COMPARISON OF PERFORMANCE ON SPIN-K BETWEEN NON-NATIVE KANNADA SPEAKERS HAVING MALAYALAM AS NATIVE LANGUAGE AND NATIVE KANNADA SPEAKERS

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CERTIFICATE

This is to certify that this dissertation entitled **"Comparison of performance on SPIN-K between non-native Kannada speakers having Malayalam as native language and native Kannada speakers"** is a bonafide work submitted as a part for the fulfilment for the degree of Master of Science (Audiology) of the student (Registration Number. 16AUD002). This has been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled "**Comparison of performance on SPIN-K between non-native Kannada speakers having Malayalam as native language and native Kannada speakers"** is a bonafide work submitted as a part for the fulfilment for the degree of Master of Science (Audiology) of the student (Registration Number. 16AUD002). This has been carried out under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Comparison of performance on SPIN-K between non-native Kannada speakers having Malayalam as native language and native Kannada speakers"** is the result of my own study under the guidance of Dr. Asha Yathiraj, Professor in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DEDICATED TO MY PARENTS

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'Gratitude unlocks the fullness of life'

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Abstract

Aim: The aim of the study was to determine the difference in performance between native Kannada speakers and non-native speakers of Kannada who had Malayalam as their native language, on a speech in noise test. The study also aimed to check the equivalence of the lists of the test in the two groups as well as determine the influnce of Kannada language proficiency on speech identification in the presence on noise.

Method: Forty native speakers of Kannada and 30 non-native speakers of the language with Malayalam as their native language were evaluated using the four lists of the Speech Perception-in-Noise test in Kannada (SPIN-K) developed by Vaidyanath and Yathiraj (2012). Prior to administering of the speech in noise tests, the participants were evaluated on a language proficiency questionnaire and a test to evaluate usage of Kannada. Both word and phoneme scores were calculated and subjected to statistical analyses.

Results: No significant difference in word scores was obtained across the four lists of SPIN-K in the native group as well as in the non-native Kannada speakers having Malayalam as their native language. However, phoneme scores were significantly different across the lists of SPIN-K in both groups. Both word and phoneme scores were significantly difference between the native and non-native Kannada speakers. Further, a significant weak correlation was observed between the total SPIN-K word scores and the language proficiency questionnaire scores. However, there was no significant correlation between the total SPIN-K phoneme scores and the language proficiency questionnaire scores.

Conclusion: As a difference exists between the native and non-native Kannada speakers on SPIN-K, it is recommended that the SPIN-K norms developed for native Kannada speakers not be used on non-native Kannada speakers who have Malayalam as their native language. The four lists of SPIN-K may be used interchangeably as the word scores were not significantly different in both groups. However, when phoneme scores are calculated, not all the scores can be used interchangeably. The study also revealed a weak correlation between the language proficiency and speech perception in noise abilities in both native and non-native language speakers.

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Chapter 1

INTRODUCTION

Rarely are individuals exposed to speech in the absence of interfering background noise. Background noise is considered as undesired auditory stimuli that presents a challenging listening environment (Crandell & Smaldino, 1995). This background noise is found to affect consonant perception, as these speech stimuli have less intense spectral energy than vowels (French & Steinberg, 1947). During speech perception in noise, it is reported that bilinguals and monolinguals experience the same difficulty with respect to signal-driven sources. However, it has been found that monolinguals need to resolve only the competition that arises within the language, but bilinguals have to deal with both within and between language competitions (Krizman, Bradlow, Lam, & Kraus, 2016).

Further, bilingual speakers have been found to comprehend speech in the presence of background noise better in their native than their non-native language (Buus, Florentine, Scharf, & Canevet, 1986; Florentine, 1985; Florentine, Buus, Scharf, & Canevet, 1984; Roussohatzaki & Florentine, 1990; Shi, 2010; Spolsky, Sigurd, Masahito, Walker, & Arterburn, 1968; Takata & Nábelek, 1990). This native-language benefit has been associated with the greater use of top-down linguistic data to aid degraded speech comprehension (Pichora-Fuller, 2008).

Meador, Flege, and Mackay (2000) found differences in native and non-native speakers in the presence of noise, even in those bilingual speakers who acquired their second language early in life. The evidence for bilingual disadvantage majorly arises from the studies that included sequential language learners (i.e., late bilinguals) on speech-in-noise perception abilities in their second, non-native language (Bradlow & Alexander, 2007; Mayo, Florentine, & Buus, 1997; Rogers, Lister, Febo, Besing, & Abrams, 2006). The studies reported that compared to monolinguals, bilinguals needed greater signal resolution, such as a larger signal-to-noise ratio (Mayo et al., 1997; Shi, 2010) or an increase in both the predictability and clarity of the speech signal (Bradlow & Alexander, 2007). Weiss and Dempsey (2008) noted that bilingual speakers who learn second language earlier in life perform better than the late bilinguals in the Hearing in noise test-HINT.

Other factors reported to affect the discrepancy in the perception of native and non-native speech in the presence of noise include the duration of non-native language study (Florentine, 1985; Roussohatzaki & Florentine, 1990), the age of the listener and the listening conditions (Takata & Nábelek, 1990). Hervais-Adelman, Pefkou, and Golestani (2014), using a functional magnetic resonance imaging technique, reported of the involvement of semantic context during the perception of noisy speech. This was seen in native but not in the non-native language speakers. This was attributed to more automated semantic access based on better established representations seen in the native speakers.

Thus, previous literature indicates that there is a difference between the way native and non-native speakers perceive speech. This difference is noted to be more marked in the presence of noise.

Need for the study

Evaluation of speech perception in the presence of noise is often done on individuals with suspected auditory processing problems. However, such tests are available in limited Indian languages. Hence, it is not uncommon that individuals are tested in a language known to them other than their native language. In such situations, the norms developed for the native speakers are referred to judge the performance of the non-native speakers. Therefore, it needs to be ascertained whether such norms can be referred to when the individual tested is a non-native speaker of that particular language.

As Karnataka has a large population of Malayalam speakers who are familiar with Kannada, these individuals are often tested using the speech-in-noise test in Kannada (SPIN-K), if required. As Malayalam is known to utilise a larger number of voiced speech sounds compared to Kannada (Geethakumary, 2002), it is possible that native Malayalam speakers are likely to be influenced by their native language when listening to Kannada. Hence, it needs to be studied whether the norms available for native Kannada speakers on SPIN-K can be utilised when evaluating non-native Kannada speakers having Malayalam as their native language.

Aims of the study

The study aimed to determine the differences in performance between native Kannada speakers and non-native speakers of Kannada who had Malayalam as their native language, on the Speech perception in noise test in Kannada (SPIN-K). The study also aimed to check the equivalence of the lists of the test in the two groups as well as determine the influence of Kannada language proficiency on speech perception in the presence on noise.

Objectives of the study

The objectives of the study were to:

- Establish the equivalency of the SPIN-K lists in native Kannada speakers and non-native speakers having Malayalam as their native language.
- Compare the SPIN-K scores (word & phoneme) between native Kannada speakers and non-native speakers having Malayalam as their native language, and
- Examine the correlation between SPIN-K scores and the scores on a Kannada language proficiency questionnaire.

