EFFECT OF MULTITALKER BABBLE OF DIFFERENT LANGUAGES ON THE SPEECH RECOGNITION SCORES IN KANNADA

(REGISTER NO. 02SH0002)

An independent project submitted in part fulfillment of the
First year M.Sc, (Speech and Hearing),
University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MANASAGANGOTHRI, MYSORE - 570006

May 2003

Dedicated to

The LORD Almighty

&

My Beloved Family

CERTIFICATE

This is to certify that the independent project entitled *"'Effect of multitalker babble of different languages on the speech recognition scores in kannada"* is the bonafide work done in part fulfillment of the degree of Master of Science (Speech and Hearing) of the student (Register No. 02SH0002).

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CERTIFICATE

This is to certify that the Independent project entitled *"Effect of Multitalker babble of different languages on the Speech Recognition Scores in Kannada"* has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

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DECLARATION

I hereby declare that this independent project entitled *"Effect of Multitalker babble of different languages on the Speech Recognition Scores in Kannada"* is the result of my own study under the guidance of Manjula P., Lecturer in audiology, Department of Audiology, All Institute of Speech and Hearing, Mysore, and has not been submitted earlier or in any other University for the award of any Diploma or Degree.

Mysore

May 2003 Register No. 02SH0002

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INTRODUCTION

Of special senses in human beings, hearing is primary for verbal communication. A direct measure of the hearing / auditory acuity is done by pure tone audiometry. But, hearing of pure tones constitutes a very small and insignificant part of the ordinary auditory experiences of most individuals. Its measurement is too limited to describe the individuals' ability to understand the speech of his fellow communicators (Hirsh, 1965).

Perception of speech is the ability of the listener to perceive the acoustic waveform produced by a speaker as a string of meaningful words and ideas and attend to it (Goldinger, Pisoni & Luce, 1996). The various factors affecting speech perception are reverberation (Bolt & Mc Donald, 1949; Moncur & Dirks, 1967; Nabelek & Pickett, 1974), type of speech material including, digits, words, words in sentence, non-sense syllables (Miller, Heise & Lichten, 1951), known and unknown message sets as well as size of the message set and number of response alternatives (Miller, et al., 1951; Pollack, 1959), noise (frequency of noise and type of noise), distance, intensity of speech stimuli, S/N ratio, context, interaural difference, spectrum of noise and speech stimuli, temporal characteristics of noise and hearing ability of an individual.

One of the major factors degrading speech perception is noise. The masking effect varies with the acoustic and semantic characteristic of the masker, i.e., the masking of a particular stimulus by noise is dependent on the intensity, spectrum, presence and duration of acoustic windows and the meaningfulness of the competing noise (Dillon, 1983, Duquensnoy, 1983; Kalikow, Stevens & Elliot, 1977).

Various types of noises include non-speech noise and speech noise. Narrow Band Noise, Broad Band Noise, Pink Noise and Speech Spectrum Noise are examples of non-speech noise. Cafeteria Noise, Multitalker babble, Cocktail party noise and Continuous discourse are examples of speech noise. Speech spectrum noise and multitalker babble are more often encountered in the everyday situations.

Speech-Spectrum noise or Speech noise is the white noise filtered to a low and mid-frequency band, simulating the long-term average spectrum (LTAS) of conversational speech. Because of its more limited band, speech-spectrum noise is some-what more efficient than white noise, with a masking advantage of about 8 dB (Konkle & Berry, 1983).

Multitalker babble is a type of additive noise, which is produced, by a group of people talking simultaneously and none of the messages are understandable to the listener and it is most common noise environment that listeners encounter in everyday life. This multitalker babble creates a difficult listening environment because it is (a) Speech spectrum shape (b) Minimally amplitude modulated and (c) Aperiodic (Sanders & Hall, 1999). A multitalker noise appears to have reasonable face validity, although there is no convincing evidence that this stimulus is more or less appropriate than other complex stimuli such as cafeteria noise, industrial street noise or speech noise.

Plomp (1986) commented that, because the noise radiated from equipment, vehicles and so forth could be reduced by acoustical treatment, the voices of people suiTounding the listener can be considered as the most prevalent "noise" that has to be accepted as it is.

Everyday listening situations require the extraction of information from speech that is masked by one or more simultaneous competing talkers. Moreover, speech from a single speaker and voice babble are the most frequent disturbing sounds in everyday listening situations. And it is most frequently used competing noise, in various test environments more recently.

There are various reports about different types of noise affecting speech to different extent [Carhart, Tillman, & Greetis, 1969; Cooper & Cutts, 1971; Lockwood & Boudy, 1992; Olsen, Jabaley, & Pappas, 1966; Speaks, Karmen & Benitez 1967]. Several authors recommend measuring speech recognition in the presence of competing noise (Dirks, Morgan & Dubno, 1982; Gatehouse, 1994; Jerger & Hayes, 1976; Moore, Johnson, Clark & Pluvinage 1992; Moore, Lynch & Stone, 1992; Plomp & Mimpen, 1979; Plomp, 1986). Speech in noise measurements have been obtained for a variety of reasons:

1. To make the test more representative of real-life listening (Jerger & Hayes, 1976; Hagerman, 1984; Kalikow etal., 1977,-Plomp, 1986; Schow & Gatehouse, **1996).**
2. To identify the probable site of auditory pathology (Jerger & Jerger, 1975; Hall, 1983; Stecker, 1992; Muller & Bright, 1994).

