

Speech Intelligibility in Noise: The Role of Talker-Listener Accent Similarity and Second Language Experience

Chutian Zhao¹

¹ Division of Psychology and Language Sciences, UCL, United Kingdom

Correspondence: Chutian Zhao, Division of Psychology and Language Sciences, UCL, United Kingdom.

doi:10.56397/RAE.2022.11.02

Abstract

According to previous research, several factors influence speech intelligibility in noise, including talker accent, listener experience, and language proficiency. The current study looked at how L2 experience, accent familiarity, and English IETLS score affect speech intelligibility. To determine whether and how these factors affect L2 learners' speech intelligibility when understanding speech in noise, the researcher recruited 30 Mandarin speakers with controlled English proficiency (the researcher set a threshold and only recruited participants who were above it). Half of them graduated from Chinese universities and have never travelled outside of China, while others have spent at least one year studying in English-speaking countries. They were asked to listen to 360 sentences recorded by two Mandarin speakers and two native English speakers, and they chose one nonsense sentence among three sentences in each trial. In the testing, all the recordings were added signal-to-noise (SNR) ratios of 0 dB to simulate the noisy environment. The results show a significant speaker effect and IELTS score effect, but cannot find a significant listener effect. The researcher came up with four potential reasons for the results and some future directions for the L2 research study.

Keywords: speech in noise, intelligibility, talker accent, listener experience, language proficiency

1. Introduction

It is undeniable that recognising English speech in noise is burdensome in non-English-speaking countries such as China. People in these countries may be confronted with many challenges. Here are their specific situations. To begin with, they may learn English from a Mandarin-accented talker. A typical case of Chinese students is that they are often exposed to Mandarin-accented English and have few opportunities to experience different accents when they study English in mainland China. As a consequence, they may find it challenging to recognise native English speakers in a noisy environment. Furthermore, they do not have as much access to authentic English media due to the fact that they do not have free access to trendy media such as Instagram and Youtube. What this means is that these learners do not have enough opportunities to be exposed to native English speakers. Due to a lack of English media and limited exposure to native English speakers, these students' lower listener comprehension can be understood. Last but not least, these learners may begin studying English at the age of 13-14, and they may do so for a relatively short period of time, which also makes it difficult to understand English in noise.

As a second language learner, the researcher is fully aware of the impact of accent and noise on understanding and comprehension. When attending a lecture, the researcher faced a variety of accents from classmates and lecturers from different countries, which were hard to understand initially. Furthermore, in the first few months, the researcher struggled to understand the instructions on the radio on public transportation due to large crowds and a variety of noises, which led me to consider the effects of accents and noise on understanding a second language. In addition, the researcher once worked as a teaching assistant for English classes and found a common situation for Chinese students: they were exposed to Mandarin-accented English most of the time and

had little chance to experience different accents when they studied English in China. As a consequence, the researcher planned to design a study to compare two groups of participants. One group of participants have overseas experiences of studying in English-speaking countries, while the other group have no such experience. The researcher assessed their understanding when they were faced with both Mandarin-accented and British-accented speeches under noise.

If the listener is familiar with the speaker's accent, speech intelligibility improves significantly. For example, they may have the same first language background or speak the same interlanguage. Furthermore, the listener experience can have a significant impact on speech intelligibility. Listeners who have travelled abroad frequently or have spent many years studying abroad may be able to understand the foreign accent. Finally, language proficiency has been used to assess how well a person understands a foreign language. If the listeners are proficient in a foreign language, they ought to better understand foreign language speakers. Three factors were investigated in the current study to determine whether they have a significant impact on speech intelligibility in noise. To begin with, speech intelligibility can have a significant impact on a speaker's foreign-accent speech. The interaction of noise and accent may play a significant role in determining how well a listener understands what is being said. Native English speakers and Mandarin-accented English speakers were recruited to record the sentences in order to modulate the talker accent effect. Furthermore, the listener's prior knowledge of the second language can have a significant impact. The researcher tested two groups of Chinese students to investigate the influence of listener experience, one group with overseas studying experience and the other group who had never been abroad. Due to the fact that previous research has shown that L2 proficiency and accent familiarity are directly associated with speech intelligibility, this study also added language proficiency as a determining factor of listener intelligibility. With the aim to modulate language proficiency, the researcher controlled the English level by only recruiting participants with IELTS scores higher than 7.0. On the basis of the results, the researcher tried to find the factors affecting such understanding of noise and tested whether participants with overseas living experience would perform better. It is hoped that the findings of this study could provide some insights into the efficient ways for English learners in China to improve and adapt to this fast-changing international world.

2. Literature Review

2.1 Speech Intelligibility

2.1.1 Definition

The degree to which a person's speech is understandable by a listener is referred to as speech intelligibility (Leddy, 1999). In natural communication contexts, such as word or utterance recognition, speech intelligibility is typically assessed (Smith & Nelson, 1985). Miscommunication, frustration, and disinterest on the part of communication partners result from reduced speech intelligibility.

In most cases, intelligibility is the result of a collaborative effort between the speaker and the listener. There has been some research focusing on the situation in a single language, which shows that audience characteristics such as familiarity with the speaker and the topic being discussed are essential (Coppens-Hofman & et al., 2016; Kent, 1993; Tjaden & Liss, 1995). When communication is disrupted or rendered incomprehensible due to speech flaws, familiarity with the speaker is advantageous (Kent, 1993; Tjaden & Liss, 1995). What is more, intelligibility varies depending on the nature of the spoken content (e.g., linguistic structure and length of utterance) and the communication situation (e.g., the acoustic transmission quality of the voice signal, availability of visual signals from the speaker, and contextual support for the message to be delivered) (Coppens-Hofman & et al., 2016).

2.1.2 Measurement

Although there is no gold standard for measuring speech intelligibility, some researchers may argue that a standardised speech intelligibility evaluation can be obtained by collecting spontaneous speech samples during an interview in which the proband is asked to describe neutral, everyday events. These audio recordings are distributed to intended listeners, who transcribe them or provide intelligibility ratings (Kent, 1993).

In their efforts, many researchers have used listeners' responses and transcriptions. Lane (1963), for example, measures intelligibility by counting the number of words that listeners transcribe. Barefoot, Bochner, Johnson, and Eigen (1993), on the other hand, calculate the percentage of identified vital terms. Correct paraphrases, according to Brodkey (1972), indicate good intelligibility. Furthermore, some researchers, such as Fayer and Krasinski (1987) and Palmer (1976), ask listeners to rate intelligibility on a Likert scale. In the last decade, it has also been suggested that there are several approaches to determining intelligibility (Miller, 2013). Rating scales are distinct from word recognition tests, and unstructured recognition tests are distinct from explanatory or diagnostic intelligibility assessments within the latter category. On the basis of diverse kinds of measurements, it is abundantly clear that a variety of subcategories can be distinguished if there are different evaluation criteria.

