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Speech Intelligibility Level Determinants and Measurement Methods

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Abstract

With the ever-increasing population of non-native speakers (NNSs) of English around the globe to the extent of exceeding the population of native speakers, encountering foreign-accented speech (FAS) has become frequent and inevitable. In this paper, the author highlights English in its new position, and its impact on speech intelligibility. The concept of speech intelligibility is discussed as it correlates with accentedness. It is viewed as an indicator for successful oral communication. A review of the different factors that impact speech intelligibility, in relation to the speakers and others related to the listeners. Moreover, speech intelligibility is modulated in relation to the different factors. Finally, numerous measurement methods that have been used regarding assisting the speech intelligibility of English in general and the intelligibility of English variety are discussed in particular.

Keywords: Foreign Accent, Speech intelligibility, Lingua Franca, Accentedness

Introduction

As a worldwide language, English has attained a crucial role in the context of international interaction (Sneddon, 2003). Thus far, the population of English language learners (ELLs) has been quickly increasing, and it remarkably outnumbers the native speakers' population (Crystal, 2003). Compared to the native English speakers (NESs) with about 375 million people, there are about 750 million people who speak English as their second language (L2). In addition, English is used in up to 70 countries with an official or special status (Reddy et al., 2016). This new status of English language has recently made it assume different roles and functions among different nations (Crystal, 1997; Graddol, 1997; Jenkins, 2007; Kirkpatrick, 2007). In particular, the widespread use of English as lingua franca (ELF) opens the door for definite interaction among non-native speakers (NNSs). As a result, speakers from different first language (L1) backgrounds, and with different levels of competence, will necessarily communicate with very different accents (Beinhoff, 2014).

English can be a difficult language to learn, as it is not a purely phonetic language — words are not necessarily pronounced the way they are written (Gebhardt, 2010; Womack, 1957). Because English pronunciation lacks a one-to-one relationship with the writing system (Schmied, 1991), pronunciation is considered quite difficult to learn (Gilakjani & Ahmadi, 2011). Therefore, ELLs typically resort to listening to native English materials in a native English accent to enhance their communication skills. It does not matter which English — British, American, Canadian or Australian — they listen to, as long as the language is native to those people who are the speaking models (Jenkins, 2000). However, this way of learning might be a double-edged sword, especially as the number of NNSs exceeds the NESs' number, and also the possibility of having one-to-one communication with native speakers of English is becoming difficult for many non-native speakers of English (Mahboob, 2014; Majanen, 2008; Mauranten, 2009; Van Splunder, 2013). That is, the probability of having to speak with NNSs is rather high (Cristia et al., 2012). Hence, being limited to one speaking model of English (particularly listening to only natives) has become a non-realistic phenomenon.

Within the ELF context, ELLs will be positively presented with a diverse variety of non-native speech; the speech that diverges from native speech. However, the distinction is not inconsistency; it is shaped by the essential differences within the language background of L2 learners. Learners are likely to recall the phonological properties of the sound system of their L1 while perceiving their L2 (Bilabo, 2002). Flege et al (2003) stated that non-native speech features mostly arise from the interaction of the phonological structures of both: L1 and L2. Accordingly, L2 speech production is created within the frame of L1 background, resulting in what is acknowledged as 'accented speech' (Escudero, 2005).

However, perceiving FAS, which is voiced within the mother tongue system, is quite different from the native speech (Escudero, 2001). Namely, such a diversity makes the communication more challenging. As Weil (2003) pointed out, FAS is among the different types of speech that degrade speech intelligibility. Debasing/imperfection in pronunciation can extraordinarily hinder communication (van Wijngaarden, 2000). Scholars argue that good pronunciation still conveys a clear message even with errors in other areas, while communication collides with bad pronunciation even if there is a good level of grammar (e.g., Gilakjani, 2012). As pronunciation is considered one of the toughest aspects of L2 acquisition to master (e.g., Munro, Flege, & Mackay, 1996), a huge number of NNSs may never achieve a native-like accent. Thus, many NNSs of English will accommodate various English speakers who are recognized as having a foreign accent.