Chapter 2

REVIEW OF LITERATURE

Noise is known mask speech, making the target signal indistinct and faint due to the overlapping of temporal and spectral features of the noise and signal. This is noted to result in a loss of acoustic and linguistic cues needed for speech perception. This has been reported to occur in normal hearing individuals (Takata & Nábelek, 1990; Van Wijngaarden, Steeneken, & Houtgast, 2002), those with auditory processing problems (Bamiou, Museik, & Kuxon, 2001; Keith, 1999), as well as those with peripheral hearing loss (Killion, Niquette, Gundmundsen, Revit, & Banerjee, 2004; Kilman, Zekveld, Hallgren, & Ronnberg, 2014; Schum & Matthews, 1992; Tschopp & Zust, 1994). Among those with normal hearing, it has been observed that those who are native speakers perform differently from non-native speakers of a language in the presence of noise (Bradlow & Pisoni, 1999; Cutler, Garcia Lecumberri, & Cooke, 2008; Florentine, 1985; Lecumberri & Cooke, 2006; Mayo et al., 1997; Rogers et al., 2006).

Bradlow and Alexander (2007) reported that bilingual speakers effectively use contextual information for word recognition in the presence of speech-shaped noise. Also, Cooke (2006) pointed out that sparseness and redundancies based on spectrotemporal glimpses facilitated speech perception in noise. For words slightly below the threshold of intelligibility, it has been noted by Savin (1962) that certain features are heard while certain are not. In this situation, the listener is thought to make use of top-down linguistic information to assist speech comprehension in degraded conditions.

Speech as well as non-speech background noise has been found to degrade target signals and interfere with important bottom-up processing cues needed for accurate speech perception. Background noise is also reported to increase the cognitive load, particularly, working memory (Cervera, Soler, Dasi, & Ruiz, 2009). Rudner, Lunner, Behrens, Thoren, and Ronnberg (2012) reported that speech perception becomes challenging as background noise hampers working memory ability. Additionally, speech is thought to deteriorate in the presence of noise either due to energetic masking or informational masking caused by maskers. Energetic maskers are reported to affect the audibility of speech and informational maskers are reported to hinder speech perception by separating the target from the masker (Lecumberri, Cooke, & Cutler, 2010). It has also been noted that stationary and fluctuating maskers result in energetic masking (Stone, Fullgrabe, & Moore, 2012; Stone & Moore, 2014) and modulation masking (Oxenham & Kreft, 2014; Stone et al., 2012). On the other hand, multi-talker babble is found to result in informational masking (Freyman, Helfer, Mc Call, & Clifton, 1999).

Speech perception in noise is reported to depend on various factors like the type of stimuli used (Boothroyd & Nittrouer, 1988), signal-to-noise ratio (Bradlow & Alexander, 2007; Rogers et al., 2006; Van Engen & Bradlow, 2007), language of testing (Buss, Florentine, Scharf, & Canevet, 1986; Gat & Keith, 1978; Mayo et al., 1997), type of masker that is presented (Lecumberri et al., 2010) and attention factors (Cooke, 2006). Yet another variable that has been found to influence perception of speech in the presence of noise is whether the listener is a native speaker of the language (Bradlow & Alexander, 2007; Bradlow & Pisoni, 1999; Broersma & Scharenborg, 2010; Burki-Cohen, Miller, & Eimas, 2001; Cooke, Garcia Lecumberri, & Barker, 2008; Crandell & Smaldino, 1996; Cutler et al., 2008; Rogers et al., 2006).

Depending on the proficiency of individuals in the language being tested, their speech perception in the presence of noise is reported to vary (Bialystock & Hakuta, 1994).

Thus, in literature, several factors are noted to influence speech perception in the presence of noise. The following section includes information regarding the influence of type of noise, age of second language acquisition and language proficiency in non-native speakers of a language.

2.1 Effect of noise on bilingual speakers

In degraded situations, bilingual speakers have been found to perform significantly poorer than monolingual speakers (Florentine, 1985; Golestani, Rosen, & Scott, 2009; Mayo et al., 1997; Shi & Sanchez, 2010; Von Hapsburg & Bahng, 2006; Von Hapsburg, Champlin, & Shetty, 2004). Soares and Grosjean (1984) noted that the conflicts faced by the bilinguals are as a result of slower processing. Von Hapsburg and Bahng (2006) suggested that the poorer performance could be due to the constant interaction of the two phonetic systems within the bilingual brain during speech processing. Similar findings were reported by Cutler, Weber, Smits, and Cooper (2004), who studied the differences in speech perception in noise between native and non-native English speakers. They concluded that the difficulties faced by non-native speakers in disadvantageous conditions could be attributed to phoneme misidentifications.

The perception of second language in the presence of background noise by bilingual speakers is reportedly affected by a number of factors. These include the type of competing stimulus (Cooke et al., 2008; Lecumberri & Cooke, 2006; Shi, 2009; Shimizu, Makishima, Yoshida, & Yamagishi, 2002), age of second language acquisition (Mayo et al., 1997; Weiss & Dempsey, 2008) and length of second language experience/use (Gat & Keith, 1978; Meador et al., 2000; Shi, 2009).

2.1.1 Effect of type of noise on speech perception in noise in non-native speakers. Although non-native speakers may be fluent in their second language, in degraded speech conditions, they are found to be more adversely affected when compared to native speakers. These have been reported for stationary non-speech noise (Bergman, 1980; Bradlow & Bent, 2002; Cutler et al., 2004; Florentine, 1985; Gat & Keith, 1978; Lecumberri & Cooke, 2006; Mayo et al., 1997; Rogers et al., 2006; Takata & Nábelek, 1990), multi-talker babble (Van Wijngaarden et al., 2002) and reverberation (Nabalek & Donahue, 1984). When the background noise was a speech signal (multi-talker babble), the speakers reportedly experienced difficulty in processing speech, as the multi-speaker babble affected their listening abilities (Cutler et al., 2004; Lecumberri & Cooke, 2006; Mayo et al., 1997; Van Engen & Bradlow, 2007). Native language noise has been reported to be more deleterious than non-native language noise for perception of native language speech targets (Calandruccio, Dhar, & Bradlow, 2010; Lecumberri & Cooke, 2006; Rhebergen, Versfeld, & Dreschler, 2005; Van Engen & Bradlow, 2007).

Previous literature has reported differences in speakers from various language backgrounds using a broad range of noise. Mayo et al. (1997) used speech noise of 12-talker babble in English to study the differences between native English speakers and native Spanish speakers who had English as their second language. They reported of significant difference in speech perception between the groups. Hazan and Simpson (2000) used English VCV syllables along with speech shaped noise and reported differences in perception between native speakers of English and non-native English speakers who had Japanese or Spanish as their native language.

Using different types of noises (competing talker noise, 3-speaker babble, 8-speaker babble, modulated speech shaped noise, speech shaped noise, & factory noise), VanDommelen and Hazan (2010) compared consonants identification scores between native and non-native English speakers. They reported that the competing noise and modulated speech shaped noise had similar consonant identification scores. However, these were significantly higher than speech shaped noise identification scores. Further, the identification scores for 3-speaker babble was significantly poorer than 8-speaker babble in both the groups. Also, factory noise resulted in the poorest identification scores in both the groups.

Studies reported in literature have noted differences between native and non-native speakers for specific speech stimuli / masking noise. Bradlow and Bent (2002) used English sentences embedded in white noise and reported significant differences between native speakers of English and non-native English speakers. Also, Van Wijngaarden et al. (2002) noted differences in speech recognition threshold in noise between native speakers of Dutch, English, and German and their non-native counterparts using the respective native language sentences in speech shaped noise. Cutler et al. (2004) reported significant differences in perception of monosyllables in the presence of multi-speaker babble between native English speakers and non-native English speakers who had Dutch as their native language. Further, Lecumberri and Cooke (2006) studied the differences between native English and Spanish speakers using English VCV syllables in the presence of non-speech noise, English 8-talker babble, and competing speech in both English and Spanish languages. They found that non-native speakers are adversely affected by both energetic and informational masking when compared to native speakers. It was also observed that the native speakers performed better when the competing speech was presented in their non-native language. They also reported a strong correlation between non-native performance in quiet and degree of deterioration in noise. Hence, they concluded that non-native phonetic category learning can be fragile.

