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Original Research Article

Auditory training through cochlear habilitator (software) in children with cochlear implantation– A pre-post therapy comparison

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ABSTRACT

Cochlear Habilitator is an animated hypothetical cochlear pattern right and left with illumination from frequencies 125 Hz to 13000 Hz awareness and saving contours. This programmed has complete battery of training and testing on pure tones from 125 Hz to 10,000 Hz and environmental sounds numbering 79. The present study aimed to see the efficacy of cochlear habilitator in cochlear implant children. A total 10 cochlear implant children under which 4-female and, 6-male participants with in the age range of 3-7 years participated in this study with normal IQ and no history of any health problems. The cochlear habilitator (software) was installed in a laptop connected with two loudspeakers, which are configured with the cochlear habilitator (software) with azimuth angle of 180 degree. The 10 cochlear implant participants were selected based on the subject selection criteria, from the speech and hearing clinic and auditory training was provided for 28 days/sessions. The data was analyzed using SPSS software (version 17.0). T test values shows there is a significant difference in all tasks individually and on overall performance. The mean scores of Post therapy test is higher than the pre-therapy test. Hence cochlear habilitator computer based online software is a useful tool for cochlear implant children's management in auditory training.

1. Introduction

Hearing is one of the most important senses of human being. It forms a vital link to the world of communication. Hearing is essential for the acquisition of the speech and language. The hearing mechanism is also essential for monitoring one's own speech production (*Yost*, 1994). The essence of a hearing loss thus, has its effect on communication and resulting impact on cognition, speech, language and psychological development and functioning of human (*Vernon & Andrews,* 1990). The impact of hearing loss has its onset during adulthood and depends on several factors, these include age of onset (i.e., prevocational or post vocational) nature, degree and configuration of hearing loss, life style and occupation of the person, and perceived handicap. Amplification device provide a valuable communication link between the hearings impaired listener and his acoustic environment. If the loss is severe to profound, amplification device may not provide good benefit. Cochlear implantation (CI) is today the best-known treatment for bilateral profound hearing loss for those who does not respond to the use of powerful external hearing aids.

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After cochlear implantation, the most important aspect is intervention of the children. For the intervention of the child there are various steps, in these first step is auditory training. Several authors have described about auditory training. *Carhart* (1960), *Oyer* (1966) and *Rose* (1972) reported that the auditory training is a systematic training of an individual. Residual hearing for the improvement of auditory abilities. *Goldstein* (1939) viewed auditory training as involving the stimulation or education of the hearing mechanism and its associated sense organs by sound vibration as applied either by voice or by sonorous instrument. It includes differentiation of pitch, rhythm, accent, volume and inflection as well as analysis and synthesis of speech sounds presented as tactile impressions. His definition goes beyond the auditory input level to include the perception and integration of speech. [1]

The ultimate aim of auditory training is to achieve maximum communication potency developing the auditory sensory channel to its fullest. Although the primary goal of auditory training is to maximize communication abilities, it is important to point out that achieving this basic goal can result in other achievements including acquisition of more proficient speech and language skills and successful psycho-social adjustments (*Schow and Narbonne*, 1989). [2]

Cochlear Habilitator is an animated hypothetical cochlear pattern right and left with illumination from frequencies 125 Hz to 13000 Hz awareness and saving contours. This programmed has complete battery of training and testing on pure tones from 125 Hz to 10,000 Hz and environmental sounds numbering 79. Total of 79 sounds of environments choose over 10 different categories with a phenomenal structured looping of sounds from seconds to minutes to hours highlighting auditory spatial memory awareness, discrimination, identification and stabilization.

2. Method

The present study aimed to see the efficacy of cochlear habiliator in cochlear implant children.

3. Participants

A total 10 cochlear implant children with in the age range of 3-7 years participated in this study.

The following Inclusion criteria were used to select the participants.

The participants should have normal IQ, Cochlear implant should be done with in the age of 3-7 years, before cochlear implant minimum 1 year of speech therapy, after cochlear implant minimum 6 months of speech therapy.

The following Exclusion criteria were used to select the participants.

The participants have no history of neurological problems and any health problems.

Table 1: Details of participants.

