# Effect of Bilingualism on Speech in Noise Perception in Young Adults

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**Structured Abstract**

**Introduction:** Although speech is typically well understood under quiet conditions and low task demands, many environmental factors such as noise and reverberation negatively affect speech understanding (Crandell & Smaldino, 2000; Nabelek & Mason, 1981).

These factors are present to some degree in the listening environments encountered in everyday life and it masks the speech signal by obscuring the less intense portions of the signal, resulting in a reduction in the redundancy of acoustic and linguistic cues in speech (Helfer & Wilbur, 1990). This effect increases as the signal to noise ratio (SNR) decreases (Miller, Heise, & Lichten, 1951). In addition, other factors, including cognitive demand (Luce, Feustel, & Pisoni, 1983), and listener- or speaker-related variables such as language background may also affect speech understanding even in quiet, and can combine with environmental factors to further degrade the speech understanding (Helfer & Huntley, 1991; Nabelek, 1988; Newman & Hochberg, 1983; Takata & Nabelek, 1990).

There is strong evidence that bilinguals have a deficit in speech perception for their second language compared with monolingual speakers under unfavourable listening conditions, despite performing similarly to monolingual speakers under quiet conditions. This deficit persists for speakers highly proficient in their second language and is greater in those who learned the language later in life. Bilingual (BL) listeners typically achieve a similar level of recognition of their second language (L2) in quiet relative to monolingual (ML) listeners. Under degraded listening conditions, both BL and ML listeners' speech recognition deteriorates. However, when perceiving L2 stimuli, BLs are disproportionately more affected by noise compared to MLs of that language (Cooke, Garcia Lecumberri, & Barker, 2008; Garcia Lecumberri & Cooke, 2006; Kang, 1998).

**Need for the Study:** Most of the studies which have considered the language variables affecting speech in noise perception have considered bilingual language acquisition. In addition, only few studies of speech perception by bilingual listeners have carefully controlled for second language proficiency and even fewer have presented speech in everyday listening environments that contain noise and reverberation. Furthermore, only limited numbers of studies have considered the effects of variables pertaining to language background on the perception of speech in noise in adults especially in Indian languages.

**Aim and Objectives:** The purpose of this study was to assess the effect of language proficiency in bilinguals on speech perception in noise in varying signal-to- noise ratio (SNRs).

**Method:** A total of 20 normal hearing Kannada- English bilinguals between age ranges of 18 to 25 years participated in the present study. The subjects were divided into two groups based on their language proficiency according to international second language proficiency rating scale (Wylie, 2006). Group 1consisted 10 bilinguals who achieved a score of 1 (Basic transactional proficiency) and Group 2 consisted of 10 bilinguals with a score of 4 (Vocational proficiency). Participants had normal hearing sensitivity defined by pure-tone thresholds of 20 dBHL or better at octave frequencies from 250 Hz through 8000 Hz in both the ears and none of the participants had any difficulty in speech recognition in quiet.

Speech perception ability in noise was assessed using Speech-in-Noise Test (SPIN) administered at 4 different SNRs. The stimuli used for SPIN test included 35words in which 7 words were practice items in both Kannada and English respectively. The words were selected based on high frequency occurrence and familiarity rating by 5 Kannada-English speakers. These words were digitally recorded in a sound treated room on to a DELL Inspiron N4010 laptop via a Logitech MPW 21 microphone and using the PRAAT software at a sampling frequency of 44100 Hz. Four-talker babble was used to generate words with 4 different SNRs using Mat lab software 7.10 version, which yielded a total of 4wordlists each with 7words.

The first list had a SNR of +5dB and the second, third and fourth list had SNR of 0dB, -10dB, -20dB respectively. The test was carried out in a sound treated room suite with ambient noise levels within permissible limits (re: ANSI, 1991, as cited in Wilber, 1994). The SPIN test was administered binaurally via TDH 39 headphones in pseudo random order using GSI-61 Audiometer, and DELL Inspiron N4010 laptop. The presentation level was set to MCL.