3. To increase test sensitivity (Beattie, 1989).
4. To assess the effects of medical or non-medical treatment.
5. To ascertain which ear is most suitable for amplification (Hagerman, 1984, Penpord, 1994).
6. To compare hearing aids (Flexer, 1993; Frank & Craig, 1984; Jerger & Hayes, 1976; Moore et al., 1992 ab, Schwartz, SUIT, Montyomey, Prosey & Walden, 1979).
7. To award compensation (Hagerman, 1984).

Although it is generally agreed that speech-in-noise tests can be a useful component of the audiologic evaluation, such tests are not conducted routinely in audiologic clinics (Martin and Sides, 1985). One reason is that, we do not have a good understanding of how speech recognition for a variety of speech material is affected by background competition. Moreover, investigators do not agree on standard procedures or a preferred speech in noise test (Danhauer, Doyle & Lucks 1985; Dirks et al., 1982; Dubno & Dirks, 1982; Jerger & Hayes, 1976; Plomp, 1986). And evidence indicates that word recognition scores are dependent on the particular recording of specific test stimuli and background competition (Frank & Craig, 1984; Martin & Mussell, 1979).

Need for the study

- ✓ In a Multilingual country like India, usually people are exposed to speech of different languages in many situations.

There are a few studies on the effect of multitalker babble on perception of same language and there is a dearth of studies on the effect of multitalker babble of different languages

If the speech performance differs in the presence of speech noise and multitalker babble, then use of multitalker babble for masking in diagnostic evaluation, better reflects the real life performance.

In the view of the foregoing considerations, the present study was designed to know whether the effect of multitalker babble of different languages has similar effect as the multitalker babble of the same language on the perception of that language.

Objectives of the study

To obtain speech recognition scores in quiet, speech noise and multitalker babble (of Kannada, Hindi and Malayalam languages,separately

To study and compare the effect of speech noise and multitalker babble of different languages on the speech recognition scores (SRS) in Kannada

To compare the effect of multitalker babble among different languages (Kannada, Hindi and Malayalam) on speech recognition scores (SRS) in Kannada.

REVIEW OF THE LITERATURE

Perception of speech is the ability of the listener to perceive the acoustic waveform produced by a string of meaningful words and ideas and attend: to it (Goldinger, Pisoni and Luce, 1996). Various factors affect speech perception. These include reverberation (Bolt & Me Donald, 1949; Moncur & Dirks, 1967; Nabelek & Pickett, 1974), type of speech material including, digits, words, words in sentence, non-sense syllables (Miller, Heise & Lichten, 1951), known and unknown message sets as well as size of the message set and number of response alternatives (Miller et al., 1951; Pollack, 1959), noise (frequency of noise and type of noise), distance, intensity of speech stimuli, S/N ratio, context, interaural difference, spectrum of noise and speech stimuli, temporal characteristics of noise and hearing ability of individual.

The masking of speech by speech in real life conditions is of considerable interest since a practical problem encountered in real life conditions is the need to understand a speaker against a background of one or more irrelevant voices. Several authors recommend measuring speech recognition in the presence of background competition (Dirks, Morgan & Dubno, 1982; Jerger & Hayes, 1976; Kalikow, Stevens & Elliot, 1977). Kalikow et al. (1977) stated that the principle effect of competition is to mask some of the sounds in speech, so that listeners have less acoustic information on which to base their interpretation. Moreover, the masking effect varies with the acoustic and semantic characteristics of the masker (Dillon, 1983; Kalikow et al., 1977, Martin & Mussell, 1979). That is, masking of a particular stimulus is dependent on the intensity, spectrum, presence and duration of acoustic windows (gaps), and the meaningfulness of the competitor.

Various types of noises include non-speech noise and speech noise. Narrow Band Noise, Broad Band Noise, Pink Noise and Speech Spectrum Noise are examples of non-speech noise. Cafeteria Noise, Multitalker babble, Cocktail party noise and Continuous discourse are examples of speech noise. Speech spectrum noise and multitalker babble are more often encountered in the everyday situations.

Various studies report that different types of noise affect speech perception to different extent. Lockwood and Boudy (1992) explained that an isolated word recognizer trained on real speech perception gives 100% accuracy with clean speech; this typically dropped to 30% when used in a car traveling at 90 km/hr. Cooper and Cutts (1971) studied the linear portion of articulation function in quiet and in noise (cafeteria noise) at S/N ratios of 4 dB, 8 dB and 12 dB. They found that the articulation function decreased by 3.57%/dB.

Olsen, Jabaley and Pappas (1966) studied the discrimination using high fidelity system and three different hearing aids in quiet and in the presence of speech spectrum noise at 6 dB S/N ratios. They found that in easier listening conditions (at 18 dB S/N ratio and in quiet), the scores closely clustered around 90%. These scores decreased as the level of noise increased. Speaks, Karmen and Benitez (1967) reported that the Performance-Intensity (P-I) function rose approximately from 2 to 6% per dB (%/dB) when the competing message consisted of a passage of continuous discourse recorded by the same talker who recorded the primary message. Carhart, Tillman and Greetis

(1969) said that speech babble interferes with speech intelligibility more than random non-speech noise. Carhait et al. (1969) have reported that there was excess masking in multitalker babble due to added difference with sorting semantic information.