Van Engen and Bradlow (2007) observed that native English speakers perceived English target stimuli better in the presence of 2-talker Mandarin babble when compared to the presence of 2-talker English babble. Based on this finding they concluded that under certain conditions, the language of the interfering speech can affect the intelligibility of the target speech. They also proposed that the findings demonstrate informational masking on sentence-in-noise recognition in the form of 'linguistic interference'.

Several studies report of noise resulting in the phenomenon of energetic masking (Cutler et al., 2004; Lecumberri & Cooke, 2006; Van Engen & Bradlow, 2007; VanDommelen & Hazan, 2010). Besides these studies, few other studies have also noted that noise could result in informational masking. Cooke et al. (2008) studied the effect of informational masking between native and non-native groups of participants. They examined the effects of energetic and informational masking by comparing the effects of a primarily energetic masker (stationary non-speech noise) with a primarily informational masker (single competing talker). They reported that both the maskers affected the perception in the non-native group when compared to the native group. However, informational maskers were reported to have a greater effect. They also suggested that the non-native speakers may have compromised tracking and attention abilities which are essential to perceive speech signal in noise.

Kilman et al. (2014) also concurred that informational maskers interfere more with perception than the energetic maskers in non-native speakers. They used 2-

talker babble as an informational masker and fluctuating noise and stationary noise as energetic maskers.

Therefore, from the above studies it can be noted that the type of masker noise plays a key role for speech perception in noise for both native and non-native speakers. Besides the type of masker, the age of acquisition of the second language has also been noted to affect the perception of speech in the presence on noise.

2.1.2 Age of acquisition of non-native language. The age of acquisition of non-native language has been found to have a significant effect on the perception of speech in noise for that particular language (Krizman et al., 2016; Mayo et al., 1997; Meador et al., 2000; Rogers et al., 2006; Shi, 2009; Shi, 2010). Ezzatian, Avivi, and Schneider (2010) compared speech reception in native and non-native English speakers using nonsense sentences in the presence of noise and speech maskers. They classified the non-native speakers into 3 groups: speakers who acquired English between 7 to 14 years of age; speakers who acquired English after 15 years of age; and a mixed group where speakers were raised in non-English environment but were exposed to spoken English at an early age. Although there was a significant difference noted between each group, the native English speakers and the mixed listener group had better vocabularies than the other two groups. Therefore, they concluded that early second language acquisition led to higher vocabulary scores, which are further correlated with better thresholds in noise condition.

Krizman et al. (2016) studied the difference between the performance of monolingual and bilingual speakers using Quick Speech-in-Noise test (Killion, Niquette, Revit, & Skinner, 2001), Hearing-in-Noise test (Nilsson, Soli, & Sullivan, 1994), Word-in-Noise test (Wilson, Carnell, & Cleghorn, 2007) and tones-in-noise condition. They reported a significant difference in recognition thresholds between the two groups. They also found a bilingual advantage for early bilingual speakers during the perception of non-linguistic auditory target.

To determine the effect of age of acquisition of second langue on speech perception in noise, Mayo et al. (1997) evaluated monolingual English speakers, early bilingual (who learnt fluent English before the age of 6 years) and late bilingual speakers (who learnt fluent English after age of 14 years). Speech Perception in noise test (Kalikow, Stevens., & Elliott, 1977) was administered on all the participants in the presence of competing babble noise. They noted that the differences in speech recognition abilities in monolinguals and the early bilingual speakers were not statistically significant. However, the late bilingual listener group performed significantly poorer than the monolingual and early bilingual groups. These findings indicated that learning a second language at an early age is important for the acquisition of efficient high-level processing of speech, at least in the presence of noise.

In an attempt to establish the effect of age on speech in noise thresholds in adolescents (12 to 17 years), Jacobi, Rashid, Laat, and Dreschler (2017), studied participants who had Dutch as their native language by administering the online Speech-in-Noise screening tool Earcheck. They reported a significant effect of age on the speech in noise threshold. This indicated the presence of tuning of speech-in-noise processing in adolescents.

Meador et al. (2000) evaluated native English and non-native English speakers with a word recognition test. The non-native English group having Italian as their native language were divided into 3 subgroups based their age of exposure to English.

The early (average of 40 years of residence) and native English listener groups had higher scores compared to the mid (average of 34 residence) and late (28 years of residence) exposure groups. Hence, they concluded that the sensitive period of language learning, if exceeded, may have significant effect on speech perception, especially in adverse conditions.

Shi (2009) obtained word recognition scores from English monolingual, simultaneous bilingual and sequential bilingual groups in a quiet condition and in the presence of speech-weighted noise, multi-talker babble, forward-playing music, and time-reversed music. Across the different types of noise, they found significant differences between the groups. However, the monolingual and simultaneous bilingual groups had similar scores and the early sequential bilinguals (acquired English between 5 to 12 years) performed better than late sequential bilinguals (acquired English between 13 to 33 years). Therefore, they concluded that early bilinguals perform better than late bilinguals, irrespective of the type of background noise presented.

Thus, studies reported in literature supports the fact that learning a second language at an early age is important for the acquisition of efficient high-level processing of it. Although most of the studies reveal significant difference between monolingual and bilingual speakers (Jacobi et al., 2017; Krizman et al., 2016; Mayo et al., 1997; Rogers et al., 2006; Shi, 2009; Shi & Sanchez, 2010), Lopez, Martin, and Thibodeau (1997) reported no significant difference between monolingual and bilingual speakers when Synthetic Sentence Identification with ipsilateral competing message (SSI-ICM) test was used.

2.1.3 Effect of language proficiency on speech perception. Proficiency of a non-native language is noted to have an effect on non-native speech perception. Imai, Walley, and Flege (2005) obtained word recognition scores in the presence of multitalker babble in native and non-native English speakers. Using the average foreign accent rating scale, they grouped the non-native speakers into high pronunciation proficiency and low pronunciation proficiency subgroups. The word recognition scores were significantly higher for the native English speakers and non-native high pronunciation proficiency groups when compared to non-native low pronunciation proficiency group. They concluded that the mismatch effect of responses for non-native high proficient speakers and non-native low proficient speakers was quite large.

To study the influence of non-native language proficiency on speech perception in noise, Kilman et al. (2014) administered Hearing-in-Noise test (Nilsson et al., 1994) on native and non-native Swedish speakers. They measured the proficiency using the English proficiency test, as English was the non-native language considered for the study. They found a significant difference between native and non-native Swedish speakers. However, when English babble was presented, the high proficient English speakers had lower speech reception thresholds when compared to low proficient English speakers.

Shi (2011) utilized NU-6 list consisting English mono-syllabic word recognition in quiet condition to establish the minimum level of self-reported English proficiency that identifies bilingual speakers who may perform on par with monolingual speakers. The testing was conducted on 125 normal hearing bilingual speakers who rated their English proficiency on Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007). The author reported that bilingual speakers who rated themselves as highly proficient had better word recognition scores when compared to lesser proficient participants.

Therefore, from the above studies on language proficiency, it can be inferred that proficiency plays a key role in defining the linguistic abilities of the listener in the non-native language. It also has an effect on the speech perception in noise thresholds.

