkers' and listeners' proficiency, syllable position in association with L1 and L2 phonological structure, context, and word neighborhood density.

**Key words:** intelligibility, English liquids, proficiency, context, lexical density

### 1. Introduction

Intelligibility is broadly defined as the extent to which the native speaker understands the intended message (Munro & Derwing, 1999). Many studies concerning the intelligibility of native and non-native speech for native and non-native listeners have shown that speech intelligibility is affected by many factors such as speech rate, certain acoustic properties of

speech, degree of speech clearness, word frequency, etc. (Bradlow & Bent, 2002; Bradlow & Pisoni, 1999; Derwing & Munro, 2001; Markhan & Hazan, 2002 among others). Moreover, the language background of talkers and listeners has been demonstrated to be a salient role in the intelligibility of speech (Bent & Bradlow, 2003; Munro, 1998; van Wijngaarden, 2001; Hayes-Harb et al., 2008). That is, 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. This is presumably attributed to the similar L2 phonological representations directly generated from the same L1, which is called 'interlanguage'. Therefore, nonnative listeners obtain benefits from the same L1 nonnative talkers' L2 speech in determining intelligibility, and Bent & Bradlow (2003) defines it as 'interlanguage speech intelligibility benefit (ISIB)'.

Mayo et al. (1997) claim that the contextual constraints

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influence the intelligibility of non-native speech for both native and non-native listeners in such a way that the advantage from the context is significantly greater for native and early non-native listeners than late non-native listeners. Koster (1987) conducted a series of linguistic experiments with Dutch subjects, systematically manipulating the context of a test word and found that the effect of semantic constraints on word recognition was almost equal for native and non-native listeners. In contrast, it was asserted in Hayes-Harb et al. (2008) and Smith et al. (2009) that ISIB effectively operated when the target sounds were given in isolation without any context. That is, listeners might take the strategy to listen to the relevant sounds, without getting access to the lexicon or sentence.

In addition, previous work has suggested that talker and listener proficiency in the target language may affect its interaction with the intelligibility of L2 speech. High proficient talkers and listeners showed the ISIB-T effects (Bent & Bradlow, 2003; van Wijngaarden, 2001), and the listeners who were more proficient subjects were likely to have 'near-native' use of contextual constraints (van Wijngaarden et al., 2002). On the other hand, Hayes-Harb et al. (2008) show that ISIB holds only for the case that the low proficiency non-native listeners listen to the speech produced by low proficiency non-native talkers.

Similarly, L2 experience, in particular, age of L2 onset has been shown to affect L2 listeners' performance on L2 speech; Mayo et al. (1997) tested L1 Mexican-Spanish listeners with different ages of L2 English acquisition and found that extensive exposure to the L2 did not result in native-like performance if the listener did not acquire the L2 in early childhood.

Neighborhood density has been shown to be another significant contributor to the ISIB (Bradlow & Pisoni, 1999; Imai et al., 2005). Imai et al. 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 such as minimal pairs, listeners can easily get confused. The native listeners seemed to be confused when they identified non-native talkers' words with dense lexical neighborhood, which led to non-native listeners' outperforming over native listeners. Bradlow & Pisoni (1999) showed a consistent finding that word recognition by non-native listeners is worse for low frequency words in high density neighborhoods than for high frequency words in sparse neighborhoods. The

norm of lexical neighborhood is determined in terms of segments shared across words; therefore, these findings suggest that ISIB, which always accesses lower level processing at the segmental level, is closely connected with a higher level processing at the word level.

ISIB has been further developed to two refined types: ISIB-T (talkers) and ISIB-L (listeners) (Hayes-Harb et al., 2008). The ISIB-T refers the cases where nonnative speech is more intelligible to nonnative talkers than native speech, while the ISIB-L refers the cases where nonnative speech is more intelligible to nonnative talkers than it is to native talkers. The ISIB-T and ISIB-L are also divided into two sub-categories depending on whether the nonnative talkers and listeners share the same L1 or not: matched ISIB-T vs. mismatched ISIB-T and matched ISIB-L vs. mismatched ISIB-L. According to Bent & Bradlow (2003), ISIB sometimes occurs between non-native talkers and listeners who do not share the L1, which is called mismatched ISIB, while matched ISIB refers to the intelligibility benefit from the non-native talkers' speech with non-native listeners, whereby both non-native talkers and listeners share the L1.

There have been also studies arguing against the interlanguage speech intelligibility benefit. Munro et al. (2006) presented the empirical evidence that no intelligibility benefit occurred between Cantonese talkers and listeners. They showed striking similarities in the comprehension of non-native utterances across 4 language listeners: Cantonese, Japanese, Polish and Spanish. According to Major et al. (2002), Chinese listeners showed intelligibility disadvantage for the Chinese talkers' English speech. Furthermore, Stibbard and Lee (2006) reported a speech experiment that there is limited evidence in favor of the matched ISIB but that no evidence supports the mismatched ISIB. Recently, Hayes-Harb et al. (2008) demonstrated that there was no evidence to support ISIB-T and that ISIB-L is effective only for the low proficiency L2 talkers and listeners. They further claimed that there were no ISIB effects in their German and English final stop voicing and devoicing study (Smith et al., 2009).

Many studies on speech intelligibility have mostly focused on vowels (Bent, Bradlow & Smith, 2007; Fogerty & Kewley-Port, 2009; Rogers, 1997; van Wijngaarden, 2001). It might be attributed to the fact that vowels are perceptually more salient than consonants and that the perception tasks associated with vowels are, thus, more convenient and permissive to L2

listeners than those of consonants. Vowels are asserted to have a stronger effect than consonants to non-native speech intelligibility (van Wijngaarden, 2001). Most studies on L2 consonant intelligibility have used word final stop voicing (Hayes-Harb et al., 2008; Smith et al., 2009). What is notably different from the intelligibility work associated with vowels is that their studies did not find strong evidence for ISIB. Hayes-Harb et al. (2008) observed that there were no ISIB-T effects, and Smith et al. (2009) even further contented that ISIB did not occur at all. That is, German listeners did not take advantage over English listeners in recognizing German talkers' production of English final stops, and moreover, English listeners did not show a better chance to comprehend English talkers' production of the German final stops, either.

There have been two different interpretations about 'benefit' in 'interlanguage speech intelligibility benefit' studies. When Bent & Bradlow (1999) 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 & Lee (2006) and Hayes-Harb et al. (2008). It is their contention that the word 'benefit' should be used only when performance by non-native listeners exceeds that by native listeners. In this paper, we follow the definition more strictly applied to 'benefit' like Stibbard & Lee and Hayes-Harb et al. Non-native accented speech is obviously less intelligible to native listeners than native speech, which may sometimes result in native listeners' poor comprehension (Munro, 1998; Munro & Derwing, 1995). Consider that non-native listeners listen to the same accented speech. If their accented speech is as intelligible to non-native listeners as native listeners, that is, 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. Therefore, 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.