Babble has been found to be a more effective masker of speech (Carhart,et al., 1969; Elliot, Connors, Killie, Levin, Ballik & Katz, 1979; Lewis, Benignus, Muller, Mallot & Barton, 1988). There are various factors determining speech perception in the presence of multitalker babble. They are the following:

(a) Number of talkers in a babble.

(b) Language of the babble.

(c) Speech sounds in a babble.

(d) Head-shadow effect.

(a) Number of talkers in a babble

There are various opinions on the number of talkers in babble for it to be effective. Most of the studies using the multitalker babble suggested that two to four talker babble has maximum effect in masking when compared to other number of talker combinations.

Carhart, Tillman and Greetis (1968) found that a continuous, two-talker masker was more effective than continuous white noise in masking the recognition of spondee words. They reported that the two-talker masker resulted in thresholds that were approximately 5-6 dB higher than for the continuous white noise masker presented at the same level. This extra masking associated with the two-talker masker

, was termed as "perceptual masking". On the other hand, Carhart et al. (1969) found that a single-talker masker resulted in less masking than the noise masker. They suggested that the single-talker masker was relatively ineffective because it possessed abundant temporal "windows" during which the target word could be processed.

Miller (as cited in Dirks & Bower, 1969) measured the intelligibility for Phonetically Balanced (PB) words in a competing message, which consisted of combining from one to eight male and female voices. Once the number of voices reached four, there was relatively little more masking present than when six to eight voices were used. He noted that the intelligibility function obtained in the presence of four or six voices was similar in configuration and masking efficiency to that obtained with wide-band white noise. The masking efficiency decreased when only one voice was used and the steepness of function was flattened.

Carhart, Johnson and Goodman (1975) investigated perception, of normal hearing listeners, of spondees in competition with unmodulated and modulated filtered noise and with speech (various talker combinations). A three-talker competitor resulted in about 10 dB more masking than the other combinations and non-speech competitors. As the number of talke is in the combination was increased beyond three, the masking decreased, the spectrum probably began to resemble a noise masker. However, even when the number of talkers was increased to 32 or more, this type of masker still produced a relatively constant 3.5 dB increase over the other conditions. They attributed this additional masking produced by the speech competitor to a central auditory filter mechanism, which is capable of separating speech stimuli from non-speech maskers, but not the speech target from a speech competitor. They thought that perceptual masking caused the additional threshold shift obtained for the speech competitor and distinguished it from the peripheral masking noted for non-speech competitors.

Miller (as cited in Vasantha, 1976) measured the discrimination ability of normal hearing listeners in the presence of a babble of voices. PB-50 monosyllabic words were used as stimuli. The competing message consisted of two, four, six and eight voices speaking simultaneously. The intelligibility function became much steeper in the transition from one voice to two voices. About 7 dB reduction in masker level was required to maintain a discrimination score. Further, transition to eight voices or to continuous white noise itself produced an increasing masking of only 3 dB and 4 dB respectively. Pollack and Pickett (1958) supported this finding.

Kacena and Nicholis (as cited in Vasantha, 1976) studied performance of subjects on discrimination test for continuous discourse, for amplitude modulated filtered noise and for unmodulated filtered noise, they found that the scores were systematically poorer as the number of speakers, employed to produce the masker increased. This was true up to a point, specially up to three speakers, but further increase in the number of speakers did not result in substantial increase in masking effectiveness of that masker.

Kacena and Nicholis (1974) conducted a study and their results indicated that the ability to discriminate embedded numbers in the presence of competing signal was maximal when the background consisted of only one talker. This was true for both forward and backward masking (competing message was reversed and reproduced in a backward mode in an attempt to eliminate its semantic content and meaning). The subjects scored poorly as the number of talkers used to produce the masker was increased. This was true for the two and three talker conditions. The forward speech masker produced most disruption. Since the forward speech masker and amplitude-modulated noise had the same gross temporal and spectral characteristics, the two maskers should have produced equivalent masking. This was not true, however, when the speech masker contained more than one talker, the forward speech was consistently better than backward speech or any other noise maskers.

(b) Language of the babble

There are studies reporting that the language of the babble does not play any role in masking speech. Miller (as cited in Dirks & Bower, 1969) interspersed laughter or introduced foreign language babble with the competing voices, the intelligibility scores were not significantly altered. The investigator suggested that the crucial factor for intelligibility seemed to be the masking spectrum rather than the linguistic or semantic content of the babble.

Dirks and Bower (1969) studied using eight subjects to determine the effect of semantic content or meaning of a competing speech message on the identification of synthetic sentence material. The competing message was presented in forward mode and reversed and reproduced in a backward mode to eliminate its semantic content or meaning. They found no important difference between the performance-intensity functions in the forward or backward mode. They concluded that the semantic content of the competing message did not contribute to the plateau in the slope of the Performance-Intensity (P-I) function, but the plateau was primarily due to the similarity of the primary and competing messages, which occurred when intensities of both messages, were equal. They conducted another experiment using English and foreign language competing message (Latin) to find out the reduction in scores of Performance- Intensity function. The results indicated that reduction of scores of P-I was same in both languages. Thus, indicated that this reduction in scores was due to combination of equivalent message intensities and similarity in temporal pattern and quantity of both messages rather than its semantic content.

Trammel and Speaks (1970) indicated that when competing message was presented in the forward mode, the listeners were distracted by the content of the message and hence scored poorly. And they also found that by the end of the practice period of competing message, the semantic content or the meaning had ceased to have significant effect on performance.

Brandt and Stewart (as cited in Vasantha, 1976) have also demonstrated that it is the masking spectra, rather than semantics, of the competing message that is important.