2.2 Phonemic differences between languages

It has been observed that languages across the world have different phonemic inventories. The existence of a non-native disadvantage during speech perception in noise is reportedly attributed to mismatch of phoneme categories leading to phonetic decisions based on the native repertoire (Cutler et al., 2004). This gives rise to a need for understanding phonemic differences between the languages outside India as well as within India.

2.2.1 Phoneme differences in non-Indian Languages. Many linguistic differences across various non-Indian languages have been reported in the literature. Dauer (1983) reported major differences in English, Thai, Spanish, Italian, and Greek. The differences were with respect to morphophonemic structure and the syllable structure. Earlier, Aziz (1974) observed differences between English and Iraqi language with respect to nasal sounds and also pointed out that the British fricatives /v, /z/ and /r/ also existed in Iraqi. Flege and Port (1981) in their study regarding cross linguistic interferences between Arabic and English, reported the absence of phoneme /p/ in Arabic, which was produced with glottal pulsing during the stop closure interval by the Arabic speakers. Kayne (1981) pointed out that French speakers omit the phoneme /h/ at the beginning of words when speaking English because of the phonemic differences between the languages. Kenworthy (1987) noted that Japanese has only 5 vowels in its vowel inventory when compared to English language which has 15 vowels. Thus, it is evident that languages across the world differ in terms of the phonemes available in each language.

2.2.2 Phoneme differences in Indian Languages. Languages spoken in India are found to belong to several language families, the major ones being the Indo-Aryan languages, spoken by 75% of Indians and the Dravidian languages spoken by 20% of Indians. Dravidian languages are found to be classified as South, South-Central, Central and North subgroups (Krishnamurthi, 2003). The most widely spoken Indo-Aryan languages are Hindi, Bengali, Konkani, Marathi, Gujarati, Punjabi, Rajasthani, Assamese, Maithili and Odiya (Cardona, 2003) . The phonemes of the languages across India have been noted to differ, with some differing more than the others.

It is reported that the voiced aspirates sounds (/b^h/, /d^h/, /j^h/, & /g^h/) are common among Indo-Aryan languages such as Hindi and Marathi, but are absent in Kashmiri. Malayalam is reported to have some speech sounds (/p/, /l/, /m/, /n/, /k/) that are pronounced with double articulation. Malayalam has also been note to utilize more voiced speech sounds compared to Kannada (Geethakumary, 2002). However, in both Kannada and Malayalam languages, dative markers are used before adjectives. It has been also observed that polarity specification is absent in Malayalam.

Telugu, on the other hand, is observed to not have contrastive stress, and speakers vary on where they perceive stress (Lisker & Krishnamurthi, 1991). Tamil language reportedly does not have /z/, /h/ and /f/ in its phonetic inventory.

Due to these phonemic differences between the languages, bilingual speakers have been observed to face confusions between the target phonemes. Failure to make use of the full range of phonemic identity cues is considered to render phoneme identification more difficult in bilingual speakers than in monolingual speakers (Cutler et al., 2008).

The above studies indicate that in adverse listening conditions, differences in speech perception occur between native and non-native speaker groups. The age of acquisition of the second language, proficiency of the language and the type of noise are also variables that affect perception of speech in the presence of noise.

Chapter 3

METHODS

The study was designed to determine the difference in performance between native Kannada speakers and non-native speakers of Kannada on the Speech Perception in Noise test in Kannada (SPIN-K), developed by Vaidyanath and Yathiraj (2012). The non-native speakers of Kannada had Malayalam as their native language. The study was carried out using a standard comparison design.

3.1 Participants

The 70 participants included in the study were selected using a purposive sampling technique. Forty participants were native Kannada speakers and the other 30 were native Malayalam speakers who were fluent Kannada speakers. All the participants were young adults aged 18 to 40 years. The native group had a mean age of 27.12 years (range = 18 to 40 years) and non-native group had a mean age of 28.36 years (range = 18 to 40 years). To be included in the study, the participants were required to have normal hearing sensitivity in both the ears. They were considered to have normal hearing if their air conduction and bone conduction thresholds were within 15 dB HL; air-bone gap was not more than 10 dB HL; and bilaterally they obtained 'A' type tympanograms with both ipsilateral and contralateral reflexes being present. Absence of auditory processing difficulties was confirmed using the Screening Checklist for Auditory Processing in Adults (Vaidyanath & Yathiraj, 2014). Further, they were required to have no report of any otological, neurological, speech and language problems.

Individuals were considered as native Kannada speakers if they were exposed to Kannada from early childhood and spoke the language fluently. On the other hand, they were considered as non-native speakers of Kannada if they acquired Kannada during early adolescence. It was also mandatory that the non-native speakers of Kannada had Malayalam as their native language and were exposed to it from early childhood as well as spoke it fluently. Additionally, native and non-native speakers were grouped based on their scores on the 'Linguistic Profile Test in Kannada' developed by Karanth (1980) and 'Language Proficiency Questionnaire' developed by Maitreyee and Goswami (2009), that was modified as a part of the current study. Those with scores of ≥ 73.43 on the 'Linguistic Profile Test in Kannada' were included in the study. On the 'Modified Language Proficiency Questionnaire', the native participants were selected only if they got a score of at least 75 and the non-native participants were required to obtain at least a score of 60.

3.2 Equipment

A calibrated dual channel audiometer (Maico MA 53) with TDH-39 headphones and B-71 bone vibrator were used to test the air conduction, bone conduction respectively. The audiometer was used for evaluating pure-tone thresholds and speech audiometry. Additionally, for SPIN-K testing, a laptop computer (Intel core i5 processor) with a CD player was used to route the recorded audio signals through an auxiliary input to the audiometer. A calibrated immittance meter (GSI tympstar) was used to carry out tympanometry and reflexometry and to rule out middle ear problems.

3.3 Material

The material used in the study included tests for selection of the participants, tests to determine the language proficiency of the individuals and tests to evaluate speech perception in the presence of noise. Most of the tests used were existing tests, while one of the tests was modified for the purpose of the study.

3.3.1 Material for subject selection. The tests for selection of the participants included the 'Screening Checklist for Auditory Processing in Adults' (SCAP-A) developed by Vaidyanath and Yathiraj (2014) to assess the auditory processing capabilities; The syntax section of the 'Linguistic Profile test in Kannada' developed by Karanth (1980), was utilised to assess the language competence of the non-native Kannada speakers, where the maximum possible score was 100; The language proficiency was evaluated using the 'Language Experience and Proficiency Questionnaire' (LEAP-Q), adapted to the Indian context as 'Language Proficiency Questionnaire' by Maitreyee and Goswami (2009). The test was further modified in the current study. The adapted questionnaire by Maitreyee and Goswami (2009) included 18 questions regarding language acquisition and usage to determine bilingual proficiency. Of these questions, seven questions pertaining to language acquisition and language usage in various situations were utilized and one question about the usage of language in hours per day was added. The eight questions evaluated the various domains such as language understanding, speaking, reading and writing. The scoring procedure in the modified language proficiency questionnaire also differed from the one developed by Maitreyee and Goswami (2009). Details of the 'Modified Language Proficiency Questionnaire' and the scoring are provided in Appendix 1. The maximum possible score in the modified version was 100. The participants provided information about all the languages that they used. However, for the present study, they were scored only for their usage of Kannada.

This modified version of language proficiency questionnaire was verified by six Speech and Hearing professionals by reviewing the content of the questionnaire and the scoring pattern. Additionally, it was tested on three native Kannada speakers and three non-native Kannada speakers to check if they could follow the items and carryout the task. The lowest score obtained by the native speakers (score = 75) was chosen to be the cut-off score that differentiated the two groups. However, for the non-native speakers a lower cut-off score was selected (score = 60) as this was the lowest score obtained by the non-native participants who met the requirement on 'Linguistic Profile test in Kannada'.

