
LANGUAGE IN INDIA

Strength for Today and Bright Hope for Tomorrow

Volume 14:1 January 2014
ISSN 1930-2940

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Phonological Awareness Skills in Children with Early Transient Ear Infections

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INTRODUCTION

An extremely important factor in language development is the sheer amount of speech input that the infant and young child receives. Even before the child understands the meaning of words, the child notices regularities in the acoustic properties of speech input. Consequently the infant develops acoustic-phonetic representations for sound categories that allow him or her to ignore acoustic variation that is not meaningful and attend selectively to acoustic variation that is meaningful. Children who experience recurrent ear infections in their early infancy typically

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receive less speech input from their parents and show delays in speech perception, phonological awareness, and language development relative to children who receive adequate input

A hearing loss, first and foremost, interferes with a child's detection and recognition of speech. In the case of a conductive type of hearing loss, for example due to Otitis media, it may cause fluctuating hearing levels and the development of auditory skills that are prerequisite to the development of receptive and expressive language skills, as well as speech intelligibility, are delayed. In turn, a delay in the early development of auditory skills caused by a hearing loss negatively impacts a child's ability to learn and use an auditory–oral language system. The reduced auditory input, if in the early years of life when the auditory neural system is still maturing, may adversely influence the structural as well as functional development of the system, which in turn will affect the normal acquisition of speech, language and communication.

Otitis media (OM) is a general term used to describe any inflammatory process of the middle ear (Jung & Hanson, 1999). A number of studies (Teele, et al., 1980; Marchant, et al., 1984; Gravel, et al., 1988; Owen, et al., 1993; Hogan, et al., 1997; as cited in Hartley, 2000) reported that almost all (50 – 100%) children have an episode of OME in the first few years of life. Though most children only suffer from one or two brief episodes, a significant minority (18%) (Hogan et al., 1997 as cited in Hartley, 2000) suffers from OM for more than half of the first three years of life. In India, it is reported that OM was the cause of conductive hearing loss in nearly 71% of the 1505 persons ranging in age from 1 – 80 years. (Parsram & Jalvi as cited in Maruthy & Mannarukrishnaiah, 2008).

Otitis Media and Its Sequelae

During human development a period appears during which normal auditory input is crucial for a later development of optimal auditory function. In humans, the first three years of life are important for language development (Meyuk, 1996; cited in Gravel & Ruben, 1996).

One of the first reports on the developmental effects of early ear disease was made by the psychologist working with the language learning problems (Eisen, 1962 cited in Northern & Downs, 2002).

In a prospective and cross-sectional study (Wertzner, Santos, Pagan-Neves, 2012) speech errors in children with early onset otitis media were studied in twenty-one subjects aged between 5 years and 2 months & 7 years and 9 months with speech sound disorder grouped according to the presence of otitis media history: experimental group 1 (EG1) with 14 subjects with otitis media history and experimental group 2 (EG2) with seven subjects without otitis media history. The amount of speech errors (distortions, omissions and substitutions) and the articulation indexes were calculated. Picture naming and words' imitation tasks from the phonology test of the Infantile Language Test developed for Brazilian Portuguese-speakers was applied. The calculated the speech errors based on these tasks. The performances of EG1 and EG2 regarding the indexes were different from each other in both phonological tasks applied. They concluded that the greater occurrence of speech errors observed in the picture naming task in children with otitis media history indicates that such errors are possibly associated to difficulties in phonological representation secondary to fluctuating conductive hearing loss.

Rvachew , Slawinski , Williams & Green (1996) studied the impact of early onset otitis media on babbling and early language development. The study investigate d the impact of OM on the development of canonical babble in children who experienced at least one episode during the period birth through 6 months of age, in comparison with children who did not experience OM during this period. The results show a consistently lower rate of canonical syllable production among children with early onset OM, when compared to children with later onset OM, during the period 6 through 18 months of age. In addition, a relationship between canonical babbling ability and expressive vocabulary size was observed at 18 months of age.

