LANGUAGE IN INDIA

Strength for Today and Bright Hope for Tomorrow

Volume 10 : 9 September 2010

ISSN 1930-2940

Speech Identification Scores in Children With Bimodal Hearing

R. Phanindra, S.G.R. Prakash, K. Balaganesan, Shusma, and Sravanthi

---

Introduction

"To hear is as natural and effortless occurrence as it is invisible, man could ask himself how breathing keeps him physically alive as how hearing keep him psychologically alive" (Levins, 1996). Normal-hearing individuals use auditory inputs from both ears to localize sounds and to understand speech better in adverse listening situations. One might assume that binaural hearing should be better than the monaural hearing because the listener should be able to take advantage of interaural timing and level difference between two ears. The brain can also combine the speech and noise from both ears to reduce the impact of noise on understanding speech by about 2 dB on average. This is referred to as 'binaural squelch' (Zuric, 1993).

Research shows that bilateral cochlear implants (CICI) are beneficial for some individual in some conditions (e.g. Litovsky et al.2004 ; Muller et al. 2002, Van Hoesel 2004), and individuals with bilateral cochlear implant typically have better localizations when using both implants than using one implant. (Nopp, et al. 2004). However the localization is still inferior compared with normal hearing and some bilateral implants listeners do not reveal any substantial benefit in localization (Seeber, et al. 2004).

Generally cochlear implantation (CI) is done monaurally, as a result of the cost of the equipment and surgical procedures. Surgical considerations for CI include implanting the poorer ear, with no or less benefits from hearing aids. However, monaural implantation may result in auditory deprivation in the contra-lateral ear, along with problems of localization and understanding speech in noisy situation. These disadvantages of monaural amplification can be overcome by fitting a hearing aid in contra lateral ear. Cochlear implant in one ear and hearing aid in contralateral ear is termed as "binaural-bimodal hearing". Even though there is evidence to suggest the possibility of a loudness mismatch between the outputs of the two devices, most of the studies using different methodologies and test materials have shown binaural benefits with bimodal hearing (Ching *et al.*, 2004).

Teresa Ching, Pauia Incerti, and Mandy Hill in 2004, reported a better speech performance, localization and functional performance by the subjects with cochlear implant and using hearing aid in the contra lateral ear than the subjects with cochlear implant alone. Hamzavi, J., *et al.,* in 2004 reported a higher speech recognition scores in bimodal subjects than the subjects with cochlear implant alone.

Sang - Huen et al., in 2008, reported that, speech performance in noisy environment was significantly better with bimodal hearing than in CI alone.

Michal Luntz, Noam Yehudai and Talma Shpak in 2007, examined the hearing progress in patients using CI along with hearing aid in contra-lateral ear in the first 3 years after implantation in 13 subjects. The study revealed improvement in the speech identification scores as the subjects continuously used HA in the contra-lateral ear. However, the mean scores obtained using CI alone and CI and hearing aid in the contra lateral ear were statistically not significant.

Research shows that, the cochlear implant in one ear and hearing aid in the contra lateral ear (Bimodal hearing ear) may result in binaural advantages in speech perception, localization and functional performance in real life, greater naturalness of sounds and better quality of people's voice (Ching, T. Y. C., *et al.,* 2005; Michal luntz, Noam Yehudai & Talma Shpak, 2007).

This study is designed to evaluate the speech identification scores in subjects with cochlear implant alone (monaural hearing) and cochlear implant in one ear and hearing aid in the contra lateral ear (bimodal hearing).

The objective of the current study is to determine the difference in aided puretone thresholds and speech identification scores in three different situations such as Quiet, S/N +10 dB, S/N +5 dB of children using cochlear implant alone (monaural hearing) and children using cochlear implant and hearing aid in the opposite ear (Bimodal hearing).

Materials & Methods

Subjects

A total number of 10 Telugu speaking children in the age range of 5 – 10 years (7.8 years) who used cochlear implant in one ear for at least 8 months and used hearing aid for about 2 years binaurally before the cochlear implantation. All the children were attending auditory verbal therapy after cochlear implantation. The cochlear implants used by the children were from a similar manufacturer (MED-EL). All the children were having language age more than 33-36 months (based on REELS) were included in the study.