Carhart et al. (1969) suggested that part of the masking effect associated with a small number of talkers is related to perceptual processes in which all of the existing speech sounds are first perceptually segregated and then the target spondee is analyzed for its identity. This process was conceptualized as consisting of selective attention to the target spondee and inhibition of the "semantic nuances of the competing signals". This perceptual masking interpretation was supported by data from Sperry, Wiley, and

Chial (as cited in Hall III, Grose, Bus, & Dev, 2002) who found that the masking effectiveness of a six-talker masker was reduced when the masker was time-reversed.

The detrimental effect of competing signal may be expected to be as low as the temporal character and the semantic content of the babble of voices was very much different from that of primary message. Perhaps,no one voice in the babble was intelligible to disrupt the perception of primary message (Vasantha, 1976).

Cahart, Johnson and Goodman (1975) found in their experiment that as the waveform of the multitalker masker becomes increasingly noisy, the semantic content associated with a constituent speaker becomes less available, reducing the potential for perceptual masking.

(c) Speech sounds in a babble

The number of speech sounds presented in a paragraph read by the talker or in a spontaneous conversation in a multitalker babble, whether all the speech sounds of the language are present in a babble and how many times a sound is repeated in a babble has an effect on the effectiveness of the multitalker babble.

Kalikow, Stevens and Elliot (1977) said that the intelligibility of a word in noise depends upon the sequence of sounds that constitute the word. Some classes of sounds are more susceptible to masking by noise than others and consequently words containing these sounds are likely to be less intelligible than words containing sounds that are resistant to masking.

(d) Head shadow effect

This factor has not been widely studied. Bronkhorst and Plomp (1988,1992) indicated that not only that head shadow had a considerable effect on free-field speech intelligibility in noise, but also that the interaural level differences (ILD) caused by head-shadow interference with unmasking through ILD. It is of interest to investigate the effect of cocktail party noise and other types of speech noise using free field.

Effect of multitalker babble and other types of noise

There are studies indicating that multitalker babble affects speech more than the other types of noises. Findlay (1976) showed that when CID W-22 word lists were presented against a background of speech spectrum noise or against the background babble of three male and three female talkers, the separation in the performance of normal and hearing impaired subjects was more distinct for the speech babble competition.

Kalikow et al. (1977) commented that speech babble could produce more masking than a speech noise because the babble produces false speech cues and increases the load on attention and memory processes.

Danhauer and Lepper (1979) studied speech discrimination scores obtained for the California consonant test (CCT) in 4-noise competitors (1) a four-talker complex (FT), (2) a nine-talker complex developed at bowling green state university (BGMTN), (3) cocktail party noise (CPN) and (4) white noise (WN) at 7-different S/N ratios. The results revealed that noise types produced few differences on the CCT scores over most of the S/N ratios tested, but that noise competitor similar to peripheral maskers (CPN and WN) had less effect on the scores at more severe levels than competitors more similar to perceptual maskers (FT and BGMTN). The results may be,due in part,to the difference between peripheral and perceptual masking,noted earlier by Carhart, Johnson and Goodman (1975) or to the differential effects of different maskers on speech stimuli presented in more severe listening conditions,as noted by Horii, House and Hughes (1971).

Holmes, Frank and Stoker (1983) investigated the influence of side-tone feedback on the telephone listening ability of 30 normal-hearing subjects in a background of multitalker (MT) and white noise (WN) presented at 65, 75, and 85 dB SPL in two conditions where the side-tone feedback was present and in three conditions where the side-tone was eliminated. Telephone listening ability significantly decreased as the level of the noise increased for both MT and WN and for all listening conditions. Telephone listening ability was significantly poorer in the background of MT than WN for each noise level and listening condition.

Loven and Hawkins (1983) studied interlist equivalency of the CID W-22 (four word lists) in quiet and in presence of multitalker babble (0 dB S/N ratio). The results indicated that; (1) the lists are equivalent when administered in a quiet; (2) the lists are not equivalent in a background of multitalker babble; (3) the addition of noise changes the relationship among the words lists in a non-predictive manner; and (4) the addition of noise changes the level of difficulty of some words of each list to a greater degree, relative to the other words.

Danhauer, Doyle and Lucks (1985) studied performance of normal hearing listeners in a Non-sense Syllable Test (NST) and Northwestern University list 6 (NU6) meaningful word test under three noise competitors (white noise, multitalker noise and white noise which was amplitude modulated by the multitalker noise) each at a 0 dB S/N ratio. The results indicated that the multitalker noise condition was the least effective competing signal for both tests. The following hierarchy of competitors, from least to most effective, was obtained from the data: (1) multitalker noise, (2) white noise, and (3) amplitude modulated white noise.

Waghray and Panagoda (2000) studied speech discrimination scores using English PB words in the presence of speech noise and multitalker babble in 30 normal adults at 40 dB SL at a S/N ratio of 10 dB. The results indicated that there was no significant difference between the speech noise and multitalker babble.

Thus, the review of literature reveals equivocal findings on the relative effectiveness of multitalker babble (MTB) and speech noise. There are various factors determining the effectiveness of masking, which have to be considered while comparing the results of various studies. There is a dearth of studies on the effect of multitalker babble of different languages. Hence, keeping the Indian context in mind, where the listener is usually exposed to a babble of different language/s, the present study was undertaken. The objective of the present study was to study the relative effectiveness of MTB and speech noise as maskers.

