

Critical Review: Effects of mild to moderate sensorineural hearing loss on the language development of school aged children

John Hillier

M.Cl.Sc (AUD) Candidate

University of Western Ontario: School of Communication Sciences and Disorders

Language development, in school aged children with permanent mild to moderate sensorineural hearing loss (MMSHL), has been given little consideration with few studies devoted to the subject. Children with MMSHL often face many obstacles in the domain of language development as the characteristics of their hearing loss often lead to language input being degraded and distorted. This critical review examines the research on the effects of MMSHL on normal language development. The selected research papers address the effects of minimal and moderate permanent hearing loss on certain factors of language development in school aged children and if these language delays persist as the child ages. The research concludes that children with MMSHL do perform poorly in certain linguistic skills, such as phonology and syntax. Three of the four studies included in this paper linked poor performance in these areas to more complex difficulties in language and communicative ability.

Introduction

Recently, it has been suggested by a number of researchers that mild to moderate bilateral sensorineural hearing loss (MMSHL) does have a significant effect on the language development of a school aged child. Despite this discovery there have been few studies conducted to investigate and define the precise difficulties that may arise. Due to the dearth of published research there remains a lack of awareness by professionals who work with school aged children as to how these difficulties exactly affect normal language development.

Briscoe, Norbury and Bishop (2001) define mild hearing loss as a pure tone average threshold of 20 dB HL to 40 dB HL whereas their definition of moderate hearing loss is thresholds ranging from 40 dB HL to 70 dB HL. Presently, this definition is universally accepted amongst researchers. In the past, the primary focus of research, for a number of reasons, was on the management of children with severe to profound hearing loss. With advancements in hearing assessment and screening and the ability to reliably detect milder losses, researchers have begun to turn their attention to populations with less severe hearing loss. Until the 1980s and the initial work of Fred Bess it was the prevalent belief that school aged children, who suffer from milder degrees of sensorineural hearing loss, do not experience any considerable difficulties in language development (Tharpe, 2008). However, current research now indicates that these children may have significant difficulties in a number of aspects of language development which could possibly have far reaching effects on the child's communicative ability and scholastic achievement throughout the individual's life (Delage & Tuller, 2007). Research has shown that

MMSHL has been associated with deficiencies in frequency discrimination, expressive language and in production of verb morphology. It has also been concluded that children with MMSHL experience difficulties in phonological processing (Moeller, McCleary, Putman, Tyler-Krings, Hoover & Stelmachowicz, 2010). Due to a number of misconceptions concerning children with MMSHL educators and other professionals may conclude that these children may not be suffering any major difficulties due to their hearing loss. However, it should be realized that the disrupted auditory input due to MMSHL that occurs during the time of normal language development may cause deficiencies and delays in certain linguistic skills (Norbury, Bishop & Briscoe, 2001).

Objectives

The primary objective of this paper is to critically review selected studies that present evidence concerning the effects of mild to moderate sensorineural hearing loss on the language development of school aged children. A secondary objective is to identify and discuss the clinical implications of this research.

Methods

Search Strategy

The following databases were included in the literature search: PubMed and Medline. The search strategy was as follows:

(mild to moderate hearing loss) AND (sensorineural hearing loss) AND (language development)

Limitations on the search included: studies in English and all children (0-18 years). Google Scholar was used to supplement the search of academic databases to identify any obscure or grey literature.

Selection Criteria

Articles selected for this review included studies that researched the effects of mild to moderate sensorineural hearing loss on the language development of school aged children.

Data Collection

The articles that corresponded to the above literature search and met the selection criteria included three case control studies that investigated the effects of mild to moderate sensorineural hearing loss on language, literacy and various linguistic skills such as phonology, morphosyntax and morphology. The fourth article retrieved involved longitudinal research on the language development of children with late identified mild to moderate hearing loss. Two of these articles (Moeller et al, 2010; Delage and Tuller, 2007) also investigated the normalization of language skills in adolescents with MMSHL.