Test Material

Speech Identification Test for Telugu Speaking Children (Avanija, 2007) was administered to collect the data. It is a closed set speech identification test consisting of 200 picture words, among which 50 were target words. For the purpose of this study 116 picture words were selected consisting of 24 target words and 5 words for practice. In the picture booklet each page consisted of 4 words, in that one picture represented as target word and rest three pictures were the distracters and the words selected were within the child's vocabulary. The target words were recorded by using Adobe audition version 2.0 in mono mode with a sampling rate of 44.1kHz and 16 bit by a native female Telugu speaker. Multi talker babble noise has been recorded from 3 speakers and mixed with signal in order to obtain required SNR (+10dB and +5dB) by using Adobe Audition Version 2.0.

Test Procedure

Subjects were subjected to detailed case history, and basic hearing evaluation including puretone audiometry and immitance audiometry. Puretone audiometry was performed across the octave frequencies from 250 Hz to 8 KHz using orbiter 922 (Madsen) clinical diagnostic audiometer connected to TDH 49 supra aural head phones. Immitance audiometry was carried out using Amplaid A 756 impedance audiometer with 226 Hz probe tone in order to rule out the conductive component.

Later a suitable single channel digital hearing aid was selected and programmed according to subjects hearing loss using NAL – NL1 prescribed procedure (recommended for bimodal fitting procedure- Ching, 2004) and fitted to the ear contra lateral to the implanted ear. Free field audiometry for octave frequencies from 250Hz to 8KHz by using Orbiter 922 (Madsen) diagnostic audiometer connected to Ahuja SCM-15XT public address sound column speaker were used to obtain aided thresholds. The subjects were placed at 0 degree azimuth and 0 degree elevation at front side. Aided threshold were obtained with cochlear implant alone (CI alone) and with bimodal device (CI + HA).

Speech identification scores were obtained in both the aided conditions (CI alone & CI + HA) using "Speech Identification Test for Children Speaking Telugu" (Avanija 2007).
The subjects were instructed to point to the correct picture that represents the word that they heard. The words were presented through loud speaker at 70 dB SPL in 3 situations, i.e in Quiet, +10dB SNR, and +5dB SNR. The correct response is given a score of one and incorrect response as zero. The obtained data was analyzed using repeated measures of ANOVA and to paired't' test too find the significant difference between the two conditions.

Results and Discussion

The results of the present study will be discussed in two terms (i) The difference in aided puretone thresholds between the children using cochlear implant alone (monaural hearing) and children using cochlear implant and hearing aid in the opposite ear (Bimodal hearing). (ii) The difference in speech identification scores in three different situations such as Quiet, S/N +10 dB, S/N +5 dB of children using cochlear implant alone (monaural hearing) and children using cochlear implant and hearing aid in the opposite ear (Bimodal hearing).

Comparison of Aided Puretone Thresholds

Frequency	CI only		CI+HA	
	MEAN	SD	MEAN	SD
250 Hz	65.5	11.8	54.5	11.6*
500 Hz	48.0	7.1	41.0	6.1*
1 kHz	49.5	7.6	46.5	7.0*
2 kHz	54.0	8.4	54.0	8.4
4 kHz	52.0	10.0	52.0	10.0
8 kHz	77.0	9.7	76.0	9.9

* Level of significance **P < 0.05**

Table 1: Aided mean threshold values of 10 subjects using cochlear implant (CI) and bimodal device (CI+HA) across octave frequencies.