In the Dunedin Study, a long term research programme, Bennett, Haggard, Silva & Stewart, I. (2001) found that some effects of otitis media with effusion on children's reading can be shown under some circumstances. They reported that at age thirteen reading and spelling appeared to be negatively influenced by a history of otitis media with effusion. They found that

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there was at least a two-year delay in reading scores for children with persistent otitis media with effusion in childhood compared with children with normal ears.

Bennett, et al. (2001) suggest that the causal pathway from early otitis media with effusion to reading effects is unclear, however, they do suggest that a possible association is less efficient phonological coding in short term memory, which is a predictor of early reading ability. But this does not necessarily suggest the cause of the long term effect, although they suggest it may be associated with an aspect of identity and motivation which reasserts itself with age (Bennett, et al., 2001).

Following a review of nineteen studies which attempted to find a relationship between otitis media and academic achievement, Wallace and Hooper (1997) came to the conclusion that there “may be a modest effect of OM on academic skills, with the effect somewhat stronger for language-based skills such as reading, spelling, and written language”. They found that few of the studies included other variables such as parental education and intelligence or the quality of the care-giving environment, which could have explained the relationship between otitis media and academic achievement. They also noted that the studies examined did not look for an effect related to the duration of time the children had the disease, that is whether or not the disease had resolved by the age of three or continued on into the preschool and early school years.

Nittrouer & Burton (2005) studied the role of early language experience in the development of speech perception and phonological processing abilities: evidence from 5-year-olds with histories of otitis media with effusion and low socioeconomic status. Participants were forty-nine 5-year-olds, evenly distributed among four groups: those with chronic otitis media with effusion (OM), subjects with low socio-economic status, subjects with both conditions, or subjects with neither condition (control). All children participated in tasks of speech perception and phonological awareness. Children in the control and OM groups participated in additional tasks examining verbal working memory, sentence comprehension, and temporal processing. Children in the OM group differed from those in the control group on tasks involving verbal working memory and sentence comprehension, but not temporal processing.

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Winskel (2006) aimed at ascertaining the effects of a history of OM in early childhood on later language and literacy skill development. Forty-three children from Grade 1 and Grade 2, between 6 and 8 years old with an early history of OM and 43 control children, matched for chronological age, gender and socio-economic status, participated in this study. Children were tested on multiple measures of phonological awareness, semantic knowledge, narration and reading ability. The performance of children with and without a history of OM was compared on the different measures. There was a general tendency for children with a history of OM to achieve lower scores on phonological awareness skills of alliteration, rhyme and non-word reading, semantic skills of expressive vocabulary and word definitions and reading than non-OM children. These findings highlight the potential problems an early history of middle ear infection can have on school-aged children's later language and literacy development.

As part of a prospective study of possible effects of early-life Otitis media on speech, language, cognitive, and psychosocial development (Paradise, Dollaghan, Campbell, Feldman, Bernard, Colborn, Rockette, Janosky, Pitcairn, Sabo, Kurs-Lasky & Smith, 2003) tested relationships between children's cumulative duration of middle ear effusion (MEE) in their first 3 years of life and their scores on measures of language, speech sound production, and cognition at 3 years of age. Results indicated weak to moderate, statistically significant negative correlations between children's cumulative durations of MEE.

To examine whether Otitis media with effusion and associated hearing loss (HL) during the first 5 years of life were related to children's language skills during the preschool years and to school readiness skills at entry to kindergarten (Roberts, Burchinal, Jackson, Hooper, Roush, Mundy, Neebe, Zeisel, 2000), the results revealed that there was not a significant relationship between children's early OM history or HL and language skills during the preschool years. However, children with more frequent OM had lower scores on school readiness measures.

The studies indicate that there are contradictory findings in the literature regarding the long-term effects of early onset Otitis media. 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.