METHOD

The following method was adopted in order to obtain the speech recognition scores in the presence of multitalker babble of different languages (Kannada, Hindi, & Malayalam).

Subject selection

40 participants knowing only Kannada.

Equal number of males and females in age group of 18 to 40 years (further equally divided into 18- 29 years and 30- 40 years).

All the participants had normal hearing (<15 dB HL at audio metric frequencies).

Participants had no significant history of otological / neurological symptoms.

All participants had normal immittance results ('A' type tympanogram and reflexes present on screening).

Material Used

The multitalker babble in Hindi, Kannada and Malayalam languages on a compact disc.

Kannada paired words [developed by Rajasekhar (1976), (cited in Nagaraj, 1990)] for obtaining speech recognition threshold (SRT).

Phonetically Balanced (PB) Kannada word list which consisted of two lists (List A and List B, each containing 50 words), developed by Vandana

(1998) was taken for the study for obtaining speech recognition scores (SRS).

Instrumentation

A calibrated diagnostic audiometer (Madsen Orbiter -922, Version 2) with headphones (TDH 39 earphones fitted in to ME70 Noise-excluding Headset), bone vibrator (Radio ear-71) and sound field speakers (Jamo E-100).

Compact disc containing multitalker babble, for 10 minutes each, in Kannada, Hindi and Malayalam.

Tape recorder (Philips AZ 2160 V) to play the CD.

A calibrated middle ear analyzer (Grason Stadler Model 33, Version 1).

Digital tape recorder, Sony portable Minidisc recorder (MZ R-70).

Personal computer with software (Audio lab-Version 1).

Test Environment

The test was carried out in an air-conditioned sound treated double room suite with ambient noise levels within permissible limits (re: ANSI, 1991; cited in Wtlk«% 1994).

Procedure

The collection of data was carried out in two phases:

Phase 1: Development of multitalker babble in Kannada, Hindi and Malayalam.

Phase 2: Administration of the test to study the effect of multitalker babble on SRS in Kannada.

Phase 1: Development of multitalker babble (MTB)

Each of the five males and females read a passage in Kannada. The passage contained all the sounds of the language. This passage was recorded on to the Minidisc digital tape recorder (Sony MZ R-70), taking care to monitor the V-U meter deflection. The recorded sample was then transferred to a computer to obtain the babble. The ten samples were normalized and then accumulated. This normalized and accumulated sample was copied and pasted such that the sample duration was ten minutes. This ten minutes sample, the MTB in Kannada,was recorded on a compact disc with a calibration tone. This same procedure was followed to develop the MTB in Hindi and Malayalam languages.

Phase 2: Administration of the test

The participants were made to sit comfortably in the patient room, the two speakers kept at an angle of 45° azimuths, one on either side of the subject.

To obtain the SRS in the presence of MTB in Kannada, Hindi and Malayalam, the participants were instructed to repeat the Kannada words presented to them through the speakers. And while testing in the presence of noise condition, they were asked to concentrate only on words presented to them.

The experiment was carried out in the following steps:

Step 1: The speech recognition threshold (SRT) of the participant was obtained through the audiometer loud speakers, in quiet situation, by presenting Kannada paired words using descending method given by Olsen and Tillman (1973).

***Step** 2:* The sound field speech recognition scores (SRS) were obtained at 40 dBSL (re: SRT), in quiet situation, through the sound field audiometer using phonetically balanced (PB) word list in Kannada [i.e., SRS in quiet or SRSQ]. The subject was instructed, as "you will now hear a few words in Kannada. Please repeat them".

Step 3: The speech noise was presented through both the speakers at 40 dBSL (re: SRT) and Kannada PB word list was presented through the left speaker for 20 participants and through the right speaker for 20 participants at 0 dB S/N ratio. In this condition, speech recognition scores were obtained, i.e., SRS in the presence of speech noise or SRSSN.

Step 4: The SRS was obtained in the presence of multitalker babble of Kannada (KB), Malayalam (MB) and Hindi (HB) languages separately instead of speech noise, i.e., SRSKB (SRS in the presence of Kannada babble), SRSMB (SRS in the presence of Malayalam babble), and SRSHB (SRS in the presence of Hindi babble) were obtained for 40 participants in each language babble at OdB speech-to-babble (S/B) ratio.

Please note: To avoid the effect of order of presentation of PB lists, the order of presentation of different PB word lists was different for each step and the order of steps were varied.

Data Recording

The tester presented the word list using Monitored Live Voice and the participants were asked to repeat the words. The data was recorded as number of correct words repeated in each of the situations [i.e., in quiet, in speech noise, and in multitalker babble (Kannada, Hindi and Malayalam separately).]. The tester's hearing was normal (<15 dB HL), at all audiometric frequencies.

Scoring

Each PB list (List A and List B) had 50 words each. Each correct response was scored 2% for converting the correct scores into percentage scores.

Analysis of the data

The scores for each subject were tabulated. The data was statistically analyzed by using measures of central tendency (Mean) and variability (Range and Standard deviation). Test of significant difference (paired t-test) was also applied to find out whether there was any significant difference between the following conditions:

1. SRS in quiet and in multitalker babble (Kannada, Hindi and Malayalam Babbles separately).
2. SRS in Speech noise and in multitalker babble (Kannada, Hindi and Malayalam Babbles separately).
3. SRS among different multitalker babble (Kannada, Hindi and Malayalam).

