Sound Field FM Use by Children With Severe Hearing Loss: Two Case Studies

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The use of sound field amplification systems in regular education classrooms has increased steadily since the 1980s. The presence of one national manufacturer of sound field equipment has grown into at least five manufacturers, most with product lines varying from desk top sound field FM units to ceiling systems.

The original Mainstream Resource Room Study (MARRS) research (Sarff, 1981) and subsequent sound field studies primarily targeted children with fluctuating or minimal degrees of hearing loss. As sound field amplification systems in classrooms proliferated, the following questions were often asked, "Can sound field amplification be used with children who are hard of hearing and wearing hearing aids in the classroom?" and "When should amplified classrooms be recommended versus personal FM systems?" This paper will provide case studies to help the educational audiologist answer these questions.

In the inaugural issue of the Educational Audiology Monograph, this author offered a philosophy to support the use of sound field classroom amplification for some students who were hard of hearing (Anderson, 1989). Considerations included the following: (a) sound field amplification was not as stigmatizing to students as body-worn personal FM systems; (b) students who refused to utilize personal FM units due to cosmetic and peer acceptance concerns could be placed in sound field amplified classrooms and receive at least some signal-to-noise (S/N) enhancement; (c) the acoustic properties of a personal FM set on FM+HA provided only a slight or equal acoustic advantage as compared to a sound field amplification system used in conjunction with personal hearing aids with directional microphones. Based on the above considerations, it was concluded that "The hearing aid user who is optimally amplified and consistently wears binaural hearing aids; who has fair to good discrimination for speech in the presence of noise; and who has adequate speech and language skills, may be considered as a candidate for classroom amplification versus a personal FM system or just personal hearing aids" (p. 25).

The purpose of this article is to provide two case studies of students with hearing impairment who have used sound field amplification over a period of years. Their subsequent academic performance is provided as well as reflections on the considerations mentioned above.

Case Descriptions

For the purpose of these descriptions, subjects in these cases will be called Abner and Polly. Abner and Polly were chronologically two years apart; however, Abner had repeated kindergarten and was only one academic year ahead of Polly. Each child was first encountered on entry into kindergarten.

Abner had a profound sensorineural hearing loss in his right ear, and a sloping severe-to-profound mixed hearing loss in his left ear. Personal amplification was used in the left ear only. Aided thresholds were within the normal range through 1000 Hz, 45-55 dB HL at 2000 - 6000 Hz and 70 dB at 8000 Hz. His aided speech reception threshold (SRT) was 20 dB HL and word discrimination at 50 dB HL was 80%. Abner utilized a personal FM system, under protest, throughout kindergarten and first grade. In the second grade Abner was placed in a sound field amplified classroom. He did not rely on speechreading consistently to aid him in speech understanding, and assessment by the school psychologist revealed that Abner had minor visual processing difficulties in addition to his hearing impairment. Language skills were within the normal range. He was very capable of average school performance with educational support and concentrated effort on his part.

Polly had a moderate-to-severe mixed hearing loss bilaterally. The loss was symmetrical and her unaided speech reception threshold was 70 dB HL in each ear. Aided thresholds were in the mild loss range with the aided SRT being 30 dB HL. Aided word discrimination at 50 dB HL was 68%. Polly consistently utilized binaural hearing aids in kindergarten, but was inconsistent in wearing her right hearing aid in first grade, which resulted in her refusal to wear the right hearing aid in grade two and above. A trial period with a personal FM system occurred during the beginning of Polly's kindergarten year. The option of continuing use of the personal FM system was rejected after she apparently sabotaged the unit. A sound field FM system was put into use in Polly's kindergarten class. Polly was a very bright little girl with excellent speechreading skills who already had beginning reading skills upon entry into kindergarten. Language skills were at or above the normal range. Little academic support outside of teacher inservice and consultation was needed.

This audiologist provided Abner and Polly aural habilitation on a bi-weekly basis for four years, seeing them individually or together. Primary objectives were to improve listening in noise, auditory memory skills, and to develop communication repair

strategies. Steady improvement was made by both children, resulting in their passing all subtests of the Test of Auditory Comprehension (Trammell et. al, 1976) and being dismissed for aural habilitation services at the end of four years. Both children attended a school which housed a relatively large number of students with hearing impairment; however, Polly moved to her home school in grade four.