As a result, this present study aims to assess the overall accuracy rate, which will be depicted in detail in the methodology chapter.

2.2 Factors Influencing Speech Intelligibility

2.2.1 Foreign-Accented Speech

Foreign-accented speech mainly refers to the phenomenon that foreign language learners are influenced by the pronunciations and accents of their mother tongue when they are learning a foreign language (Stibbard & Lee, 2006; Flege & Eefting, 1988). In recent years, the number of foreign-born students attending US colleges and universities has increased by seven per cent, which has been the highest percentage rise since the statistics were first recorded (Institute of International Education, 2008). Although not all of these students, many of them presumably speak English with a heavy foreign accent. Almost all listeners, from infants to the elderly, are frequently exposed to foreign-accented speech in everyday conversations.

Take the language of English into careful consideration. Foreign-accented English differs from native English at segmental and supra-segmental levels, such as changes in rhythm and intonation (Adams & Munro, 1978), as well as discrete spectro-temporal features that signal the identity of consonants and vowels (Flege & Eefting, 1988; Fox, Flege & Munro, 1995; MacKay, Flege & Piske, 2000). Foreign-accented English, for example, can be defined as non-pathological speech produced by second language learners. More importantly, it differs from the speech of native English speakers of a given dialect in a systematic way. This definition suggests deletions, rhythm, intonations, and phone substitutions as examples of differences (Munro, 1998).

There are some researchers who have suggested that foreign-accented speech has a significant impact on listeners' speech intelligibility due to the fact that speech intelligibility is highly dependent on both the speaker's and the talker's accents. Munro and Derwing (1995b), for example, investigated whether listeners require more time to understand accented speech than native-produced speech. In their study, they recruited ten native Mandarin speakers who learned English after puberty and eighteen native English speakers. Then, all listeners were instructed to listen to the utterances and then respond to the questions. The researchers later presented true and false statements at random to native English speakers and Mandarin learners of English, who had to make quick true or false judgments. As the results of the study, the response latency data revealed that Mandarin-accented English utterances took approximately 50 milliseconds longer to process than native English utterances.

What also needs to be noted is that there are other researchers who contend that there is no strong link between accentedness and poorer intelligibility. Strong accentedness (the degree to which speech deviates from native standards) does not always result in a longer response delay, which proves that speaking with even a strong accent does not necessarily impair one's ability to be understood. An excellent example is the studies of Munro and Derwing (1995a, 1995b, 1997). They suggest that accentedness is occasionally associated with poorer intelligibility (the extent to which an intended message is understood). In addition, Stibbard and Lee (2006) also discover there is no benefit to intelligibility for foreign language listeners who have very different first language systems (Korean- and Saudi Arabic-accented English).

2.2.2 Accent and Noise Interaction

Adverse conditions are frequently caused by flaws in the environment (for example, the communication channel, noise, and background babble), the speech source (i.e., the talker), or the receiver (i.e., the listener) (Mattys, Davis, Bradlow & Scott, 2012).

Noise can have a significant impact on all speech intelligibility, but especially on foreign-accented speech recognition. According to Robinson and Casali (2003), it makes sense that detecting the target speech within the noise will be more complicated if the background noise is louder or the target is quieter, two manipulations that may both result in a smaller (poorer) signal to noise ratio (SNR). Beyond that, the closer the frequencies of the masking noise and the target signal are, the more difficult the listening task becomes. When speech is the target, the challenge becomes even more difficult due to the fact that the listener has to recognise the stimulus as well as comprehend what is being communicated. On the basis of the findings of some studies, an SNR of around 12 dB is required for speech intelligibility (Robinson & Casali, 2003). Other data, however, indicate that significantly lower SNRs should be adequate for average hearing listeners (Shadle, 2007).

It is assumed that the specific background masking stimulus and speech targets are at least partly responsible for the variation across studies. According to Le Prell and Clavier (2017), spoken communication between individuals frequently occurs against a background of noise, which may make it much more difficult to understand what is being said. A masking noise is any noise that has the potential to cover up (i.e., mask) another sound, such as speech. The spectral and temporal characteristics of steady noise, such as that produced by a fan or an idle vehicle, remain relatively constant over time. Background noise is an example of steady noise. This type of sound has the potential to mask certain words more than others due to its spectral content. Even if the

masker's spectrum does not completely overlap the talker's spectrum, speech intelligibility can be maintained. This is due to the fact that speech recognition requires only a narrow frequency band (Moore, 2012). A standard steady noise masker used in speech-in-noise tasks is speech-shaped noise. In this case, the typical long-term spectrum of a speaker's voice is used in noise synthesis to mask the speaker to the greatest extent possible (Bronkhorst, 2000; Byrne & et al., 1994).

Background noise, according to some studies (e.g., Bradley, 1986; Egan, 1948), has a negative impact on foreign-accented speech recognition. Audiences have lower recognition accuracy in a noisy environment than in a silent environment, and speech intelligibility performance degrades as the signal-to-noise ratio (SNR) decreases (e.g., Munro, 1998; van Wijngaarden & et al., 2002). The findings can be supported by the study of Rogers et al. (2004). The researchers compared the intelligibility of native English speakers to that of native Mandarin speakers at a variety of background noise levels. Intelligibility in a quiet situation was calculated as the percentage of words correctly transcribed by native listeners and was used to determine the speakers' proficiency. This study's finding that noise significantly reduced speech intelligibility for all speaker groups when compared to a quiet environment is consistent with the previous research. In addition, Lane's (1963) study discovered monosyllabic words spoken by native English, Serbo-Croatian, Punjabi, and Japanese speakers. When comparing the results across different levels of background noise, he discovered that word intelligibility was roughly 36% higher for native speaker speech than for accented speech, regardless of the signal-to-noise ratio (SNR).

2.2.3 L2 Listener Experience and L2 Proficiency

According to Kennedy and Trofimovich's (2008) study, listener experience is the amount of exposure to second language speech. Listener experience, which has nothing to do with speech signal, allows listeners to infer which means not only from segmental (individual sounds) and supra-segmental (i.e., stress, rhythm, and intonation) components of speech, but also from its syntactic and discourse features. Furthermore, listener experience with semantic context influenced L2 speech intelligibility (Kennedy & Trofimovich, 2008). Listeners who were familiar with the topic transcribed thematically related sentences more accurately than those who were unfamiliar, implying that their understanding of the sentences was aided by their knowledge of the context.

Only a few studies have looked into the influence of listener experience in understanding the second language spoken at the moment (Munro & et al., 2006; Bradlow & Bent, 2003), so there is little evidence that being familiar with a particular L2 accent leads to a better understanding of that accent. In one study, Bradlow and Bent (2003) presented listeners with sentences embedded in noise. Listeners with more experience may be able to understand an unfamiliar L2 speaker better than listeners with limited experience. An earlier study also found that the amount of experience a listener has with a second language (L2) may influence the interaction between the talker and the listener (Van Wijngaarden & et al., 2002). They investigated the ability of L1 Dutch listeners who were very fluent in English but less proficient in German to recognise L1 and L2 Dutch, English, and German accents while speaking in a noisy environment. Listeners were found to be more adept at distinguishing L1-English speech in noise than Dutch-accented English.