The listeners were instructed to listen to the words carefully and repeat the words they perceived. Prior to actual testing, the listener was familiarized with the task and stimuli by making them listen to several trials passively. The test was administered in both languages for both the groups. Each correctly repeated word was awarded one point for a total possible score of 28 points. The percentage of correctly repeated words was calculated for each list.

The obtained data was subjected to descriptive statistics to obtain the mean and standard deviation and inferential statistics to obtain the significance levels.

**Results and Discussion:** The mean recognition scores for group 1in kannada SPIN test at SNR5, SNR0, SNR-10 and SNR-20 were100%,95,71%,95.71%and54.28% respectively. For group 2 at SNR 5, SNR 0, SNR -10 it achieved a score of 100% and for SNR -20 it was 54.92%.In contrast for English SPIN test both groups achieved mean recognition score of 100% at SNR5, 0, and -10.At SNR -20 reduction in scores were seen for both the groups (Group 1-74.28% and Group 2 -77.78%) Thus, maximum recognition scores were obtained at SNR 5 and minimum scores obtained at SNR-20 in both the groups for both English and Kannada. In other words, the recognition scores reduce with reduction in the SNR.

The result of the present study is well in accordance with previously reported literature, which has demonstrated that speech recognition scores decreases as the SNR decreases (Miller, Heise, & Lichten, 1951). To estimate the statistical significance among the two groups, Independent samples'' test was carried out and mean scores were compared between and within the groups across different SNRs. The results revealed that there was no statistically significant difference between the groups for both Kannada and English SPIN test at all the SNRs (SNR 0 (t=0.081>0.05), SNR -10 (t=0.081>0.05), SNR-20 (t=0.962>0.05) for Kannada and SNR -20 (t=0.663>0.05) for English). The results also indicated that there were no differences in the recognition scores within the groups for SNR -20 for both Kannada and English SPIN tests though, both groups performed poorer in Kannada SPIN TEST. Hence the findings revealed that both the groups performed better in their second language compared to the first language, these results are in contradiction to the previous findings (Cooke, Garcia Lecumberri, & Barker, 2008).

**Summary and Conclusion:** The results of the present study did not reveal any observable differences for speech in noise perception between two groups of bilinguals. These findings are not in consonance with the previous findings which report degraded speech in noise perception in bilinguals compared to monolinguals. These differences in the findings can be attributed to differences in the type of bilingual group, type of the stimuli and different language combinations considered in the study compared to previous studies. This cautions further research in the particular domain using different types of speech stimuli and language combinations to find the speech in noise perception skills in bilinguals.

## Introduction

Speech perception involves the mapping of speech acoustic signals on to linguistic messages (e.g., phonemes, distinctive features, syllables, words, phrases etc). Although speech is typically well understood under quiet conditions and low task demands, many environmental factors such as noise and reverberation negatively affect speech understanding (Crandell & Smaldino, 2000; Nabelek & Mason, 1981). Both noise and reverberation are present to some degree in the listening environments encountered in everyday life (Helfer & Wilbur, 1990).

Reverberation refers to the persistence of a sound in an enclosed environment. It is measured in reverberation time (RT), the time required for a sound pressure wave of a specific frequency to decay by 60 dB after the signal ceases. Speech perception tends to deteriorate as RT increases (e.g., Moncur & Dirks, 1967; Steinberg, 1929). When noise is present in an acoustic environment, it masks the speech signal by obscuring the less intense portions of the signal (Helfer & Wilbur, 1990).

The result is a reduction in the redundancy of acoustic and linguistic cues in speech, an effect that increases as the signal to noise ratio (SNR) decreases. That is, performance on speech-perception tasks tends to deteriorate as the SNR decreases (e.g., Miller,Heise, & Lichten, 1951).

