Effect of Spatial Noise on Speech Identification Scores

by Asha Yathiraj

PROJECT PROPOSAL FORMAT Part –A

1.0	**Title of the Project**	„Effect of Spatial Noise on Speech Identification Scores"
Area of Research :		Speech, Language, Hearing
1.1	**Principal Investigators**	**Prof Asha Yathiraj**
1.2	**Principal Co-Investigator(s)**	-
1.4	**Collaborating Institution**	-
1.5	**Total Grants Required (in figures and in words)**	
1.6	**Duration of the Project**	**One year**
2.0	**Project Summary** (Max. 300 words)	Enclosed
3.0	**Introduction** (under the following heads)	Enclosed
3.1	Definition of the problem	:
3.2	Objectives	:
3.3	Review of status of research and development in the subject	:
3.4	International and national status	:
3.5	Importance of the proposed project in the context of current status	:
4.0	**Work Plan**	Enclosed
4.1	**Method**	

Subjects / Participants :
Material :
Procedure :
Analyses :

6.0	**Implications of the results of the study** (Illustrative) :	**Enclosed**

a) Presentation of scientific papers in professional seminars / publication of articles

:

b) To utilize the results in the development of remediation

7.0	**Utilization of results**	**Enclosed**

of the study

2.0 Project Summary

To study the effect of different noise reduction algorithms in a natural set-up, popular form of noise used in research studies is „R-SPACE™ noise". It is claimed that this noise provides "an efficient, accurate, and standardizable means of testing the real-world performance of a broad range of audio devices used in noise". This noise has been use in the evaluation of several devices such as hearing aids and assistive devices, cochlear implants, computer voice recognition systems, noise-cancelling listening systems, cellular telephones, and other communication systems (http://www.revitronix.com/r-space.html). The noise is presented through eight different loudspeakers in a sound field situation. The noise presented from each loudspeaker has different environmental sources of noise that vary in terms of frequency, intensity and temporal characteristics over a period of time. As the noise varies 3

from time to time, it is possible that the masking effect of the noise for standard speech stimuli would vary from one test session to another, in the absence of any other change. Thus, the test-retest reliability could be compromised due to the varying effect of the noise source. Thus, this variation could be co-variable affecting the findings of studies reporting of performance with different algorithms on listening devices. The extent of this variable needs to be investigated to determine how valid it is to utilise noise similar to „R-SPACE™ noise". **3.0 Introduction** 3.1 Definition of the problem It is a known fact that perception of speech varies depending on the type of noise that is used. It has been reported that depending on the frequency, intensity or temporal characteristics of noise, speech perception scores vary (Prosser, Turrini, & Arslan, 1991; Larsby & Arlinger,1994; Papso & Blood, 1989; Parikh & Loizou, 2005). Thus, it can be assumed that noise that varies in terms of these parameters is likely to result in varying speech perception scores in individuals with normal hearing. Thus, when noise that has varying frequency, intensity or temporal characteristics is used to make judgment about specific algorithms used in listening devices, it is likely to contaminate the research findings. Thus, it is essential to note the extent to which such noise serves as a variable in these studies. 3.2 Objectives The aim of the present study is to determine the influence of noise similar to „R-SPACE™ noise" in speech identification. The specific objectives of the study will be as follows:

- Develop noise similar to „R-SPACE™ noise".
- Check the influence of such noise on word identification scores of lists that are reported to be equivalent in the presence of constant noise.
- Check the influence of different signal-to-noise ratios with the noise similar to „R-SPACE™ noise".

3.3 Review of status of research and development in the subject

Studies have been carried out to investigate the effect of noise on speech perception. It has been shown that perception varies depending on the frequency, intensity and temporal 4

characteristics of noise. However, studies have used such varying noise in establishing the influence of different algorithms or features in listening devices. This is likely to act as a co-variable in the findings of these studies. 3.4 International and national status **Larsby and Arlinger (1994)** measured speech recognition threshold and just follow conversation level using speech spectrum random noise and continuous forward speech. They reported of more masking for speech spectrum random noise than speech maskers. The mean signal-to-noise ratio required for recognition threshold and just follow conversation level was greater in case of speech spectrum noise (-1.0 dB). Word recognition performance of 4 to 6 year old children and adults was established by **Papso and Blood (1989)** on the Word Intelligibility by Picture Identification test using Multitalker noise and pink noise. It was reported that in children, multitalker noise resulted in more adverse speech discrimination scores than the pink noise on (77.9% & 67.6%) and in adults no significant difference between conditions was noted (pink noise – 97.6% & MTB – 94.9%). Thus, the influence of noise type varied depending on the age of the individual. Parikh and Loizou (2005) studied how multi-talker babble and speech-shaped noise influenced speech perception. The effect of noise was measured in terms of differences of spectral envelope between the noisy and clean spectra in 3 frequency bands, presence of reliable F1 and F2 information in noise, and changes in burst frequency and slope. The acoustic analysis showed that F1 was detected more reliably than F2 and most differences of spectral envelope was seen in the mid-frequency band between the noisy and clean vowel spectra. In poor SNR conditions, the listeners relied on relatively accurate F1 frequency information along with some F2 information to identify vowels. Stop consonant recognition was found to be high even at −5 dB though the disruption of burst cues was seen due to additive noise. Sperry, Wiley and Chial (1997) noted that more masking occurred for multitalker competing message compared to speech-spectrum noise. They reported that as the acoustic and linguistic features of the target signal and the competing signal become more similar, it becomes more difficult to differentiate between the target signal and the competing signal. 5

