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A Study on the Effects of Early History of Recurrent Ear Infections on Word Discrimination Abilities in Children

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Introduction

Hearing is important for speech and language development, communication, and learning. Early history of recurrent conductive type of hearing loss disturbs the hearing mechanism which causes significant reduction in the hearing sensitivity. The reduced auditory

input, if in the early years of development may adversely affect the structural as well as functional development of the auditory system. Some possible causes of conductive hearing loss are fluid in the middle ear from colds, Otitis media, poor Eustachian tube functioning, eardrum abnormalities, impacted earwax, infection in the ear canal, absence or malformation of the outer ear, ear canal, or middle ear.

Otitis media (OM) in its all forms is one of the most frequently occurring diseases (Majeed & Harris, 1997). This condition and its various effects, including fluctuating conductive hearing loss may have a long term impact on how the child behaves and learns. It has been well established that many children experience episodes of Otitis media and although they tend to resolve rapidly, a variety of sequelae may develop (Daly, 1997). The sequelae may be medical or non-medical and may exist for a short or long period of time. It has been reported that hearing loss which results from Otitis media would lead to a variety of non-medical sequelae which include "adverse effects in speech, language, development and balance in some children (Casselbrant , Gravel, Margolis, Bellussi,, Dhooge, & Downs, 2002) culminating in learning and behavioral problems (Klein, 2001, as cited in J. S. Stenton , 2003).

Finitzo, Gunnarson & Clark (1990) suggested that not only is the central nervous system sensitive to even minor fluctuation in hearing in early life there is also a basis for a hypothesis if a critical developmental period for auditory abilities that can be disrupted by auditory deprivation from early Otitis media with effusion. This view leads to the suggestion that even minor aberrations in auditory input in the early stages of child development could result in permanent impairment in auditory processing (Vernon- Feagans & Proctor, 1994). According to Benasich & Tallal (2002) it is possible that a history of Otitis media with effusion lead to a delay in the maturation of central auditory path ways in children because of the auditory deprivation resulting from a conductive hearing loss. There is support too for the theory that these abnormal sensory input may be associated with chronic perceptual disability (Hall, Grose, & Drake, 1997) which could lead to delays in child development and learning. Hasenstab in 1992 have attempted to identify various aspects of speech detection, discrimination, and development which may be

affected by conductive hearing loss as a result of history of Otitis media. Deficits were found in processing and representing auditory information and immediate recall for sequential patterns were also below the expected level.

Because of the fluctuating nature of the hearing loss some researchers believe that its impact may be greater than that of the permanent hearing loss (Madell, 1999). Earlier researchers like Northern, Downs and Menyuck (Vernon & Feagans, 1999) assumed that Otitis media with effusion that lead to prolonged periods of hearing loss would result in a degraded input for children and this would affect their language development and speech discrimination skills immediately, resulting in poor verbal skills several years later with subsequent problems in academic development. A number of studies have been attempted to identify whether or not there is impact on academic learning and communication skills caused by conductive hearing loss resulting from Otitis media with effusion (Zinkus, Gottlieb & Schapiro, 1978; Winskel & Heather, 2006). Children with Otitis media exhibited reduced phonemic sensitivity and poor application of phonic knowledge which could lead to difficulties in spelling and reading (Dwyer 1992). Southern California Evidence based practice center prepared an evidence based report (Shekelle, Takata & Chan, 2003) for the Agency for Healthcare Research and Quality, Rockville in 2003. The report reviewed the 449 articles and identified 20 studies that fulfilled their criteria for analysis. Based on the limited number of cohort studies, there was no evidence to support an impact of early life Otitis media at less than 3 years of age, on expressive language, receptive language, or cognitive verbal intelligence at age older than 3 years.