Foreign accent is an increasingly researched phenomenon, but it is still debated as an interesting area of empirical investigation. Munro (2008) indicated the effect of this phenomenon on both speakers and listeners. He referred to it as the most complex aspect of language because it affects communication in terms of perception and production as well as in social interaction. Linguistics has essentially concentrated on the intelligibility aspect of FAS (e.g., Bradlow & Bent, 2008; Derwing & Munro, 1997; Munro & Derwing, 1995a; van Wijngaarden, 2001), and how native listeners recognize other speakers of L2 by perceiving their accents (e.g., Flege, 1984). Even though a foreign-accent is certainly not always destructive to communication, its impact is often obstructive (Podlipský, Šimáčková, & Petráž, 2016). For that reason, lots of research has been conducted to find out the factors affecting

its degree, such as the beginning of L2 acquisition, the quality of L2 learning and the quantity of time spent on it as well as the frequent usage of the L1 (Piske et al., 2001).

Scholars have studied speech intelligibility from different angles (e.g., Weil, 2003; Davis et al., 2005; Baese-Berk, Bradlow & Wright, 2013; Salheen et al., 2019; Bello et al., 2020), yet there is still gap existing in literature. In many studies, researchers have examined their established problem using what directly serves their research objectives. There appears to be no study discussing this research theme in terms of the whole aspects: the nature, the factors, and the methods addressing the related obstacles. So, this research is trying to achieve the following objectives:

- To identify the position and status of English in non-native contexts
- To understand the nature and impact of speech intelligibility and accentedness in non-native contexts
- To determine the factors influencing the level of speech intelligibility and the methods used in measuring the level of speech intelligibility.

As such, this review can help future researchers to be conversant about the stated subject, which is speech intelligibility. The article proposes to broaden the scope of researchers' thinking as to provide multi-level insights with a comprehensive background for understanding the subject of speech intelligibility and highlighting what is related to the stated topic in one article. The article was developed by visiting literatures related to speech intelligibility including the ones investigating or discussing the issue caused by it. The author focused on the last 40 years since the phenomenon emerged and became a questionable subject hoping to introduce a piece of value article.

English as Lingua Franca

Over the time, English has accomplished numerous terms referring to or indicating its position, as English as international language, English as global language, or English as world language ending up recently with English as lingua franca (ELF) (Seidlhofer, 2004). Today, the majority of English users are non-native speakers (Llurda, 2004), and this represents what the term lingua franca means "an additionally acquired language system that serves as a means of communication between speakers of different first languages" (Seidlhofer, 2001). Therefore, English with the newest term, 'ELF' does not belong to any specific nation: however, ELF is spoken by all English speakers around the globe representing a great deal of linguistic variation (Seidlhofer, 2001; Majanen, 2008). This diversity does not imply ending up as a language of incomprehensibility. Instead, such a variety in linguistic background can be overcome by involving special kinds of communication skills in order to promote intelligibility among ELF speakers (Mauranen, 2006; Majanen, 2008).

One of the useful descriptions for the spread of English was launched by (Kachru, 1985). He gave a clear description for the English community by dividing them into three categories in his famous explanation "the circle shape". These three concentric circles are: the inner circle, the outer circle and the expanding circle. As the Figure 1 shows, all the English-speaking countries- whose English is the native language (ENL)- represent the inner circle; this circle represents/embraces the native speakers of English in their English-speaking community such as the UK and Australia. Following, the outer circle that is referring to those countries which had been colonized by English-speaking countries. Therefore, English that has been

established in these countries such as Singapore, India, and Nigeria is used as a second language (ESL). The last circle, the expanding circle, is the one that includes those countries whose English is considered as a foreign language (EFL), such as Finland, China, and Israel. In fact, it is not easy to segregate the outer and the expanding circles as they share many characteristics (Majanen, 2008).