The present study attempts to evaluate the ISIB-L effects, focusing on English liquids. The reason we examine ISIB-L rather than ISIB-T is to see if there are consistent results with Hayes-Harb et al., (2008). Liquids are chosen among consonants because they are very strongly sonorous and perceptually more

salient than stops or fricatives, which may have similar permissive effects to vowels on listeners' perception. In the perception experiment, Chinese talkers' production of English liquids is presented to three different groups of listeners such as native L1 listeners, Chinese L2 listeners and Korean L2 listeners. Due to the fact that L2 proficiency is one of the most inconsistent and arguable factors in determining intelligibility, we examine ISIB-L effects with high and low proficiency non-native talkers and listeners. Furthermore, we investigate the contextual effects on speech intelligibility, attempting to see if foreign accented speech is more intelligible when perceived with richer contextual cues and how the interlanguage speech intelligibility is implemented in association with contexts. As Bradlow & Pisoni (1999) pointed out, it might be true that ISIB merely occurs at the pre-lexical level. They content that ISIB is influenced by the various phonological features of a sound that nonnative talkers and listeners share rather than word or syntactic structures; therefore, ISIB is assumed to occur in pre-lexical level as opposed to lexical or post-lexical level.

This study further examines the effects of lexical neighborhood density, with comparing the identification accuracy obtained from minimal pair tokens with that from non-minimal pair tokens. We attempt to see if the targets /l/ and /r/ are less accurately identified when given within the minimal pair words and ultimately lead to listeners' confusion as shown in Bradlow & Pisoni (1999) and Imai et al. (2004).

The present study investigates the positional effects of the English liquids on ISIB-L. Now that three different language backgrounds of listeners, (American) English, Chinese and Korean, differ in the phonological structure and phonetic realizations of the liquid sounds, the ISIB-L will be potentially intricate, depending on their syllable position. 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 phonotactic 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, and it is always preceded by schwa [ə] in the final position (Shimizu & Dantsuji, 1987). 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 (Yunjuan, 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 and the retroflex [ɭ] is restricted to occur only in the syllable final position. In the case of Korean, only one liquid phoneme /l/ exists, and there is no phonological contrast between /r/ and /l/. It is well known that the Korean liquid phoneme shows the complementary distribution allophonically; the flap [ɾ] occurs in syllable-initial position, and the lateral approximant [l] occurs in the other positions (Shimizu & Dantsuji, 1987).

Most previous studies about L2 liquids /l/ and /r/ in Second Language Acquisition have focused on Japanese L2 talkers' production and native English L1 listeners' and/or Japanese L2 listeners' perception (Aoyama et al. 2004; Goto, 1971; Guion et al., 2000; Komaki et al. 1999; Takagi & Mann, 1995; Takagi, 1993). There are also many studies on training Japanese adults on the English /ɹ/ and /l/, suggesting that Japanese non-native subjects in the adaptive training group showed more native-like identification and discrimination functions along the trained continuum than subjects in the fixed training group or subjects in the untrained control group (Lively et al., 1993; Logan et al. 1991; McCandliss et al., 2002; Strange & Dittmann, 1984, among others). There have been very few studies on the ISIB effects with non-native talkers' production of English liquids and native and non-native listeners. In fact, the languages with systematic phonological differences in liquids, such as English, Chinese 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 and/or 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 non-native Chinese talkers than 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 and Korean play a role in ISIB-L.

There have been contradictory arguments on the influence of talkers' and listeners' proficiency on ISIB; it is maximized when the talkers' and listeners' proficiency is high (Bent &

Bradlow, 2003; van Wijngaarden, 2001; van Wijngaarden et al., 2002), but when the talkers' and listeners' proficiency is low (Hayes-Harb et al., 2008). Such inconsistent results might be attributed to a variety of different approaches to determining learners' proficiency. Bent & Bradlow (2003) categorized talkers as high- and low proficiency based on their intelligibility to native listeners, van Wijngaarden et al. (2002) used self-reports of general proficiency in learners' L2, and Imai et al. (2005), Stibbard & Lee (2006) and Hayes-Harb et al. (2008) carried out an accentedness judgment task, where non-native speakers with lower accentedness ratings were categorized as a more proficient group in their L2. Similar to their approach, the current study adopts the method of their Accentedness Judgment to evaluate non-natives' proficiency; thus, high and low proficiency non-native talkers and listeners are elicited. The accentedness task, if given to all the non-native subjects regardless of their L1 language, may provide more precise and consistent norms relevant to the evaluation of speech intelligibility.

## 2. Experiment 1: Accentedness Judgment Task

### 2.1 Subjects

30 non-native talkers and listeners (10 Chinese talkers, 10 Chinese listeners and 10 Korean listeners) participated in the Accentedness Judgment Task. The Chinese talkers and listeners were all exchange students at a university in Seoul, Korea. They had been staying in Korea less than a year, and their ages were between 18 and 26. They all reported that Cantonese was their native language, and that they began to study English between ages 8 and 13. The Korean participants were all college students at the same university that the Chinese subjects attended, and their ages were also between 18 and 26. They also began to study English between ages 8 and 13. The Chinese talkers were composed of 5 males and 5 females, but 4 males and 6 females took part in the Accentedness Judgment Task from the Chinese and Korean listener groups.

30 non-native subjects who participated in the Accentedness Judgment Task were potentially the candidates for the Identification Task, but only those who belong to the identical accentedness rating range would be selected for the Identification Task. Since each group might possibly show a different average score, the lowest subjects in each group would not be consistently selected as low proficiency; the subjects within the same rating range across the groups were categorized as the same level of proficiency. For example, if the lowest

three subjects in a group were distributed within the same accentedness rating range as the mid three subjects in another group, those 6 subjects were the same level of proficiency.

## 2.2 Methods

30 participants were respectively 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 Accented Judgment Task

- a. Language is an instrument for communication.
- b. He told a rather rude joke, and everyone looked embarrassed.
- c. They were watching a rugby match when I was cooking.

90 stimuli produced by 30 participants (3 sentences \* 30) were randomized and given to five English speakers (1 male and 4 females) for accentedness rating. The English native judges were instructors in a Korean college. The Accentedness Task was programmed in Superlab 4.0, and the judges rated accentedness 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.

## 2.3 Results

Figure 1 shows the relative accentedness of the 10 non-native Chinese talkers, 10 non-native Chinese listeners, and 10 non-native Korean listeners. The X-axis indicates the subject numbers, and the Y-axis shows the accentedness scales (0 to 9). All of the three groups evenly showed three subjects with the lowest ratings, that is, under 3, and they were categorized as high proficient listeners.

Similarly, each group consistently involved three subjects who obtained the rating scores over 7. Chinese talkers 1, 2 and 10 were labeled as low proficiency because higher accentedness was associated with low proficiency. Chinese listeners 2, 4 and 9 were categorized as low proficiency because they all showed the average ratings higher than 7. Korean listeners 2, 6 and 9 all showed higher accentedness ratings; thus, they were low proficiency listeners.

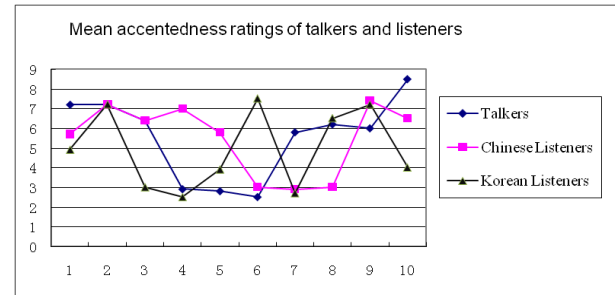


Figure 1 Mean accentedness ratings of talkers and listeners.

Three high and low proficiency non-natives were elicited on the basis of the accentedness ratings, and they carried out the Identification Task along with three native English listeners. The native English listeners were not the ones who participated in the Accentedness Judgment Task.