Need for the Study

The existing literature on sensory deprivation and literature on the development of auditory abilities strongly suggest that early auditory deprivation can result in the inferior use of the auditory channel which in turn may impede the acquisition of Speech, language and auditory skills. Serious consequences of early middle ear disease are especially significant in view of the numbers of children affected.

There has been little published research on the related but somewhat different questions of the effect of early middle ear disease on the auditory abilities of children in whom the disease (and hearing loss) has been resolved. While it is of interest to study the auditory functioning of children who have sustained mild hearing loss, in order to support the contention that the results of the research demonstrated the effects of early auditory deprivation it seems reasonable to suggest that the subjects must have had functionally normal hearing at the time of testing.

The literature and research on the effects of temporary restrictions of sensory input on human organisms supports the hypothesis that children who have experienced fluctuations in auditory sensitivity may fail to develop normal auditory abilities. The studies which have investigated the effects of early conductive hearing loss in children are in essential agreement that children who have suffered recurrent episodes of auditory restriction differ in several dimensions from normal children.

The adverse effects of auditory deprivation resulting from sensorineural hearing loss in infancy and early childhood have been well documented. In the Indian context there have been a few investigations particularly focusing on the brainstem and cortical auditory processing (Maruthy & Mannarukrishnaiah, 2008; Sailaja, 2005; Tyagi, 2002; Amala, 2003). However, all aspects of human communication have not been focused in a group of children who have suffered episodes of OM in their childhood.

Keeping the above in view, aspects of language performance and the phonological awareness are investigated in the present study. This study is expected to throw new light in the current ambiguous understanding of effects of early Otitis media in later school age in the area of Metaphonological ability.

Aim of the Study

The study explored the Metaphonological awareness skills in children who had a history of otitis media in early childhood. Specifically it aimed to compare the performance on Metaphonological test between Otitis group and normal group.

METHODOLOGY

The proposed study was carried out at the laboratories of Dr. M V Shetty College Speech & Hearing, in collaboration with different private and government schools in Mangalore situated within 4kms in the surrounding areas of Dr. M V Shetty College of Speech and Hearing, Malady Court, Kavour were proposed for the study. Children aged 7 to 10 years were included in the study. The subjects were selected through a parent questionnaire which was given to the parents through the class teachers. All the children thus selected through the parent questionnaire had a history of minimum of three episodes of Otitis media within two years of age. The parents of the children selected for the study were contacted through the telephone number and addresses available from the questionnaire. To indicate their willingness to do this they were requested to complete a permission form and return it to the school teacher. The children who had early onset Otitis media (OG) (experimental group) were included in the study after obtaining the consent of the parents and, if they also:

- 1) Had an average of thresholds of 500Hz, 1000Hz, and 200Hz of less than 15d BHL for air conduction and bone conduction.
- 2) Had normal intelligence as confirmed by psychological evaluation.
- 3) Had normal tympanometry and acoustic reflex.
- 4) Had no oro facial abnormalities.

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- 5) Had no neurological problem.
- 6) Had successful scholastic performances as reported by class records.

Based on these criteria, thirty six children with early history of OM were selected for the study. A control group (NG) of 36 normal children, matched for age, and without the history of Otitis media or any ear pathology was also included in the study. The children in control group were selected if they:

- 1) Had normal pure tone audiometry.
- 2) Had normal tympanometry and acoustic reflex.
- 3) Normal auditory processing by the screening checklist ‘ Screening checklist for central auditory processing’ (Yathiraj & Mascarenhas, 2003).
- 4) Had no oro facial abnormalities.
- 5) Had no neurological problem.
- 6) Had successful scholastic performances as reported by class records.

All subjects in both the OG and NG groups, an oral cavity examination was also carried out to rule out any articulation defect. The children in both the group were native speakers of Kannada.

Measure

Since the study was proposed to identify the effects of early history of fluctuating ear infections, the subjects selected for the study in both experimental and control group were evaluated for different measures of Tests for Meta phonological skills (Prema, 1997).