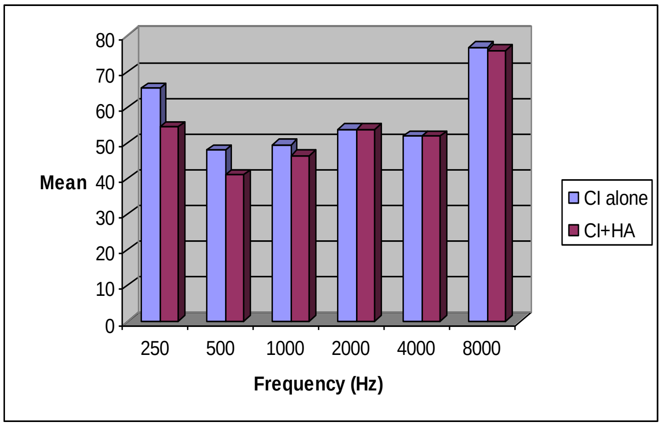

Table and figure 1 shows the aided mean thresholds of 10 subjects using cochlear implant (CI) and bimodal device (CI+HA) across octave frequencies. The mean thresholds obtained in bimodal (CI + HA) aided condition were better than CI alone aided condition at 250 Hz, 500Hz and 1KHz, which was statistically significant($p< 0.05$) . However, the mean thresholds obtained at 2 KHz, 4 KHz and 8 KHz were similar in both aided conditions.

Speech Identification Scores in two aided condition

CI alone condition

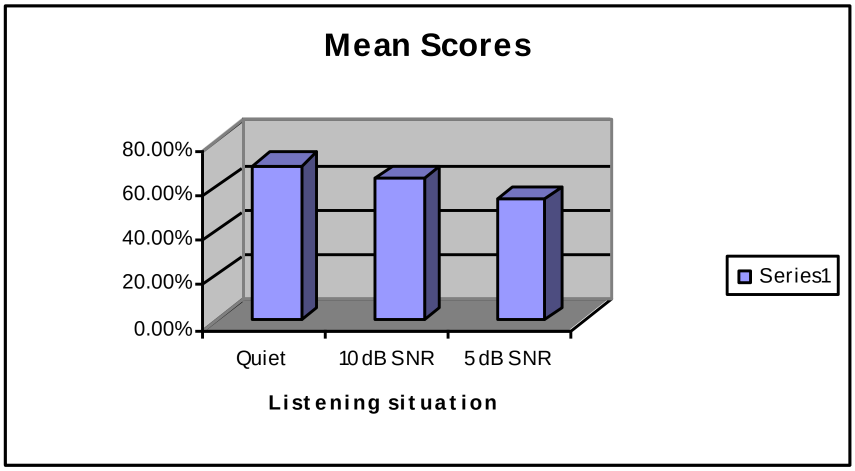

Fig: 2 Mean speech identification scores with CI alone condition in three situations

A statistically significant (p<0.05) difference was obtained when the subjects were compared for speech identification scores at CI only condition in three different situations (quite, +10dB SNR, +5dB SNR). The scores were higher (70 %) for quite situation, (63.75 %) for +10dB SNR and (54.50 %) for +5dB SNR respectively which was shown in the figure 2. This indicates that the signal to noise ratio (SNR) is directly proportional to that of the mean speech scores of the children.

CI + HA Condition

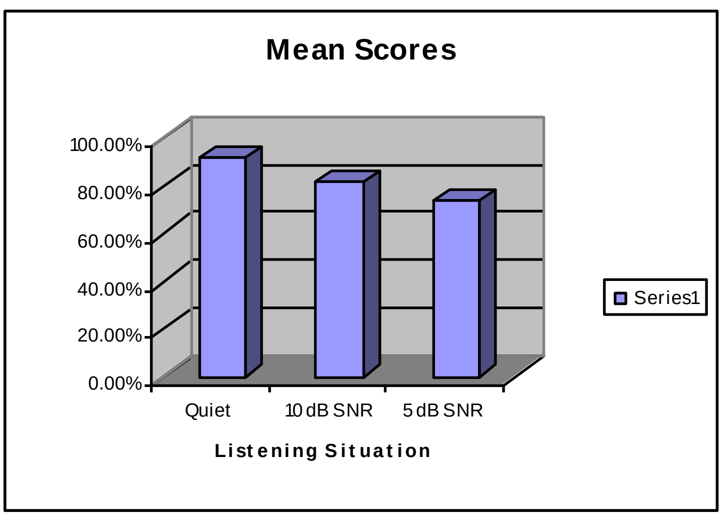

Fig: 3 Mean speech identification scores with CI + HA condition in three situations