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

### 3.1. Subjects

Chinese listeners 6, 7 and 8 and Korean listeners 3, 4 and 7 participated in the Forced-choice Identification Task as high proficiency listeners. Chinese listeners 2, 4 and 9 and Korean listeners 2, 6 and 9 were identified as low proficiency listeners. Three native speakers, who did not conduct the Accentedness Task, participated in the Identification Task as English native listeners. They were also instructors in a college in Seoul, Korea, and had been living in Korea between 1 and 2.5 years. They were between 29 and 36 years old.

### 3.2 Methods

40 sentence samples recorded for the Accentedness Judgment Task were used; the stimuli included four different distinctive phonotactic distributions of English liquids, that is, initial /l/, initial /r/, final /l/ and final /r/. Each target sound was included in actual words, and the words were also embedded in carrier sentences. The target liquids different in position were used to make 10 sentences, respectively; therefore, there were all 40 'target stimuli' in total. The initial /l/ and /r/ targets were intentionally preceded by a word ending in a consonant, and the final /l/ and /r/ targets were followed by a word starting with a consonant or placed in the final position in a sentence. This was intended to avoid an unnecessary resyllabification of the target liquid sounds as well as to facilitate a clear cut of the target segments and words when the segment and word stimuli were edited from the sentence recordings. The 10 target stimuli

included 5 minimal pair words (e.g., read-lead) and 5 non-minimal pair words (e.g., rim-lease) to see if the lexical density effects occurred in the ISIB-L. The stimuli used for the experiment are presented in Appendix.

For the high proficiency talkers' stimuli, 40 sentences recorded in the Accentedness Judgment Task extracted from Chinese talkers 4, 5 and 6, and for the low proficiency talkers' stimuli, the same 40 sentence productions were elicited from Chinese talkers 1, 2 and 10. Therefore, the total target stimuli were 240 sentences from 6 high and low proficiency Chinese talkers. In addition, we included another 40 'fillers' to prevent listeners from noticing the purpose of the experiment. These were recorded by each Chinese talker prior to the Identification Task.

To investigate the contextual effect on ISIB-L, this experiment included the liquids in three different contexts: segment, word and sentence. The segment stimuli were built up from the original sentence recordings in such a way that the target segments (the initial /l/, the final /l/, the initial /r/, and the final /r/) were copied and created as an independent segment for listener's identification. The word stimuli were generated in a similar way that the target words including the 4 distinct positional liquids were simply extracted. Therefore, 240 segment stimuli and 240 word stimuli were created along with 240 sentence stimuli. The filler stimuli (240 segments, 240 words and 240 sentences) were also made in the same way.

Due to the fact that a listener was not able to accomplish the identification task with utilizing 1440 tokens ( $240 * 6$ ), the stimuli given to each listener was reconstructed in that all the 120 targets from each proficiency level were randomized and grouped in 20. Each group of 20 targets should equally include 5 of each positional liquids, and this process applied to the three groups of target segments, words and sentences. As shown in (1), each cell contains 20 targets, and the whole stimuli consisting of 6 cells (#1 to #6) were given to 6 listeners (low and high Chinese listeners; LC 1-3 and HC 1-3) in the Identification Task. Also, the same stimuli were given to another 6 listeners (low and high Korean listeners; LK 1-3 and HK 1-3), and the 3 native listeners carried out 60 stimuli (cells # 1 to 3). Since 120 stimuli of the same level were sufficiently randomized, those 60 stimuli did not contain a specific talker's production and wouldn't have a talker's effect on listeners' identification, even though the other 60 stimuli (cell # 4 to 6) were not used.

Table 1. Total 120 stimuli of each level of proficiency (each cell contains 20 target stimuli)

Cell#1	Cell#2	Cell#3	Cell#4	Cell#5	Cell#6
CL1	CL2	CL3	CH1	CH2	CH3
KL1	KL2	KL3	KH1	KH2	KH3
NL1	NL2	NL3			

In the Identification experiment, a listener listened to 180 stimuli in total; 40 target segments (20 from low proficiency talkers and 20 from high proficiency talkers), 20 segment fillers, 40 target words (20 from low proficiency talkers and 20 from high proficiency talkers), 20 word fillers, 40 target sentences (20 from low proficiency talkers and 20 from high proficiency talkers), and 20 sentence fillers.

All the stimuli were programmed in Superlab 4.0. and the subjects listened to the sentence stimuli first, then word stimuli, and finally segment stimuli, because they would have been otherwise able to recognize the target sounds. 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, where the target word was blanked, popped up on the computer screen simultaneously as they listened to it. Below the sentence were four choices of examples shown with numbers 1, 2, 3, and 4. 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. Once their response was sent, the next sentence automatically popped up on the screen with its speech production. 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 the target words which were usually composed of one syllable and the segments were too short in duration and that the listeners would need some time to reset themselves for the next stimulus. It took approximately half an hour for each listener. The identification accuracy ratings of each listener were obtained from Superlab 4.0.

### 3.3. Results

#### 3.3.1. Intelligibility of four different positional liquids.

Figure 2 shows the listeners' identification accuracy ratings to the liquids in different positions produced by low proficiency talkers. The identification scores across segments, words, and sentences are all pulled up together, but distinctively sorted and

displayed only by the target liquids' position, listeners' proficiency levels and backgrounds. The X-axis indicates the listeners arranged by their proficiency levels and language backgrounds, and the Y-axis displays the identification accuracy ratings. HPL and LPL refer to the listeners with high proficiency and the listeners with low proficiency, respectively. A one-way ANOVA was executed to analyze the results in Figure 2 (the liquids in different positions were dependent variables, and the listeners with different proficiencies and different language backgrounds were factors).

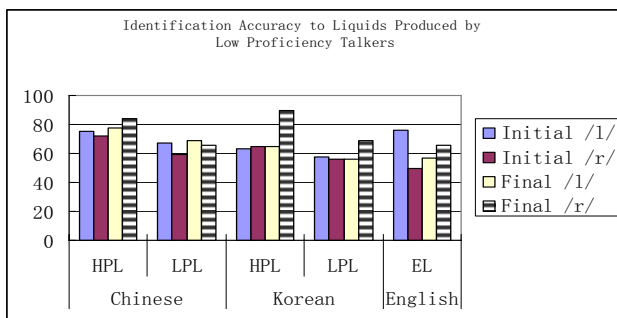


Figure 2. Identification accuracy ratings to liquids produced by low proficiency talkers (%).

As shown in the leftmost bars in each group, native English listeners (EL) show an exceeding performance than both Chinese and Korean listeners in identifying the initial /l/. The English listeners were significantly more accurate at identifying the initial /l/ ( $[F(1,24)=52.74, p<0.05]$  for high proficiency Chinese listeners (hereafter, Chinese HPL),  $[F(1,24)=67.09, p<0.05]$  for low proficiency Chinese listeners (hereafter, Chinese LPL),  $[F(1,24)=74.6, p<0.05]$  for high proficiency Korean listeners (hereafter, Korean HPL) and  $[F(1, 24)=90.23, p<0.05]$  for low proficiency Korean listeners). That is, the non-native Chinese listeners did not seem to take advantage of the interlanguage which might presumably exist between non-native talkers and listeners, and this does not support the matched or mismatched ISIB-L for the initial /l/.

The second bars in each group, show the identification results of the initial /r/. Non-native Chinese and Korean listeners showed higher accuracy ratings than English native listeners, and the differences were all statistically significant ( $[F(2,43)=34.89, p<0.05]$  for Chinese HPL,  $[F(2,43)=82.01, p<0.05]$  for Chinese LPL,  $[F(2,43)=32.43, p<0.05]$  for Korean HPL and  $[F(2, 43)=22.35, p<0.05]$  for Korean LPL). Contrary to the initial /l/, this suggests both matched and mismatched ISIB-L effects.