RESULTS AND DISCUSSION

The speech recognition scores (SRS) in Kannada were obtained from 40 participants, in different conditions such as, in quiet, in speech noise, and in multitalker babble (Kannada, Hindi and Malayalam separately). The obtained data were tabulated and statistically analyzed. Mean, Range, Standard deviation and paired 't' test (Garrett, 1979) were carried out to analyze the data.

1. SRS in quiet and SRS in multitalker babbles of Kannada, Hindi and Malayalam languages (i.e., SRSQ VS. SRSKB; SRSQ VS. SRSHB and SRSQ VS. SRSMB).

2. SRS in speech noise and SRS in multitalker babble of Kannada, Hindi and Malayalam languages (i.e., SRSSN VS. SRSKB; SRSSN VS. SRSHB and SRSSN VS. SRSMB).

3. SRS in the presence of multitalker babbles of Kannada, Hindi and Malayalam languages (i.e., SRSKB VS. SRSHB; SRSHB VS. SRSMB and SRSMB VS. SRSKB).

The statistical analysis revealed the following:

1 *SRS in quiet and in multitalker babble (KB, HB & MB).*

Table 1: ***The Mean, Range, SD andt-values of SRS in quiet and SRS in multitalker babble (KB, HB & MB)***

Variable	*Mean*	*Range*	*SD*	*t-values*
SRSQ (N =40)	99.10%	96-100%	1.26	11.30**
SRSKB (N = 40)	84.95%	68-98%	7.91	
SRSQ (N = 40)	99.10%	96-100%	1.26	12.03**
SRSHB (N=40)	84.90%	66-98%	7.32	
SRSQ (N = 40)	99.10%	96-100%	1.26	10.56**
SRSMB (N = 40)	84.95%	66-98%	8.44	

**P<0.01

Table 1, reveals that there is a significant difference (P<0.01) between SRS in the presence of multitalker babble (KB, HB & MB) and SRS in quiet. The standard deviation of speech recognition scores in quiet (S.D = 1.26) is less as compared to SRS in Kannada babble (S.D = 7.91), Malayalam babble (S.D = 8.44) and Hindi babble (7.32). The hierarchy of variations in conditions ranged from highest to least are (a) SRS in Malayalam babble (S.D = 8.44), (b) SRS in Kannada babble (S.D = 7.91), (c) SRS in Hindi babble (S.D = 7.32) and (d) SRS in quiet (1.26). The range indicates the wide spread of values (for SRS) in Malayalam babble (66-98%), Hindi babble (66-98%) and Kannada babble (68-98%) compared to SRS in quiet (96-100%).

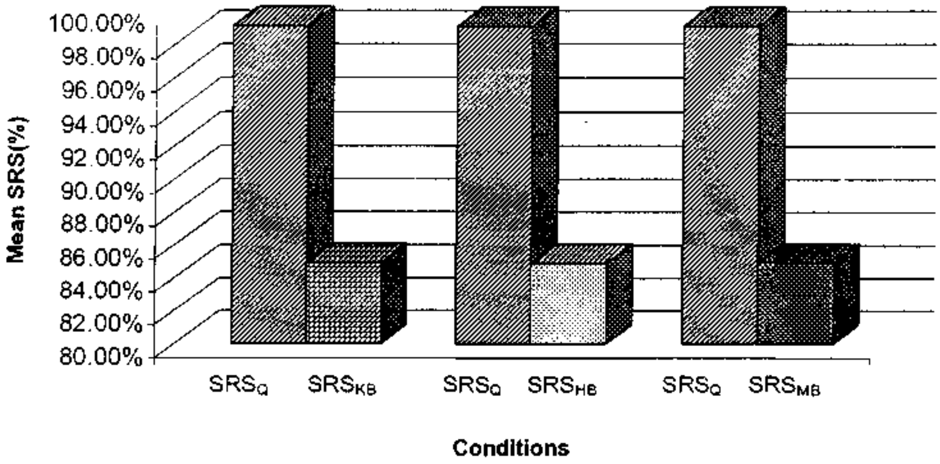

Figure 1: Mean SRS in quiet and SRS in babble of different languages

The Figure 1 indicates that the mean SRS in KB is 84.95%, HB is 84.90% and MB is 84.95%. These scores were poorer than the mean SRS in quiet (99.10%). Obviously it is noticed that the multitalker babble has a degrading effect on the SRS. This finding agrees with that of studies done by Elliot, et al., 1979; Moore et al, 1992b; Loven and Hawkins 1983.

2. SRS in speech noise and multitalker babble (KB, HB and MB)

Table 2, reveals that there is a significant difference (P<0.01) among SRS in the presence of various multitalker babbles (Kannada, Hindi and Malayalam) and SRS in speech noise. As compared to the standard deviation scores in speech noise (S.D = 4.77), the standard deviations scores seen in multitalker babble of different languages [Hindi babble (S.D = 7.32), Kannada babble (S.D = 7.91) and Malayalam babble (S.D = 8.44)] was more. And the range also indicates the wide spread of values (for SRS) in

Malayalam babble (66 -98%), Hindi babble (66 -98%) and Kannada babble (68 -98%), when compared to that in speech noise (82 -100%).

Table 2:The Mean, Range, SD, t-values of SRS in speech noise and SRS in multitalker babbles (KB, HB & MB).

