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Abstract

The present study assessed the school functioning of children with unilateral hearing loss (UHL) in comparison to the functioning of their hearing classmates. The effect of the degree of hearing loss and the use of hearing aids were assessed as well. Forty seven elementary school children participated in the study: 33 children with UHL and 14 children with normal hearing. The Screening Instrument for Targeting Educational Risk (SIFTER) questionnaire was used to assess the children's performance in the schools. The questionnaire assessed the children's performance in 5 domains: academics, attention, communication, class participation and school behavior. The results revealed significant differences between the performances of the children with UHL and the children with normal hearing in all SIFTER domains. There was no significant correlation between the severity of hearing loss and the child's performance. There was no significant difference between the children who were fitted with hearing aids and those without hearing aids. The results suggest children with UHL are likely to develop difficulties in school. Teachers should be aware of the adverse affect of UHL and should follow the performance of these children in school closely in order to meet their needs when supplying the necessary services.

Keywords: unilateral hearing loss, school functioning, assessment

Introduction

The advantages of listening with both ears rather than one are well documented. Binaural hearing improves speech perception in quiet as well as difficult listening environments, enhances sound localization abilities, offers advantages in signal segregation and enhances qualitative benefits of sounds, such as naturalness and clarity of voice perception (Feurstien 1992; Gatehouse & Noble 2004; Hall, Grose, Buss & Dev 2002; Hawley, Litovsky & Culling, 2004; Kidd, Mason & Rohtla 1995; Mechner & Davis 2006; Noble & Gatehouse 2006; Tyler, Dunn, Witt & Prece 2003). Nevertheless, for years, professionals have not considered individuals with unilateral hearing loss (UHL) as being at risk (Northern & Downs, 1978).

However, for the past twenty years, a great deal of research has documented the adverse effects of UHL on development in various domains.

These children were found to be at higher risk for encountering academic difficulties. Reports demonstrated they were approximately 10 times more likely to fail a grade than their normal hearing peers (Bess & Tharpe, 1984; Oyler, Oyler & Matkin, 1988). They scored lower on intelligence tests (Klee & Davis-Dansky, 1986) and in many cases, there were reports on them receiving special services in school (McKay, Knightly, Marsh, Amann & Gravel, 2007). Children with UHL were reported to have attention difficulties. Culberstone & Gilbert (1986) reported that teachers described these children as daydreamers; They were easily distracted and had difficulties in following instructions.

Children with UHL were found to be at risk for speech and language delays. For example, Kiese-Himmel (2002) reported that their average age for two-word utterances was found to be delayed, on the average appearing at 23.5 months. Borg et al. (2002) studied 58 children with severe to profound UHL aged 4-6 years and found significant language delay in comparison to children with normal hearing. Children with UHL were found to be at greater risk for encountering social-emotional difficulties in comparison to normal hearing peers. Bess & Tharpe (1986) reported that 20% of the children were considered by their teachers to have behavioral problems. Stein (1983) reported that 42% of the school-age children with UHL in that study were described by teachers and parents as having behavioral difficulties, including aggression and social withdrawal.

Degree of UHL and Use of Hearing Aid

The effect of the degree of the UHL on the child's functioning was previously examined in several studies. In a review on this issue, Lieu (2004) reported on no significant correlations between the child performance in school and the severity of the UHL. Other researchers, however, reported on correlations between the severity of the UHL and the children's intelligence scores. Those with severe to profound hearing loss (HL) scored lower than those with lesser degrees of hearing loss (Culbertson and Gilbert, 1986).

Many children with UHL are not fitted with hearing aids and if they are, this is not done before they reach school age. This late-fitting is the result of late diagnosis (Johnson et al., 2005; Oyler & McKay, 2008), the audiologist's decision to wait until more audiological data is acquired ("watchful waiting"), or dependent upon parental decision (McKay et al., 2008). Davis et al. (2001) reported that those who were fitted with hearing aid (HA) were

those with poorer hearing and at age 5, only 50% of the children are fitted with HA. According to the American Academy of Audiology Pediatric Amplification Protocol (2003), the use of HA should be considered on the basis of the individual's level of functioning. Thus, the recommendation for HA does not comprehensively cover everybody with UHL, since there is no clear-cut evidence to support this need (McKay, Gravel & Tharpe, 2008). Yoshinaga-Itano, Johnson, Carpenter and Brown (2008) claimed that the rejection of the amplification by children with UHL has become common as a result of the late identification of the hearing loss. Since many of the children were only identified as having hearing loss after the age of five, a lack of auditory stimulation for many years might have impacted their ability to develop auditory skills.