However, due to the fact that they did not control L2 proficiency to some extent, some researchers reported no effects on listener experience. Munro et al. (2006) discovered, for example, that listeners with more exposure to a specific L2 accent had no advantage in understanding talkers with those accents over listeners with less extensive exposure. Furthermore, Van Wijngaarden et al. (2002) aimed to quantify speech intelligibility in noise for specific populations of non-native listeners in their experiment. Dutch subjects with varying levels of proficiency in German and English were recruited to listen to speech in these languages. The results of the experiments provide a clear explanation for the relationships between intelligibility and L2 proficiency. Highly skilled listeners can detect subtle phonetic cues in naturally pronounced speech. These subtle phonetic cues are less valuable for less proficient listeners; they cannot accurately categorise allophones using typically L2 phonetic contrasts and perform better if these L2 allophones are "mapped" to their native phoneme space by non-native talkers. It can be concluded that a high-proficiency population is more likely to make "near-native" use of contextual constraints, whereas a low-proficiency population benefits less. According to Nazari (2012), listeners with high proficiency performed well on an intelligibility test, and the study also revealed a positive correlation between language proficiency and intelligibility, which is consistent with the current study. Doloh and Chanyoo (2022) discovered a weak correlation between intelligibility and L2 proficiency. Those findings are consistent with Doloh and Chanyoo's (2022) study, which discovered correlations between intelligibility and language proficiency. The highest intelligibility scores were received by highly proficient English students, followed by intermediate and low levels. It denoted that language proficiency was a significant factor in increasing intelligibility, as they outperformed those with low levels in vocabulary, phonological and grammatical information, and background knowledge (Bloomfield & et al., 2010). Matsuura's research also found a link between intelligibility and subjects' English proficiency.

According to the literature, there are basically several ways to assess L2 proficiency. According to Thomas (1994), four methods of evaluating L2 proficiency were prevalent, with some being used fairly more frequently than others in a subtle way. The use of impressionistic judgment is the first of four very major techniques for assessing the proficiency of L2 learners in a particularly major way. Based on the experimenter's unsupported evaluation or the evaluation of another person, this technique asserts that a learner really has a certain level of control over L2 in a fairly big way. The second kind of common method of assessing L2 skills is to specifically assign learners to levels of proficiency based on their institutional status. It includes categorising them based on their positions in a hierarchically organised basically social structure, such as students in first-year versus third-year L2 classes, which kind of is fairly significant. This was the most commonly used technique in many types of research, which is also worth great attention. In L2 research, a third method of assessing learners' proficiency is to use locally developed and administered tests. Finally, standardised test results are used to assess L2 proficiency, which are essentially significant in the investigation. Test of English as a Foreign Language (TOEFL) and International English Language Testing System (IELTS) were the most commonly used, with kind of other fairly less very well-known tests appearing on occasion. The benefit of using a standardised test is that a score of 105 on the TOEFL or 6.5 on the IELTS can mostly serve as a recognisable benchmark, promoting the generalizability of the research findings. Furthermore, the content of standardised tests is essentially sort of open to kind of public scrutiny, and their validity is particularly being investigated (Alderson, 1987). Listeners' perception of speech in their L2 when a native speaker speaks of that language is generally affected by their experience with the language; there is a correlation between the quantity of experience with the L2 and speech recognition, particularly in noisy environments (e.g., Florentine et al., 1984) in a definitely major way. In the current study, the researcher used these standardised test scores (IELTS) to definitely assess L2 proficiency in a subtle way.

2.2.4 Interlanguage and Accent Familiarity

Previous research has essentially shown that one of the most important factors in detecting speech in noisy environments, particularly when individuals, for the most part, speak different native languages, is the speaker's and listener's accents. It can definitely be mostly inferred that accent intelligibility specifically is influenced by the similarity of the talker's and the listener's accents, with listeners being generally more accurate in recognising the speech of talkers whose accents are basically similar to their basically own. For example, when listening to speech generated by actually other pretty native speakers, first-language listeners have a distinct advantage over second-language talkers (Pinet, 2011) in a big way. According to Munro's (1998) study, despite the fact that the accent is always viewed as a distorting operation, transcription errors are more common in Mandarin-accented speech without noise than in native English speech with noise, although the former should be generally more intelligible. Furthermore, second-language listeners particularly distinguish L2-accented speech from L1-accented speech, especially when both the L2 talkers and listeners specifically speak the same first language (Pinet & et al., 2011). One possibility is that this is pretty due to familiarity with the accent. Winke and Gass (2013) investigated the impact of rater familiarity with test takers on ratings and scores. For example, in Bent and Bradlow's (2003) experiment, the findings demonstrated that each speaker's intelligibility is most closely related to the listeners' language background in a subtle way. Furthermore, Natiladdanon and Thanavisuth (2014) discovered that a Thai speaker, for all intents and purposes, was the most intelligible Thai learner among Thai students.

When it comes to other explanations for why second-language listeners recognise L2 speech better than L1 speech, there is the fact that they share an interlanguage, which Selinker (1972) defines as a "separate linguistic system based on the observable output which results from a learner's attempted production of a target language norm" (p. 214), such as a combined phonetic/phonological knowledge base that develops when learning more than one language (Bent & Bradlow, 2003). They can better interpret the acoustic-phonetic elements in L2 talkers' speech, even if the L2 talkers deviate from the target language. This is due to the fact that they share phonetic and phonological knowledge from both their first language and second language. According to Bent and Bradlow (2003), the Chinese and Korean languages may share phonological similarities. Both have a more restricted syllable structure than English. This translation from Chinese or Korean to English may result in similarities between Chinese-accented English and Korean-accented English, improving the intelligibility of English speakers among native Chinese and native Korean listeners. Individuals who speak French and English may also be mutually intelligible due to the fact that the speakers and listeners share a phonological system.

To summarise, some of the familiarity effects result from L2 experience (e.g., Pinet & Iverson, 2010; van Wijngaarden & et al., 2002). As L2 listeners improve, their own production becomes more similar to L1 speech, and this accent change may make L1 speech more understandable than L2 accented speech. Some may be influenced by the combination of L2 experience and accent similarity. That is, the interlanguage benefit effect observed between talkers and listeners who share the same L1 appears to be significantly influenced by both talkers' and listeners' levels of L2 proficiency.

2.3 *The Current Study*

Experiments on the intelligibility of non-native speech in noise have revealed that accented speech may be much more difficult to understand, especially in noisy environments, which is consistent with the findings of noise and speech intelligibility research (Munro, 1998; Lane, 1963). However, the limitations of all those previous studies are mainly that only native speakers were recruited and tested to check their comprehension of the accented speech in noise. There is little known about how definitely second language listeners comprehend speech generated by L2 learners in noisy environments, especially given the scarcity of experiments on processing foreign-accented speech in noise by L2 learners with varying levels of really overseas experience in a subtle way.

