DEPARTMENT OF AUDIOLOGY

SH/ARF/AUD(AY)/2016-2017 24/06/2016

Submitted to the Director

Subject: AIISH research fund- Project

Please find enclosed a project proposal titled, 'Effect of Spatial Noise on Speech Identification Scores' with the undersigned as principal investigator. It is requested that the proposal be considered for funding from the AIISH research fund.

Principal Investigator

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 :

4.2	**Time schedule of activities giving milestones (also append a bar diagram)**		
	Review of literature	:	2 Months
	Recording and analyses of data	:	6 Months
	Data interpretation and report writing	:	4 Months

5.0	**Budget summary**	:	
	Item		**Expenditure**
	Salaries Designation(No. of persons)* Monthly Emoluments * No. of months		1*34,000*12= 4,08,000
	Consumables		Rs.10,000.00
	Travel		Rs.10,000.00
	Other costs (Preparation of software)		Rs.5000.00
	Total		**Rs.4,33,000**
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 of the study**		**Enclosed**

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^{TM} 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 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 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.

R-Space noise was utilised 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 presprocessing 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 0^0 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 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.

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 0^o azimuth and the spatial restaurant noise will be presented through speakers placed at $+45^o$, -45^o, $+90^o$, -90^o, 180^o, $+135^o$, and -135^o. 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.

References

Brockmeyer, A. M., & Potts, L. G. (2011). Evaluation of different signal processing options in unilateral and bilateral cochlear freedom implant recipients using R-Space background noise. *Journal of American academy of audiology, 22*(2), 65-80.

Gifford, R. H., & Revitt, L. J. (2010). Speech Perception for Adult Cochlear Implant Recipients in a Realistic Background Noise: Effectiveness of Preprocessing Strategies and External Options for Improving Speech Recognition in Noise. *Journal of American Academy of Audiology, 21,* 441–451.

Yathiraj A. & Muthuselvi T. (2009). Phonemically balanced monosyllabic test in Indian-English. Developed at the Department of Audiology, All India Institute of Speech and Hearing, Mysore, India.

Part B

1.0 Personal profile of Principal Investigators and Principal Co-Investigators

1.1 Personal profile of Principal Investigators

1.1.1	Name	Prof. Asha Yathiraj
1.1.2	Date of birth : 10.05.1960	Age: 56 years
1.1.3	Present Position held	Professor of Audiology
1.1.4	Institution	All India Institute of Speech and Hearing
1.1.5	Whether belongs to SC/ST	No
1.1.6	Academic & Professional Career Academic	

Degree / Position Held	Year	University / Institution
Ph.D (Sp & Hg)	1995	University of Mysore

Professional

Degree / Position Held	Year	University / Institution
Degree / Position Held	Year	University / Institution
Ph.D (Sp & Hg)	1995	University of Mysore

1.1.7	Projects completed (Principal Investigator)	Nine
1.1.8	Projects completed (Co-investigator)	: -
1.1.9	Doctoral theses guided	: 7
1.1.10	Doctoral theses under progress	: 2
1.1.11	Master's dissertation guided	: 42 masters dissertations 28 masters independent projects
1.1.12	Master's dissertation under progress	: 3
1.1.13	Publication in journals	: 30
1.1.14	Books edited, monographs	: Edited 5 books & Editor of 2 journals
1.1.15	Awards	- 2 international best paper awards - 8 national best paper awards

		Prof. Padmashri S Kameshwaran Oration award
1.1.16	Memberships	- ISHA - CIGI
1.1.17	Others	: 48 publications in books/ monographs/ proceedings of seminars
1.1.18	Other research projects as Co-Investigators (ARF, Extra Mural)	: -
1.1.19	Principal Investigator address	: Dr. Asha Yathiraj AIISH Manasagangothri Mysore -570006

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Publications

International:

1. Maggu A. R. & **Yathiraj A.,** (2011). Effect of Noise Desensitization Training on Children with Poor Speech-In-Noise Scores. Canadian Journal of Speech-Language Pathology and Audiology, Vol. 35(1), 56-63.
2. **Yathiraj, A.,** & Maggu, A. R. (2012). Screening Test for Auditory Processing (STAP): Revelations from Principal Component Analysis. *SSW report*, *34*(3), 18-23.
3. Pottackal Mathai, J., & **Yathiraj, A.** (2013). Effect of temporal modification and vowel context on speech perception in individuals with auditory neuropathy spectrum disorder (ANSD). *Hearing, Balance and Communication, 11*(4), 198-207.
4. Mathai, J. P., & **Yathiraj, A.** (2013). Audiological Findings and Aided Performance in Individuals with Auditory Neuropathy Spectrum Disorder (ANSD) – A Retrospective Study. *Journal of Hearing Science, 3*(1), 18-26.
5. **Yathiraj, A.,** & Maggu, A. R. (2013). Comparison of a screening test and screening checklist for auditory processing disorders. *International journal of pediatric otorhinolaryngology, 77*, 990–995.
6. **Yathiraj, A.,** & Rao, A. (2013). Preprocessing strategies and Speech perception in Cochlear Implant users. *Journal of Hearing Science,* 3(2), 50-59
7. **Yathiraj, A.,** & Maggu, A. R. (2013). Screening Test for Auditory Processing (STAP): A Preliminary Report. *Journal of the American Academy of Audiology*, 24(9), 867-878.