Kiese-Himmel (2002) reported that the children in their study with UHL who used HA showed no language delay. The benefit and satisfaction from the use of HA is dependent upon the degree of hearing loss. A survey on the use of HA among children with UHL reported that of the 27 children who were fitted with HA, 26% used the HA all the time, 4% used it only at school and 50% did not use it at all (Davis, Reeve, Hind & Bamford, 2001). Most of the children who used HA and were satisfied with them were those having moderate to severe HL or better. Those having more serious hearing loss did not benefit from the HA (McKay, 2002).

In previous studies, Most (2004, 2006) examined the effect of the degree of the hearing loss on the functioning of children in school in both the Jewish and the Arab sectors in Israel. The children were evaluated by using a teacher questionnaire – the Screening Instrument for Targeting Educational Risks (SIFTER). The results of both studies demonstrated that the children with UHL, and those with mild hearing loss, functioned significantly lower than children with poorer hearing status. The author explained these results by the fact that essentially, these children "missed out" on any benefits, having receiving neither audiological nor academic support. In most cases, the teachers were unaware that these children had hearing difficulties.

On the basis of the previous research, which was conducted mainly on English-speaking children and showed the adverse effect of UHL on various developmental aspects such as academic, communication and social-emotional domains, the aim was to focus upon this population and examine the school functioning of children with UHL. Thus, the purpose of the present study was to assess the school functioning of children with UHL

in comparison to the functioning of their hearing classmates. The effect of the degree of hearing loss and the use of hearing aids were assessed as well. Three hypotheses were developed for the study: (a) The children with UHL would demonstrate a poorer performance in the different domains of school functioning in comparison to the hearing children; (b) Among the children with UHL, there would be correlation between the degree of hearing loss and the school functioning; and (c) The children with hearing aids would perform better than those not using hearing aids.

Method

Participants

The study consisted of 47 children with a mean age of 10.89 years (*SD* = 2.55). Of this sample, 33 children had unilateral hearing loss and 14 had normal hearing in both ears. Unilateral hearing loss was defined as an average pure tone threshold of < 20 dBHL in the good ear and > 20 dBHL in the poor ear. Average pure tone threshold was calculated in the following frequencies: 500Hz, 1 kHz, and 2 kHz. The children's average pure tone threshold in the good ear was 17 dBHL (*SD* = 4.30). The children's average pure tone threshold in the poor ear was above 55 dBHL (*M* = 79.1, *SD* = 13.3). Twelve of the children were fitted with hearing aids in the poor ear but only six used them consistently, and two did not use them at all. Twenty-one were not fitted with hearing aids at all. All of the children attended school in regular school systems with hearing children. Eight of them attended classes with younger children (chronological age). Fifteen of the children were reported by their teachers as having additional difficulties such as learning and or attention deficits. There were 14 children with normal hearing (average pure tone threshold of < 20 dBHL in both ears). These children were classmates of some of the children with the unilateral hearing loss. According to their teachers, these children had no known disabilities

Instrument

The Screening Instrument for Targeting Educational Risk (SIFTER) questionnaire was used to assess the children's performance in the schools. Anderson (1989) designed the SIFTER to evaluate children's functioning in the classroom and to identify those students educationally at risk, possibly as a result of hearing problems. The SIFTER is comprised of a written questionnaire completed by the child's teacher. The teacher rates the child

in comparison to the other children (the average child) in the class. The instrument includes 15 questions divided into five domains of 3 questions each: academics (e.g., "What is your estimate of the student's class standing in comparison of that of his/her classmates?"), attention (e.g., "How distractible is the student in comparison to his/her classmates?"), communication (e.g., "How do the student's vocabulary and word usage skills compare with those of other students in his/her age group?"), class participation (e.g., "How often does the student volunteer information to class discussions or in answer to the teacher's questions?") and school behavior (e.g., "Does the student demonstrate any behaviors that seem unusual or inappropriate compared to other students?"). The teacher evaluates each question on a 5-point scale ranging from below average (1) to above average (5). Higher scores indicated more adaptive functioning.