R-Space noise was utilized by Gifford and Revitt (2010) to assess speech perception for adult cochlear implant users to determine whether commercially available preprocessing strategies and/or external accessories yielded improved sentence recognition in noise. The noise generated by an eight-loudspeaker was considered to represent a realistic restaurant simulation. Thirty-four subjects, ranging in age from 18 to 90 years, participated in the study. SRTs in noise were assessed with the participants" preferred listening programs as well as with the addition of either BEAM of Cochlear Corporation or the T-Mic accessory option of Advanced Bionics. Adaptive SRTs with the Hearing-in-Noise-Test sentences were obtained for all 34 subjects. In addition, 16 of the 20 Cochlear Corporation subjects were reassessed obtaining an SRT in noise using the combination of noise reduction algorithms: ADRO, ADRO+ASC, and ADRO+ASC+BEAM. It was found that the scores varied depending on the preprocessing strategy used in the Cochlear Corporation recipients. Further, it was also observed that the T-Mic accessory option in Advanced Bionics significantly improved the SRT when compared to the BTE mic. Speech recognition of 27 unilateral and three bilateral adult Nucleus Freedom CI recipients in R-SPACE was measured by Brockmeyer and Potts (2011). This was done using four processing options (standard dual-port directional (STD), ADRO, ASC, and BEAM at two noise levels). Hearing-in-Noise-Test sentences were presented at 0o azimuth with R-SPACE restaurant noise at 60 and 70 dB SPL. The reception threshold for sentences (RTS) was obtained for each processing condition and noise level. The results showed that scores varied as a function of the process used and the noise level. The authors suggested that the use of processing options involving noise reduction would improve a CI recipient"s ability to understand speech in noisy environment. 3.5 Importance of the proposed project in the context of current status
Studies reported in literature indicate that speech perception varies depending on the frequency, intensity and temporal property of noise. Despite this, studies have used R-SPACE test system, developed by Compton-Conley and colleagues, to replicate a restaurant environment. The R-SPACE consisted of eight loudspeakers positioned in a 3600 arc through which a recording of a restaurant background noise was played. This noise includes varying speech as well as non-speech noise. This is likely to have an impact on the speech identification scores. Thus, studies that claim that varying noise reduction algorithms have 6

an effect on speech perception performance, may be influence by the varying nature of the noise used. **4.0 Work Plan 4.1 Method** Participants: Two groups of participants, varying in age, will be recruited for the study. Children aged 6 to 7 and young adults aged 18 to 25 will evaluated. The participants would meet the following inclusion criteria:

- They should have thresholds less than 25 dB HL from 250 Hz to 8000 Hz
- Normal middle ear functioning as determined by immittance evaluation;
- Presence of TOAEs; Speech identification scores of greater than 75% in quiet;
- No report of otological or neurological problems,
- No history of speech and language problems,
- No symptoms of APD on a screening checklist,
- The children should have been educated in an English medium school for at least 3 years and the adults should be fluent speakers of Indian-English.

Material:

- Speech identification will be tested using the „Phonemically balanced speech identification test in Indian-English" (Yathiraj & Muthuselvi, 2009).
- The spatial restaurant noise will be developed as a part of the current study to represent typical Indian restaurant / cafeteria during lunch time.

Procedure: The study will be carried out in two phases. Phase I *Development of the spatial restaurant noise* Noise from a typical Indian restaurant will be recorded on 8 tracts of an audio software (Adobe Audition -3). The recording of each tract will be done using a directional microphone. The recoding will be done in 7 different locations in the restaurant. The noise on each tract will be scaled such that the average amplitude will be similar on the 8 tracts. 7

Phase II All the participants who meet the selection criteria will be tested in a sound field situation having 8 loudspeakers. The speech stimuli will be presented at 0₀ azimuth and the spatial restaurant noise will be presented through speakers placed at +45₀, -45₀, +90₀, -90₀, 180₀, +135₀, and -135₀. The speech identification in the presence of noise will be tested at 0 dB SNR and 10 dB SNR using all the words available in the „Phonemically balanced speech identification test in Indian-English". Each individual will be tested thrice in the presence of the developed spatial noise and twice in the presence of continuous speech noise. The words will be randomized to prevent the effect of word familiarity. Analyses: MANOVA will be carried out to investigate the effects of age, SNR, and type of noise.

6.0 Implications of the results of the study (Illustrative) The study will through light on the influence of varying noise on speech perception. This in turn will provide information regarding the validity of studies that have used such noise to simulate real life situations. **7.0 Utilization of results of the study** The study will highlight the validity of research that has been carried out using noise similar to R-space noise.

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