In an Indian study (Maruthy & Mannarukrishnaiah, 2008) on the effect of early onset Otitis media on brainstem and cortical auditory processing**,** Click evoked auditory brainstem responses (ABRs) and late latency responses (LLRs) were recorded from thirty children, who had Otitis media between 6 and 12 months of age these children, and the responses were compared with those from age and gender matched normal children without any history of Otitis media. The mean central conduction time was significantly increased and the mean amplitude of wave I and III of Auditory brainstem response (ABR) was significantly reduced in children with early onset

OM compared to normal children. Also, the latency of all LLR waves was significantly less in children with early onset OM than in normal children. There was a significant, but negative association between central conduction time and latency of LLRs.

In another study (Tyagi, 2002) central auditory processing disorders in children with history of Otitis media were investigated using ABR, LLR and Mismatch negativity (MMN). The analysis of results revealed that majority of subjects had normal ABR as reflected by normal inter peak latency. Abnormality in ABR indicating brainstem dysfunction was noticed in only two subjects. The onset of Otitis media was earlier in these two subjects when compared to others whereas the abnormalities on LLR and MMN were seen even when the onset was late.

Auditory processing ability in children who had history of early Otitis media with effusion was studied by Amala in 2003 using Duration pattern test, Speech-in-noise test, Dichotic CV test. The results revealed that the subjects with unilateral or bilateral history of Otitis media exhibited significantly poorer performance in all the three tests, indicating the deficits in temporal ordering skills, auditory separation tasks and auditory integration skills. Sailaja (2005) studied the auditory temporal processing deficits in subjects with Otitis media using psychophysical just noticeable difference (JND) and then later for physiological JND using MMN. Results indicated that values of psychophysical JND obtained in the subjects with Otitis media was compared to be more than normal groups also the MMN latencies were more prolonged in subjects with Otitis media indicating the deficits in temporal processing.

Auditory discrimination tests could be used to identify the speech discrimination abilities of the children with recurrent attacks of Otitis media. Auditory discrimination is used to refer to the ability to differentiate behaviorally between auditory stimuli of many types. These skills affect an equally broad range of auditory behaviors, like word recognition and speech comprehension in quiet and noisy environment, or the ability to distinguish the musical or prosodic aspects of speech. The children with auditory discrimination problem may perform poorly on speech and language skills.

Need for the Study

A brief review of literature discussed above highlights the current status of research in the area of effects of early Otitis media on speech, language and hearing skills. The studies indicate that there are contradictory findings in the literature regarding the long-term effects of early onset Otitis media. Although there have been research focused on this area, all of it seems to be in foreign context and there are very few studies which highlight Indian context. It is important to explore whether the early auditory deprivation due to inferior use of auditory channel impede the acquisition of various skills for developing Speech, Language and Hearing. A particular concern for Audiologists, Speech Language Pathologists and Otolaryngologists in India is the lack of data on Indian population of children having early history of Otitis media. Hence research in this area requires additional inputs. Keeping all of these factors in mind the present study aims at identifying the effect of early history of recurrent ear infections on auditory discrimination abilities in Malayalam speaking children.

Methodology

The study was carried out in children between the age ranges of 6 to 8 years of age among various urban and semi-urban schools across Kottayam town in Kerala. Since the study was meant to understand the history of ear infections in children, parent information was considered important. The questionnaire was prepared in English and translated in to Malayalam language. The language constancy, clarity of intended meaning i.e., content validity was established. Ten experienced audiologists validated the questionnaire with 90% or more agreement.

The parent questionnaire prepared can be divided into three parts.

1. Information of the child and the parents (Name, age, sex, parent' occupation, income, etc.).
2. Information including the history of ear disease and other questions relating the treatment issues.

3. A 7-point rating scale based on the perceptual evaluation of the parents over the various symptoms associated with Otitis media.