Moving on to the results of the final /l/, the identification accuracy scores were not significantly different between Korean LPL and EL ( $[F(1,37)=83.21, p=0.582]$ ). However, high and low Chinese listeners and high Korean listeners showed a significantly higher identification accuracy than EL ( $[F(1,37)=88.0, p<0.05]$ ,  $[F(1,37)=95.62, p<0.05]$  and  $[F(1,37)=65.45, p<0.05]$ ). This indicates that the language background and non-native listeners' proficiency play an important role in the IBIS-L; that is, the matched ISIB-L occurred to both high and low proficiency Chinese listeners, but the mismatched ISIB-L occurred only to high proficiency Korean listeners.

As observed in the rightmost bars in each group, non-native high proficiency Chinese and Korean listeners were significantly more accurate at identifying the final /r/ than native listeners ( $[F(1, 37)=88.05, p<0.05]$  and  $[F(1,37)=83.21, p<0.05]$ ), and also low proficiency Chinese listeners performed significantly better than native listeners ( $[F(1,37)=95.62, p<0.05]$ ). However, Korean LPL did not exhibit a significant difference from EL ( $[F(1,37)=65.45, p=0.582]$ ). This suggests that the matched ISIB-L occurred regardless of proficiency, but that the mismatched ISIB-L effects seem to be confined to Korean HPL.

When we compare high proficiency non-native listeners with low proficiency non-native listeners, the high proficiency listeners were significantly more accurate than the low proficiency listeners ( $[F(1,24)=34.05, p<0.05]$  for initial /l/,  $[F(1,43)=80.91, p<0.05]$  for initial /r/,  $[F(1,37)=89.05, p<0.05]$  for final /l/ and  $[F(6,24)=47.76, p<0.05]$  for final /r/).

Figure 3 displays the identification accuracy ratings of the target liquids in different positions produced by the high proficiency Chinese talkers. There was no significant difference in identification performance of the initial /l/ between the Chinese listeners and English listeners ( $[F(3,7)=4.15, p=0.513]$  for high proficiency and  $[F(3,7)=56.17, p=0.109]$  for low proficiency) and between Korean HPL and EL ( $[F(3,7)=69.74, p=0.128]$ ). The English listeners also identified the initial /l/ sounds significantly better than the low Korean listeners ( $[F(3,7)=86.17, p<0.05]$ ). In other words, either matched or mismatched ISIB-L does not seem to occur to the initial /l/ sounds produced by the high proficiency talkers, and this is consistent with the results of the initial /l/ produced by the low proficiency Chinese talkers as presented in Figure 2.

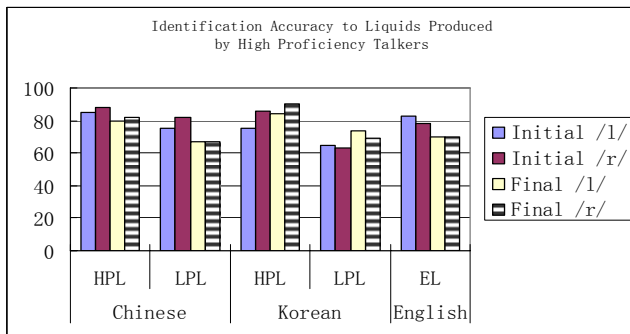


Figure 3. Identification accuracy ratings to liquids produced by high proficiency talkers (%).

For the initial /r/ identification, the performance of the high proficiency non-native listeners excelled that of EL ([F(1,15)=78.327,  $p<0.05$ ] for Chinese HPL and [F(1,15)=86.25,  $p<0.05$ ] for Korean LPL). No significant difference was, however, found between Chinese LPL and EL ([F(1,15)=32.78,  $p=0.553$ ]). EL's were more accurate at identifying the initial /r/ sounds than Korean LPL ([F(1,15)=75.15,  $p<0.05$ ]). Therefore, the matched and mismatched ISIB-L occurred, but this seems to hold true only for the high proficiency listeners.

The third bars from the left in each listener group show that Chinese HPL identified the final /l/ significantly better than English listeners ([F(2,14)=100.15,  $p<0.05$ ]), but there is no significant difference between Chinese LPL and EL ([F(2,14)=76.07,  $p=0.141$ ]). This suggests that the matched ISIB-L seems to occur only for high proficiency listeners to the final /l/. Both Korean HPL and LPL performed better than English listeners for the final /l/ ([F(2,14)=24.15,  $p<0.05$ ] for high listeners and [F(2,14)=31.56,  $p<0.05$ ] for low listeners), which can be interpreted as saying that the mismatched ISIB-L also occurred to Korean listeners.

Concerning the identification accuracy of the final /r/, the high proficiency non-native listeners performed significantly better than English listeners ([F(1,13)=103.23,  $p<0.05$ ] for Chinese HPL and [F(1,13)=135.87,  $p<0.05$ ] for Korean HPL), but no significant difference was found between the low proficiency non-native listeners and EL ([F(1,13)=86.15,  $p=0.089$ ] for Chinese LPL, and [F(1,13)=75.69,  $p=0.451$ ] for Korean LPL). This might suggest that the matched and mismatched ISIB-L occurs only for the high proficiency listeners in the identification of the final /r/.

Non-native high proficiency listeners identified all the four target liquids more accurately than those with low proficiency ([F(3,7)=21.19,  $p<0.05$ ] for initial /l/, [F(1,15)=120.98,  $p<0.05$ ] for initial /r/, [F(2,14)=83.21,  $p<0.05$ ] for final /l/

[F(1,13)=34.67,  $p<0.05$ ] for final /r/).

### 3.3.2. Intelligibility of target sounds in different contexts.

Figure 4 exhibits the identification accuracy ratings of the three different contextual liquid targets produced by the low proficiency Chinese talkers. The leftmost bars in each group show the identification accuracy in segment context. Chinese HPL's were significantly more accurate than EL when they identified the liquid segments alone with no other contextual cues ([F(2,13)=37.42,  $p<0.05$ ]). This indicates a significant advantage for Chinese HPL over native EL. However, in the cases of Chinese LPL and Korean listeners, native listeners performed significantly better (F(2,13)=37.42,  $p<0.05$ ) for Chinese LPL, F(2,13)=230.12,  $p<0.05$ ) for Korean HPL and [F(2,13)=90.43,  $p<0.05$ ] for Korean LPL). Therefore, the matched ISIB-L seems to hold true only for high proficiency listeners in the segment context. Both Chinese and Korean listeners with high proficiency were more accurate at identifying English liquids than the corresponding listeners with low proficiency ([F(2,213)=81.32,  $p<0.05$ ] for Chinese listeners and [F(2,123)=76.09,  $p<0.05$ ] for Korean listeners).

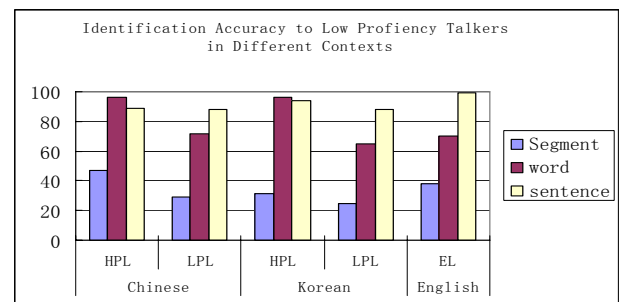


Figure 4. Identification accuracy ratings to low proficiency talkers in different contexts (%).