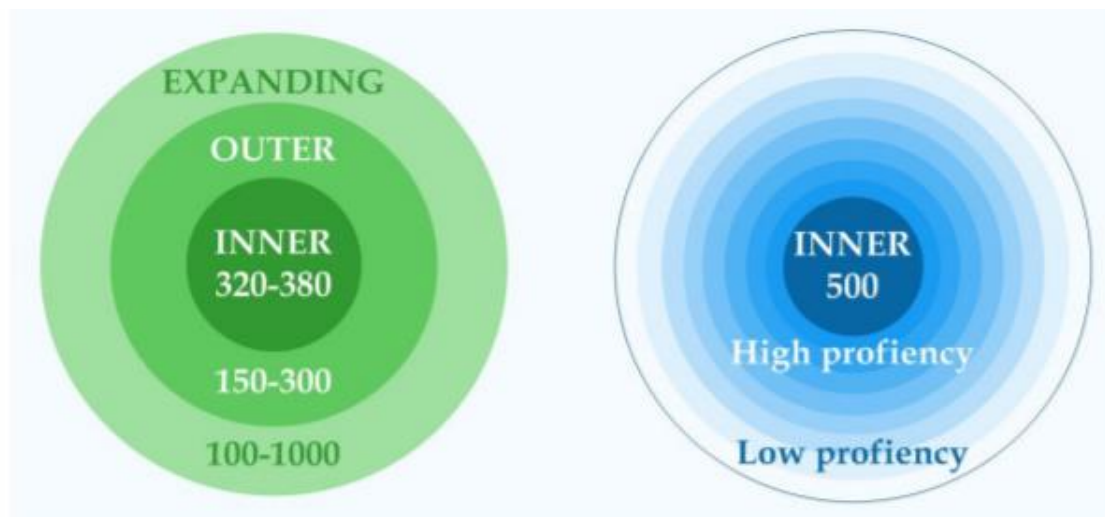


Figure 1 Kachru's (1985, 2004) circles of English

However, the division of Kachru (1985) of the three circles has increasingly become problematic, because the concept of ENL, ESL, and EFL has reduced to an unclear image within the globalized world (Graddol, 2006). Later on, Kachru proposed another classification in his circle design (See Figure 1, the right-hand circle), where he relied on the proficiency level of English. As the figure shows, the inner circle represents those speakers whose English proficiency is high — both native or non-native — and the outer and the expanding circles have combined into one community representing less proficient users of English (Kachru, 2004). With this new division of proficiency level, the nature of English within the new term is reasonably depicted, where ELF indicates all users of English including natives (Seidlhofer, 2004).

Speech Intelligibility

Understanding speech in a language is recognized to be a human-based ability in listening to speech which is acknowledged to be the most important target of the hearing sense (Nielsen & Dau, 2009). In the framework of second language learning, L2 learners are encouraged with the goal of being understood using their target language while communicating with other speakers within multiple contexts (Munro & Derwing, 1995a). However, communicating with non-native speakers is challenging where the presence of non-native accents affects intelligibility (Munro & Derwing, 1995b). Speech intelligibility, which has been the focus of much research investigating FAS (Bradlow & Bent, 2008; Derwing & Munro, 1997; Munro & Derwing, 1995a), is viewed as an indicator for successful oral communication (Munro & Derwing, 1995a, 1995b). But what does intelligibility in speech mean? Or maybe, what features of speech represent a good level of intelligibility?

Speech intelligibility is defined as the percentage of linguistic units (words) that are being correctly recognized by a listener and what a listener recognizes from the speech signal, which

is also determined by the percentage of words, sentences, or phonemes correctly identified (Hassan et al., 2013). To be precise, speech intelligibility represents speech-language output through which a listener interprets a speaker's meaning (Ertmer, 2010). Munro and Derwing also referred to intelligibility as the degree to which a speaker's message is really comprehended (1995a, 1995b).

Additionally, the same idea indicating intelligibility is repeated in Derwing and Munro (1997), with reference to the work of Nelson (1982), who defines intelligibility as "the apprehension of the message in the sense intended by the speaker." On first look, these definitions may seem open to interpretation. One critical interpretation might likely be listening comprehension. However, Munro and Derwing's operationalization of intelligibility makes it clear that they do not associate intelligibility with listening comprehension (1997). Rather than treating intelligibility as the ability to understand meanings at the level of an utterance or text, they measure listeners' ability to correctly recognize individual words within an utterance. The ability to recognize individual words undoubtedly contributes to successful listening comprehension and emphasizes a bottom-up rather than top-down process. The top-down process might allow listeners to arrive at the intended meaning despite some words within an utterance being unintelligible (Derwing & Munro, 1997). However, one might argue if the top-down process works positively for a successful communication regardless the intelligibility level of speech, why is intelligibility considered as a critical factor in oral communication? In fact, not all speech comes in contexts that allow for top-down processing; in oral communication messages sometimes come in one word. So, the bottom-up process is more efficacious and safeguarding.

The typical way used to measure speech intelligibility is by asking native listeners to transcribe specific words spoken by foreign-accented speakers (More details discussed later). Scholars have shown that native speakers of English are able to recognize speech from fellow native speakers more than from foreign-accented speakers. In addition, studies have demonstrated such a result even when there was some noise (Munro & Derwing, 1995a). In fact, the degree of intelligibility is typically affected by the strength of a speaker's accent; speech intelligibility improves when the accent is reduced (Bradlow & Bent, 2008). Different studies on the degree of intelligibility (Fayer & Krasinsk, 1987; Munro & Derwing, 1995) have indicated that higher intelligibility and lower frustration are linked with lower degrees of foreign accent, which is the most strictly judged measure (del Puerto et al., 2007). Nevertheless, identifying a speaker with a foreign accent does not essentially reduce intelligibility of the said speaker (Munro & Derwing, 1995a). Intelligibility in speech is a concept dependent on numerous variables in communication such as the speakers' prosody, resonance, phonation, and articulation along with listener familiarity, visual cues, and speech topic (De Bodt, Hernandez-Diaz & Heyning, 2002). The following section gives more details about the factors affecting speech intelligibility.