The questionnaire consisted of 19 questions most of which were Yes/No questions. The questionnaire prepared in Malayalam and English languages was distributed according to the preferences of the teachers as to the number of English or Malayalam questionnaires they would require to distribute them to the children. Question 1 to 6 were to elicit responses of the history of ear infections that is, the age of first occurrence, frequency of occurrence, age at last infection, etc. Questions 7 to 19 were concerned with the medical and other treatment issues related to Otitis media. A total of five hundred questionnaires were distributed among various urban and semi-urban schools across Kottayam town. The questionnaire was given to the parents through the class teachers of respective schools to be filled by either of the parents and was asked to return it after 4 days.

The questionnaires were taken back after 4 days from all the schools and were analyzed for various issues. Out of the 500 questionnaires that were distributed, 350 questionnaires were returned. In the 350 questionnaires that were returned, 20 children were found to have the incidence of ear infection more than five times at age of 0 to 3 years. This 20 children were undergone audiological screening and hearing thresholds were found within <20dBHL.

"Auditory discrimination test in Malayalam" (Varghese, 2009) was administered on twenty children who had recurrent ear infection. The stimulus unit used for the study consisted of 36 word pairs recorded at two different conditions. In one condition the entire set of the stimuli was recorded at quiet condition, while in the other condition the white noise was added to the entire stimulus duration at 0dB SNR. Thus the stimulus was recorded in two conditions- quiet and noisy. The testing was carried out in the school setup. The at most care was taken to ensure that the testing environment is far from the noise and other distractions. Prior to the presentation of the stimuli the subjects were trained by the examiner to respond correctly. The entire training was done with the help of five word pairs that was orally told by the examiner. The stimuli were

presented via a Philips headphone with frequency response ranging from 20HZ to 20KHZ using the laptop. The output volume of the headphone was calibrated and set at 70dB SPL. The children were presented with minimal pair of words and were asked to report whether the words were same or different. The presentation was done in both quiet and noisy situations.

Results

Of the 500 questionnaires distributed 350 were returned after filling, making the response rate as 70%. The questionnaires were returned after 4 days and responses were analyzed.

Table 1 shows the total amount of questionnaire's that were distributed and total number of filled questionnaire's that were returned. From the total number of questionnaire's that were retuned it can be seen that the, 20% (70 out of 350) of the children had at least one attack of ear infection during their early years. It was also seen that 20 out of 350 had ear infections more than 5 times in their childhood, which accounted to 5.71%.

Total No. of school children given the questionnaire	500
Total No. of questionnaire filled and returned.	350
Total No. of subjects having at least one incidence of middle ear infection.	70
Total No. of subjects having ear infection more than 5 times.	20
Percentage of subjects having incidence of single middle ear infection.	20%
Percentage of subjects having incidence of recurrent ear infection.	5.71%

Table 1: Shows the total number of subjects having at least one incidence of ear infection and the total number of subjects having more than 5 incidences of ear infection.

The 20 children who had more than 5 attacks of ear infections were further tested using an auditory discrimination test in Malayalam language. The table 2 shows the normative values for the performance of children on auditory discriminations in quiet and noisy conditions. The

50th percentile was taken as the cut off score during testing the auditory discrimination skill in children with recurrent attacks of ear infection.

	25th percentile	**50th percentile**	**75th Percentile**
QSD	28	29	30
NSD	27	28	29

Table 2: Represents the normative values for the performance of children on auditory discrimination in quiet and noisy condition.

Sub no.	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
QSD	28	29	27	31	30	30	29	28	33	28	29	28	33	30	29	31	27	29	31	29
NSD	21	22	25	19	23	25	22	26	20	23	24	22	24	21	24	26	26	19	25	22

QSD: same and different in quiet condition;
NSD: same and different in noisy condition.

Table 3: Shows the results of auditory discrimination test which were done in quiet and noisy conditions on children with recurrent ear infection.