Results

Children with MMSHL and development of language

Norbury et al. (2001)

In this study, Norbury et al. compare the production of verb morphology of two groups: children with specific language impairment (SLI) and children with MMSHL. The authors of this paper are interested in morphological development in children with moderate degrees of hearing loss. Their research is primarily concerned with how degraded auditory input affects learning of finite verb morphology. This study included four groups of children: a MMSHL group, a SLI group and two control groups. It should be noted that one control group was matched on age and nonverbal ability to the SLI and MMSHL groups and the other was matched on language-age to the SLI group.

The researchers used analysis of variance (ANOVA) to compare group means on all language assessments. To identify patterns amongst the subgroups the post-hoc Scheffe test was conducted. Results revealed that children in the MMSHL group had most difficulty on measures of expressive language. This group also scored significantly poorer on measures of phonological processing than the age matched control group [$F(3, 62) = 9.26, p < .001, \eta^2 = .309$]. A series of t-tests was conducted to identify differences in the MMSHL group. The groups were determined depending on whether the children were impaired or unimpaired on tense marking tasks. It was shown that the impaired group (6 children) and the unimpaired group (13 children) differed significantly on language measures such as receptive vocabulary and grammar, expressive verb vocabulary and phonological discrimination. T-tests also showed that these two groups differed significantly in age ($t=3.99, p=.001$) with the impaired group being

younger. This led the researchers to conclude that degraded auditory input during this period of language acquisition may cause delays in the development of certain language skills.

Briscoe et al. (2001)

In this paper, the researchers use a case-control study to assess and compare the phonological skills, language ability and literacy scores of children with MMSHL and children with SLI. The two clinical samples were recruited and compared with two control groups of normally developing children. Included in the MMSHL group were children who had a mild (PTA 20-40 dB HL) to moderate (41-70 dB HL) bilateral sensorineural hearing impairment, were attending mainstream school and were not using sign language. Each child was administered a battery of tests including standardized language assessments as well as tests of phonological awareness, phonological discrimination, expressive phonology and digit recall. Scheffe tests set at $p < .05$ showed very few significant differences between the MMSHL group and the SLI groups. It was shown that the MMSHL group and the SLI group were equally impaired on tests of phonological awareness, phonological discrimination and nonword repetition. However, the MMSHL group did not show any of the deficiencies in language and literacy which were prominent in the SLI group. Subsequently, the researchers analyzed the data of the hearing impaired group based on whether they were impaired or unimpaired on the phonological tasks. This was to further examine the extent certain factors, such as, severity of hearing loss, age of diagnosis of hearing loss, or general cognitive ability have on phonological deficits in children with MMSHL. T-tests were conducted and no significant differences between the impaired and unimpaired groups in age were found: unimpaired mean = 8.78, impaired mean = 8.53 years; $t(17)=0.39, p=.0705$. The two groups also did not differ on age at diagnosis of hearing loss: 49.2 months for those without phonological impairments: 47.1 months for those with phonological impairments. However, the two groups did differ in degree of hearing loss. ANOVA showed a significant effect of subgroup, $F(1, 17) = 7.56, p = .014$ but no interaction between subgroup and frequency, $F(4,68) = 0.29, p=.280$. The study showed that there were some differences in language literacy skills, with the phonologically impaired group performing worse. However, the researchers ultimately concluded that, despite there being a link between poor phonological awareness and phonological discrimination with vocabulary acquisition, there is no relation between poor performance on phonological tasks and other language abilities or literacy.