When the subjects were compared for speech identification scores at CI + HA condition in three different situations (quite, +10dB SNR, +5dB SNR) the scores were higher (91.60 %) in quite situation comparing with the remaining two listening situations (81.6 %) for +10dB SNR and (70.75 %) for +5dB SNR which was statistically significant ($p<0.05$). These finding are in consonance with the study conducted by Leandra Tabanez do Nscimento, Maria Cecilia Bevilacqua 2005.

Comparison of speech identification scores between CI alone and CI +HA conditions in three listening situations

The obtained aided speech identification scores were compared between CI alone and CI + HA conditions. The results showed that the mean speech identification scores were higher in CI + HA condition that CI alone in all the three listening situations which was shown in the figure 3 and table 2. The obtained results were statically significant ($p<0.05$) at all the condition and situations.

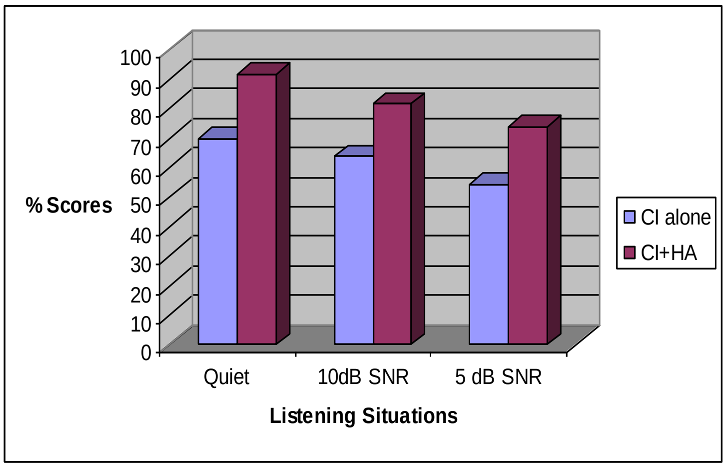

Fig 4. Mean scores in different listening situations with two aided conditions.

Listening situation	**Mean speech identification scores**	
	CI alone	**CI+HA**
Quiet	70	91.6
+10dB SNR	63.5	81.6
+5dB SNR	54.5	70.75

Table 2. mean scores of speech identification in CI alone and CI + HA condition in three listening situation.

Discussion

The aim of the present study is to determine the difference in aided puretone thresholds and speech identification scores in three different situations such as Quiet, S/N +10 dB, S/N +5 dB of children using cochlear implant alone (monaural hearing) and children using cochlear implant and hearing aid in the opposite ear (Bimodal hearing). The obtained puretone thresholds showed that the subjects performed better at 250 Hz, 500Hz and 1KHz in bimodal (CI + HA) aided condition than CI alone aided condition. However, the mean thresholds obtained at 2 KHz, 4 KHz and 8 KHz were similar in both aided conditions.

This could be attributed to the reason that the hearing loss usually have better hearing threshold at low frequencies than the high frequencies. Conversely, CI electrode arrays cannot usually be inserted into the lowest frequency regions of the cochlea.

Thus, the balance of low frequency, low pitched sensations from the CI will be a crucial feature affecting the sound quality of the bimodal devices. When speech identification scores for CI alone was compared in three different listening situations, the subjects showed better scores in quiet situation compare to that of the other two listening situations. This could be possibly considered that when the SN ratio increases which in turn increases the speech identification scores. In the similar fashion when speech identification scores for CI+HA was compared in three different situations, subjects performed better in quite than compared to the remaining two situations, which in turn proclaims that the SNR is contributing factor in speech identification. The findings of the study are in consensus with the study by Jafar Hamzavi, et al., 2004, who reported that speech recognition scores are better in CI alone than HA alone and were better in bimodal condition than in CI alone. Another study by Sang-Huen et al., 2008 showed that, the speech performance in noisy environment was significantly better with bimodal hearing than with CI alone which are in consonance with the results of the current study.