S.No.	Chronological age	Cochlear implant age	Gender
1.	7 years	6 months	Male
2.	6 years	1 year	Male
3.	3 years	1 year	Male
4.	4 years	6 months	Male
5.	3.6 years	6 months	Male
6	5 years	1year	Male

In Table 1 there were 6 male participants with an age range of 3-7 years with mean age of 4.7 years.

Table 2: Details of participants.

S.No.	Chronological age	Cochlear implant age	Gender
1.	3 years	6 months	Female
2.	5 years	6 months	Female
3.	4 years	6 months	Female
4.	4 years	1 year	Female

InTable 2 there were 4 female participants with an age range of 3-7 years with mean age of 4 years.

4. Equipment

In this study cochlear habilitator (software) was used. The software is installed in a laptop (Lenovo, Window), connected to internet and two loudspeakers (Sony), which are configured with the cochlear habilitator (Software) with azimuth angle of 180 degree.

Cochlear Habilitator is an animated hypothetical cochlear pattern right and left with illumination from frequencies 125 Hz to 13000 Hz awareness and saving contours. This programme has full batteries of training and testing on pure tones from 125 Hz to 10,000 Hz and environmental sounds numbering 79. Total of 79 sounds of environments choose over 8 different categories with a phenomenal structured looping of sounds from seconds to minutes to hours highlighting auditory spatial memory awareness, discrimination, identification and stabilization. Statistical data reports login and daily, weekly, and monthly report can be generated with performance outlook with pie diagram, bar diagram, line diagram and percentage growth. In this software have two types of Task: Task 1 (awareness of sound) have eight modules, Transports (8 items), Birds (5 items), Animals (4 items), Water (6 items), Sports (5 items), Households (10 items), Music (4 items) and Electronics (6 items). Task 2 (discrimination of sound) also have eight modules, Transports (8 items), Birds (5 items), Animals (4 items), Water (6 items), Sports (5 items), Households (10 items), Music (4 items) and Electronics (6 items). [3–6]

Room setup: In this study auditory training was carried out in a quiet, noise free AVT room. The room has a table,

chair, laptop and loudspeaker. The child was seated in front of the laptop and the loudspeaker are placed at the 3 feet from the child.

5. Procedure

The 10 cochlear implant participants were selected based on the subject selection criteria of the present study, from the speech and hearing care clinic, Patna. The entire procedure was carried out in four phases.[7] Phase I checked the working condition of cochlear implant- electrodes through cochlear habilitator by giving the different frequencies of sounds, phase II pre-therapy testing of task 1 (awareness of sound) and Task 2 (discrimination of sound), phase III auditory training on task 1 (awareness of sound) and Task 2 (discrimination of sound), phase IV Post- therapy testing task 1 (awareness of sound) and Task 2 (discrimination of sound) was carried out. Entire testing and auditory training was carried out in an Auditory Verbal Therapy room setup.

Phase 1: The cochlear habilitator was used to check the working condition of cochlear implant- electrodes through cochlear habilitator by giving the different frequencies (125Hz — 13000 kHz pure tone.) of sounds for cochlear implant participants. The responses were written in response sheet (Appendix: 1). The instructions were given verbally along with hand gesture by the researcher (and their parents as required) are as follows:

"Now, I am going to present you different types of sounds, as you hear the sound, you have to raise your hand".

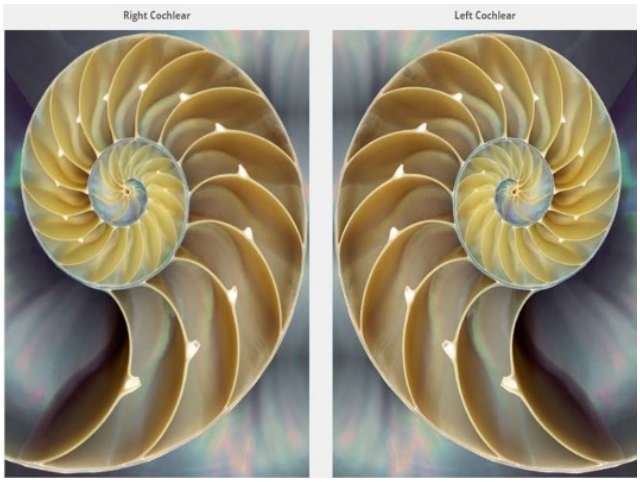

Fig. 1: Cochlear.