Delage and Tuller (2007)

The purpose of this study was to evaluate the nature of the link between hearing loss and language impairment in adolescents with mild-to-moderate hearing loss. Nineteen monolingual French speakers ranging in age from 11 to 15 years were recruited. All subjects suffered from bilateral sensorineural hearing loss with thresholds between 27 dB to 69 dB. These adolescents were compared to two control groups and a group of children with SLI. Language and literacy skills were assessed with a battery of standardized tests including tests of phonology, as assessed by a word repetition task, expressive grammar and reading. To define language impairment, scores on the standardized tests were converted to z scores. The authors chose the threshold of < -1.65 SD which corresponds to the fifth percentile in the normal distribution as the cutoff score for difficulty. Scores on these tests showed that adolescents with MMSHL had difficulties with phonology (63.2% participants with scores < -1.65 SD) and morphosyntax (31.6% with scores < -1.65 SD). Similar difficulties were seen in the SLI group but not the control groups. There were few difficulties seen in other language skills, such as oral comprehension, written language and vocabulary for the MMSHL group. Spearman correlation tests were conducted to determine links between language performance and other variables. A link was found with degree of hearing loss and performance in expressive grammar ($r = -.51, p < .05$) and in word repetition ($r = -.61, p < .01$). Subjects with higher degrees of hearing loss performed worse on these measures. Results from this study showed that more than half of the children in the MMSHL group performed poorer than control groups in areas of phonology and grammar and language scores were linked to degree of hearing loss.

Longitudinal study of language development and language normalization*Moeller et al. (2010)*

This study was the first longitudinal study that examined the effects that late-identified mild-moderate hearing loss can have on a child's language development. Longitudinal measures were taken throughout the study and changes were noted and analyzed. Baseline results indicated that, as compared to the normally developing control group, the hearing impaired children performed poorly on measures of phonology. In particular, all four of the MMSHL children had difficulty producing fricatives and the immaturity of their consonant inventories, suggested marked delays in consonant production. The deficits in phonology were also accompanied by impaired production of morphology for three of the children in the MMSHL group as evidenced by the persistent

production of morphological errors. At baseline, all four of the children with MMSHL fell below the lower limits of the 95% confidence interval for the control group. One of the questions the researchers explored was whether the spoken language skills of the MMSHL group normalized with age. Results indicated that with age and intervention three of the four children showed improvement. However, the researchers further reported that delays persisted in speech production, production of fricatives and morphology. They believe these results are attributable to the combination of degraded audibility and reduced auditory experience due to the hearing impairment during the early period of language acquisition.

Critical Appraisal of Selected Case Control Studies

Case control studies are designed to explore factors that contribute to a certain condition of a patient by comparing patients with the condition of interest (case) to patients who do not present with the condition (controls). The Oxford Centre for Evidenced Based Medicine place case control studies as level 2b evidence. It is expected that studies ranked this highly in the Oxford Hierarchy should yield valid and important evidence. Greenhalgh (1997) suggests that the two most important factors of the research design of a case control study to consider are the diagnosis of "caseness" and how the decision of when the individual became a case is made.

Strengths of Selected Case Control Studies

All of the case control studies selected for this paper employ sensible research design and explore pertinent and salient questions, which have rarely been investigated. The researchers of the case control studies have used statistical analysis to show that the results were statistically significant, thus increasing the validity of the evidence. For example, Delage and Tuller (2007) use the nonparametric Wilcoxon test appropriately to analyze within groups data. The studies also define the characteristics of the groups being investigated. In their paper, Briscoe et al. (2001) clearly outline the thresholds of the children in the MMSHL group. The researchers also attempt to limit confounding factors by excluding children with certain characteristics such as neurological impairment or other comorbidities. To further strengthen the evidence presented researchers attempted to match the case and control groups on factors such as age and other characteristics such as nonverbal ability. All language assessments were standardized and significant bias in outcome assessment is unlikely for the selected studies.

Limitations of Selected Case Control Studies

The research designs of the studies did also include some limitations. One limitation of the study conducted

by Norbury et al. (2001) involves the fact that the researchers only recruited students from mainstream schools to take part in their research. This could result in sampling error and confound the results of the study. To avoid this problem, the researchers could have recruited subjects from both mainstream schools and children who were educated in specialist units. Additionally, the sample sizes for all three case control studies were relatively small (19-20 children for each study). This limitation could negatively impact the power used to accurately make conclusions about the effects of the condition.