Although both noise and reverberation can degrade a speech signal in isolation, these distortions often occur simultaneously and, together, are more detrimental than the sum of the component distortions (Nabelek, 1988) Hochberg, 1983; Takata & Nabelek, 1990).The documentation of language background variables is of particular importance; these variables may include language history (age of onset of acquisition), percentage of language use for both languages, language competency in both languages, language stability (the extent to which proficiency is changing) for both languages, and contexts of language use in both languages (Grosjean, 1997;). van Hapsburg & Pena, 2002

Language factors that could account for the decreased speech- recognition performance of bilingual listeners in their second language have been suggested (Flege, 1995; Mayo et al., 1997). Reasons for these performance decrements has been attributed to a number of factors, including degree of exposure to the language, age of second-language acquisition and adversity of the listening environment. For example, Florentine (1985b) found that while non-native listeners' ability to understand English speech in noise improved as their exposure to the language increased, only two non-native listeners with exposure to English since infancy performed like native listeners, when assessed with the Speech Perception in Noise (SPIN) test (Bilger et al. 1984, Kalikow et al. 1977).

These findings are suggestive of the existence of other factors that could account for reduced speech-in-noise performance in bilinguals, such as the complexities involved in the management of two languages. In the bilingual speech recognition process, phonological input is believed to spread activation to phonologically-similar lexical candidates of both the target language and the non-target language. This cross-language activation then generates cross-language competition, which is thought to cause a slowing of their cognition process (Colomé, 2001).

There is strong evidence that bilinguals have a deficit in speech perception for their second language compared with monolingual speakers under unfavourable listening conditions, despite performing similarly to monolingual speakers under quiet conditions. This deficit persists for speakers highly proficient in their second language and is greater in those who learned the language later in life. Bilingual (BL) listeners typically achieve a similar level of recognition of their second language (L2) in quiet relative to monolingual (ML) listeners.

Under degraded listening conditions, both BL and ML listeners' speech recognition deteriorates. However, when perceiving L2 stimuli, BLs are disproportionately more affected by noise compared to MLs of that language (Cooke, Garcia Lecumberri, & Barker, 2008; Garcia Lecumberri & Cooke, 2006; Kang, 1998).

**Need for the Study**

From the above literature, it is clear that the language background has an effect on speech in noise perception. Most of the studies which have considered the language variables affecting speech in noise perception have considered bilingual language acquisition. In addition, only few studies of speech perception by bilingual listeners have carefully controlled for second language proficiency and even fewer have presented speech in everyday listening environments that contain noise and reverberation. Furthermore, only limited numbers of studies have considered the effects of variables pertaining to language background on the perception of speech in noise in adults especially in Indian languages.

**Aim of the study**

The purpose of this study was to assess the effect of language proficiency in bilinguals on speech perception in noise in varying signal-to- noise ratio (SNRs).

**Method**

A total of 20 normal hearing Kannada-English bilinguals between age ranges of 18 to 25 years participated in the present study. The subjects were divided into two groups based on their language proficiency according to international second language proficiency rating scale (Wylie, 2006). Group 1consisted 10 bilinguals who achieved a score of 1 (Basic transactional proficiency) and Group 2 consisted of 10 bilinguals with a score of 4 (Vocational proficiency).

Participants had normal hearing sensitivity defined by pure-tone thresholds of 20 dBHL or better at octave frequencies from 250 Hz through 8000 Hz in both the ears and none of the participants had any difficulty in speech recognition in quiet. Speech perception ability in noise was assessed using Speech-in-Noise Test (SPIN) administered at 4 different SNRs. The stimuli used for SPIN test included 35words in which 7 words were practice items in both Kannada and English respectively.

The words were selected based on high frequency occurrence and familiarity rating by 5 Kannada-English speakers. These words were digitally recorded in a sound treated room on to a DELL Inspiron N4010 laptop via a Logitech MPW 21 microphone and using the PRAAT software at a sampling frequency of 44100 Hz. Four-talker babble was used to generate words with 4 different SNRs using Mat lab software 7.10 version, which yielded a total of 4 wordlists each with 7words. The first list had a SNR of +5dB and the second, third and fourth list had SNR of 0dB, -10dB, -20dB respectively.