Phase 2: In this phase Pre-therapy test on task 1 (awareness of sound) and Task 2 (Discrimination of sound) was done. It was carried out through cochlear habilitator that consists of eight modules (79 items) of awareness and discrimination, different environmental sounds. The scoring was given in response sheet-2, score "1" for correct response and "0" for incorrect response. The participants were instructed by the researcher as follows:

"Now, I am going to present different sounds from the environment, as you hear the sound you have to point it out on laptop screen".

Phase 3: In this phase auditory training for task 1 (awareness of sound) and Task 2 (discrimination of sound) was given to all the participants for 28 days, 30 minutes each session. The auditory training was carried out through cochlear habilitator (software) which consist of awareness, discrimination and statistics.[8,9] Firstly, A trained and qualified audiologist and speech language pathologist will

Fig. 2: Aero plane.

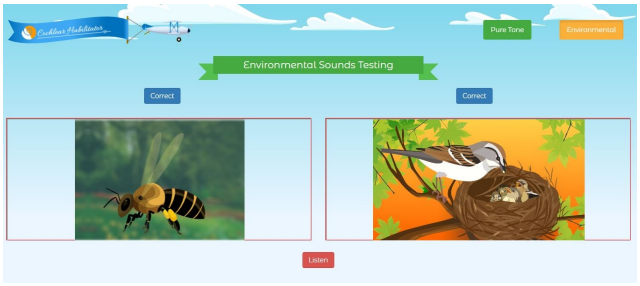

Fig. 3: Differentiation.

Table 3: Comparison of pre-therapy and post-therapy performance of 10 cochlear implant children on Task 1 (awareness of sound).

Modules	Pre-therapy test		Post-therapy test		P-value
	Mean	**Standard deviation**	**Mean**	**Standard deviation**	
Transport *	16.25	10.29	66.00	9.66	0
Bird *	24.00	12.64	57.50	12.07	0
Animals *	45.00	10.54	65.00	21.08	0.015
Water *	0	0	33.33	11.42	0
Sports*	0	0	13.14	5.71	0
Household *	5.00	8.49	35.00	17.48	0
Music*	0	0	18.19	4.59	0
Electronics *	0	0	25.00	11.78	0

* P< 0.05 Significantly difference

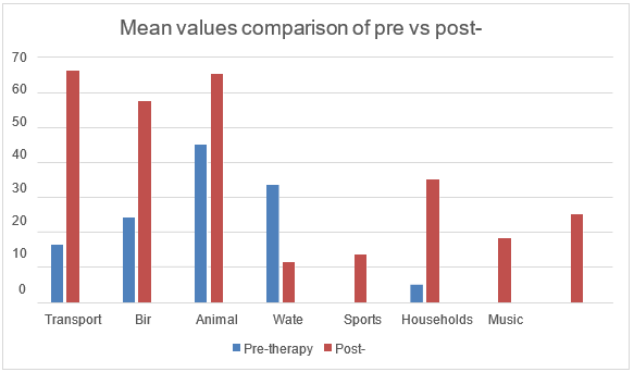

Fig. 4: Comparison of pre-therapy and post-therapy performance of 10 cochlear implant children on Task 1 (awareness of sound).

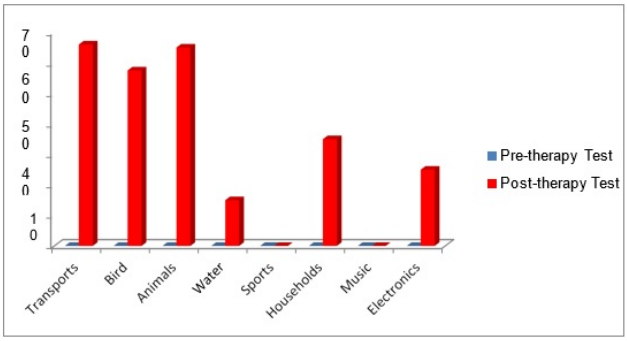

Fig. 5: Comparison of pre-therapy and post-therapy performance of 10 cochlear implant children on Task 2 (discrimination of sound).