3.3.2 Material for evaluation of SPIN-K. Paired Kannada words, developed at the Deparment of Audiology, AIISH, were used to calculate the speech recogntion threshold. This measure was utilized as the reference for presenting the stimulus for speech perception in noise test.

The Speech in noise in Kannada (SPIN-K) developed by Vaidyanath and Yathiraj (2012) was used to assess speech perception in the presence of noise and to rule of risk of an auditory processing disorder. The stimuli consisted of phonemically balanced words in Kannada developed by Yathiraj and Vijayalakshmi (2005), while the noise consisted of 8-speaker Kannada babble. The test was designed to be presented monaurally at 0 dB SNR. The test consisted of four lists, with each list having 25 words. None of the words were repeated across the four lists.

3.4 Test environment

All the audiological tests were carried out in an acoustically treated suite that met the specification of ANSI S3.1-1999 (R2013). The testing suites had optimum temperature and lighting and were free of any type of distractions.

3.5 Procedure

3.5.1 Selection of Participants. To select the participants, pure-tone air conduction and bone conduction thresholds were measured using the modified Hughson and Westlake procedure (Carhart & Jerger, 1959). The air conduction and bone conduction were evaluated at the octave frequencies between 250 Hz to 8 kHz and 250 Hz to 4 kHz, respectively. Speech Recognition Threshold (SRT) was measured for each ear independently.

Middle ear function was tested using a calibrated Immittance meter. Tympanogram was obtained using a standard 256 Hz probe tone. The ipsilateral and contralateral acoustic reflexes were obtained at 500 Hz, 1 kHz, 2 kHz and 4 kHz.

The Screening checklist for Auditory Processing (SCAP-A) was administered individually on the participants. Individuals who obtained a score of ≤ 6 were included for the study.

The Linguistic Profile Test in Kannada was administered on the non-native Kannada speakers. The participants who obtained scores greater than 73.43, indicating that they had a language age of greater than 10 years as per the norms given by Suchithra and Karanth (1990), were selected to form the non-native Kannada speaking group. The test was administered on 15 native Kannada speakers. As all of them obtained the maximum possible score of ≥ 87.41, the test was not administered on the remaining native Kannada speakers.

The 'Modified Language Proficiency Questionnaire' containing eight questions was administered on all the participants. In the native group, the participants who scored ≥ 75 were included for further testing. In the non-native group, the participants who scored ≥ 60 were included for further testing.

3.5.2 Procedure for administering the SPIN-K Test. Those who met the participant selection criteria were evaluated with the Speech-Perception-in-noise test in Kannada (SPIN-K) developed by Vaidyanath and Yathiraj (2012). The stimuli and noise were presented at 40 dBSL (Ref. SRT) at 0 dB SNR, ipsilaterally. The recorded stimuli was played through a laptop having a CD player. The output from the laptop was routed via an audiometer to headphones. A 1 kHz caliberation tone was used to adjust the VU meter deflection of the audiometer to 0, prior to the presentation of the speech stimulus. Lists 1 and 2 were presented to one ear and Lists 3 and 4 were presented to the other ear. In order to avoid ear effects, right ear was tested initially for the first 15 particpants and left ear was tested intially for the next 15 participants. The participants were instructed to listen to the stimulus carefully and repeat the words heard by them. The responses obtained were audio recorded and scored after the testing was completed.

3.5.3 Scoring. Each word repeated correctly was assigned a score of 1 and an incorrect response was scored 0. The maximum possible score was 25 for each list. Additionally, each correctly identified phoneme was given a score of 1 and an incorrect phoneme a score of 0. Also, a negative score of -1 was assigned if the participants added a phoneme that was not present in the stimulus. The maximum possible phoneme score was 100, 103, 101 and 105 for the four lists respectively. Due to these variations in total phoneme score across the lists, the responses were converted into percentage.

3.6 Statistics analyses

The data obtained from the participants was statistically analysed using SPSS version 20 statistical software. Shapiro Wilks test of nomality was used to determine whether the data are normally distributed or not. As the data were not normally distributed, non-parametric statistical tests were conducted.

Chapter 4

RESULTS

Statistical analyses were carried out on the native Kannada speakers and the non-native Kannada speakers having Malayalam as their native language, to obtain within group as well as between group comparisons. The within group comparison of SPIN-K scores (word & phoneme scores) was carried out to check list equivalency for the two participant groups (native & non-native groups) using Wilcoxon signed rank test. The between group comparison was carried out separately for the word and phoneme scores using the Mann-Whitney U test. Additionally, the correlation was also checked between the 'Modified Language Proficiency Questionnaire' scores and the SPIN-K word and phoneme scores.

The results are provided under the following headings:

4.1. Equivalency of the SPIN-K lists within the two groups (native& non-native) for word and phoneme scores.

4.2. Comparison of SPIN-K scores (word & phoneme) across native and non-native groups.

4.3 Correlation between SPIN-K scores and the modified language proficiency questionnaire scores.

4.1 Equivalency of the SPIN-K lists within the native and non-native speakers

The mean, median, standard deviation, minimum and maximum word and phoneme scores of SPIN-K indicate that the scores varied only marginally across the lists (Table 4.1). It can be seen from the table that this occurred for the word and phoneme scores for the native Kannada speakers as well as the non-native speakers.

While raw scores are provided for the word scores, the phoneme scores are provided in percentage as the maximum possible phoneme scores varied across the lists.

To check whether the word scores for the four lists of SPIN-K were statistically significant in the *native group,* a Friedman's test was carried out. It indicated that there was no significant difference across the four SPIN-K lists [χ^2 (40) = 4.88, p > .05]. Therefore, no further analysis was carried out. However, the phoneme scores were found to be significantly different across the four lists in the native group [χ^2 (40) = 22.08, p < .001]. Therefore, Wilcoxon's signed-rank test was carried out, which indicated a significant difference between lists 1 and 3 (Z = 3.11 p < .01), lists 2 and 3 (Z = 4.10, p < .001), and lists 3 and 4 (Z = 3.75, p < .001).

Similarly, the Friedman's test revealed that, within the *non-native group* there was no significant difference observed in the word scores across the different lists [χ^2(30) = 6.67, p > .05]. On the other hand, the Friedman's test indicated that the phoneme scores across the lists were significantly different in the non-native group [χ^2 (30) = 11.56, p < .001]. Hence, Wilcoxon's signed-rank test was done to determine which of the pairs of lists differed from each other. A significant difference was seen only between lists 3 and 4 (Z = 2.87, p < .01).