The mid bars in each category indicate the identification accuracy scores in the word context; in other words, the listeners were supposed to identify the target /l/ and /r/ within a word. Both Chinese and Korean high proficiency listeners performed better than English listeners ([F(2,26)=156.78,  $p<0.05$ ] and [F(2,26)=132.09,  $p<0.05$ ]). However, there is no significant difference between Chinese LPL and EL ([F(2,26)=39.24,  $p=0.835$ ]). Furthermore, Korean LPL performed a poorer identification accuracy than English listeners ([F(2,26)=94.21,  $p<0.05$ ]). Again, this shows that the matched and mismatched ISIB-L only occurred for high proficiency listeners in word context. The rightmost bars in each category



show the results in sentence context, whereby the listeners identified the target liquids within a sentence. Interestingly, English listeners were more accurate than all the non-native listeners ( $[F(1,14)=85.07, p<0.05]$  for Chinese HPL,  $[F(1,14)=129.04, p<0.05]$  for Chinese LPL,  $[F(1,14)=89.05, p<0.05]$  for Korean HPL, and  $[F(1,14)=167.89, p<0.05]$  for Korean LPL). Either Chinese or Korean non-native listeners did not seem to take advantage over native listeners when they listened to Chinese accented English liquids within a sentence. That is, the targets were not as intelligible as or more intelligible to non-native listeners than to native listeners in sentence context; there were no ISIB-L effects.

Considering the overall patterns of accuracy rate across the three contexts, all listeners performed better in the word and sentence contexts than in the segment context ( $[F(3,32)=156.04, p<0.05]$ ). The liquids in the sentence context are 100% intelligible to native English listeners, and the contextual cues seem to be richer from segment to sentence as they show higher accuracy in identifying the targets in a sentence than in a word and the segments by themselves are the least intelligible. A similar tendency was observed in non-native low listeners ( $[F(3,32)=79.62, p<0.05]$  and  $[F(3,32)=134.56, p<0.05]$ ), but the non-native high listeners do not show a significant difference between word and sentence contexts. They were significantly more accurate at understanding the liquid targets in both word and sentence environments than the segment alone context.

Figure 5 shows the word identification results of the three different contextual target liquids produced by Chinese high proficiency talkers. In the segment context, Chinese HPL performed better than English listeners ( $[F(4,18)=342.56, p<0.05]$ ). However, the other non-native listeners, that is, Chinese LPL and Korean HPL and LPL were significantly less accurate at identifying the liquids in the same context ( $[F(4,18)=212.89, p<0.05]$  for Chinese LPL,  $[F(4,18)=219.07, p<0.05]$  for Korean HPL and  $[F(4,18)=187.65, p<0.05]$  for Korean LPL). That is to say, the matched ISIB-L only occurred for high proficiency listeners in segment context.

As for the word context identification, there was no significant difference between non-native listeners and English listeners except for Korean low proficiency listeners ( $[F(4,17)=90.67, p=0.428]$  for Chinese HPL,  $[F(4,17)=312.44, p=0.237]$  for Chinese LPL, and  $[F(4,17)=76.89, p=0.346]$  for Korean HPL). Korean LPL were significantly less accurate at identifying the liquid in a word than the native English

listeners. ( $F(4,17)=144.72, p<0.05$ ). Therefore, either Chinese or Korean listeners did not take advantage of the ISIB-L for the word contextual liquids at all.

The identification accuracy rates in sentence context are shown by the rightmost bars in Figure 5. EL performed better than Chinese listeners and Korean LPL ( $[F(1,17)=96.75, p<0.05]$  for Chinese HPL,  $[F(1,17)=81.58, p<0.05]$  for Chinese LPL, and  $[F(1,17)=78.91, p<0.05]$  for Korean LPL). Moreover, there is no significant difference between EL and Korean HPL ( $[F(1,17)=93.33, p=0.356]$ ). Therefore, no ISIB-L seems to hold for Chinese and Korean listeners in sentence context.

Consistently enough to the results of Figure 4, all the listeners were more accurate at identifying the liquids in the word and sentence contexts than in the segment context ( $[F(8,12)=178.54, p<0.05]$ ). The listeners' accuracy rates were not significantly different between word and sentence contexts ( $[F(8,12)=76.06, p=0.08]$  for Chinese HPL,  $[F(8,12)=72.43, p=0.13]$  for Chinese LPL listeners,  $[F(8,12)=84.4, p=0.16]$  for Korean HPL), except Korean LPL ( $[F(8,12)=125.32, p<0.05]$ ).

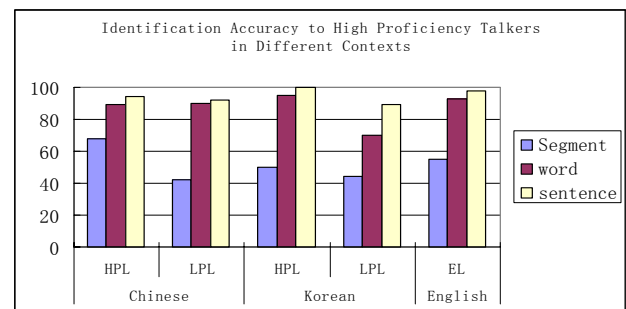


Figure 5. Identification accuracy ratings to high proficiency talkers in different contexts (%).

### 3.2.3. Intelligibility of words with different word neighborhood density.

In order to investigate the effect of word neighborhood density on the intelligibility, the responses to word and sentence contexts were extracted and analyzed. Word neighborhood density is always accessible at a higher level processing like word or sentence; therefore, the identification of /l/ and /r/ in the segment context is not concerned with neighborhood density. ANOVA was executed with different proficiency and different word neighborhood density as factors. Figure 6 shows the correct ratings toward low proficiency talkers' production.

The overall sketch of Figure 6 is that all listeners performed better to non-minimal pair tokens than to minimal pair tokens

( $[F(5,12)=109.34, p<0.05]$  for Chinese HPL,  $[F(5,12)=139.02, p<0.05]$  for Chinese LPL,  $[F(5,12)=167.1, p<0.05]$  for Korean HPL,  $[F(5,12)=91.23, p<0.05]$  for Korean LPL and  $[F(5,12)=192.01, p<0.05]$  for EL). Next, in the case of minimal pair tokens, non-native listeners with high proficiency outperformed than English listeners ( $[F(5,12)=55.2, p<0.05]$  for Chinese HPL and  $[F(5,12)=67.95, p<0.05]$  for Korean HPL). No significant difference was found between Chinese LPL and EL  $[F(5,12)=81.44, p=0.081]$ . The EL showed a better performance than Korean LPL in minimal pair token identification  $[F(5,12)=173.39, p<0.05]$ . Therefore, this can be interpreted as stating that both matched and mismatched ISIB-L effects occurred, but it holds true only for high proficiency listeners. The upper line in Figure 6 shows the results of non-minimal pair tokens; there was no significant difference between non-native listeners and English listeners ( $[F(5,12)=99.55, p=0.327]$  for Chinese HPL,  $[F(5,12)=86.71, p=0.12]$  for Chinese LPL,  $[F(5,12)=92.13, p=0.79]$  for Korean HPL, and  $[F(5,12)=145.02, p=0.279]$  for Korean LPL). This suggests that non-native listeners did not take advantage over English listeners; no ISIB occurred.