Conclusions

In conclusion, the results of the present study have shown that the use of hearing aid and cochlear implant in opposite ear results in binaural advantages in speech perception. Therefore, bimodal hearing may be considered as one of the better option in aural rehabilitation approach for the children with unilateral cochlear implant and future research can be carried out on localization and functional abilities.

Acknowledgement

The authors would like to thank Mr. R. Rangasayee Director AYJNIHH, Mumbai, India for his encouragement and support and motivation for the completion of this article. Also we would like to thank the Asst. Director AYJNIHH (SRC) for permitting us to carry out this study as a part of Dissertation. Also we would like to thank the clients and their parents who participated in this study.

References

Avanija . (2007). Speech identification test for children speaking Telugu; performance of children with hearing impairment. Unpublished Master's Dissertation, Hyderabad: Osmania University.

Ching, T. Y. C., Hill, M., Brew, J., Incerti, P., Priolo, S., Rushbrook, E., & Forsythe, L. (2005). The effect of auditory experience on speech perception, localization, and functional performance of children who use a cochlear implant and a hearing aid in opposite ears. *International Journal of Audiology, 44*, 677-690.

Ching, T. Y. C., Incerti, P., Hill M, *et al.*, (2004). Fitting and evaluating a hearing aid for recipients of unilateral cochlear implant: the NAL approach. Part2. Binaural benefits.Hear rev, 60, 11(8), 32-40.

Hamzavi, J., Pok, S. M., Gstoettne, W., Wolf-Dieter Baumgartner, W. D. (2004). Speech perception with a cochlear implant used in conjunction with a hearing aid in the opposite ear. *International Journal of Audiology, 43, 61*–65.

Litovsky, R., Johnstone, P. M., & Godar, P. S. (2006). Benefits of bilateral cochlear implants and/or hearing aids in children. *International Journal of Audiology, 45(Supplement 1)*:S78-S91.

Luntz, M., Yehudai, N., & Shpak, T. (2007) Hearing progress and fluctuations in bimodal_binaural hearing users (unilateral cochlear implants and contralateral hearing aid). *Acta Oto-Laryngologica*, *127*, 1045-1050.

Nascimento, L. T., & Bevilacqua, M. C. (2005). Evaluation of speech perception in noise in cochlear implanted adults. *Brazillian Journal of Otorhinolaryngology, 71 (4)*, 432-438.

Sang-Huen Lee, Lee, K. Y., Huh, M. J., & Hee-Sang Jang. (2008). Effect of bimodal hearing in Korean children with profound hearing loss. *Acta Oto-Laryngologica*, 128, 1227-1232.

Seeber, B.U., Baumann, U., Fastl, H. (2004) Localization ability with bimodal hearing aids and bilateral cochlear implants. *J Acoust Soc Amer*,116(3), 1698-1709.

Zurek, P. M. (1993). Binaural advantages and directional effects in speech intelligibility. Cited in G. A. Studebaker & I. Hockberg. Acoustica, *Factors Affecting Hearing Aid Performance, 2nd Edition* (pp. 255-276). Boston: Allyn & Bacon.

R. Phanindra
Consultant Audiologist
Beltone Hearing Care Centre
Apollo Hospital
Hyderabad
Andhra Pradesh, India

S.G.R Prakash, Ph.D.
A.Y.J.N.I.H.H (SRC)
Manovikas Nagar
Secunderabad - 500009
Andhra Pradesh, India
prakash_nihh@rediffmail.com

K. Balaganesan,
A.Y.J.N.I.H.H (SRC)
Manovikas Nagar,
Secunderabad - 500009
Andhra Pradesh, India

Ms. Sravanthi, M.Sc. Candidate
A.Y.J.N.I.H.H (SRC)
Manovikas Nagar,
Secunderabad - 500009
Andhra Pradesh, India

Ms. Susma, M.Sc. Candidate
A.Y.J.N.I.H.H (SRC)
Manovikas Nagar,
Secunderabad - 500009
Andhra Pradesh, India
500009.