Abner and Polly were considered candidates for sound field amplification rather than personal FM system use in their classrooms. Candidacy was based on several factors: (1) their rejection of personal FM for cosmetic concerns; (2) consistent use and dependence upon use of at least one hearing aid; (3) functional ability as hard of hearing students within the classroom setting; and (4) fair-to-good word discrimination while listening and watching the teacher when noise was present. Table 1 lists the results of informal listening testing of Polly and Abner when they were in grades 3 and 4 respectively. As can be inferred from this information, both children were highly reliant on speechreading as well as audition. Using speechreading and audition, these children had word recognition scores of 80% or higher, which was relatively high considering the severity of their respective hearing losses.

Table 1. Informal listening test using WIPI stimulus words presented from 12 feet in a therapy room. Background noise was taped cafeteria noise, presented at +5 dB signal to noise ratio. Monaural hearing aids only.

	Abner 3 feet	Abner 12 feet	Polly 3 feet	Polly 12 feet
Audition plus vision, in quiet	90%	80%	90%	80%
Audition only, in quiet	50%	50%	50%	50%
Audition plus vision, in noise	80%	80%	80%	80%
Audition only, in noise	50%	20%	50%	20%

Monitoring Classroom Performance

The children's teachers were asked to complete the Screening Instrument For Targeting Educational Risk (SIFTER) (Anderson, 1989) at each grade level. The SIFTER screens for performance in the areas of Academics, Attention, Communication, Class Participation and School Behavior. Based on a teacher's rating of a child's performance in comparison to peers, the child can pass, fail or receive a marginal rating in each area.

Abner

Increasing concern was expressed by Abner's teachers (gr. 3-4) regarding his ability to follow directions effectively in the classroom, pay attention, and keep up with academic demands. Serial SIFTERs were examined and it was clear that his ability to function in a classroom setting had degraded over time. Following examination of serial SIFTERs since grade two, it was decided that a trial period with a personal FM system was warranted. The final SIFTER scores in Table 2 were obtained following a trial with a Phonak MicroLink FM module.

Table 2. Abner's SIFTER scores from grades two through four. P = pass, M = marginal performance (at-risk), F = fail. The first four SIFTERs were completed while a sound field system was in use in the classroom. The last SIFTER score followed a trial period with an ear-level personal FM system.

Abner's Grade	Academics	Attention	Commun.	Class Part.	Sch. Beh.
2 - Spring	Pass	Pass	Pass	Pass	Pass
3 –Mid-year	Fail	Marginal	Marginal	Marginal	Pass
3 - Spring	Marginal	Marginal	Marginal	Fail	Pass
4 - Fall	Marginal	Fail	Marginal	Pass	Pass
5 –Mid-year	Pass	Pass	Marginal	Pass	Pass

In conjunction with the personal FM trial period in grade four, Abner was asked to complete the student appraisal form of the Listening Inventory For Education (LIFE) (Anderson & Smaldino, 1998). During the administration of the LIFE, Abner was asked to rate his ease of listening under fifteen listening conditions that commonly occur in a elementary school. Choices were: Always Difficult, Mostly Difficult, Sometimes Difficult, Mostly Easy, Always Easy. The first ten situations relate specifically to classroom listening. The last five relate to additional listening situations, such as peer communications, assemblies, and gym. A total of one hundred points can be scored in each of these two sections.

In the fall of fourth grade, and three months prior to initiation of the MicroLink trial period, Abner rated his ease in listening as sometimes difficult to always difficult for eight out of ten listening situations presented. His LIFE pre-test total score was 29 out of 100 possible for classroom listening and 15 out of 100 possible for additional listening situations. Following use of the MicroLink FM system for five weeks, Abner was again administered the LIFE. His post-test total score had increased to 77 for classroom listening situations and to 95 for additional listening situations. In addition, his teacher completed the LIFE teacher appraisal of listening difficulty following the five week trial period. The total appraisal score was 34 out of 35 possible points, indicating very strong support for benefit from the personal FM.

Polly

Polly had strong academic performance and readily participated in her classrooms (grades K-4). Attention problems and difficulty following verbal instructions developed into significant problem areas as expressed by her teachers and as evidenced by serial SIFTERs. Although Polly was highly capable, the SIFTER scores for grades 1-4 indicated increasing difficulties over time (Table 3). Communication skills declined as her peer group became more sophisticated communicators. There were concerns about Polly's behavioral choices within the classroom. It was inferred by the teacher and audiologist that her behavior was

possibly related to her inattention and frustration with, or misconstruing of, classroom instructions, activities or peer communication. Academic abilities remained high, despite questionable work habits.

Table 3. Polly's SIFTER scores from grades one through four. The initial three SIFTER were completed while a sound field system was in use in the classroom. The last SIFTER score followed non-use of hearing technology for the last half of the school year.