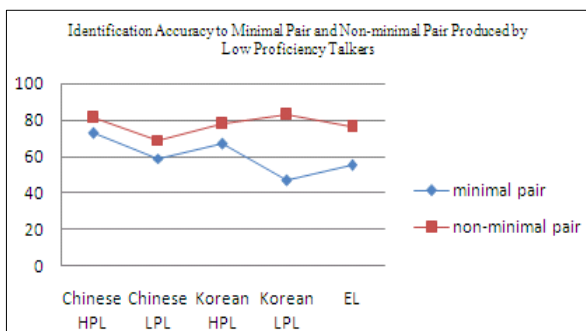


Figure 6. Identification accuracy ratings to minimal pair and non-minimal pair produced by low proficiency talkers (%)

Figure 7 shows the correct ratings for high proficiency talkers. All listeners were more accurate at identifying the target /l/ and /r/ from non-minimal pairs than from minimal pairs ( $[F(3,27)=401.249, p<0.05]$  for Chinese HPL,  $[F(3,27)=301.491, p<0.05]$  for Chinese LPL,  $[F(3,27)=89.01, p<0.05]$  for Korean HPL,  $[F(3,27)=216.71, p<0.05]$  for Korean LPL and  $[F(3,27)=400.9, p<0.05]$  for EL). The bottom line shows the identification accuracy for minimal pair tokens. There was no significant difference between Chinese and English listeners ( $[F(3,27)=320.01, p=0.12]$  for Chinese HPL and  $[F(3,27)=49.03, p=0.09]$  for Chinese LPL). Korean HPL performed better than EL  $[F(3,27)=210.02, p<0.05]$ , indicating that the mismatched

ISIB-L occurred for high proficiency listeners. Korean LPL, however, were significantly less accurate than EL ( $[F(3,27)=139.01, p<0.05]$ ).

Similar to the results shown in Figure 6, none of the non-native listeners were more successful to identify the target /l/ and /r/ from non-minimal pairs than English listeners. That is, there was no significant difference between non-native listeners and English listeners ( $[F(3,27)=120.01, p=0.067]$  for Chinese HPL,  $[F(3,27)=178.2, p=0.16]$  for Chinese LPL,  $[F(3,27)=140.92, p=0.29]$  for Korean HPL, and  $[F(3,27)=210.8, p=0.49]$  for Korean LPL). This suggests no ISIB-L in recognizing the targets from the non-minimal pairs.

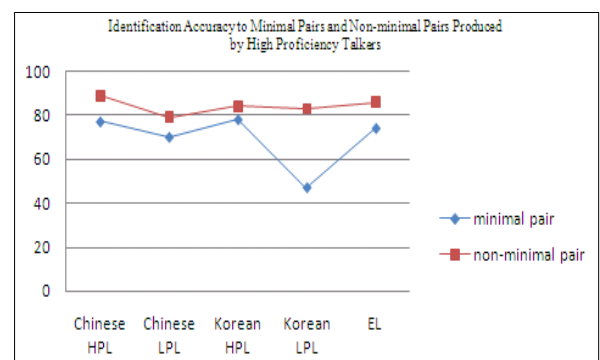


Figure 7. Identification accuracy ratings to minimal pair and non-minimal pair produced by high proficiency talkers (%)

#### 3.4. Discussion

We have seen that the matched and mismatched ISIB-L generally holds for non-native high proficiency listeners when they identify Chinese accented English liquids except for the case of the initial /l/. As mentioned in Introduction, we follow a more strict definition of the ISIB suggested by Stibbard & Lee (2006) and Hayes-Harb et al. (2008) that the word 'benefit' should be used only for the case where performance of non-native listeners exceeds that of native listeners. Even though high proficiency Chinese listeners did not show a significant difference from English listeners in identifying the initial /l/, this is not considered as the matched ISIB-L in this study. Unlike the initial /l/, the initial /r/, the final /l/, and the final /r/ are substantially more intelligible to non-native Chinese and Korean listeners than native English listeners, even though the ISIB effects vary depending on both talkers' and listeners' proficiency. In the cases of identification of low proficiency Chinese talkers' final /l/ and initial and final /r/, they are more intelligible to both low and high Chinese listeners, but it is true only for high proficiency Korean listeners. In the case of high

proficiency Chinese talkers' final /l/ and initial and final /r/, they are more intelligible only for high proficiency Chinese and Korean listeners. This is consistent with van Wijngaarden (2001). Contrary to Hayes-Harb et al. (2008) who observed that ISIB-L effects were held only for the low phonological proficiency listeners and the low phonological proficiency speech, our finding in this study shows that ISIB effects occurred not only between high proficiency listeners and talkers but also between both high and low proficiency listeners and low proficiency talkers. In other words, the English sounds /l/ and /r/ produced by low proficiency Chinese talkers are more intelligible to both high and low Chinese listeners than English native listeners, except for the initial /l/. The ISIB-L for these three targets occurred regardless of listeners' proficiency when produced by low proficiency talkers. Less proficient talkers' speech is usually more accented and presumably entails more L1-like phonological and/or phonetic features. Therefore, speech intelligibility is easily facilitated by a greater number of similar sound features to their L1 in the interlanguage. On the other hand, high proficiency talker's speech, which is less accented, has relatively a fewer number of L2 and a greater number of L1 sound features. The overall shared phonological/phonetic knowledge may not successfully serve as sufficient information to low proficiency listeners. This seems to enable only high proficiency listeners to recognize the speech more readily because more proficient talkers and listeners share more L2-like features in their interlanguage. Therefore, the matched ISIB-L is implemented to high proficiency listeners when the sounds are produced by high proficiency talkers. In consideration of talkers' and listeners' proficiency, L2 proficiency seems to be a crucial factor that influences the ISIB-L.

Concerning Korean listeners' proficiency, the mismatched ISIB was observed only for high proficiency listeners whether the Chinese talkers were high or low proficiency. According to Bent & Bradlow (2003), the mismatched interlanguage speech intelligibility results from the talker's and listener's shared knowledge, as does the matched ISIB, but their shared knowledge is constructed when listeners and talkers apply general strategies in learning to produce and perceive a foreign language. This will shed light on a different structure of the interlanguage, such that more proficient non-native listeners, who have a more similar or more L2-like knowledge base than less proficient listeners, may be more accurate at identifying non-native talkers' L2 target sounds. Therefore, the mismatched ISIB was observed merely to high proficiency Korean listeners.

Let's turn our attention to the positional effects of English /l/ and /r/ on ISIB-L. The overall configuration of the positional intelligibility for /l/ and /r/ is that the initial /l/ was more intelligible to native English listeners than Chinese and Korean listeners, but that the other three targets, initial /r/, final /l/ and final /r/ are generally more intelligible to the non-native listeners than native English listeners, even though quite distinctively implemented according to non-native talkers' and listeners' proficiency.

As shown in Table 2, Chinese liquids seem to be drastically different from English liquids except the initial /l/ with respect to both phonological structure and phonetic manifestations. Chinese accented liquids may considerably deviate from English when they are initial /r/, final /l/ and final /r/, even though their acoustic measurement has not been carried out in this study. The initial /r/ is phonetically realized as either the retroflex approximant like English or the retroflex fricative, but the latter is absolutely not attested in English. The final /l/ is not allowed in Chinese, which may lead to a problem not only with Chinese talkers' producing /l/ correctly in this position but also with articulating the totally authentic L2 English sound, dark [ɫ]. The final /r/ is always followed by schwa /ə/ in Chinese, which may give rise to a deviant production of /r/ in other vowel environments in L2 English speech. That is, Chinese accented English sounds such as initial /r/, final /l/ and final /r/ might be phonetically deviant from the corresponding English ones, which could possibly decrease English listeners' identification performance to some extent. Thus, Chinese accented speech of /l/ and /r/ in these positions might not be as intelligible as or more intelligible to native English listeners than to non-native listeners.