The test was carried out in a sound treated room suite with ambient noise levels within permissible limits (re: ANSI, 1991, as cited in Wilber, 1994). The SPIN test was administered binaurally via TDH 39 headphones in pseudo random order using GSI-61 Audiometer, and DELL Inspiron N4010 laptop. The presentation level was set to MCL. The listeners were instructed to listen to the words carefully and repeat the words they perceived. Prior to actual testing, the listener was familiarized with the task and stimuli by making them listen to several trials passively. The test was administered in both languages for both the groups.
Each correctly repeated word was awarded one point for a total possible score of 28 points. The percentage of correctly repeated words was calculated for each list. The obtained data was subjected to descriptive statistics to obtain the mean and standard deviation and inferential statistics to obtain the significance levels.

**Results and discussion**

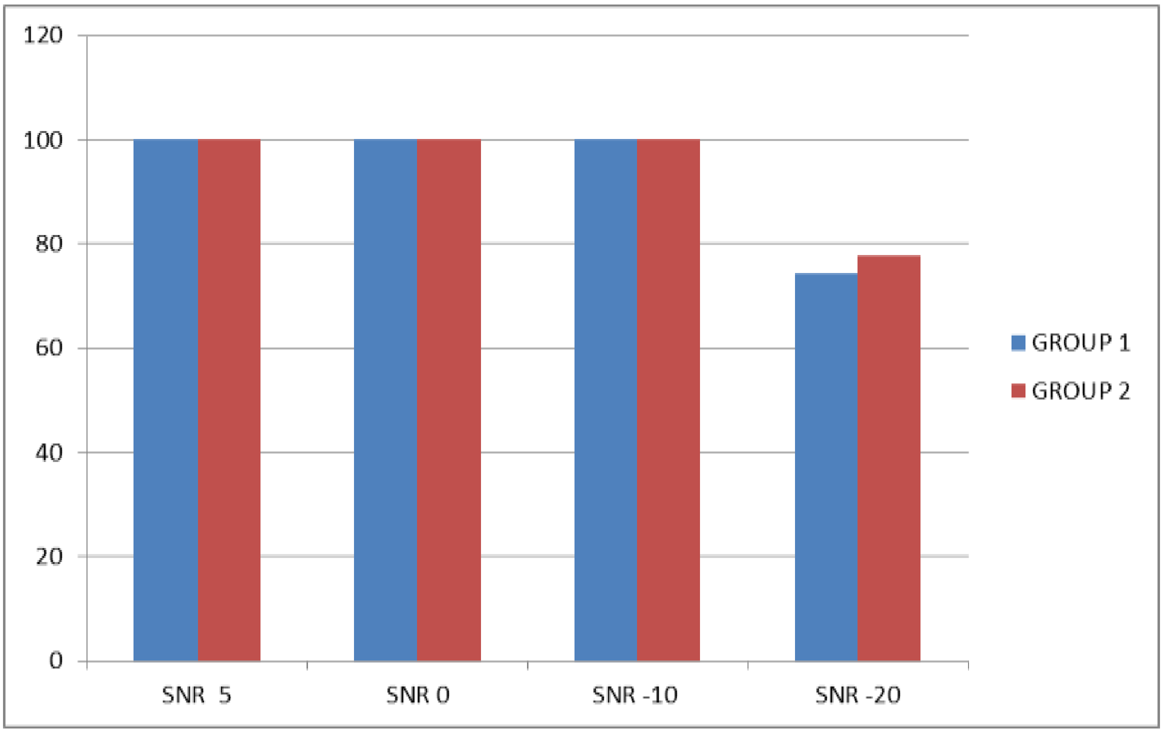
The task performed in both Kannada and English SPIN test at different SNR's by the two different levels of bilinguals (ie. group 1 and group 2) were subjected to statistical analysis. The mean recognition scores are shown in table 1. In Kannada SPIN test Group 1 achieved a score of 100%, 95.71%, 95.71% and 54.28% at SNR5, SNR0, SNR-10, and SNR -20 respectively. Whereas for group 2 at SNR 5, SNR 0, and SNR 10 it achieved a score of 100% and for SNR -20 it was 54.92%.