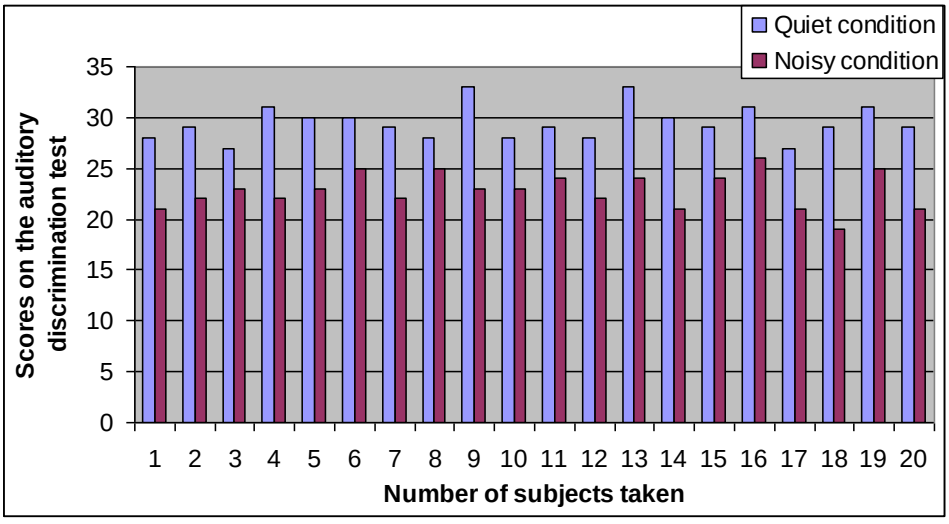

Figure 1: Shows the scores on the auditory discrimination test by 20 subjects in quiet and noisy conditions.

The table 3 and figure 1 show the scores of the 20 children with recurrent ear infections on the auditory discrimination test in quiet and noisy conditions. The scores obtained by each subject were compared to the normative values provided. The 50th percentile was the cut off score taken as the passing criteria on the auditory discrimination test. From the above figure it can be seen that most of the children had normal scores, that is above 29 at 50th percentile in quiet listening condition, except of subject number 1, 3, 8, 10, 12, 17, who slightly poorer scores in the quiet listening conditions as well. When the subjects were tested in the noisy condition it was seen that all subjects had poorer scores and had scores of less than 28, which was the cut off for the noisy condition. In quiet listening condition 14 out of 20 subjects reached 50th percentile point scores. In noisy listening all 100% of subjects failed to reach the 50th percentile cut off score on the auditory discrimination task. Indicating that under difficult condition the auditory discrimination performance is markedly reduced. Though an in-depth statistical analysis was not carried out to see the significance between the scores in two conditions, that are noisy and quiet, the results show a marked difference between the scores in noisy condition and the scores in quiet condition.

Discussion

The present study reports significantly reduced auditory discrimination abilities in children of 6 to 8 years old having 5 or more episodes of ear infections in their first three years of age. This finding is supported by studies (Benasich &Tallal, 2002; Hasenstab, 1992; Hall, Grose & Drake, 1997), which have shown multiple auditory problems in speech discrimination and perception. Its i possible that intermittent period of reduced hearing sensitivity in interaction with factors such as environmental stimulation can result in difficulties of perceiving entire spectrum of speech stream. The minimal pairs used in the present study in Malayalam language in addition to the phonologically different or also semantically different. Hence consequences of this deficit could be severe on general language processing and further education.

Generally auditory deficits in children with early fluctuating hearing loss are restricted to peripheral deficits. The auditory discrimination deficits in the present study point to central auditory deficits which raises the risk value of ear infections. It could be interesting to understand which aspects of spectral information are contributing to the deficit reported. Future studies can focus on isolating the spectral data. Since the auditory discrimination test used in present study is at word level conclusion regarding the impact of linguistic context cannot be drawn. It appears reasonable to assume that the language context may compensate phoneme discrimination deficits caused by Otitis media. Future studies can incorporate this issue.

Conclusion

In this preliminary study of testing speech discrimination abilities of Malayalam speaking children having been five episodes or more of ear infection significantly poor performance has been noted and this points to need for more detailed investigations. Prevention and treatment of ear infections in early childhood needs to be taken up with renewed vigor.

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