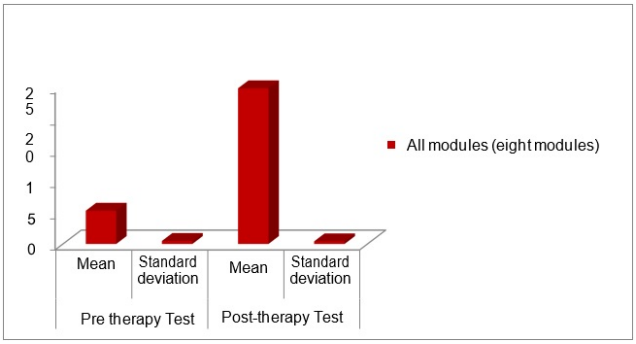

Fig. 6: Comparison of overallperformance of 10 cochlear implant children.

work on awareness (i.e. task 1) and discrimination (i.e. task 2) which consist eight modules each. After completing the tasks, a graphical representation of the overall child's performance is displayed by pressing statistics icon and load the task sheet.

Phase 3: In this phase Post — therapy test on task 1 (awareness of sound) and Task 2 (discrimination of sound) was done. It was carried out through auditory skill test that consists of Eight Module of awareness and discrimination with different environmental sounds. The scoring was given in response sheet "1" for correct answer and "0" for incorrect answer. The participants were instructed by the researcher as follows:

"Now, I am going to present different sounds from the environment, as you hear the sound you have to point out with the help of finger".

6. Results and Discussion

The data collected, was analysed using SPSS software (version 17.0). In this study mean and standard deviations were compared for Task 1 (awareness of sound) and Task 2 (discrimination of sound) for pre-therapy performance and post-therapy performance on ten cochlear implant children. T test was used for comparison of overall performance on ten cochlear implant children for pre-therapy performance and post-therapy performance. [10]

Analysis was done to obtain mean and standard deviation score of Task1 (awareness of sound) and Task2 (discrimination of sound) for pre-therapy test and post-therapy test on ten cochlear implant children, overall performance of pre-therapy test and post therapy test for ten cochlear implant children. The result revealed that there was significant difference in Task 1 (awareness of sound) and Task 2 (discrimination of sound) for pre-therapy test and post- therapy test on ten cochlear implant children and overall performance of pre-therapy test and post therapy test for ten cochlear implant children. The post therapy performance of task 1 (Awareness of sound) and task 2 (discrimination of sound) shows improvement. [11]

The mean score for pre-therapy and post-therapy performance Task 1(awareness of sound) of transport, bird, Animal, Water, Household and electronics for ten cochlear implants children are better in post-therapy test than pre-therapy test. The post therapy performance of task 1 (awareness of sound) sounds of transport, bird and animal module are higher than compared to pre-therapy performance task 1 (awareness of sound). In pre-therapy performance scores of water and electronic sounds modules were zero (i.e. floor level) but in post therapy performance after 28 sessions of auditory training shows average improvement. The sounds of household module in pre-therapy performance were 5% but in post therapy performance it can see 35% of improvement. The score of Sport and music sounds modules were zero in pre-therapy performance while in post-therapy it shows average improvement.

Thus, the pre-therapy performance of task 1 (awareness of sounds) are better than post- therapy performance of task 1 (awareness of sounds) because the cochlear habilitator is an attractive tool with animations, children listen the sounds as well as see picture of that sounds. So, the attention of the children is better during the auditory training session. To learn auditory skills child's attentive and active participation

Table 4: Comparison of pre-therapy and post-therapy performance of 10 cochlear implant children on Task 2 (discrimination of sound).

Modules	Pre-therapy test		Post-therapy test	
	Mean	Standard deviation	Mean	Standard deviation
Transports	0	0	66.00	14.14
Bird	0	0	57.50	17.67
Animals	0	0	65.00	53.03
Water	0	0	15.00	35.35
Sports	0	0	0	0
Households	0	0	35.00	35.35
Music	0	0	0	0
Electronics	0	0	25.00	17.67

Table 5: Comparison of overall performance (task 1 and task 2) of 10 cochlear implant children.