Critical Appraisal of Longitudinal Study

The selected longitudinal study was a comparative study with concurrent controls and is therefore ranked as level 2b evidence according to the Oxford Centre for Evidence based medicine hierarchy. Strengths of this study include the design. For example, children with hearing loss were age-matched and compared to children with normal hearing. Baseline measures were taken near the point of identification and standardized measures of language assessment were used. The limitations of this study include a small sample size (n=4) and the fact that the authors of this study did not use any statistical methods to determine if there were any significant differences between the impaired hearing group and the normal hearing group.

Having considered the strengths and weaknesses of each study, the research presented in the case control studies can be categorized as compelling. However, due to a small sample size and lack of statistical analysis the evidence presented in the longitudinal study could be considered suggestive.

Discussion

All four of the papers examined in this study found fairly strong evidence of significant differences between children with MMSHL and normally developing children in the domain of language development. The majority of these difficulties involved impairments in phonology and expressive language. Two of the studies (Delage & Tuller, 2007; Moeller et al., 2010) found evidence that adolescents with MMSHL may still display relatively severe language impairments. This would indicate that delays in language development persist in certain children. It has been shown that the language skills of these children do improve with age, as compared to younger children with MMSHL, however they do continue to show poorer performance than their normally developing peers on certain language production tasks. The early school years encompass the critical period for language development (6 to 7 years). It is this reason that impairments in

phonology and syntax are most prevalent as these language skills are the most susceptible to atypical development during this period. It must be noted that there is a great deal of intersubject variability and not all children with MMSHL suffer from delays in language development or show long term effects (Delage & Tuller, 2007). A number of researchers have concluded that children with MMSHL are at increased risk for psychoeducational deficits and poor scholastic achievement (Tharpe, 2008). This statement is in contrast with the findings of certain studies identified in this paper. Briscoe et al. (2001) found that the deficiencies in phonology and expressive language found in some of the children suffering from MMSHL could not be linked with large scale problems in language and literacy. However, Delage and Tuller (2007) suggest that long term impairments in language development due to degraded auditory input, may be severe enough for some adolescents with MMSHL, to experience delays in school. Moeller et al. (2010) have similar findings to those of Delage and Tuller. In their longitudinal study, these researchers found that, despite the normalization of certain linguistic skills, their group of children with late identified MMSHL still had persistent delays in speech intelligibility. This impairment in speech intelligibility was compounded by difficulties in phonological skills, especially the production of fricatives, and morphology. Research has shown that children with such difficulties are prone to speech errors and have difficulty making themselves understood due to a lack of vocabulary (Tharpe, 2008). It is therefore possible that these deficits could negatively affect the communicative ability and psychoeducational development of these children.

Clinical Implications

There are a number of clinical implications which arise from the research surveyed in this paper. Firstly, awareness is an issue when it comes to the effects of MMSHL on natural language development. Studies conducted on this subject are rare and there are certain myths surrounding the development of children with MMSHL because of this lack of knowledge. Many professionals believe that preferential seating in front of the classroom is sufficient for children with MMSHL (Goldberg & Richburg, 2004). Teachers and other professionals should be advised that degraded auditory input has been shown to affect the language development of children with MMSHL. Therefore other considerations, such as FM systems, should be made in order to ensure that the child is receiving proper auditory input.

Secondly, at this moment, many universal newborn hearing screening programs are designed to identify

moderate or worse sensorineural hearing loss and often consider children with milder degrees of hearing loss as unwanted false positive results (Wake, 2006). These guidelines may need to be reviewed as Moeller et al. (2010) show that children with late identified MMSHL demonstrate language delays.

Conclusion

The findings of the research discussed above indicate that children with MMSHL have difficulty in their development of certain linguistic skills. Furthermore, a number of the studies linked these deficits with more complex difficulties in language and communicative ability. However, additional research should be conducted to identify factors which would predict which children with MMSHL would be at highest risk for these difficulties as there is much intersubject variability within this population. Increasing awareness in teachers and other professionals who work with children with MMSHL as to difficulties that these children may experience would also be recommended for the future.

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