The total of the three scores in each content domain reflects the child's functioning in that domain. The totaled scores for each domain can be plotted on a chart that indicates pass, marginal or fail. The SIFTER is brief and can be completed in a relatively short period of time. The Hebrew version of the SIFTER was used in a previous study (Most, 2004).

The reliability values for each the five domains were calculated. The five coefficients of internal consistency (Cronbach alpha) were high: .79 for academics, .93 for attention, .86 for communication, .79 for participation, and .86 for behavior.

Procedure

The children were recruited via the SHEMA Organization for the Education and Rehabilitation of Children and Youth with Hearing Impairement, with parental consent. SHEMA is a non-profit association which assists school-age children (aged 7-18 years) with hearing loss. SHEMA supports the children and their teachers during school hours and during extra-curricular activities. This organization receives the names of any children who fail the routine hearing screening test administered to all first graders on a national basis. SHEMA has several branches, and the present data was collected in the northern branch, located in Tiberias. The children recruited were those with UHL who were enrolled in general elementary schools. Their teachers were approached and asked to fill out the questionnaire. Only teachers who knew the children for at least six months were approached.

SIFTER questionnaires were given to each teacher and the teacher was asked to evaluate the child with hearing loss. In addition, the teachers were asked to report on the child's marks in Hebrew and mathematics. Data collection also included demographic information contained in the SHEMA files for the children with hearing loss which related to their degree of hearing loss, the use of sensory aids and additional difficulties.

The teachers were asked to complete the SIFTER questionnaire for an additional child with normal hearing from the same class as the child with hearing loss. The child with normal hearing was selected from the class roster: the 14th child on the list was selected, provided that according to the teacher's report, the child was known not to have any additional difficulties. Whenever the 14th child had additional difficulties, another child was selected. Only 14 teachers completed the questionnaire for the additional child with normal hearing.

Results

Table 1 presents the mean, standard deviations and *t* values of the SIFTER scores for each of the five domains and for the total score for the two groups: children with normal hearing and children with UHL. As can be seen from the table, the children with normal hearing scored significantly better in all the SIFTER domains than the children with UHL.

Each individual child's scores in the five domains were plotted on a chart to assess a passing, failing or marginal score in each domain. Table 2 presents the percentage of children in the pass category and the percentage of children in the combined marginal and fail categories for each of the groups (normal hearing and UHL). Fisher's exact test was used to evaluate the differences in the proportions of percentages of pass versus the percentages of the combined marginal and fail categories in each of the domains between the two groups. The results revealed significant differences in the following domains: attention, communication, class participation and behavior. Within the UHL group, there were more children that fit into the combined marginal and fail category than those within the normal hearing group that fit into this combined category.

There were two subgroups within the group of children with UHL with regards to additional difficulties: 18 children (out of the 33) did not have any other known difficulties, while the other 15 were reported as having

additional difficulties such as learning and/or attention difficulties. The performance of the children with UHL with no additional difficulties was compared to that of the children with normal hearing. Table 3 presents the mean standard deviation and the obtained *t*-test values in each of the SIFTER domains. As can be seen from the table, significant differences between the groups surfaced in all of the domains. The children with normal hearing received higher scores.

Table 4 presents the percentage of children in the pass category and the percentage of children in the combined marginal and fail category for each of the groups (normal hearing and UHL with no additional difficulties). Fisher's exact test was used to evaluate the differences between the two groups with regard to the proportion of the percentages of pass versus the percentages of the combined marginal and fail category in each of the domains. The results revealed significant differences in the following domains: communication, class participation and behavior. More children within the UHL group fit into the combined marginal and fail category than those within the normal hearing group that fit into this combined category.