In contrast, for English SPIN test both groups achieved mean recognition score of 100% at SNR5, 0, and -10. At SNR -20 reduction in scores were seen for both the groups that is (Group 1-74.28% and Group 2 -77.78%) Thus, maximum recognition scores were obtained at SNR 5 and minimum scores obtained at SNR-20 in both the groups for both English and Kannada.

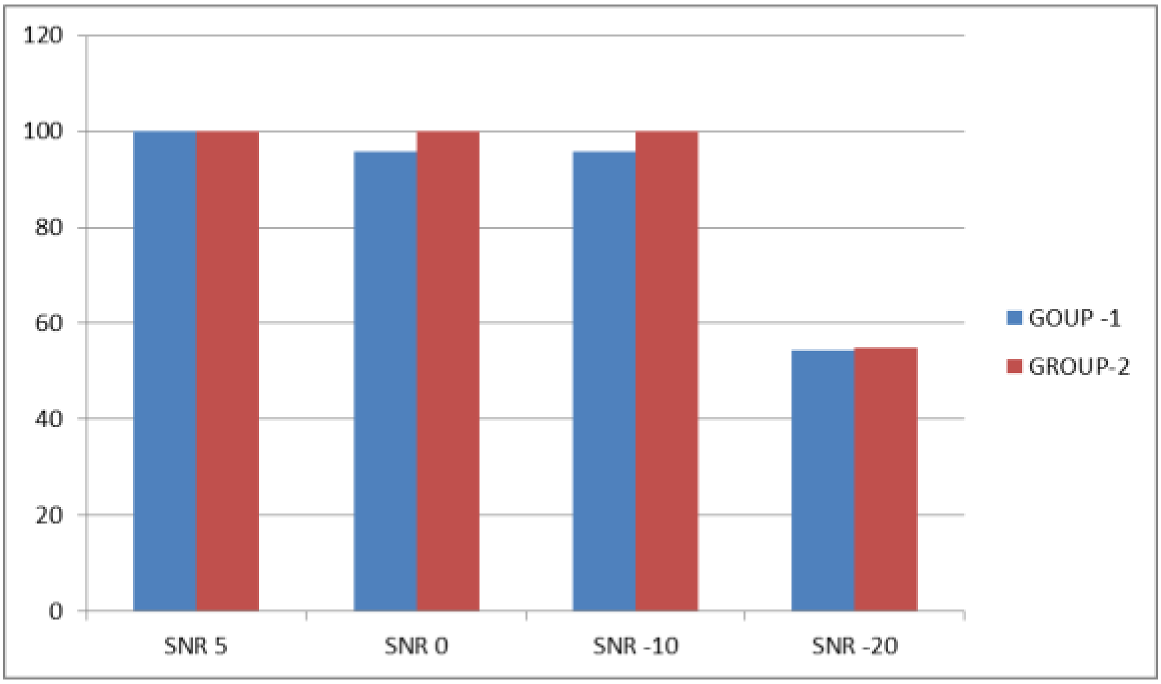
**Table: 1** Mean recognition scores of group 1 and 2 in both Kannada and English SPIN test.

| | SNR 5 | SNR 0 | SNR -10 | SNR-20 |
|---|---|---|---|---|
| Kan Group-1 | 100 | 95.71 | 95.71 | 54.28 |
| Group2 | 100 | 100 | 100 | 54.92 |
| Eng Group1 | 100 | 100 | 100 | 74.28 |
| Group 2 | 100 | 100 | 100 | 77.78 |