Tests for Meta Phonological Skills

Test for Meta phonological skills (Prema, 1997) consists of six sections:

- 1) Rhyme Recognition, 2) Syllable Stripping, 3) Syllable Oddity (words), 4) Syllable Oddity (non-words), 5) Phoneme Stripping, and 6) Phoneme Oddity.

Rhyme Recognition

The test contains twelve pairs of rhyming and non-rhyming words with CVCVCV configuration. The children were asked to read the item and identify whether the paired words were rhyming or not. Each correct response receives a score of one. Total Score: 12.

Syllable Stripping

The test contains twelve words of CVCVCV combination. The children were asked to read the item and strip or delete a syllable indicated by the tester and say the rest of the word. Each correct response receives a score of one. Total Score: 12.

Syllable Oddity (Words)

The test consists of twelve sets of four words each with CVCVCV configuration. The children were asked to read and identify the particular word that did not belong to the set. Each correct response receives a score of one. Total Score: 12.

Syllable Oddity (Non-words)

The test consists of twelve sets of four non-words each with CVCVCV configuration. They were asked to read the test item and to choose the one that did not belong to the set. Each correct response receives a score of one. Total Score: 12.

Phoneme Stripping

This consists of twelve bi-syllabic words of CVCV type. The children were asked to read the item and strip or delete a small part of the word and say the rest. Each correct response receives a score of one. Total Score: 12.

Phoneme Oddity

This test contains twelve sets four non-words each with CVCV combination. The children were asked to read and choose the one that did not belong to the set. Each correct response receives a score of one. Total Score: 12.

Analysis

The data obtained on 36 subjects belonging to the three age groups (7-8, 8-9, 9-10) on the six major measures Rhyme recognition (RR), syllable stripping (SS), Syllable oddity for words (SOW), Syllable oddity for non-words (SONW), Phoneme Stripping (PHS), and Phoneme oddity (PHO) of the Metaphonological test are reported in the next section.

RESULTS

The responses obtained on the Metaphonological test between the subjects of age groups 7-8, 8-9, 9-10 was carried for the following. The descriptive statistics between 7-8, 8-9, 9-10 with each OG and NG groups were carried out using two way analysis of variance and Bonferroni multiple comparisons. The pair wise comparisons were done using paired 't' test to compare dependent variables within each age group. Multivariate test (Wilk's Lambda) was used to measure the effect within and across groups. Similarly the above measures were also used for between group comparison.

The overall results of the present study in children with early onset Otitis media are as follows:

The raw data for the different subjects of Metaphonological test, i.e., Rhyme recognition (RR), syllable stripping (SS), Syllable oddity for words (SOW), Syllable oddity for non-words (SONW), Phoneme Stripping (PHS), and Phoneme oddity (PHO) were subjected to statistical analysis for calculation of Mean and Standard deviation as given in Table 1.1. The close examination of the mean data reveals that the performance of NG group was better than the OG group. The results also reveal that there is a development trend in the acquisition of Metaphonological skills, of the six test, the tests for Rhyme recognition and Syllable stripping

were found to be easiest as indicated by the mean scores and these appears to be earliest to be developed. The scores for syllable oddity test (words and non-words) are not on par with the scores of Rhyme recognition and syllable stripping, between the words and non-words the difference was negligible. The scores for phoneme stripping and phoneme oddity were generally poor and shown a gradual but slow rise, showing that in lower age groups the syllable tests are easier than the phoneme tests. Similar trend is observed for both OG and NG with OG group scoring lower in all tasks.

Table 1.1 indicates the mean and standard deviation of six major domains of Metaphonological test.