Within the group of children with UHL, there were two subgroups regarding hearing aid use: 12 children were fitted with hearing aids and 21 did not have hearing aids. *T*-test analyses were conducted to compare the SIFTER scores of the children with and without hearing aids. These analyses revealed no significant differences between these two subgroups in all 5 domains ($p > .05$).

Pearson correlations were conducted to evaluate the correlations between the severity of the UHL and the SIFTER scores. These analyses revealed no significant relations between the degree of UHL and the SIFTER scores in all five domains ($p > .05$).

In addition to the SIFTER scores, there were data regarding the children's grades in mathematics and in Hebrew for 19 of the children with the UHL (out of 33). Pearson correlation analyses were conducted in order to examine the correlations between these grades and the SIFTER scores. Table 5 presents the obtained *r* values between the SIFTER scores in each of the five domains and the grades in mathematics and Hebrew.

Discussion

The present study compared the class performance of children with UHL to children with normal hearing. The results demonstrated significant differences between the two groups in all of the SIFTER domains: academics, attention, class participation, communication and school behavior. The results of the present study were consistent with findings from previous research (Most, 2004, 2006). In these previous studies, children with unilateral and mild hearing loss demonstrated poorer performance in comparison to children with poorer hearing loss. Likewise, other studies have demonstrated the negative effect of minimal or unilateral hearing loss on children's functioning (Bess et al., 1986; Blair, Peterson & Viehweg, 1985; Oyler, Oyler, & Matkin, 1988).

The children with only minimal or UHL received considerably fewer support services. In most cases, they experienced no intervention or therapy, and teachers generally remained unaware of the negative effects that such a hearing loss might have on their class performance. Perhaps this paucity of support was linked to the fact that the performance level of these children was lower than their capacity.

Since some children in the UHL group were reported as having additional difficulties, the performance of those with no supplementary difficulties was compared to those with normal hearing. In this comparison as well, the results still showed disparities in the performances of the two groups. The children with UHL performed less well than the children with normal hearing. Therefore, it seems that the poor performance was a result of the hearing loss. Children with UHL have difficulties in listening when there is background noise and they find it difficult to localize the sounds (Bess, Tharpe & Gibler, 1986). These auditory skills are of particular importance in the classroom environment where there is background noise and children are talking from different directions. Consequently, the children with UHL miss much of the formal as well as informal information, and this affects their performance in the various domains in class.

When referring to the children with UHL and additional difficulties, it is not clear whether the difficulties reported by the teachers were a result of hearing loss or whether they were additional difficulties, not associated with the hearing loss. The difficulties were mostly related to attention or learning and as mentioned above, these difficulties may arise from UHL

and the communication difficulties might be misinterpreted as learning difficulty.

It should also be noted that there were teacher reports describing social, emotional and behavioral difficulties for 21 children out of the 33 children with UHL. The teachers reported violence, isolation, low self-esteem and shyness. These reports supported previous reports on social-emotional and behavioral difficulties (Bess et al., 1986). Oyler and McKay (2008) claimed that if it is necessary for a child to make a constant effort to listen, the child may feel insecure or left out. Consequently, the child may become withdrawn and isolated.

Beyond the comparison between the two hearing status groups, this study also investigated the correlations between the severity of hearing loss and the school performance of the children with the UHL. The hypothesis was that as the children's hearing loss becomes greater, they will demonstrate lower classroom performance. The results did not show any significant correlations to support this hypothesis. It appears that when the child relies only on one ear it affects their performance in class. Thus, performance is affected by the fact that the child relies on one ear but the severity of loss in the poor ear is not significant. It is possible that these insignificant results were due to the fact that all the children in the present study had UHL greater than 55 dBHL. Thus, all the children had moderate to profound hearing loss and 28 out of the 33 children had severe to profound hearing loss. Future research should also include individuals with mild to moderate UHL, and then it will be possible to realistically examine this effect upon the performance. It is possible that better hearing in the poor ear improves performance.