Variable	*Mean*	*Range*	***SD***	*t-values*
SRSSN (N = 40)	92.20%	82-100%	4.79	4.96**
SRSKB (N=40)	84.95%	68-98%	7.91	
SRSSN (N=40)	92.20%	82-100%	4.79	5.29**
SRSHB (N = 40)	84.90%	66-98%.	7.32	
SRSSN (N = 40)	92.20%	82-100%	4.79	4 72**
SRSMB (N = 40)	84.95%	66-98%	8.44	

** P<0.01

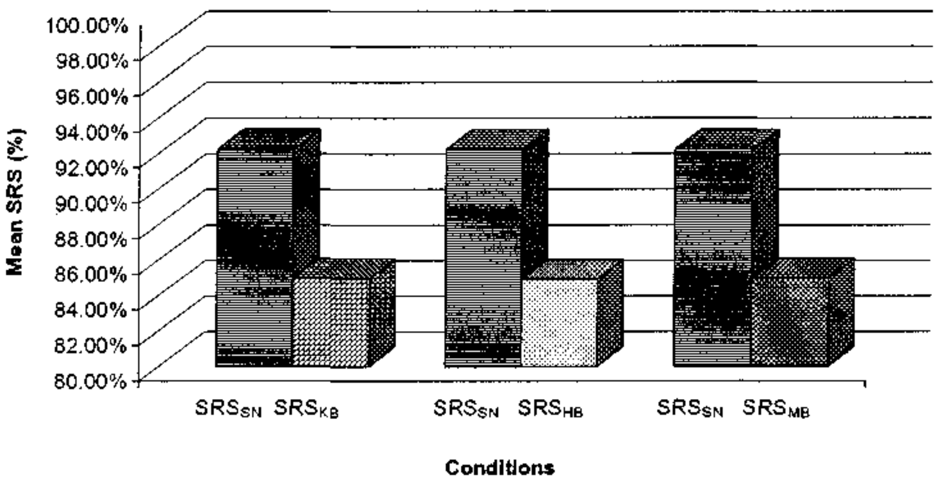

Figure 2: Mean SRS in speech noise and SRS in babble of different languages

The Figure 2 reveals that the Mean SRS in **KB** (84.95%), **MB** (84.95%) and **HB** (84.90%), these SRS scores were significantly poorer than the mean SRS in spj^ggo^.

noise (92.20%). Further, it can also be inferred that multitalker babble has more masking effect than the speech noise. Similar results were reported in the literature by Findlay, (1976); Kalikow, Stevens and Elliot (1977); and Carhart, Johnson and Goodman (1975). Kalikow et al. (1977) commented that speech babble could produce more masking than a speech noise because the babble produces false speech cues and increases the load on attention and memory processes. Carhart et al. (1975) attributed this additional masking produced by the speech competitor to a central auditory filter mechanism, which is capable of separating speech stimuli from non-speech maskers, but not the speech target from a speech competitor. Further, they thought that perceptual masking caused the additional shift in speech scores obtained for the speech competitor and distinguished it from the peripheral masking noted for non-speech competitors. However, Waghray and Panagoda (2000) have found no significant difference between the SRS in multitalker babble and SRS in speech noise. And Danhauer, Doyle and Lucks (1985) have reported that the multitalker babble is the least effective as masker compared to white noise and amplitude modulated white noise. These variations in findings are due to many factors involved in the competitors.

3. SRS in the presence of multitalker babble of different languages (KB, HB and MB):

Table 3, reveals that there is no significant difference on the SRS in the presence of babble of different languages (Kannada, Hindi and Malayalam babble). The results conformed to those by Miller (1947); Dirks and Bower (1969); Brandt and Stewart (as cited in Vasantha, 1976). The reasoning for such a findings was that the crucial factor for masking was the masking spectrum rather than the linguistic or semantic content of the babble.

Table 3: The Mean, Range, Standard Deviation (SD) and t-values ofSRS in multitalker babble (KB, HB & MB).

Variable	*Mean*	*Range*	***SD***	*t-values*
SRSKB (N = 40)	84.95%	68-98%	7.91	0.029 (NS)
SRSHS (N = 40)	84.90%	66-98%	7.32	
SRSKB (N-=40)	84.95%	68-98%	7.91	0.0 (NS)
SRSMB (N = 40)	84.95%	66-98%	8.44	
SRSMB (N=40)	84.95%	66-98%	8.44	0.028 (NS)
SRSHB (N=40)	84.90%	66-98%	7.32	

NS: Not Significant

The deviation of speech recognition (SR) scores from mean is more in Malayalam babble (S.D = 8.44), compared to Kannada babble (S.D = 7.91) and Hindi babble (S.D = 7.32). The range of SR scores in Kannada babble (68-98%), Hindi babble (66-98%) and Malayalam babble (66-98%) is wide and almost the same, showing slight differences among them. Thus, indicating that there is a wide range of SRS seen among individuals for each babble conditions and the variability in SRS among babble is less. Thus, the effects of all the three-language babble on SRS in Kannada are similar. Hence,again it is conformed that the crucial factor for masking was the masking spectrum rather than the linguistic or semantic content of the babble.