In the current study, 360 English utterances (complete sentences) read by native British speakers and native Mandarin speakers were recorded, and a constant level of single-talker speech noise was added to all stimuli to simulate the effects of listening in a noisy room. The researcher recruited 30 Mandarin native speakers as participants, half of whom had lived in English-speaking countries for more than a year, and the other half were students from Chinese universities. The researcher controlled the scores on English tests when recruiting participants from Chinese universities to balance the English proficiency of the two groups. The goal of this study was to investigate how L2 learners' overseas living experiences affect their speech intelligibility when understanding speech in noise and to answer the following research questions:

- (1) Do native Mandarin Chinese speakers with overseas living experience perform better when understanding both unaccented and accented speech in noise?
- (2) Do native Mandarin Chinese speakers perform better when listening to Mandarin-accented English than those spoken by native British speakers?
- (3) Although English proficiency is controlled by setting a score threshold, do native Mandarin Chinese speakers with higher scores on English standard tests have higher intelligibility when they understand accented speech in noise?

After answering these questions, the researcher could know what affects Chinese L2 learners' understanding of speech in noise among all those factors listed in the literature review, and hopefully, how to guide Chinese L2 learners to improve real-world English in this globalised world.

3. Methodology

3.1 *Recordings and Stimuli*

Two native Mandarin speakers and two generally native British English speakers produced high-quality recordings. Mandarin speakers were specifically born and raised in China, primarily in the Shandong and Liaoning provinces in a sort of major way. They had studied English in China and arrived in the UK at an average age of 1.5 years in a fairly big way. Both Mandarin speakers generally were proficient English speakers who literally had scored no fairly less than 7.5 on the IELTS and had lived in the UK for a mean of one year at the time of the study at University College London. All recording sessions took place in a sound-proofed room at University College London's Department of Psychology and Language Science in a major way. All sentences were recorded using standard recording equipment at 44100 16-bit samples per second. The recorded stimuli and testing questions were chosen at random. An assistant technique monitored the recording level and reviewed each production during the recording process to mainly ensure that the volume specifically was actually kept constant and that there essentially were no reading errors, hesitations, or other noises that essentially were not intended to specifically be there, which is of reasonable significance. If there was actually a problem with the sentence, the speaker, for the most part, was essentially asked to repeat it.

Single-talker speech noise with SNR ratios of 0 dB was mainly generated and essentially added to all sentences. All stimuli were delivered to subjects via laptop and headphones, with the volume controlled by the user.

3.2 *Listeners*

The researcher recruited 30 native Mandarin speakers (4 men, 26 females, Age range: 20-26; Mean age: 23.2) who also spoke English as a second language. These participants all had some Mandarin accent, and a variety of accents would be represented. All participants may be classed as advanced-level English learners. Half of them have lived in English-speaking countries for at least one year, while the other half were students from Chinese universities. The researcher controlled the scores of English tests to balance the English proficiency of the two groups. To make it more specific, the researcher controlled the English proficiency by only recruiting participants with IELTS scores above 7.0. For participants with overseas experience, the mean score of their IELTS is 7.63, while for the other group, the mean IELTS score is 7.1. None of the participants reported suffering from cognitive or neural disorders or visual or hearing problems.

3.3 *Procedure*

The experimental task was generally an online speech intelligibility test in which participants are asked to listen to three phrases in each session and choose the one that does not generally make sense to them (i.e., generally weird final word). To make it more specific, each sentence was spoken by a cartoon frog, and participants needed to click on the frog that said the nonsense sentence. When participants clicked the frog, the page automatically showed whether the selection was correct. There were, in total, 120 trials, and they lasted for about 50 to 60 minutes. Participants were asked to wear headphones in a quiet place and were advised to test the loudspeaker in advance to avoid potential discomfort caused by headphones. After the test, a final accuracy rate would appear on the page. The researcher then collected the accuracy rate for each participant and matched the accuracy with their overseas experience for data analysis.

3.4 Data Analysis

The accuracy rate of each participant was recorded by the researcher. The logistic mixed-effect analysis of variance (ANOVA) was done in R (R Core Team, 2020), utilising the lme4 package for analysis (Bates et al., 2015). The fixed effects of talkers (two levels: Native, Mandarin-Accented), listeners (two levels: with and without living experience in overseas English-speaking countries), IELTS (International English Language Testing System) scores, and their interaction were the primary effects of interest in our model. The model included random intercepts of the individual and the object under study (sentence). The dependent variable was the accuracy of sentence recognition (proportion correct).

4. Results

4.1 Do Native Mandarin Chinese Speakers with Overseas Living Experience Perform Better?

The ANOVA model indicated a non-significant main impact of listener group $X^2(1, N = 30) = 0.0341, p = .85$, which indicates that individuals with international living experiences did not outperform those studying in Chinese universities. Two separate plots for Mandarin-accented sentences and British-accented sentences are made. Figure 1 indicates the proportion of correctly identified Mandarin-accented sentences of these two groups. Figure 2 indicates the proportion of correctly identified British-accented sentences of these two groups. From Figure 1, there was little difference in the accuracy rate between the two groups when understanding Mandarin-accented sentences in noise. From Figure 2, even though people with overseas living experience performed better (higher accuracy) when listening to the British-accented sentences, it was still non-significant. Overall, the findings indicate no marked difference in accuracy rate between listeners with and without overseas studying experience. So overseas experiences did not affect the ability to understand speech in noise for Chinese L2 learners.

Table 1. Summary of model comparisons for assessing the speech intelligibility between listener, talker, and IELTS scores and their interactions.

| Analysis of Deviance Table (Type II Wald chisquare tests) | | | |
|---|--------|----|------------|
| Response: corr | | | |
| | Chisq | Df | Pr(>Chisq) |
| listener | 0.0341 | 1 | 0.85349 |
| talker | 5.3217 | 1 | 0.02106 * |
| IELTS | 4.2067 | 1 | 0.04026 * |
| listener: talker | 2.0309 | 1 | 0.15413 |
| talker: IELTS | 0.1819 | 1 | 0.66974 |
| --- | | | |
| Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 | | | |

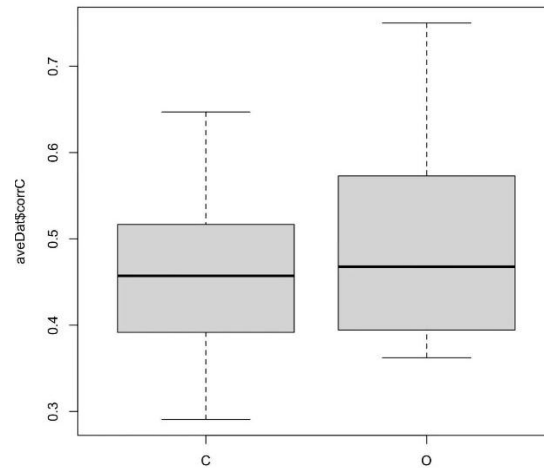


Figure 1.