Factors Affecting Speech Intelligibility

Studies concerning speech intelligibility in a native or a non-native speech for native or non-native listeners, have come up with several factors that seem to impact speech intelligibility. Some factors are related to speakers, while others are related to listeners.

- **Influence of The Speaker**

Starting with the speaker factors, speech rate is considered one of the factors that could affect the level of intelligibility, as stated by Derwing and Munro (2001). With fast speech rate, difficulty in understanding occurs, while it is commonly projected that slower speaking rate improves intelligibility (Derwing & Munro, 2001; Zhao, 1997). On the other hand, 'slowing down' is not always a beneficial strategy for better perception as revealed by Derwing and Munro (2001). Hence, normal or natural speech rate is likely to be of assistance to speech perception. Considering such a factor, this study sets out to record the participants (speakers) at a normal speaking rate. In addition, idiosyncratic habits that some speakers have within their speech can send confusing messages. Therefore, speakers whose speech habit is unique should not be involved in speech intelligibility studies, and not be used to represent a target variety. Other factors relating to speakers are pausing, intonation, and stress (Anderson-Hsieh & Koehler, 1988; Munro & Derwing, 1998, 2001; Tajima et al., 1997; Trofimovich & Baker, 2006), and how the speech is clearly delivered (Bradlow & Bent, 2002). Pausing time found to have a negative relationship with perception (Derwing, 1990).

Moreover, word frequency is found to be an effective variable in speech intelligibility. Easy or similar lexical items that were used in such experiments were perceived to have higher degrees of intelligibility (Bradlow & Pisoni, 1999). The speech context also affects the degree of intelligibility (Mayo et al., 1997). Grammatical errors are also among the speaker factors that affect speech intelligibility, as stated by Ensz (1982). Additionally, the degree of accent similarly affects the level of speech intelligibility. With regard to accented speech, different studies have shown that rating of foreign accents is associated with the segmental and prosodic frequency that differ from the native speech patterns; the less accented a speaker is, the more intelligible the speech is and vice versa (Magen, 1998; Munro & Derwing, 2001).

- **Influence of The Listener**

With regard to listeners' factors, the factors of experience, L2 proficiency, context, and speech familiarity are all among the main factors which affect speech intelligibility. Experience or previous exposure to L2 speech has been found to correlate with speech recognition, interpretation which translates to intelligibility benefits (e.g., Florentine, Buus, Scharf, & Canevet, 1984). With regard to proficiency, Smith (1992) stated that L2 proficiency level is also a factor in comprehensibility tasks. In addition, different studies have shown that speakers' proficiency in the target language influences intelligibility (Bent & Bradlow, 2003; Stibbard & Lee, 2006; van Wijngaarden, 2001; van Wijngaarden et al., 2002a, 2002b). Context of the speech also can be supportive in terms of decoding the intended message, especially with inter-personal communication, which in most case enhances intelligibility (Field, 2003; Fry, 1955; Jenkins, 2002).

The term familiarity may indicate either familiarity with non-native speech or context familiarity (Gass & Varonis, 1984). In general, studies that involved native speakers have proven that utterances produced by familiar speakers are more easily understood than those produced by unfamiliar ones (Bradlow et al., 1999; Goldinger, 1996; Munro, 1998; Nygaard et al., 1994; Van Wijngaarden, 2001). The result can be applied to non-native speakers and in context, as well. This can be interpreted as speech intelligibility in the case of familiarity with a given variety as well. According to Munro, Derwing and Morton's (2006) study, unfamiliar accented speech calls for a greater effort in perception, while Bent and Bradlow (2003)

concluded that non-native listeners of English find familiar accented English more intelligible than native speech.

Speech Intelligibility Measurement Methods

For many years, the measurement of speech intelligibility has served numerous purposes for different fields with different goals in mind (Schiavetti, 1992). It has assisted communication engineers to evaluate speech distortion handled through different systems, particularly telephones (Fletcher, 1953). More recently, audiologists used intelligibility measures in assessing the speech recognition or discrimination performance of those who are hearing-impaired (Penrod, 1985). With regards to linguistics, speech intelligibility measurements have been used to determine how related speech varieties are considered as different dialects or different languages on the basis of common intelligibility (Comrie, 1987; Schiavetti, 1992).