Table 4.1*: List wise Mean, Median, Standard deviation (SD), Minimum (Min) and Maximum (Max) of the SPIN-K word and phoneme scores for the native and non-native speakers*

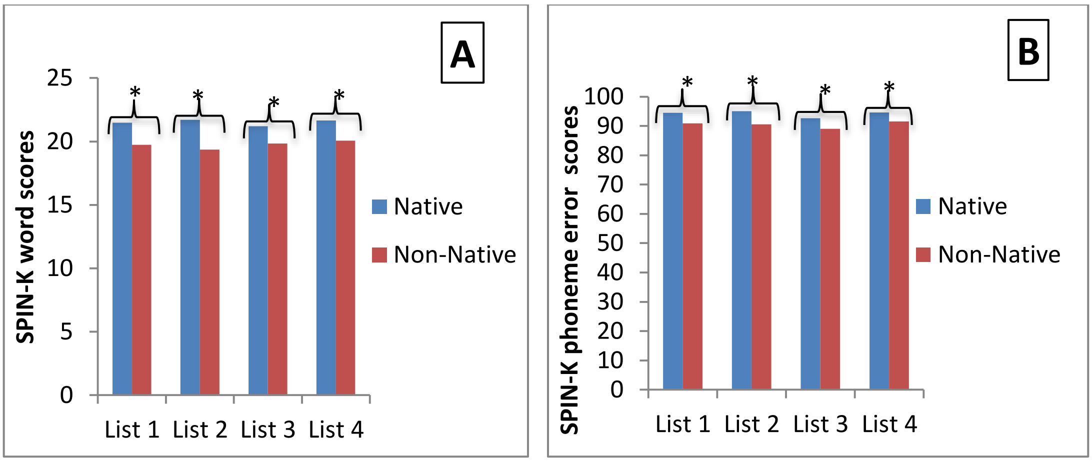
		Native speakers (N = 40)		Non-native speakers (N = 30)	
Lists		**Word Scores**	**Phoneme Scores**	**Word Scores**	**Phoneme Scores**
List 1	**Mean**	21.47	94.50	19.73	90.87
	Median	21.50	95.00	20.00	90.50
	SD	1.57	3.05	1.91	3.24
	Min & Max	18.00 & 24.00	88.00 & 99.00	15.00 & 23.00	83.00 & 97.00
List 2	**Mean**	21.70	95.07	19.3	90.54
	Median	21.50	95.14	19.5	90.29
	SD	1.24	2.41	1.44	2.38
	Min & Max	19.00 & 24.00	89.32 & 99.00	16.00 & 22.00	85.43 & 95.14
List 3	**Mean**	21.20	92.67	19.83	89.08
	Median	21.50	93.13	19.00	90.19
	SD	1.36	3.02	1.82	4.35
	Min & Max	18.00 & 24.00	85.29 & 98.03	17.00 & 24.00	77.45 & 97.05
List 4	**Mean**	21.65	94.58	19.41	91.56
	Median	22.00	94.66	20.00	92.30
	SD	1.27	2.31	1.74	3.04
	Min & Max	19.00 & 24.00	89.42 & 99.03	16.00 & 23.00	84.61 & 97.11

Note. Maximum possible word score = 25; Maximum possible phoneme score = 100%

4.2 Comparison of SPIN-K scores (word & phoneme scores) across native and non-native groups.

The mean, median, standard deviation, minimum and maximum scores of the two participant groups (Table 4.1) were lower for the non-native group when compared to the native group. This is evident for the word scores and the phoneme scores. This can also be seen from the mean SPIN-K word scores for both the groups in Figure 4.1.

To examine whether the difference in scores between the two groups were statistically significant, inferential statistics were carried out. The SPIN-K *word scores* of each list were compared between the native and non-native groups using Mann-Whitney U test. A significant difference was obtained between the two groups for *list 1* (Z = 3.64, U = 296.50, p < .001, r' = 0.43), *list 2* (Z = 5.65, U = 132.0, p < .001, r' = 0.67), *list 3* (Z = 3.40, U = 317.50, p < .001, r' = 0.40) and *list 4* (Z = 3.85, U = 282.50, p < .001, r' = 0.46).



Note. * = p < 0.05; Maximum SPIN-K word score = 25: Maximum phoneme error score = 100%

Figure 4.1. Mean word scores (A) and phoneme scores (B) of SPIN-K for the four word lists

The SPIN-K *phoneme scores* compared for each list between the native and non-native groups revealed a significant difference between the two groups across the four lists. The native speakers obtained significantly better scores than the non-native speakers for *list 1* (Z = 4.16, U = 250.50, $p < .001$, r' = 0.50), *list 2* (Z = 5.77, U = 116.0, $p < .001$, r' = 0.69), *list 3* (Z = 3.67, U = 291.50, $p < .001$, r' = 0.44) and *list 4* (Z = 3.94, U = 269.50, $p < .001$, r' = 0.47).

4.3 Correlation between the SPIN-K scores and language proficiency

The correlation between the SPIN-K scores and the 'Modified Language Proficiency Questionnaire' scores were established with all the participants grouped together (N = 70). This was calculated separately for the word scores and the phoneme scores using Spearman's correlation.

Table 4.2: *Combined Mean Standard deviation (SD), Minimum (Min) and Maximum (Max) of SPIN-K word scores, phoneme scores and the 'Modified Language Proficiency Questionnaire' scores for native and non-native speakers* (N = 70).

	Total word scores	**Total phoneme scores**	**Modified Language proficiency questionnaire scores**
Mean	82.94	92.68	70.55
SD	6.03	2.83	7.13
Min & Max	65.00 & 94.00	85.00 & 98.00	60.00 & 85.00

Note. Maximum possible total word score = 25; Maximum possible total phoneme score = 100%; Maximum possible language proficiency questionnaire score = 100.

The comparison between the four lists indicated that there was no significant difference between them for the word scores and for the phoneme scores. Hence, they were combined, resulting in the maximum total word scores being 100 and total phoneme scores being 100%. The results of Spearman's correlation showed a significant weak correlation between the total SPIN-K *word scores* and Modified Language Proficiency Questionnaire scores (r = 0.31, p < .05). However, for the *phoneme scores* SPIN-K there was no significant correlation (r = 0.19, p > .05) with the Modified Language Proficiency Questionnaire.

From the findings of the study, it was seen that there was a significant difference in scores (word & phoneme) between the native and non-native groups. Further, the four lists in SPIN-K were found to be equivalent with reference to the word scores but not with reference to the phoneme scores in both groups. The lists that differed in terms of the phoneme scores varied between the two groups. The correlation between SPIN-K word scores and the 'Modified Language Proficiency Questionnaire' scores was low or not significant.

Chapter 5

DISCUSSION

The results of the study that aimed to compare SPIN-K scores of native Kannada speakers with that of non-native Kannada speakers who were native speakers of Malayalam, are discussed. The results of the study are discussed regarding the equivalency of the four SPIN-K lists within the two groups (native & non-native) for word and phoneme scores; comparison of SPIN-K scores (word & phoneme) across native and non-native groups; and correlation between SPIN-K scores and the language proficiency questionnaire scores.

5.1 Equivalency of the SPIN-K lists within the two groups (native & non-native) for word and phoneme scores

In the present study, the *native Kannada speakers* had no significant difference in word scores across the four SPIN-K lists. However, they obtained a significant difference in phoneme scores across most of the lists (lists 1 & 3; lists 2 & 3; and lists 3 & 4). Similarly, in the *non-native Kannada speakers* the word scores were not significantly different across the four SPIN-K lists, but the phoneme scores differed significantly across lists 3 and 4, but not across the other lists.

Similar findings regarding equivalence of word scores across the SPIN-K lists were noted by Vaidhyath and Yathiraj (under review) and by Mamtha and Yathiraj (under review). The former study established the equivalence on a group of young native adults and the latter study on a group of native Kannada speaking children. Thus, it can be inferred that when word scores are calculated, the four lists used can be utilized interchangeably as there are equivalent. Hence, the lists that are equivalent in quiet continue to be comparable in the presence of noise. However, if phoneme scores are to be calculated, it is recommended that list 3 not be used interchangeably with the other lists. This is especially if native Kannada speakers are evaluated.