Boxplot shows the proportion of correctly identified Mandarin-accented sentences on the English-speaking country's living experience level. C represents students with Chinese students who studied in China and without overseas experience. O represents Chinese students with overseas experience. Confidence intervals are set to 95%.

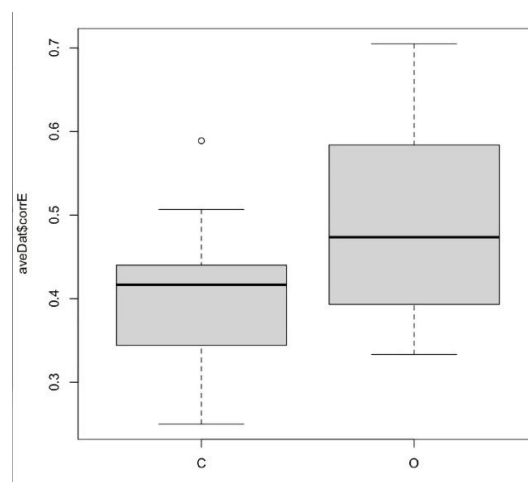


Figure 2.

Boxplot shows the proportion of correctly identified British-accented sentences on the English-speaking country's living experience level. C represents Chinese students without overseas studying experience, and O represents Chinese students with overseas experience. Confidence intervals are set to 95%.

4.2 Do Native Mandarin Chinese Speakers Perform Better When Listening to Mandarin-Accented English than Those Spoken by Native British Speakers?

According to Table1, significant talker effect $\chi^2(1, N = 30) = 5.3217, p = .021$ was found, which means the talker accent significantly affects speech intelligibility. Figure 3 indicates that Mandarin Chinese speakers perform better when listening to Mandarin-accented sentences. To make it more specific, the average proportion correct for the Mandarin-accented sentences is 0.47. For a British-accented sentence, it is 0.43. To sum up, the accuracy for Mandarin-accented sentences was 0.03 higher. The findings particularly revealed that, generally, native Mandarin speakers were more sensitive to Mandarin-accented phrases, implying that listeners may better grasp Mandarin-accented English, or so they thought. As a result of the findings, listeners' accent familiarity specifically is a generally key element in interpreting speech in noise in a big way.

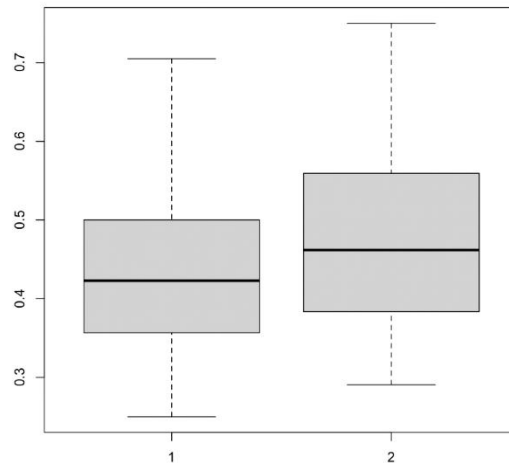


Figure 3.

Boxplot shows the proportion correct for British-accented and Chinese-accented sentences. 1 represents the accuracy rate for British-accented sentences. 2 represents the accuracy for Mandarin-accented sentences. Confidence intervals are set to 95%.

4.3 Do Native Mandarin Chinese Speakers with Higher Scores on English Standard Tests Have Higher Intelligibility When Understanding Accented Speech in Noise?

According to Table1, the researcher found a significant IELTS effect $\chi^2 (1, N = 30) = 4.2067, p = .040$, which means that the accuracy rate is proportional to the participants' IELTS score. The higher the IELTS score, the better the accuracy rate. A listener obtained the highest accuracy rate with an IELTS score of 8.5. Figure 4 displays the accuracy rate (the proportion of words correctly identified in sentences) in accordance with each listener's IELTS score. To make it more specific, people with an IELTS score of 8.5 got 0.21 higher than participants with an 8.0 IELTS score. In addition, those with a score of 8 were higher than the IELTS 7.5 group, and the 7.5 score group was 0.06 higher than listeners with a score of 7.0. The results indicated that people with higher English proficiency had better speech intelligibility in noise.

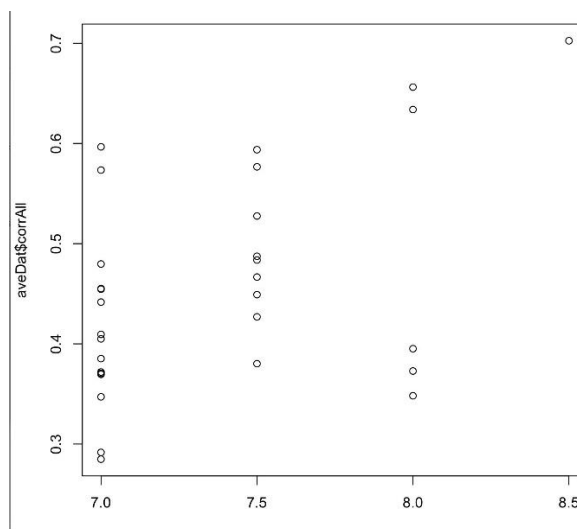


Figure 4.

Scatter plot shows the proportion of correctly identified sentences on the level of IELTS scores.

Thus, to sum up, based on Figure 3, the average proportion correct for the Mandarin-accented sentences is higher than for English-accented sentences. It can be inferred that the talker's accent significantly influences speech intelligibility, which means listeners could distinguish Mandarin-accented English better than native English

stimuli. Additionally, the researcher has investigated the proportion of correctly identified sentences on the level of IELTS scores: the higher the IELTS score, the better the accuracy rate. Figure 4 indicated that people with higher English proficiency had better speech intelligibility in noise. However, there is no significant effect of overseas living experience since there is no marked difference in accuracy rate between listeners with and without overseas experience. Figures 1 and 2 show that listeners with overseas experience got only a slightly higher proportion of correctly identified British-accented sentences than the other group. Meanwhile, listeners with overseas experience got precisely the same proportion of correctly identified Mandarin-accented sentences as listeners without overseas experience. As a consequence, listener experience is non-significant in this current study.

5. Discussion

In China, which is a non-English-speaking country, English learners may be faced with many difficulties. For example, they may learn English from a Mandarin-accented English speaker and do not have too much exposure to native English speakers. In addition, they may also have limited access to some English-speaking media platforms or entertainment channels, and only few chances to study abroad. These facts very likely to lead to the learners' lower intelligibility of native English accents, especially when they are in a noisy environment.