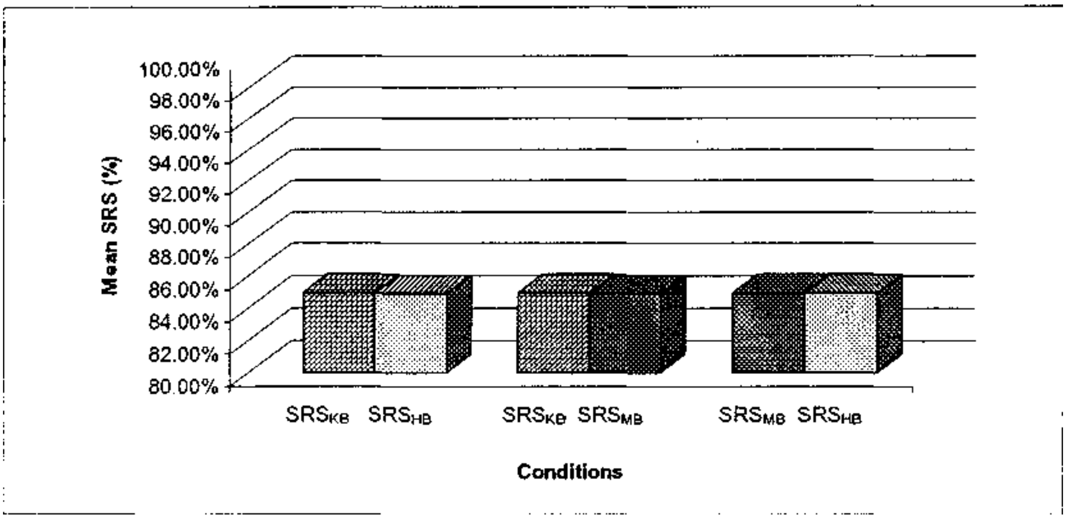

Figure 3: Mean SRS in babble of different languages.

From above Figure 3, it can be observed that, the Mean SRS in Kannada babble is 84.95%, in Hindi babble is 84.90% and in Malayalam babble is 84.95%. So, from this it can be inferred that babbles of different languages affect the SRS to the same extent.

The results from this study indicate that:

- The masking effectiveness of multitalker babble of different languages is the same. This can be attributed to that the language or semantic content of the babble does not play a role in masking speech; rather it is the spectrum of the babble that is important.
- The masking effectiveness of multitalker babble is more than the speech noise. Thus, in clinical set-up, multitalker babble can be used in obtaining the masked speech measures. This speech measure would reflect the real-life situations better.

SUMMARY AND CONCLUSION

Multitalker babble is a type of additive noise, which is produced, by a group of people talking simultaneously and none of the messages are understandable to the listener and it is the most common noise environment that listeners encounter in everyday life. This multitalker babble creates a difficult listening environment because it is (a) speech spectrum shape (b) minimally amplitude modulated and (c) Aperiodic (Sanders & Hall, 1999). The various factors determining speech perception in the presence of multitalker babble are number of talkers in the babble, language of the babble, speech sounds in a babble and head shadow effect.

The study was carried out with the aim to find the effect of multitalker babble of different languages on SRS in Kannada. The aim was also to study the relative effectiveness of MTB and speech noise as maskers. The study was undertaken, as there is a dearth of studies on the effect of MTB of different languages on the speech recognition.

The speech recognition scores was measured for 40 normal hearing subjects (20 males and 20 females) using Kannada Phonetically Balanced (PB) words in the presence of multitalker babble of different languages (Kannada, Hindi and Malayalam), in quiet and in speech noise. SRS in quiet condition was considered as reference for comparison of SRS in multitalker babble and SRS in speech noise. The subjects were instructed to repeat the Kannada PB word list (2 lists of 50 words each, presented in a random order) in the above of conditions.

The test was carried out in an air-conditioned sound treated double room suite. Multitalker babble was presented from compact disc through audiometer speakers, which were kept at 1-metre distance at 45° azimuth. SRS for Kannada PB wordlist was obtained, in quiet. Later, competitors [speech noise, multitalker babble (KB, HB and MB)] were presented through both the speakers and PB wordlist in Kannada was presented through either left or right speaker to obtain the SRS. The presentation level was 40 dBSL (re: SRT) and the speech-to-competitor ratio was zero. The percentage of correct responses (out of 50 words presented) in each conditions (quiet, speech noise, and in MTB of different languages) were obtained. The SRS was tabulated for each condition, for each participant.

The data was statistically analyzed to obtain Mean, Range, Standard deviation, and t-values. The following observations were made from the study:

SRS in the presence of multitalker babble (Kannada, Hindi and Malayalam) were poorer than the SRS in the presence of speech noise. From this, it could be inferred that multitalker babble has better masking effect than speech noise.

No significant difference was found among SRS in the presence of multitalker babble of different languages (Kannada, Hindi and Malayalam).

Multitalker babble of any language can be used to check the person's speech recognition scores rather than the speech noise. MTB resembles the real life situation more closely than the speech noise. Hence the SRS obtained could be extrapolated for everyday life situations.

The following hierarchy of competitors, from least to most effective, was obtained from the study:

(a) Speech Noise.

(b) Multitalker babble.

Implications of the study

Helps in designing digital hearing aids (for developing noise reduction algorithms).

Used in fitting verifications and counseling about use of communication strategies in difficult listening situations.

Have implications in testing and counseling clients with auditory processing disorders (APD).

Suggestions for future research

The effect of combined multitalker babble of three languages (Kannada, Hindi and Malayalam) may be studied for finding their effect on speech recognition scores.

This study may be done on children.

Comparison of the effect of multitalker babble on children and adults may be studied.

Speech recognition scores in multitalker babble may be studied at different S/B ratios.

Extent of masking effect of multitalker babble in hearing impaired listeners may be studied.

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