Group			N	Mean	Std. Deviation
RR	OG	7 - 8	12	7.75	.452
		8 - 9	12	9.42	.515
		9 - 10	12	8.67	.492
		Total	36	8.61	.838
	NG	7 - 8	12	9.58	.515
		8 - 9	12	10.50	.522
		9 - 10	12	10.50	.522
		Total	36	10.19	.668
SS	OG	7 - 8	12	7.67	.492
		8 - 9	12	8.08	.289
		9 - 10	12	10.33	.492
		Total	36	8.69	1.261
	NG	7 - 8	12	9.58	.515
		8 - 9	12	9.67	.492
		9 - 10	12	11.50	.522
		Total	36	10.25	1.025
SOW	OG	7 - 8	12	4.92	.289
		8 - 9	12	6.25	.452
		9 - 10	12	7.33	.492
		Total	36	6.17	1.082
	NG	7 - 8	12	6.33	.492
		8 - 9	12	6.75	.452
		9 - 10	12	6.75	.452
		Total	36	6.61	.494
SONW	OG	7 - 8	12	4.25	.452
		8 - 9	12	5.42	.515
		9 - 10	12	7.33	.492
		Total	36	5.67	1.373
	NG	7 - 8	12	5.08	.289
		8 - 9	12	5.75	.452
		9 - 10	12	6.75	.452
		Total	36	5.86	.798
PHS	OG	7 - 8	12	3.25	.452
		8 - 9	12	3.50	.522
		9 - 10	12	4.67	.492
		Total	36	3.81	.786
	NG	7 - 8	12	4.00	.000
		8 - 9	12	4.58	.515
		9 - 10	12	5.50	.522
		Total	36	4.69	.749
PHO	OG	7 - 8	12	3.25	.452
		8 - 9	12	3.00	.000
		9 - 10	12	4.00	.000
		Total	36	3.42	.500
	NG	7 - 8	12	4.50	.522
		8 - 9	12	4.50	.522
		9 - 10	12	4.50	.522
		Total	36	4.50	.507

The mean scores were statistically analyzed using two way analysis of variance with various tests as dependent factor, as given in Table 1.2. The means of the groups were highly significant at ($P < 0.05$), except for SONW which is not significant ($P > 0.05$). The significant

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difference were also found to be seen between age groups and also groups across age groups ($P < 0.05$).

Table 1.2

Dependent Variable	Source	F	df	p	
RR	Group	177.806	1, 66	.000	HS
	Agegroup	41.756	2, 66	.000	HS
	Group * Agegroup	4.433	2, 66	.016	sig
SS	Group	193.798	1, 66	.000	HS
	Agegroup	168.770	2, 66	.000	HS
	Group * Agegroup	3.770	2, 66	.028	sig
SOW	Group	18.051	1, 66	.000	HS
	Agegroup	62.263	2, 66	.000	HS
	Group * Agegroup	30.532	2, 66	.000	HS
SONW	Group	3.390	1, 66	.070	NS
	Agegroup	171.503	2, 66	.000	HS
	Group * Agegroup	15.428	2, 66	.000	HS
PHS	Group	67.855	1, 66	.000	HS
	Agegroup	64.608	2, 66	.000	HS
	Group * Agegroup	.861	2, 66	.427	NS
PHO	Group	123.933	1, 66	.000	HS
	Agegroup	9.533	2, 66	.000	HS
	Group * Agegroup	9.533	2, 66	.000	HS

The pairwise comparison with Bonaferonni multiple comparisons was carried out when the subject groups were compared for different test with an age group to the other age groups, the results showed significant difference between all comparison ($P < 0.05$), except for the following;

OG-SS-7-8 to 8-9, OG-PHS-7-8 to 8-9, OG-PHO-7-8 to 8-9, NG-RR-8-9 to 9-10

NG-RR-9-10 to 8-9, NG-SS-7-8 to 8-9, NG-SS-8-9 to 7-8, NG-SOW – all comparisons

NG-PHO-all comparisons, were not statistically significant ($P > 0.05$), indicating similar performance. The pairwise comparison of the means of each group with the pair age group of the other subject groups was also done with Bonferonni. The results also showed significant difference at 0.05 level, except for 8-9-SONW & SOW – when compared with OG and NG showing that their performance were similar.