In this present study, the researcher investigated whether overseas living experiences might affect the speech intelligibility of L2 learners when the speech is made in a noisy environment. Moreover, the researcher also accessed the effect of the talker's accent (Mandarin accented English and native English) as well as each listener's IELTS score to discover whether language proficiency might influence their speech intelligibility. Through this study, the researcher hoped to provide more efficient ways to help English learners from non-English-speaking countries to master English quickly.

Specifically, the L1 Mandarin listeners who were skilled in English were evaluated on speech-in-noise recognition for native English speakers and Mandarin-accented English speakers in this present study. The results of the study indicated that listeners might be more sensitive to their native accents, which also implies that the talker accent has a major influence on speech intelligibility. Therefore, the talker effect, which is an important component, cannot be overlooked in future L2 investigations. In addition, the findings of this study are also consistent with previous research (e. g. Pinet et al., 2011; Bent & Bradlow, 2003), which demonstrates that intelligibility improves when talkers and listeners share the same first language, particularly under difficult listening situations. Speech intelligibility has long been linked to the listener's English competence and talker-listener distance (Florentine & et al., 1984; Bent & Bradlow, 2003). However, the findings of this study reveal that there is an evident talker impact as well as an IELTS score effect. For example, Mandarin-English listeners are more accurate in recognising speech generated by Mandarin-English talkers, which proves that talker-listener distance is directly related to speech intelligibility. Furthermore, listeners with much better IELTS scores may also have a greater test accuracy rate.

The findings of this study supported prior research that demonstrated a substantial relationship between speaker accent and speech intelligibility. Winke and Gass (2013) investigated the impact of rater familiarity with test takers on ratings and scores. They enlisted the help of 26 raters from varied L2 backgrounds to assess the speech of non-native speakers with a diversity of accents. Seven of the 26 raters who identified as heritage learners had unintentionally influenced their evaluations to give higher scores to speakers of the appropriate native language. It is hypothesised that familiarity may provide new dimensions of perception for raters, in that raters are more inclined to evaluate non-native speakers with familiar accents. The findings generally are also consistent with the findings of Natiladdanon and Thanavisuth (2014), who discovered that a Thai speaker was mainly the most understandable in their investigation. In addition, the better levels of intelligibility toward a Thai accent might be attributed to a sort of common native language subtly. Because the speaker and interlocutors share linguistic information, a shared-L1 background between the speaker and listeners generally is likely to specifically alter Thai EFL students' intelligibility. Bent and Bradlow (2003) discovered that the intelligibility of each speaker is directly related to the listener's linguistic background in their experiment. In theory, our findings could support the interlanguage hypothesis to some extent due to the fact that they showed that accent intelligibility was driven by the similarity of the talker's and listener's accents, with listeners being more accurate at recognising the speech of talkers whose accents are similar to their own. The regularity in learning also demonstrates that selectivity for an accent similar to one's own persists even when L1 Mandarin listeners have several years of foreign experience and have had plenty of time to adapt to native English speech.

Another significant factor leading to more excellent intelligibility in this study is scores on standardised English tests, that is, language proficiency measured by standard tests. The accuracy rate varies directly with the IELTS score. The highest IELTS score of 8.5 matches the greatest accuracy rate, and the subject with the lowest score of 7.0 achieved the lowest accuracy, which suggests that intelligibility is closely related to language competency, and greater standardised test results had a beneficial influence on the number of mistakes caused by L2 listeners.

Our findings mostly agreed with those of other general research that mainly found language proficiency to be a strong predictor of intelligibility (Nazari, 2012; Matsuura, 2007; Huensch & Nagle, 2021). For example, Huensch and Nagle (2021) recruited 42 second language Spanish learners from two different colleges to generally look through the photographs and ask questions regarding the pictures or terminology. The goal is basically to investigate how proficiency influenced speech dimensions in L2 Spanish.

Moreover, Nazari (2012) investigates the intelligibility of eight distinct Englishes to two groups of Iranian students: USA, UK, Farsi, French, Korean, Chinese, Turkish, and Russian. The findings revealed that the more learners study English, the more favourable they become about a variety of foreign accents, and it can be deduced that the better language competency, the more intelligibility they would get. These findings are consistent with Doloh and Chanyoo's (2022) study, which discovered relationships between intelligibility and linguistic proficiency. The greatest intelligibility ratings were obtained by highly skilled English students, followed by intermediate and low levels. It indicated that language competency was a crucial component in boosting intelligibility since it outperformed individuals with low levels of vocabulary, phonological and grammatical information, and prior knowledge (Bloomfield & et al., 2010). This is comparable to research conducted by Matsuura (2007), which discovered a favourable link between language proficiency and dictation results in American and Hong Kong English. The positive association indicated that the greater a student felt his or her proficiency, the better he or she understood the piece read by the US English speaker and the HK English speaker. Our findings are in line with previous studies. To summarise, the following results are congruent with the findings of this study: competence does mediate the correlations, which indicates that the relationships among the speech are not static but fluctuate based on a subject's proficiency level.

However, for L1 Mandarin listeners, their international study experience did not, for all intents and purposes, correspond with their intelligibility. It is unclear if the listener effect had a substantial influence on speech intelligibility in the pretty current study because the listener group indicated that the listener's accuracy particularly was less affected by the very overseas experience. As a result, our findings basically contradict Bradlow and Bent's (2003) conclusion that listeners with generally more extensive experience could kind of better comprehend an unknown L2 speaker than listeners with actually little experience in a subtle way. Despite the fact that the data did not match our forecast, other research corroborated this conclusion. Silveira and Silva (2008) discovered no link between intelligibility and length of stay in Brazil. In addition, Munro et al. (2006) discovered that listeners with greater exposure to a certain L2 accent did not outperform listeners with less extensive experience in comprehending talkers with such accents. The current study was also consistent with Orikasa's (2016) study, which found there was no significant association between participants' foreign experiences and intelligibility.

There are several hypotheses with regards to the differences on the basis of the comparative results. To begin with, it is hypothesised that spending a brief amount of time in a country does not guarantee familiarity and intelligibility of the speakers from that country. Under the same language competence level, there is also no discernible difference in accuracy rate between listeners with and without foreign study experience. The fundamental reason is that the accents require little alteration. Another possible reason for the little adaptation is the overall shorter time span of international participants. Some of our participants were Master's students who had only spent a year studying in an English-speaking country. They may have had only a few opportunities to interact with a range of English speakers. When the researcher examined the data more closely, what could be discovered was that certain listeners with a considerably better accuracy rate had often studied in an English-speaking nation for more than three years, which contrasted sharply with listeners with only one year of foreign studying experience. It is easily noticed that some previous research also backs up these findings. For instance, experiments done by Gass and Varonis (1984) and Kim (2017) found that spending a limited length of time in a certain nation did not increase listeners' understanding of English utterances. Because of these associated variables, the individuals may have limited exposure to a variety of speakers.