In the present study, the equivalency between the lists was obtained only in the word scores and not in phoneme scores, in both native and non-native groups. This could be because when the word scores were calculated, the entire word was marked wrong even if a single phoneme was perceived wrong. While calculating phoneme scores, the specific phoneme errors were considered. From the raw data it was observed that the phonemes that were wrongly perceived across the lists varied. These errors were noted to occur more often in the context of vowel /a/ (45%), followed by /u/ (20%), /i/ (14%), /e/ (11%) and /o/ (10%). Thus, it can be inferred that coarticulated cues had an influence on the phonemes being perceived correctly or wrong and not just the direct phoneme cue.

Further, it can be observed from Table 4.1 that the native speakers had more within-list phoneme error variability than the non-native speakers. This could be attributed to the subtle phonemic confusions due to a vast phonemic inventory present in the native Kannada speakers. However, on the other hand non-native Kannada speakers have reduced phonemic representations of their non-native language leading to decrease in phonemic substitutions. Similarly, Mack (1988) reported that native speakers showed greater error patterns when compared to non-native speakers, when natural sentences were converted into synthetic sentences. This can account for why the variations across the lists were more in the native participants than in the non-native participants. In the native participants, list 3 varied from all other three lists, whereas in the non-native participants it varied only from one list.

5.2 Comparison of SPIN-K scores (word & phoneme) across native and non-native groups

The current study revealed that, significantly poorer scores were obtained by the non-native speakers when compared to the native speakers. This was observed for both word and phoneme scores. The non-native participants in the present study acquired Kannada only during adolescence, which was after the sensitivity period for acquisition of language. Thus, despite Kannada and Malayalam not being very different in terms of the speech sounds, the words in the two languages differ considerably. It can thus be construed that as the non-native participants would not have had as much exposure to the speech sounds of Kannada as the native participants, they would have had more difficulty in using auditory closure. On the other hand, the native participants would have been more equipped to use auditory closure and guess the words. This could have led to the difference between the two groups.

As seen in the current study, several other studies that compared native and non-native speakers also reported of native speakers outperforming non-native speakers in perceiving speech in the presence of noise (Bradlow & Alexander, 2007; Broersma & Scharenborg, 2010; Cutler et al., 2008; Mayo et al., 1997; Van Wijngaarden et al., 2002; VanDommelen & Hazan, 2010). These differences have been ascribed to various reasons. Cutler et al. (2008) reported that although masking affected native and non-native speakers equivalently, native speakers recover from such disadvantage using even subtle low-level cues offered by the context. They concluded that native speakers effectively used low-predictability cues provided by the constant vocalic context and constant duration of the leading noise.

Likewise, Rogers et al. (2006) attributed other reasons for the difference between native and non-native performance in the presence of noise. They opined that in bilinguals there would have been an increased demand for attentional resources or increased processing demand due to the need to deactivate the non-active language. Such a demand would not have been required in monolinguals. Earlier studies have also noted that bilinguals require to select a target phoneme from among a larger number of alternatives that are more densely distributed in a common phonological space ; or they require to match the native speaker productions to a perceptual category that may be intermediate between the norms for the two languages (Flege, 1987, 1995).

In the current study, a significant difference between the phoneme scores for the two groups was observed. Previously, Geethakumary (2002) has reported that Malayalam language contains more voiced speech sounds compared to Kannada. Therefore, the differences could be accounted to the phonemic contrasts existing in Kannada and Malayalam languages.

Therefore, the current study is in consonance with previous literature that reports significant difference in speech perception in noise scores between native and non-native language speakers. Thus, it is recommended that when a speech in noise test is administered on non-native speakers of a language, who may be familiar and fluent in the language, the normative values utilized for native speakers should not be used. This could lead to erroneously diagnosing individuals as having an auditory separation problem, despite no such problem existing.

5.3 Correlation between the SPIN-K scores and language proficiency

The ongoing study revealed a significant weak correlation between the total SPIN-K word scores and 'Modified Language Proficiency Questionnaire' scores. Further, there was no significant correlation between the total SPIN-K phoneme scores and the 'Modified Language Proficiency Questionnaire' scores. Observation of the raw data indicated that the non-native Kannada speakers who were native Malayalam speakers had scores similar to the native Kannada speakers in the 'Modified Language Proficiency Questionnaire'. This indicated that the native Malayalam speakers were proficient in Kannada. This probably occurred as Malayalam being a regional language; it was not spoken by local Kannada speakers in Karnataka. Thereby, this forced the Malayalam speakers to learn Kannada. Probably, had the native language of the non-native speakers been a national language such as Hindi, which is known to several individuals in Karnataka, they would not have made the same effort to learn the local language. The high proficiency in the Modified Language Proficiency Questionnaire scores could also be attributed to similarities between the Kannada and Malayalam as both are Dravidian languages. However, despite being proficient in Kannada, the speech perception in the presence of noise of the participants in the current study was not on par with the native Kannada speakers. Thus, it can be construed that, while the native Malayalam speakers may have proficiency in the syntax and semantics of Kannada, they may not have had the same level of proficiency in at the phonological level. This could have led to the poor correlation between the SPIN-K scores (word & phoneme) and the Modified Language Proficiency Questionnaire scores. Therefore, despite having good word proficiency in Kannada language, the non-native Kannada speakers with Malayalam as their native language, tend to perform poor with respect to phoneme identification in the presence of noise.

From the findings of the study, it can be concluded that, non-native Kannada speakers performed poorer than the native Kannada speakers in the presence of background noise, irrespective of the age of acquisition and proficiency of the non-native language. Therefore, in clinical settings, speech perception in the presence of noise should be tested in the native language of an individual. Failure to do so might result in the misdiagnosis of individuals as having an auditory separation problem.

Chapter 6

SUMMARY AND CONCLUSIONS

Speech perception in the presence of background noise is reported to be challenging in all individuals including normal hearing individuals. Native speakers of a language have been found to perceive speech better than non-native speakers in the presence of noise (Broersma & Scharenborg, 2010; Cooke et al., 2008; Cutler et al., 2008; Mayo et al., 1997). Native speakers of a language have been found to take advantage of the contextual cues (Bradlow & Alexander, 2007), sparseness and redundancies based on spectrotemporal glimpses (Cooke, 2006).

As Karnataka has a large population of Malayalam speakers who are familiar with Kannada, these individuals are often tested using the speech-in-noise test in Kannada (SPIN-K), if required. As Malayalam is known to utilise a larger number of voiced speech sounds compared to Kannada (Geethakumary, 2002), it is possible that native Malayalam speakers are likely to be influenced by their native language when listening to Kannada. Hence, it needs to be studied whether the norms available for native Kannada speakers on SPIN-K can be utilised when evaluating non-native Kannada speakers having Malayalam as their native language.

The present study aimed at comparing the difference in performance on SPIN-K of native Kannada speakers with non-native Kannada speakers having Malayalam as their native language. A total of 70 normal hearing participants, aged between 18 to 40 years, were recruited for the study. Among the participants, 40 were native speakers of Kannada language and 30 were non-native speakers of Kannada who had Malayalam as their native language. All the participants were tested using Speech-Perception-in-Noise test in Kannada (SPIN-K) developed by Vaidyanath and Yathiraj

(2012). The language proficiency of the participants was checked using the 'Modified language proficiency questionnaire', and the usage of Kannada was assessed using the 'Linguistic profile test' (Karanth, 1980).

As the data was not normally distributed, non-parametric statistical tests were administered to carry out the within group and between group comparisons. The results of the present study revealed that:

- There was no significant difference across the four SPIN-K lists for words scores in the native and non-native Kannada speakers.
- There was a significant difference across the four SPIN-K lists for phoneme scores in the native and non-native Kannada speakers.
- There was a significant difference between the native and non-native Kannada speakers for both word and phoneme scores.
- There was a significant weak correlation between the total SPIN-K word scores and Modified Language Proficiency Questionnaire scores.
- There was no significant correlation between the total SPIN-K phoneme scores and Modified Language Proficiency Questionnaire scores.