The effect of the use of sensory aids was examined as well. It was predicted that children with hearing aids would perform better than children without hearing aids. The results did not support this hypothesis. It is possible that since most of the children in the present sample had from severe and profound UHL, the HA was not beneficial. Although the literature supports the difficulties the children may encounter, there is no existing evidence to support amplification for all children with UHL (McKay, Gravel & Tharpe, 2008). Yoshinaga-Itano et al. (2008) claim that conventional HAs are not sufficient to access conversational speech in profound UHL, and thus, this raises the possibility that the quality of sound can interfere with the good quality of the good ear. In addition, Kiese-Himmel (2002) reported that there was limited or no HA use with severe or profound losses. Kiese-

Himmel (2002) further claimed that amplification is efficient only as long as the difference between the two ears is not too great. Future research should examine the effect of other technologies on the children's performance in class, such as bone-anchored hearing aids (BAHA) for children older than 5 years of age, contralateral routing of signal (CROS) hearing aid, or other sensory aids such as FM systems (Oyler & McKay, 2008).

The present findings substantiate findings of previous studies that suggest that professionals and educators should be increasingly sensitive to the adverse effects of a minimal or UHL on the child's functioning within the educational system, and they should then provide the necessary services. They should be aware of the importance of treating the classroom acoustically and optically and should receive comprehensive in-service training with regard to the everyday problems the child with UHL might encounter in school. It is important to follow up on such children in school and intervene in the case of those who fail in some domains. Future research should collect data from the children as well in order to increase knowledge on the effect of the UHL on performance in the various academic and social domains in class.

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Table 1: ***SIFTER Domains and Total Scores for the Children With and Without Hearing Impairments***

	Unilateral Hearing Loss (*n=33)*		Normal hearing (*n*=14)		*t(45)*
	M	*SD*	*M*	*SD*	
SIFTER scores					
Academics	3.43	0.83	4.23	0.76	3.10**
Attention	3.02	1.12	4.00	1.10	2.75**
Communication	3.19	0.70	4.16	0.79	4.17**
Participation	2.95	0.93	4.00	0.91	3.51**
Behavior	3.74	1.08	4.61	0.38	4.04**
Total	2.99	0.76	3.81	0.67	3.95***

**p<.01 ***p<.001

Table 2: ***Breakdown (%) of Each Group into Failing & Marginal, and Passing Categories for the Five SIFTER Domains***

	Unilateral Hearing Loss		Normal hearing	
	Fail & Marginal	Pass	Fail & Marginal	Pass
Academics	36.36	63.64	7.69	92.31
Attention*	42.42	57.58	7.69	92.31
	66.67	33.33	7.69	92.31
Participation**	42.42	57.58	0.00	100.00
Behavior*	36.36	63.64	0.00	100.00

* $p < .05$ ** $p < .01$

Table 3: ***Pearson Correlations between SIFTER Ratings and Academic Marks in Hebrew and Mathematics***

SIFTER	Hebrew mark	Mathematics mark
Academics	0.6**	0.8***
Attention	0.3	0.6**
Communication	0.5*	0.6*
Class participation	0.4	0.7**
School behavior	0.04	0.4

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 4: ***Means, Standard Deviations, and t Values for the SIFTER for the Unilateral with No Additional Difficulties and the Normal Hearing Participants***

	Unilateral Hearing Loss (without additional difficulties) (n = 18)		Normal hearing (n = 14)		$t(30)$
	M	*SD*	*M*	*SD*	
SIFTER scores					
Academics	3.65	0.75	4.23	0.90	2.18*
Attention	3.15	1.20	4.00	1.05	2.05*
Communication	3.42	0.62	4.16	0.73	2.96**
Participation	3.16	1.05	4.00	0.74	2.35*
Behavior	3.7	1.14	4.61	0.96	3.17***

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 5: r *Values Between the SIFTER Scores and Grades in Mathematics and Hebrew*

	Unilateral Hearing Loss (without additional difficulties) (n = 18)		Normal hearing (n = 14)	
	Fail & Marginal	Pass	Fail & Marginal	Pass
Academics	27.78	72.22	14.29	85.71
Attention	33.33	66.67	14.29	85.71
Communication*	55.56	44.44	14.29	85.71
Participation*	38.89	61.11	7.14	92.14
Behavior*	33.33	66.67	0.00	100.00

* $p < .05$