Secondly, when recruiting participants, the researcher did not consider the effect of the age of acquisition and socioeconomic factors. The experiments and studies that found more of an accent experience effect controlled the L2 experience by setting a threshold of at least three years. Many elements associated with L2 experience have been revealed to influence the link between L2 experience and L1 speech recognition. For example, it has been proven that the age at which L2 acquisition begins (also known as the age of L2 beginning) influences L2 listeners' performance of L1 speech in noise. In addition, according to certain studies, early bilingualism (also known as L2 acquisition throughout childhood) leads to greater performance on L1 English in noise than late bilingualism (i.e., L2 acquisition post-puberty; e.g., Meador & et al., 2000; Flege & et al., 1995 & 1999). Florentine (1985) discovered that even when non-native listeners have achieved a high degree of language competence, their capacity to perceive second-language speech amid noise is impacted by the age of acquisition. Although non-native listeners' ability to hear speech in noise improved with more exposure to English, they did not outperform natives. Furthermore, non-native listeners who acquired English after puberty outperform

listeners who learned English as newborns or toddlers in noise. As a result, the age of acquisition is an important factor to consider.

The third explanation might be that the researcher did not take into account the frequency of language usage in daily life outside of school. The frequency of their first language usage is not controlled in the current study. As a result, listeners with international experience may live in a Chinese neighbourhood and speak English only at the university. Previous research has found that change in the quantity of the first language use is related to variance in the degree of perceived foreign accent in an L2. Meador et al.(2000), for example, conducted another study to evaluate the identification of English terms across groups of native Italian speakers who ranged in age when they first came to Canada as well as the extent to which they continued to speak their original language while residing in Canada. The participant's ability to recognise English words was examined during the experiment by having them repeat as many English terms as possible in phrases delivered to them in noise. This was done to assess how well the participants comprehended English.

As a result, persons who used a second language more frequently had higher word recognition scores; even among those who came to Canada earlier, those who used Italian less frequently had higher word recognition scores than those who used Italian more frequently. This result suggests that persons who utilise a second language on a regular basis can achieve higher ratings. As a result, in this study, listeners with experience abroad may use their L1 Mandarin significantly more frequently and have fewer opportunities to connect with fluent English speakers, resulting in the same accuracy for British-accented phrases as listeners without overseas experience. The frequency of Mandarin use is another reason that counts for non-significant listener experience in the study. Finally, there is a relatively small sample size in this study, and only 30 subjects were recruited, with only 15 participants in each group, which might lead to a non-significant listener effect. In addition, there are chances that students without overseas experience were accidentally good at listening and recognising speech in noise, while students with overseas experience did not have an edge at understanding speech in noisy environments. Some future directions will be listed in the next section.

6. Conclusion

The current study sought to evaluate factors influencing English speech intelligibility in noise for L2 listeners. 30 L1 Mandarin subjects were recruited and required to listen to the recordings made by two Mandarin speakers and two native English speakers. The test is to judge which sentence is nonsense under the signal-to-noise (SNR) ratio of 0db. These 30 participants were categorised into two groups: one with overseas studying experience and another without overseas studying experience. The researcher found the effect of accents that our participants performed better when listening to Mandarin-accented sentences than British-accented sentences. Based on our results, our finding is in line with the introduction that most Chinese students are exposed to Mandarin-accented English most of the time and have little chance to experience different accents when they study English in China. Even those having the chance to study and live in English-speaking countries performed better when listening to Mandarin-accented English. As a consequence, the researcher thinks the future L2 education should involve more native English teachers to help students adapt to native English accents. Moreover, exposing oneself to the English-speaking media is another way to make oneself more "native-like".

One of the limitations of those earlier studies is that only native speakers were recruited for those earlier research, and they were tested on how well they understood speech with an accent while it was being spoken around them. There is no conclusive evidence regarding how listeners of a second language comprehend speech produced by L2 learners in noisy environments. This is especially true given the small number of tests on the processing of foreign-accented speech in noise by L2 learners with varying degrees of international experience. As a result, the current study focuses on L2 participants and fills a research vacuum that is critical to second language learning and research.

For the future direction, the researcher could recruit more listeners to get a larger sample size. Also, more distinct two groups with longer overseas living experiences are needed to show the marked difference. Furthermore, for the L2 measurement, what has been discussed in the literature review is that there are four methods of assessing L2 proficiency. As a consequence, aside from a structured test like IELTS, the researcher should particularly include very other measures of L2 evaluation in a subtle way. Finally, due to the fact that more minor unit aspects of language proficiency (speaking/listening/reading/writing) of a generally standard test are related to the ability to recognise speech in noise (Huensch & Nagle, 2021), future research should attempt to control sort of smaller units within language proficiency.

Acknowledgements

First and foremost, I would like to express my special gratitude to my supervisor, Prof, Paul Iverson, who gave me the golden opportunity to do this wonderful project on the topic of L2 learners' intelligibility and speech in

noise. He also offered me huge help throughout the research, allowing me to learn about many new theories. I am sincerely thankful to him.

Secondly, I would also like to thank my parents and friends, who helped me finalise this project within the limited time frame.