8. **Yathiraj, A.,** & Maggu, A. R. (2014). Validation of the Screening Test for Auditory Processing (STAP) on school-aged children. *International Journal of Pediatric Otorhinolaryngology, 78*(3), 479-488. doi:10.1016/j.ijporl.2013.12.02

9. Vaidyanath, R., & **Yathiraj, A.** (2014). Screening Checklist for Auditory Processing in Adults (SCAP-A): Development and preliminary findings. *Journal of Hearing Science, 4*(1), 34-43.

10. Vaidyanath, R., & **Yathiraj, A.** (2014). Relation between two scoring procedures to assess auditory memory and sequencing abilities. *Journal of Hearing Science, 4*(4), 9-20.

11. Vaidyanath, R., & **Yathiraj, A.** (2015). Comparison of Performance of Older Adults on Two Tests of Temporal Resolution. *American Journal of Audiology*, 1-10. doi:10.1044/2015_AJA-14-0064

12. Pillai, R., & **Yathiraj, A.** (2015). Auditory, visual, and auditory-visual processing performance in typically developing children: Modality independence versus dependence. *The Journal of the Acoustical Society of America, 137*(2), 923-934. doi.org/10.1121/1.4906832.

13. **Yathiraj, A.,** & Vanaja, C. (2015). Age Related Changes in Auditory Processes in Children Aged 6 to 10 years. *International Journal of Pediatric Otorhinolaryngology*, Vol 79(8), 224-234. doi:10.1016/j.ijporl.2015.1005.1018.

14. Jijo. P.M., & **Yathiraj, A.** (Under review). Performance Intensity Function and Aided Improvement in Individuals with Late Onset Auditory Neuropathy Spectrum Disorder (ANSD). Journal of Ear and Hearing.

National:

15. Maggu, A. R & **Yathiraj, A.** (2010-11). Effect of temporal pattern training on specific central auditory processes. Student Research at A.I.I.S.H. Mysore (Articles based on Dissertation done at AIISH), Vol. IX, 18-27.

16. Rao, A & **Yathiraj, A.** (2010-11). Electrically evoked stapedial reflex thresholds: Relationship with behavioral 'T' and 'C' levels in cochlear implant users. Student Research at A.I.I.S.H. Mysore (Articles based on Dissertation done at AIISH), Vol. IX.

17. Sindhushree, H. S. & **Yathiraj, A.** (2010-11). Perception of emotions in cochlear implant users, hearing aid users and normal hearing children. Student Research at A.I.I.S.H. Mysore (Articles based on Dissertation done at AIISH), Vol. IX

18. Apoorva, H. M. & **Yathiraj, A.** (2011-12). Lexical neighborhood test (LNT). Student Research at A.I.I.S.H. Mysore (Articles based on Dissertation done at AIISH), Vol X, 20-31. (published in 2014)

19. Mythri, H. M. & **Yathiraj, A.** (2011-12). Age related changes in auditory memory and sequence in younger and older adults. Student Research at A.I.I.S.H. Mysore (Articles based on Dissertation done at AIISH), Vol X, 204-214. (published in 2014)

20. Ratul, D. & **Yathiraj, A.** (2011-12). Efficacy of a hearing checklist and screening test in identifying hearing problems in primary school children. Student Research at A.I.I.S.H. Mysore (Articles based on Dissertation done at AIISH), Vol X, 225-233. (published in 2014)

21. Jijo, P., & **Yathiraj, A**. (2012). Audiological Characteristics and Duration of the Disorder in Individuals with Auditory Neuropathy Spectrum Disorder (ANSD)–A Retrospective Study. *Journal of the Indian Speech & Hearing Association, 26*(1), 17-26.

22. **Yathiraj, A.** (In press). Management of Auditory Processing Disorders: The Indian Scenario. Journal of the All India Institute of Speech and Hearing, Vol 34.

Chapters in books:

23. Yathiraj, A. (2010-11). Perception through auditory modality & Basic acoustic properties of speech and its effect on hearing aids. Self-Learning Material for block in course titled 'Aural Rehabilitation of Children with Hearing Impairment', for M.Ed. (SE-DE) (HI), New Delhi: IGNO.
24. Yathiraj, A. (2010-11). Auditory training and its importance and auditory verbal therapy (AVT). Self-Learning Material for block in course titled 'Aural Rehabilitation of Children with Hearing Impairment', for M.Ed. (SE-DE) (HI), New Delhi: IGNO.
25. Yathiraj, A. (2010-11). Application of materials and methods in classroom and outside the classroom for individuals and group. Self-Learning Material for block in course titled 'Aural Rehabilitation of Children with Hearing Impairment', for M.Ed. (SE-DE) (HI), New Delhi: IGNO.
26. Yathiraj, A. (2010-11). Evaluation of hearing aids using electro acoustic analysis instrumentation; ISI standard and technical specifications; Hearing aids under governmental schemes and their performances; Makes and models of hearing aids; Development of ear mould technology and modification. Self-Learning Material for block in course titled 'Aural Rehabilitation of Children with Hearing Impairment', for M.Ed. (SE-DE) (HI), New Delhi: IGNO.
27. Yathiraj, A. (2010-11). Technical specification for classroom devices. Self-Learning Material for block in course titled 'Aural Rehabilitation of Children with Hearing Impairment', for M.Ed. (SE-DE) (HI), New Delhi: IGNO.
28. Yathiraj, A. (2013). Approaches to habilitation of children with cochlear implants. In The Cochlear Implant - An Overview, Ed. Madhuri Gore, 71-74.