Table 2. Phonological system of liquids in English, Chinese and Korean

	English	Chinese	Korean
/l/ and /r/ distinctive?	Yes	Yes	No
Initial /l/	[l]	[l]	None
Initial /r/	[r]	[ɻ]~[ʐ]	[r]
Final /l/	[ɫ]	None	[l]
Final /r/	[r]	[ɻ]	None

On the other hand, the initial /l/ is significantly more intelligible to native English listeners than Chinese or Korean listeners as already observed in Figures 2 and 3. It is quite similar to the English /l/ both phonetically and phonotactically (Shimizu & Dantsuji, 1987; Yunjuan, 2001). The initial /l/ even

in Chinese accented speech may not be considerably deviant from the corresponding one in English, which will, in turn, demonstrate a moderate degree of perceptual similarity towards native English listeners. Therefore, English native listeners can plausibly identify it comparatively better than the other liquids. That may be the reason why the native listeners always outperformed non-native Chinese and Korean listeners, resulting in no ISIB-L.

Considering the mismatched ISIB-L, it does not seem to be the case that the intelligibility of the initial /l/ alone is remarkably lower to Korean listeners than to native listeners. In other words, the reason why the native listeners significantly outperformed Korean listeners in identifying the initial /l/ was not because the Korean listeners' identification accuracy of the /l/ was poorer than that of the other target segments but because the native listeners were significantly more accurate at identifying it. What is worth noting here is that the overall accuracy of Korean listeners was similar among the target segments. What made the initial /l/ significantly less intelligible to Korean listeners than native listeners was that again the Chinese accented /l/ was perceptually more similar to the corresponding one in English, leading English listeners to successful responses. In other words, the English /l/ and /r/ in Chinese accented speech, even though Chinese L1 may affect L2 English production, are evenly intelligible to Korean listeners, regardless of position. As shown in Table 2, the Chinese and Korean inventories of /l/ and /r/ are totally different in their phonemic status, phonetic implementation and positional distribution. Even though Chinese and Korean do not have any similar phonological or phonetic features in their native liquids, Chinese talkers and Korean listeners seem to establish an interlanguage toward English liquids. Consequently, it is worth considering that the interlanguage might not only be built up based on the common phonetic features that the same language background talkers and listeners share, but also might be constructed from a group of general phonetic features acquired in process of learning an L2. This is consistent with Bent & Bradlow (2003) that L2 learners establish an interlanguage towards the same L2 by applying general strategies in learning L2. That is, L2 talkers' accented speech, irrespective of language background, seems to be more intelligible than native talkers' L2 speech to non-native listeners. It might be also true that factors other than segmental properties per se is attributed to Korean listeners' exceeding performance over native listeners; for example, accented speech is normally

slower than native speech, and this would make the overall length of the target segment longer (Munro, 1998). The longer duration might beneficially play a role in Korean listeners' identification while native listeners don't take advantage of it at all.

Recall Figures 4 and 5. We have examined the identification accuracy of Chinese accented /l/ and /r/ in consideration of contextual effects on speech intelligibility. As contextual cues are richer from segment alone to word and from word to sentence, it is predicted that identification accuracy will increase due to accessibility to semantic information Schatz (1954) and Mayo et al. (2002). Results were somewhat complicated according to talkers and listeners' proficiency, though. The target segments produced by low proficiency Chinese talkers were the most intelligible to high proficiency Chinese listeners, resulting in the matched ISIB-L. In word environment, both matched and mismatched ISIB occurred, but this holds true only for high proficiency listeners. In sentence context, native listeners exceeded both non-native Chinese and Korean listeners; there were no ISIB effects. On the other hand, for the same targets produced by high proficiency Chinese talkers, the matched ISIB-L was observed, but only for high proficiency listeners. In word and sentence contexts, there was no ISIB-L, which means that native listeners were more accurate at identifying the target /l/ and /r/ sounds. As talkers' proficiency goes lower, foreign accent gets stronger as mentioned in Munro (1998) and Munro & Derwing (1995). Native listeners did not seem to take advantage of contextual cues when they listened to low proficiency talkers' target liquids in the word environment, even though the contextual cues successfully facilitated their intelligibility in the sentence environment. In other words, native listeners might be still confused with /l/ and /r/ even in word contexts due to less proficient talkers' stronger accent. Therefore, non-native listeners outperformed native listeners; both matched and mismatched ISIB-L occurred. This, however, holds true for only high proficiency listeners. With no contextual cues provided, i.e., in the segment environment, only high proficiency Chinese listeners took advantage of stronger accent. This suggests that both talkers' and listeners' proficiency plays an important role in contextual effects on speech intelligibility.

In identification of high proficiency talkers' targets, native listeners seemed to take advantage of contextual cues, extending over the word and sentence contexts. Contextual information in less accented speech assisted the listeners to recognize target

stimuli. On the other hand, only matched ISIB-L occurred in the segment alone context, but only for high proficiency listeners. For both low and high proficiency speech, matched ISIB-L explicitly operates in the segment level. This is consistent with Hayes-Harb et al. (2008) and Smith et al. (2009); they demonstrated that ISIB is influenced by the various phonological features of a sound that nonnative talkers and listeners share rather than word or syntactic structures; therefore, ISIB is assumed to occur in pre-lexical level as opposed to lexical or post-lexical level.

We have investigated the lexical neighborhood density effects on ISIB-L in Figures 6 and 7. The present results confirm that non-native listeners are worse in recognizing targets in high density neighborhoods than in sparse neighborhoods (Bradlow & Pisoni, 1999; Imai et al. 2005). The /l/ and /r/ sounds in the minimal pair context were, in general, more readily recognized than in the non-minimal pair context. The minimal pair stimuli are more likely to be associated with dense neighborhood because they are encompassed with more similar or perceptually confusing words.

When the lexical density effects on ISIB-L is taken into consideration, both low and high proficiency talkers are more intelligible to native listeners than to non-native listeners in the non-minimal pair context, which suggest that there is no ISIB-L in the process of recognizing sparse words. However, non-native Chinese and Korean listeners were more accurate at identifying the low proficiency talkers' targets than native listeners in the minimal pair context, and this is interpreted as both matched and mismatched ISIB-L. For high proficiency talkers, only mismatched ISIB-L was found in that Korean listeners were significantly more accurate than Chinese and native listeners in the minimal pair context. As observed above, native listeners sufficiently utilize the contextual cues at the post-lexical level, but the targets within the minimal pairs seem to be still potentially confusing because of the L2 accent, which will suppress facilitating contextual cues. Therefore, non-native listeners take benefits of their failure, leading to ISIB-L effects. On the other hand, the non-minimal pair, or sparse, context may enable them to more freely enhance word recognition accuracy, resulting in identifying the target /l/ or /r/.

#### 4. Conclusion

Very few studies have previously examined the positional effects on ISIB, but the present paper explores how

phonological and/or phonetic differences in liquids between Chinese and English affect the intelligibility of Chinese accented speech for three different groups of listeners, that is, non-native Chinese and Korean and native English listeners. The syllable-initial lateral /l/ was more intelligible to English listeners than Chinese or Korean listeners due to the fact that the Chinese lateral in the same position is perceptually more likely to be similar to the English /l/. The other targets, final /l/, initial /r/, and final /r/, were more intelligible to high proficiency non-native listeners than to English listeners; therefore, both matched and mismatched ISIB-L was observed. We conclude by noting that an implication of the present findings for acquiring the L2 phonetic substances variable with syllable position. The impact of positional differences on ISIB was more intricate in accordance with talkers' and listeners' proficiency.