Modules	Pre -therapy test		Post-therapy test		P value
Modules	Mean	Standard deviation	Mean	Standard deviation	
All Eight modules	5.30	0.48	24.80	0.42	0 *

* $P < 0.05$ Significantly difference

is very much essential. Thus, children were motivated to listen the sound. So, the auditory training through cochlear habilitator (software) is beneficial for cochlear implant children.

The present study results are correlating with the findings of *Kant and Adhyaru* (2009) developed a home based auditory training programme in Hindi and Marathi for hearing aid users which had poems embedded with environmental sounds. The result revealed good performance in 90% of the children.

The mean score of Task 2 (discrimination of sound) for transport, bird, Animal, Water, Household and electronics on ten cochlear implants children are better in post-therapy test than pre-therapy test. The score for all modules in pre-therapy performance of task 2 (discrimination of sound) are Zero (i.e. floor level) but in post therapy performance of task 2 (discrimination of sound) of transport, bird and animal modules score were ceiling level. After 28 sessions of auditory training shows average improvement in water, household and electronic sounds modules. But there was no improvement seen in sports and music sounds.

Figure 6 shows that there is a significant difference between pre-therapy test and post-therapy test. The mean scores of Post therapy test is higher than the pre-therapy test.

To check the Overall performances on Task 1 (awareness of sound) and Task 2 (discrimination of sound) of ten cochlear implant children for all eight modules of pre-therapy test and post-therapy test. It was observed that there is significant difference between Task 1 (awareness of sound) and Task 2 (discrimination of sound) for pre-therapy test and post-therapy test of Transports, Bird, Animals, Water, household and Electronics. There is no significant difference of Sports and Music.

The present study results are correlating with the findings of *Nogaki* et al. 2004 & 2005 and *Qian-jie* et al. 2007 & 2013 study results revealed the pre- therapy test were significantly lower than the post-therapy test.

Fu, Galvin, Wang, and Nogaki (2004) demonstrated significant improvement when adults with CIs completed a daily computerized training program. All participants trained for 1 hour each day, 5 days per week. Both vowel and consonant recognition improved, from 22% to 36% and from 25% to 38%, respectively. *Miller, Watson, Kistler, Wightman, and Preminge*r (2008) evaluated the effect of the Speech Perception Assessment and Training System (SPATS; described in Table 1) with a group of experienced Cochlear implant and hearing aid users. Test sentences significantly improved an average of 13% after 24 hours of training compared to the control group. In addition, participants reported that the training increased the awareness of their individual speech sound difficulties. Similarly, Stacey and colleagues (2010) evaluated a 15-hour computerized home auditory training program for adult Cochlear implant users. Researchers reported that neither sentence recognition nor vowel perception improved after training, yet consonant discrimination did improve significantly by 8%.

Wu, Yang, Lin and Fu (2007) studied the use of auditory training in improving the recognition of Chinese tones, vowels and consonants in children with hearing impairment using a computer programme. It was observed that the mean tone, vowel and consonant recognition scores significantly improved after training. The follow-up measure also shows significantly higher performance than the pre-training baseline measurement for all three stimuli, suggesting that the improvement could be retained after the training had stopped.

Qian-jie et al. (2013) investigate whether moderate amounts of computer-assisted speech training can improve the speech recognition performance of cochlear implant children. The result suggests that moderate amounts of auditory training, using a computer- based auditory

rehabilitation tool with minimal supervision, can be effective in improving the speech performance of hearing impaired children.

From the present study it can be concluded that the auditory training through cochlear habilitator is beneficial for cochlear implant children to develop the awareness and discrimination of sound. The computer based auditory training are much better than the traditional auditory training. The cochlear habiliator is an attractive tool with animations, children listen the sounds as well as see picture of that sounds. So, the attention of the children is better during the auditory training session. To learn auditory skills child's attentive and active participation is very much essential. Thus, children were motivated to listen the sound. So, the auditory training through cochlear habilitator (software) are beneficial for cochlear implant children. The clinical implication of this study is that cochlear habilitator computer based online software is a useful tool for cochlear implant children's management in clinical setup as well as auditory training at home.

7. Source of Funding

None.

8. Conflict of Interest

The author declares that there is no conflict of interest.

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