**Graph: 1** Mean recognition scores at different SNR's in Kannada SPIN test.

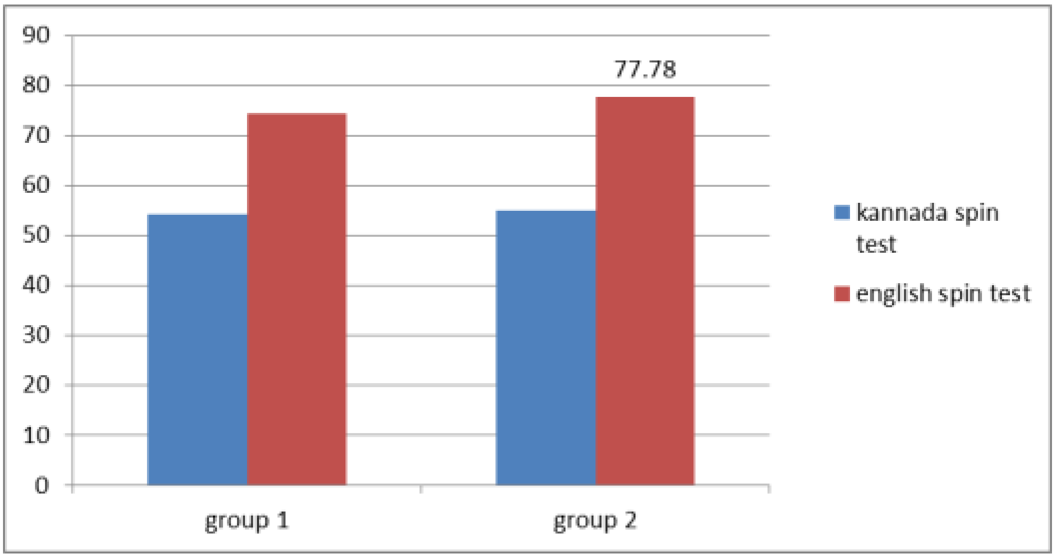


**Graph: 2** Mean recognition scores at different SNR's in English SPIN test.




As it can be evidenced from Graph 1 and 2 maximum recognition scores were obtained at SNR 5 and minimum scores obtained at SNR-20 in both the groups for both English and Kannada SPIN test. In other words the recognition scores reduce with reduction in the SNR. The result of the present study is well in accordance with previously reported literature, which has demonstrated that speech recognition scores decreases as the SNR decreases (Miller, Heise, & Lichten, 1951).

**Graph: 3** The Mean scores at SNR-20 in both Kannada and English SPIN test.




As the above graph 3 depicts there is a decreased mean recognition scores at SNR-20 and also significant difference in mean recognition scores in the groups for both Kannada and English SPIN test.

To estimate the statistical significance among the two groups, Independent samples 't' test was carried out and means scores were compared between and within the groups across different SNRs. The results revealed that there was no statistically significant difference between the groups for both Kannada and English SPIN test at all the SNRs(SNR 0(t=0.081>0.05),SNR -10 (t=0.081>0.05), SNR -20 (t=0.962>0.05) for Kannada and SNR -20 (t=0.663>0.05) for English, as depicted in table 2 and 3.

**Table: 2** Results of't' test for Kannada SPIN test.

| | SNR0 | SNR-10 | SNR-20 |
|---|---|---|---|
| 't' | -1.858 | -1.858 | -.050 |
| df | 17 | 17 | 17 |
| significance | 0.81 | 0.81 | 0.96 |

**Table: 3** Results of 't' test for English SPIN test.

| | SNR -20 |
|---|---|
| 't' | -0.433 |

| | |
|---|---|
| df | 17 |
| significance | 0.670 |

As it can be evidenced from table 1, the mean recognition scores were 100% at SNR 5 in Kannada, similarly at SNR 5, 0, and -10 for English SPIN test. Hence the significance could not be assessed.

The results also indicated that there were no differences in the recognition scores within the groups for SNR -20 for both Kannada and English SPIN tests though, both groups performed poorer in Kannada SPIN TEST. Hence the findings revealed that both the groups performed better in their second language compared to the first language, these results are in contradiction to the previous findings (Cooke, Garcia Lecumberri, & Barker, 2008).

**Summary and conclusion**

The results of the present study did not reveal any observable differences for speech in noise perception between two groups of bilinguals. These findings are not in consonance with the previous findings which report degraded speech in noise perception in bilinguals compared to monolinguals. These differences in the findings can be attributed to differences in the type of bilingual group, type of the stimuli and different language combinations considered in the study compared to previous studies. This cautions further research in the particular domain using different types of speech stimuli and language combinations to find the speech in noise perception skills in bilinguals.

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