The multivariate tests with Wilk's Lambda between groups ($f=103.438$, $df=6.000$, $P<0.05$), age groups ($f=52.948$, $df=12.000$, $P<0.05$), groups x age groups ($f=11.680$, $df=12.000$, $P<0.05$) were found to be statistically significant.

The data for the different subtests of Metaphonological test, i.e., Rhyme recognition, syllable stripping, Syllable oddity for words, Syllable oddity for non-words, Phoneme Stripping, and Phoneme oddity revealed that the performance of NG group was better than the OG group. The tests for Rhyme recognition and Syllable stripping were found to be easiest as indicated by the mean scores and these appears to be earliest to be developed. The scores for syllable oddity test (words and non-words) are not on par with the scores of Rhyme recognition and syllable stripping, between the words and non-words the difference was negligible. The scores for phoneme stripping and phoneme oddity were generally poor and shown a gradual but slow rise, showing that in lower age groups the syllable tests are easier than the phoneme tests. Similar trend is observed for both OG and NG with OG group scoring lower in all tasks. The Metaphonological skills are important for the development of characteristic of spoken language and literacy. Performance of children who had early histories of Otitis media indicate lower language competency.

DISCUSSION

The effect of ear infections particularly early transient episodes before the age of two have been studied relatively scarcely. The available literature is still ambiguous as all the measures of language especially the Metalinguistic skills need to be understood. The present study aim to achieve this integrated data. Overall subjects in all three age groups significantly performed poorly as compared to normal groups.

It is generally considered that Metaphonological abilities particularly phonological awareness skills are crucial for later literacy development. In the present study on all the subtest of phonological awareness Otitis group performed poorly. It was not the aim of present study to measure the academic performance of the Otitis group subjects, this can be one direction for the future research.

The present study has improved our understanding of the adverse effects of early Otitis media on all measures of Metaphonological skills studied in the present research namely Rhyme recognition (RR), syllable stripping (SS), Syllable oddity for words (SOW), Syllable oddity for non-words (SONW), Phoneme Stripping (PHS), and Phoneme oddity. The continued presence of the adverse effects in all the 3 age groups, namely 7-8, 8-9, 9-10 indicates that the effect of OM on language development.

The Metaphonological skills are one of the critical skills in the acquisition of reading and also important for the development of characteristic of spoken language and literacy. The results of the Metaphonological tests indicate that the performance of children who had early histories of Otitis media performed poorer in the Metalinguistic skills than the age matched normal group, indicating lower language competency. Similar findings are reported in literature (Paradise et.al,2003; Robert et.al, 2000; Nittrouer, et.al., 2005; Winskel, 2006) regarding the effect of early onset otitis media on language processing. This supports that the altered auditory sensory experience during sensitive period of development may be associated with later perceptual disabilities.

SUMMARY & CONCLUSIONS

The present study explored Metaphonological awareness skills in a cross-sectional group of 7-8, 8-9 and 9-10 subjects and without early history of Otitis media. All these subjects had normal hearing and no obvious communication deficits with above average school performance.

The results of the present study point to quiet significant difficulties faced by the subjects with early history of Otitis media, as compared with previous research. The reduced auditory experience posed difficulties to subjects in processing speech language measures even by the age of 9-10 years. This study thereby indicates that the adverse effects of Otitis media are not likely to be temporary but long lasting. All though subjects did not show any hearing loss at the time of testing and did not seem to have any difficulty in processing speech under normal circumstances. Given that the classroom conditions are noisy and often overcrowded these children may face a further disadvantage in understanding the teacher's speech. The present study does point to such

an adverse possibility as indicated by poor performance of phonological awareness tasks under Metaphonological testing.

The presence of such adverse effects in all age groups (7-8, 8-9 & 9-10) indicates the permanent nature of the damage caused by Otitis media is permanent or long lasting. The present study strongly recommends that Audiologists and other professionals work towards prevention of ear infections particularly middle ear infection to prevent the serious damage to the speech, language, processing aspects and their likely effects in later academic life. The future studies can take up the issue of academic performance in subjects with Otitis media.

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