From the results of the present study, it can be inferred that:

- The four word-lists of SPIN-K test can be utilized interchangeably.
- Non-native Kannada speakers performed poorer than the native Kannada speakers in the presence of background noise, irrespective of the age of acquisition and proficiency of the non-native language.
- The SPIN-K norms developed for the native Kannada speakers cannot be used for non-native Kannada speakers who have Malayalam as their native language, when SPIN-K is administered on them.

Implications

- From the present study, it is clear that there are differences between the performance of native and non-native language in the presence of noise. Therefore, in clinical settings, speech perception in the presence of noise should be tested in the native language of an individual. However, in the absence of a native version of the test, the non-native version can be used, but the normative data of native speakers should not be considered for the diagnosis of an auditory separation problem.
- The current study indicates that noise masks speech sounds differently in native and non-native speakers. This impacts the equivalence of a speech-in-noise test, especially when phoneme scores are calculated.
- The study indicates that despite non-native Dravidian speakers being proficient speakers of Kannada, they still do not perform similar to native Kannada speakers.

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APPENDIX 1a

MODIFIED LANGUAGE PROFICIENCY QUESTIONNAIRE

Developed by Yathiraj A., Jain S.N., and Amruthavarshini B. (2018)

Name: Age:

Gender: Male / Female

Instructions: Please read the below given information carefully and choose the most appropriate choice. Respond to all eight points by either filling in blanks or ticking (✓) the most appropriate response. (***Note:*** L1 refers to the first language that you learnt; L2 refers to the second language that you learnt; L3 refers to the third language that you learnt)

****

1. Name all the languages you have learnt since your childhood in the order of acquisition of the language.

Order of Languages acquired	Language Name
L1	
L2	
L3	

2. Since when have you been using your L1, L2 and L3 for understanding, speaking, reading and writing? *(**Note**. Please tick (✓) one duration per language for understanding, speaking, reading, & writing)*

Duration in years	Understanding			Speaking			Reading			Writing		
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**
Less than 5 years												
5 to 10 years												
10.1 to 15 years												
Greater than 15 years												

3. How would you mark your level of proficiency for understanding, speaking, reading, and writing? *(**Note**. Please tick (✓) one level proficiency per language for understanding, speaking, reading, & writing)*

Level of Proficiency	**Understanding**			**Speaking**			**Reading**			**Writing**		
	L1	**L2**	**L3**	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**
Low proficiency												
Fair proficiency												
Good proficiency												
Native like/perfect proficiency												

4. How would you rate your ability to switch between the languages? *(**Note**. Please tick (✓) one of the ratings)*

Rating Scale	**Response (✓)**
Low Ability	
Fair Ability	
Good Ability	
Perfect Ability	

5. Please tick (✓) which language you use maximum for the below mentioned situations: *(**Note**. Please tick (✓) one language per situation)*

Sl. No.	**Situations**	**L1**	**L2**	**L3**
a	Interaction with family			
b	Education/ work			
c	Listening to instruction tapes at school			
d	Text books			
e	Dictionary			
f	Story books			
g	Newspapers			
h	Internet source			
i	Writing			
j	Interacting with friends			
k	Interacting with neighbours			
l	Watching TV/ YouTube			
m	Listening to the radio (music)			
n	Market places			

6. On a scale of one to four, how often do you use the languages known to you in the following situations? *(Rating key: 1 = never; 2 = Sometimes; 3 = Most of the time; 4 = Always;* ***Note****. Please write the numbers 1, 2, 3, or 4, for each situation per language).*

Sl. No.	Situations	L1	L2	L3
A	Interaction with family			
B	Schooling/ work			
C	Listening to instruction tapes at school			
D	Text books			
E	Dictionary			
F	Story books			
G	Newspapers			
H	Internet source			
I	Writing			
J	Interacting with friends			
K	Interacting with neighbours			
L	Watching television/ YouTube			
M	Listening to the radio (music)			
N	Market places			

7. How frequently do others identify you as a native speaker based on your accent or pronunciation in the language? *(****Note.*** *Please tick (✓) one rating per language)*

Rating Scale	L1	L2	L3
Never			
Sometimes			
Most of the time			
Always			

8. For how many hours do you use the following languages? *(****Note****. Please tick (✓) one duration per language)*

Duration	L1	L2	L3
Greater than 2 hours			
Greater than 3 hours			
Greater than 4 hours			
Greater than 5 hours			

Note: Refer Scoring key for analysis

APPENDIX 1b

SCORING KEY

MODIFIED LANGUAGE PROFICIENCY QUESTIONNAIRE

Developed by Yathiraj A., Jain S.N., and Amruthavarshini B. (2018)

Instructions to professional scoring the scale: Please score the responses on a scale of 1 to 4 for each skill / question as directed.

****

1. Name all the languages you have learnt since your childhood in the order of acquisition of the languages.
   No score *(Information to be used for descriptive analysis)*

2. Since when have you been using your L1, L2 and L3 for understanding, speaking, reading and writing?

Duration (in years)	Scores	Understanding			Speaking			Reading			Writing		
		L1	L2	L3	L1	L2	L3	L1	L2	L3	L1	L2	L3
Less than 5 yrs	1												
5 to 10 yrs	2												
10.1 to 15 yrs	3												
Greater 15 yrs	4												
Total Scores		L1 = /16				L2 = /16				L3 = /16			

3. How would you mark your level of proficiency for understanding, speaking, reading, and writing?

Level of Proficiency	Scores	Understanding			Speaking			Reading			Writing		
		L1	L2	L3	L1	L2	L3	L1	L2	L3	L1	L2	L3
Low proficiency	1												
Fair proficiency	2												
Good proficiency	3												
Native like/perfect proficiency	4												
Total Scores		L1 = /16				L2 = /16				L3 = /16			

4. How would you rate your ability to switch between the languages?

Rating Scale	Scores	Response		
Low Ability	**1**			
Fair Ability	**2**			
Good Ability	**3**			
Perfect Ability	**4**			
Total Scores		**L1 = /4**	**L2 = /4**	**L3 = /4**

5. Tick (✓) which language you use maximum for the following situations:
No score *(Information to be used for descriptive analysis)*

6. On a scale of one to four, how often do you use the languages known to you in the following situations? *(**Instruction to professional scoring the scale**: Total the ratings given per language).*

Sl. No.	Situations	L1	L2	L3
a	Interaction with family			
b	Schooling/ work			
c	Listening to instruction tapes at school			
d	Text books			
e	Dictionary			
f	Story books			
g	Newspapers			
h	Internet source			
i	Writing			
j	Interacting with friends			
k	Interacting with neighbors			
l	Watching television/ YouTube			
m	Listening to the radio (music)			
n	Market places			
Total Score		**/56**	**/56**	**/56**

7. How frequently others identify you as a native speaker based on your accent or pronunciation in the language?

Rating Scale	Scores	L1	L2	L3
Never	**1**			
Sometimes	**2**			
Most of the time	**3**			
Always	**4**			
Total Score		**/4**	**/4**	**/4**

8. For how many hours do you use the following languages?

Duration	Scores	L1	L2	L3
Greater than 2 hours	**1**			
Greater than 3 hours	**2**			
Greater than 4 hours	**3**			
Greater than 5 hours	**4**			
Total Score		**/4**	**/4**	**/4**

L1	**/100**
L2	**/100**
L3	**/100**