We have also seen that the success of recognizing foreign accented speech depends on talkers' and listeners' proficiency, contexts, and lexical density, which supports many previous studies (Bent & Bradlow, 1987; Bent & Bradlow, 2003; Bradlow & Bent, 2002; Bradlow & Pisoni, 1999; Derwing & Munro, 2001; Markhan & Hazan, 2002; Mayo et al. 1997; Munro, 1998; van Wijngaarden, 2001; Hayes-Harb et al., 2008, Smith et al. 2009 among others).

#### References

- Aoyama, K., Flege, J. E., Guion, S. Akahane-Yamada, R., & T. Yamada (2004). "Perceived phonetic dissimilarity and L2 speech learning: the case of Japanese /r/ and English /l/ and /r/". *Journal of Phonetics*, 32, pp. 233-250.
- Bent, T., & Bradlow, A. R. (2003). "The interlanguage speech intelligibility benefit". *Journal of the Acoustical Society of America*, 114, pp. 1600-1610
- Bent, T., Bradlow, A. R. & Smith, B. (2007). "Segmental errors in different word positions and their effects on intelligibility of non-native speech", In Bohn, O.-S. & Munro, M. J. (Eds.), *Language experience in second language learning: in honor of James Emil Flege*. pp. 331-347. Amsterdam, Philadelphia: John Benjamin Publishing Company.
- Bradlow, A. R., & Bent, T. (2002). "The clear speech effect for non-native listeners". *Journal of the Acoustical Society of America*, 112, pp. 272-284.

- Bradlow, A.R., & Pisoni, D. B. (1999). "Recognition of spoken words by native and non-native listeners: Talker-, listener-, and item-related factors". *Journal of the Acoustical Society of America*, 106, pp. 2074-2085.
- Derwing, T., & Munro, M. J. (2001). "What speaking rates do non-native listeners prefer?" *Applied Linguistics*, 22, pp. 324-337.
- Fogerty, S. & Kewley-Port, D. (2009). "Perceptual contributions of the consonant-vowel boundary to sentence intelligibility." *Journal of the Acoustical Society of America*, 1256 (2), pp. 847-857.
- Goto, H. (1971) "Auditory perception by normal Japanese adults of the sounds 'L' and 'R'". *Neuropsychologia*, 9, pp. 317-323.
- Guion, S., Flege, J. E., Akahane-Yamada, R., & Pruitt, J. C. (2000). "An investigation of current models of second language speech perception: The case of Japanese adults' perception of English consonants". *Journal of the Acoustical Society of America*, 107, pp. 2711-2724.
- Hayes-Harb, R., Smith, B. L., Bent, T & Bradlow, A. R. (2008). "The interlanguage speech intelligibility benefit for native speakers of Mandarin: Production and perception of English word-final voicing contrasts". *Journal of Phonetics*, 36, pp. 664-679.
- Imai, S., Walley, A. C., & Flege, J. E. (2005). "Lexical frequency and neighborhood density effects on the recognition of native and Spanish-accented words by native English Spanish listeners". *Journal of the Acoustical Society of America*, 117, pp. 896-907.
- Komaki, R., Kuhl, P. K., Akahane-Yamada, R., Diesch, E., Tohkura, Y., Ketterman, A. & Siebert, C. (2001). "A perceptual interference account of acquisition difficulties for non-native phonemes". *Speech, hearing and language*, 13, pp. 106-118.
- Lively, S. E., Logan, J. S., & Pisoni, D. B. (1993). "Training Japanese listeners to identify English /r/ and /l/ II. The role of phonetic environment and talker variability in learning new perceptual categories". *Journal of Acoustical Society of America*, 94, pp. 1242-1255.
- Logan, J. S., Lively, S. E., & Pisoni, D. B. (1991). "Training Japanese listeners to identify English /r/ and /l/: A first report". *Journal of Acoustical Society of America*, 89, pp. 686-693.
- McCandliss, B. D., Fiez, J. A., Protopapas, A., Conway, M. & McClelland, H. L. (2002). "Success and failure in teaching the r-l contrast to Japanese adults: Predictions of success and failure of a Hebbian model of plasticity and stabilization in spoken language perception". *Cognitive, Affective, & Behavioral Neuroscience*, 2(2), pp. 89-108.
- Markham, D., & Hazan, V. (2002). "Speaker intelligibility of adults and children". In *the Proceedings of the international conference for spoken language processing* (Denver, September 16-20, 2002), pp. 1685-1688.
- Mayo, L. H., Florentine, M., & Buus, S. (1997). "Age of second-language acquisition and perception of speech in noise". *Journal of Speech, Language, and Hearing Research*, 40, pp. 686-693.
- Munro, M. J. (1998). "The effects of noise on the intelligibility of foreign-accented speech". *Studies in Second Language Acquisition*, 20, pp. 139-154.
- Munro, M. J., & Derwing, T. M. (1999). "Foreign accent, comprehensibility, and intelligibility in the speech of second language learners". *Language Learning*, 49, pp. 285-310.
- Rogers, C. L. (1997). *Intelligibility of Chinese-accented English*. Unpublished Ph. D. dissertation, Indiana University.
- Munro, M. J., Derwing, T. M., & Morton, S. L. (2006). "The mutual intelligibility of L2 speech". *Studies in Second Language Acquisition*, 28, pp. 111-131.
- Shimizu, K. & Dantsuji, M. (1987). "A cross-language study on the perception of [r-l]: A preliminary report". *Studia Phonologica XXI*, pp. 10-19.
- Schatz, C. D. (1954). "The role of context in the perception of stops". *Language*, No.1, 30, pp. 47-56.
- Smith, B. L., Haytes-Harb, R. Bruss, M., and Harker, A. (2009). "Production and perception of voicing and devoicing in similar German and English word pairs by native speakers of German". *Journal of Phonetics*, 37, pp. 257-275.
- Strange, W. & Dittmann, S. (1984). "Effects of discrimination training on the perception of /r-l/ by Japanese adults learning in English". *Perception Psychophysics*, 36, pp. 131-145.
- Takagi, N. (1993). *Perception of American English /r/ and /l/ by adult Japanese learners of English: A unified view*. Ph.D. Dissertation, University of California, Irvine.

- Takagi, N., & Mann, V. A. (1995). "The limits of extended naturalistic exposure on the perceptual mastery of English /r/ and /l/ by adult Japanese learners of English". *Applied Psycholinguistics*, 16, pp. 379-405.
- van Wijngaarden, S. J. (2001). "Intelligibility of native and non-native Dutch speech". *Speech Communication*, 35, pp. 103-113.
- van Wijngaarden, S. J., Steeneken, H. J. M., & Houtgast, T. (2002). "Quantifying the intelligibility of speech in noise for non-native listeners". *Journal of the Acoustical Society of America*, 111, pp. 1906-1916.
- Yunjuan, H. (2001). *The production of English /l/ by Mandarin speakers*. BA thesis, Beijing Language and Culture University.

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## Appendix

The bold faced words are targets for analysis, and the underline sentences include minimal pair target words.

### Initial /l/

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 every one 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 /l/

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**.