Nevertheless, according to Stevens (1946, 1951), there are four levels of measurement in terms of the tasks performed: nominal, ordinal, interval, and ratio. The nominal level is accomplished when there is classification by determining the equality of the characteristic to be measured. For instance, speech could be categorized into the categories of either intelligible or unintelligible. The ordinal level is accomplished by using ranking, which is done by determining a higher or lower value of the characteristic to be measured. For instance, speakers could be ranked within a scale from the most intelligible to the least intelligible. The interval level of measurement is accomplished by determining the equivalence of intervals or differences between the characteristic to be measured. For instance, this could be done by employing a seven-point interval scale to evaluate the degree of intelligibility.

Lastly, there is a ratio level of measurement, which could be accomplished by the determination of the equality of ratios on the value of the characteristic to be measured. For instance, a word identification test could be utilized to count the total number of correctly identified words by a listener or a ratio scaling procedure such as magnitude estimation, which could be utilized to evaluate the degree of speakers' intelligibility. However, selection of the level of measurement should be in this preferable order: ratio, interval, ordinal, and nominal in accordance with the choice availability (Stevens, 1951; Schiavetti, 1992).

Concerning tasks, there are basically two kinds of tasks used to measure speech intelligibility. One is the word identification tests, and the other is referred to having scaling procedures. In the former, the listener's task is to write down the words that the speaker says. In the scaling procedure, listeners are required to make judgments about the speaker's intelligibility, applying one of the following techniques, for example, direct magnitude estimation or an equal appearing interval. In the direct magnitude estimation procedure, subjects are required to estimate the magnitude of physical stimuli by assigning numerical values proportional to the stimulus magnitude they perceive, while the equal appearing interval requires subjects to adjust the differences between stimuli, or chooses stimuli from a set, so that the differences between the magnitudes of the stimuli appear equal, thereby producing an interval scale. In the case of the word identification technique, this technique allows frequency calculation based on the number of words provided by the listener that matches the words on the speaker's intended list. This frequency count is generally interpreted as a percentage or a matched words proportion to the total word list as the metric of speech intelligibility (Schiavetti, 1992).

Scaling procedures basically ask the listener to judge in some way how well his/her responses could match the speaker's list of intended words and yield a value on some predetermined scale such as a constrained seven-point interval scale or an unconstrained magnitude estimation scale. Such scale values do not correspond to a traditional unit measure of intelligibility such as percent or proportion of correctly matched words. However, scaling procedures may also be used by the listener to estimate the percentage of the words on the listener's response list that would match the words on the speaker's intended list. In other words, a scaling procedure could be used by the listener to estimate the percentage of words they could hear correctly by listening to a particular speaker (Schiavetti, 1992).

Conclusion

Today, the majority of English users are non-native speakers. English is now considered as the lingua franca of an international community giving rise to its status as ELF. This implies that English is no longer exclusive to any particular population. However, within the ELF context, English is used by many speakers descending from different language backgrounds all over the world, which breeds numerous varieties of linguistic aspects. This diversity does not infer that English would be an inconceivable language among ELF speakers. However, with each new variation of accent, new potential obstructions may occur and may require further investigation (Jaber & Hussein, 2011).

Speech intelligibility is one of the common issues associated with ELF context. Understanding the nature of such issue and becoming knowledgeable with the factors affecting its level and the different methods used to overcome such matter is no more a choice but a need. In other words, promoting speech intelligibility among ELF speakers and any English speakers is essential and required. Successful communication is the outcome of perceiving speech that must be at least fairly intelligible (Carney, 1986; Kent, Weismer, Kent & Rosenbeck, 1989). Communication among different groups is important, and much more vital for foreigners who are becoming part of any diverse society. Presented in this study is a significant contribution to the existing literature, which is sparse, especially in the scope of NNS-NNS interactions.

Therefore, this research is significant to all those researchers who have concerned on the subject of speech intelligibility in general and the intelligibility of English variety in particular. As the study highlighted English in its new position elucidating the new-fangled context of English, which is created as a consequence of different language backgrounds. So, the potential benefit of this study is extremely relevant to facilitating cross-cultural communication. Moreover, introducing the different methods used in measuring speech intelligibility can provide an overview and contribute to the existing knowledge on implementing the common intelligibility across cultural communications.

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