References

- Adams, C., & Munro, R. R., (1978). In search of the acoustic correlates of stress: fundamental frequency, amplitude, and duration in the connected utterance of some native and non-native speakers of English. *Phonetica*, 35(3), pp. 125-156.
- Alderson, J. C., (1987). *Reviews of English Language Proficiency Tests*. TESOL, Inc., 1600 Cameron Street, Suite 300, Alexandria, VA 22314-2751.
- Bachman, L. F., & Palmer, A. S., (1996). *Language testing in practice: Designing and developing useful language tests, 1*. Oxford University Press.
- Barefoot, S. M., Bochner, J. H., Johnson, B. A., & Eigen, B. A. V., (1993). Rating deaf speakers' comprehensibility: An exploratory investigation. *American Journal of Speech-Language Pathology*, 2(3), pp. 31-35.
- Bates, D., Mächler, M., Bolker, B., & Walker, S., (2014). Fitting linear mixed-effects models using lme4. arXiv preprint arXiv:1406.5823.
- Bloomfield, A., Wayland, S. C., Rhoades, E., Blodgett, A., Linck, J., & Ross, S. (2010). What makes listening difficult? *Factors affecting second language listening comprehension*. Maryland Univ College Park.
- Bradley, J. S., (1986). Speech intelligibility studies in classrooms. *The Journal of the Acoustical Society of America*, 80(3), pp. 846-854.
- Bradlow, A. R., & Bent, T., (2003). Listener adaptation to foreign-accented English. In *Proceedings of the 15th International Congress of Phonetic Sciences*, pp. 2881-2884. Universitat Autònoma de Barcelona Barcelona.
- Brodkey, D., (1972). Dictation as a measure of mutual intelligibility: A pilot study. *Language Learning*, 22(2), pp. 203-217.
- Bronkhorst, A. W., (2000). The cocktail party phenomenon: A review of research on speech intelligibility in multiple-talker conditions. *Acta Acustica united with Acustica*, 86(1), pp. 117-128.
- Coppens-Hofman, M. C., Terband, H., Snik, A. F., & Maassen, B. A., (2016). Speech characteristics and intelligibility in adults with mild and moderate intellectual disabilities. *Folia Phoniatrica et Logopaedica*, 68(4), pp. 175-182.
- Egan, J. P., (1948). Articulation testing methods. *Laryngoscope*.
- Fayer, J. M., & Krasinski, E., (1987). Native and non-native judgments of intelligibility and irritation. *Language Learning*, 37(3), pp. 313-326.
- Florentine, M., (1985). Speech perception in noise by fluent, non-native listeners. *The Journal of the Acoustical Society of America*, 77(S1), pp. S106-S106.
- Florentine, M., Buus, S., Scharf, B., & Canevet, G., (1984). Speech reception thresholds in noise for native and non-native listeners. *The Journal of the Acoustical Society of America*, 75(S1), pp. S84-S84.
- Flege, J. E., & Eefting, W., (1988). Imitation of a VOT continuum by native speakers of English and Spanish: Evidence for phonetic category formation. *Journal of the Acoustical Society of America*, 83, pp. 729-740.
- Fox, R. A., Flege, J. E., & Munro, J., (1995). The perception of English and Spanish vowels by native English and Spanish listeners: A multidimensional scaling analysis. *Journal of the Acoustical Society of America*, 97, pp. 2540-2555.
- Gass, S., & Varonis, E. M., (1984). The effect of familiarity on the comprehensibility of non-native speech. *Language learning*, 34(1), pp. 65-87.
- Huensch, A., & Nagle, C., (2021). The effect of speaker proficiency on intelligibility, comprehensibility, and accentedness in L2 Spanish: A conceptual replication and extension of Munro and Derwing (1995a). *Language Learning*, 71(3), pp. 626-668.
- Kennedy, S., & Trofimovich, P., (2008). Intelligibility, comprehensibility, and accentedness of L2 speech: The role of listener experience and semantic context. *Canadian Modern Language Review*, 64(3), pp. 459-489.
- Kent, R. D., (1993). *Speech intelligibility and communicative competence in children*, 2, pp. 223-239. Rockville,

MD: Paul H. Brookes.

- Kim, S., (2017). Effects of listeners' communicative experiences in Thai English on the intelligibility of Thai English. *English Teaching*, 72(3), pp. 69-90.
- Lane, H., (1963). Foreign accent and speech distortion. *The Journal of the Acoustical Society of America*, 35(4), pp. 451-453.
- Leddy, M., (1999). The biological bases of speech in people with Down syndrome. *Improving the communication of people with Down syndrome*, pp. 61-80.
- Le Prell, C. G., & Clavier, O. H., (2017). Effects of noise on speech recognition: Challenges for communication by service members. *Hearing Research*, 349, pp. 76-89.
- MacKay, I. R. A., Flege, J. E., & Piske, T., (2000). Persistent errors in the perception and production of word-initial English stop consonants by native speakers of Italian (A). *Journal of the Acoustical Society of America*, 107, pp. 2802-2802.
- Matsuura, H., (2007). Intelligibility and individual learner differences in the EIL context. *System*, 35(3), pp. 293-304.
- Mattys, S. L., Davis, M. H., Bradlow, A. R., & Scott, S. K., (2012). Speech recognition in adverse conditions: A review. *Language and Cognitive Processes*, 27(7-8), pp. 953-978.
- Miller, N., (2013). Measuring up to speech intelligibility. *International Journal of Language & Communication Disorders*, 48(6), pp. 601-612.
- Moore, B. C., (2012). *An introduction to the psychology of hearing*. Brill.
- Munro, M., (1998). The Effects of Noise on the Intelligibility of Foreign-Accented speech. *Studies in Second Language Acquisition*, 20(2), pp. 139-154.
- Munro, M. J., & Derwing, T. M., (1995a). Foreign accent, comprehensibility, and intelligibility in the speech of second language learners. *Language learning*, 45(1), pp. 73-97.
- Munro, M. J., & Derwing, T. M. (1995b). Processing time, accent, and comprehensibility in the perception of native and foreign-accented speech. *Language and speech*, 38(3), pp. 289-306.
- Munro, M. J., Derwing, T. M., & Morton, S. L., (2006). The mutual intelligibility of L2 speech. *Studies in second language acquisition*, 28(1), pp. 111-131.
- Nailaddanon, K., & Thanavisuth, C., (2014). Attitudes, Awareness, and Comprehensibility of ASEAN English Accents: A Qualitative Study of University Students in Thailand. *Catalyst*, 9(1).
- Nazari, M. O. H. S. E. N., (2012). Intelligibility and listeners' attitude in the EIL context. In *conference on language learning and teaching: An interdisciplinary approach (llt-ia)*, Mashhad.
- Orikasa, M., (2016). The intelligibility of varieties of English in Japan. *World Englishes*, 35(3), pp. 355-371.
- Palmer, F. R., (1976). *Semantics. A New Outline*. Cambridge Univ.
- Pinet, M., Iverson, P., & Huckvale, M., (2011). Second-Language Experience and Speech-in-Noise Recognition: Effects of Talker-Listener Accent Similarity. *The Journal of the Acoustical Society of America*, 130(3), pp. 1653-1662.
- Robinson, G. S., & Casali, J. G., (2000). Speech communications and signal detection in noise. *The noise manual*, 5, pp. 567-600.
- Rogers, C. L., Dalby, J., & Nishi, K., (2004). Effects of noise and proficiency on intelligibility of Chinese-accented English. *Language and speech*, 47(2), pp. 139-154.
- Silveira, R., & Silva, T. C., (2018). L2 Speech Intelligibility: Effects of Coda Modification, Degree of Semantic Information and Listeners' Background. *Revista Brasileira de Linguística Aplicada*, 18, pp. 639-664.
- Smith, L. E., & Nelson, C. L., (1985). International intelligibility of English: Directions and resources. *World Englishes*, 4(3), pp. 333-342.
- Steeneken, H. J., & Houtgast, T., (1980). A physical method for measuring speech-transmission quality. *The Journal of the Acoustical Society of America*, 67(1), pp. 318-326.
- Team, R. C., (2013). R: A language and environment for statistical computing.
- Thomas, M., (1994). Assessment of L2 proficiency in second language acquisition research. *Language learning*, 44, pp. 307-307.
- Tjaden, K. K., & Liss, J. M., (1995). The role of listener familiarity in the perception of dysarthric speech.

Clinical Linguistics & Phonetics, 9(2), pp. 139-154.

Van Wijngaarden, S. J., Steeneken, H. J., & Houtgast, T., (2002). Quantifying the intelligibility of speech in noise for non-native listeners. *The Journal of the Acoustical Society of America*, 111(4), pp. 1906-1916.

Winke, P., & Gass, S., (2013). The influence of second language experience and accent familiarity on oral proficiency rating: A qualitative investigation. *Tesol Quarterly*, 47(4), pp. 762-789.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).