Polly's Grade	Academics	Attention	Commun.	Class Part.	Sch. Beh.
1- Spring	Pass	Pass	Pass	Pass	Pass
2 - Spring	Pass	Pass	Pass	Pass	Marginal
3 - Spring	Pass	Marginal	Pass	Pass	Marginal
4 - Spring	Marginal	Fail	Marginal	Marginal	Fail

Polly was administered the LIFE in January of third grade. She had been placed in a sound field classroom with consistent use of the microphone by the teachers since kindergarten. Her scores on the LIFE at that time were 65 for classroom listening and also 65 for the additional listening situations. Polly received new Phonak hearing aids in February of grade three, and was urged to use both hearing aids for her symmetrical hearing loss, rather than her preferred use of just the left hearing aid. By the end of grade three, binaural hearing aid use was more consistent and a MicroLink FM system was purchased for her to use starting in the fall of grade four. Due to parent request, Polly entered her home school for grade four. She was the only student with hearing impairment in attendance at that school. Polly was excited to use the MicroLink system in the fall; however, by the end of the third week of school, she was manipulating and sabotaging the system, ultimately refusing to use the MicroLink. Polly's parent supported her choice to refuse hearing technology. Polly's teacher rated her performance using the LIFE teacher appraisal one week after the MicroLink use was discontinued, and identified notable changes already apparent within that week. The teacher appraisal score was 19 out of 35 possible points. In this case, 19 points indicated that use of a hearing aid alone, as compared to FM use, was unfavorable for Polly. Based on student and parent written request, use of classroom hearing technology was discontinued for the rest of Polly's fourth grade year. LIFE student appraisal at the end of grade four resulted in a score of 52 for classroom listening and 30 for additional situations. These scores are significantly lower than LIFE listening appraisal scores obtained at the end of grade three.

Discussion

As young children, Polly and Abner were judged to have the auditory skills needed to succeed in a mainstream classroom setting with a sound field amplification system in consistent use by the teacher. These were both capable students, liked by their peers, with language ability within the normal range and a good start to their academic careers. They received aural habilitation services and demonstrated knowledge of coping skills and the ability to understand speech in noise. Over time, both of these students developed listening and functional difficulties within the classroom setting. The SIFTER and LIFE scores provided a rough "thumbnail sketch" of developing difficulties. In general, as directions and academic expectations increased, the children's ability to follow instructions effectively decreased. Distractibility was reported by the teachers to be a significant problem for both students. Social concerns grew as the children had difficulty understanding group discussions, cooperative learning activities, and fast-paced peer communication. The children's attention span, distractibility, direction-following ability and social competence allowed them to be perceived as successful in early elementary years, relative to their normal hearing peers. As they advanced in the grades, peers' ability in these areas matured whereas the social abilities of the children with hearing impairment were judged to be increasingly different or immature.

Children with hearing impairment are often considered immature in comparison to their normal hearing peers. Studies of older deaf children have shown a decline in social competence with increasing chronological age (Greenberg, 1980; Marschark, 1993). Older deaf children are seen as more impulsive, egocentric, immature, and less socially competent. Greenberg and Kusche (1993) have suggested that these deficits are a result of socialization involving continual language deprivation, discouragement of independence and responsibility, and the absence of incidental learning. Deaf children often receive limited explanations for their feelings and roles, as well as limited reasons for their actions and the consequences of their behaviors. As a result, deaf children have more self-esteem and behavior problems due to their less-than-optimal socialization through language and resulting interpretation of social events. Although Polly and Abner were not deaf students and were capable communicators, it it appears that inconsistent auditory input may have caused a cumulative effect on their socialization and behavior, as well as their attention and ability to follow increasingly complex instruction and peer interactions.

Based on results from only two students it is impossible to provide any reliable conclusions or recommendations regarding the use of sound field versus personal FM systems for all children with moderate or greater levels of hearing loss. It is perhaps acceptable to offer some observations and considerations.

Concluding Observations and Comments

(1) The kindergarten performance of children who are hard of hearing cannot be used to predict their performance in later grades, as academic demands become more complex and social communication becomes more sophisticated.

(2) Despite the apparent capability of the learner, it is important to regularly monitor the educational performance of children who are hard of hearing. Teacher input on classroom function as well as the children's own views on their school listening abilities provide valuable insights over time as compared to peers with normal hearing.

(3) Acquisition of compensatory listening in noise abilities within an aural habilitation therapy situation does not necessarily prepare the child to cope effectively in the mainstream classroom.

(4) Sound field and personal FM amplification do not address students' needs to listen effectively to peers in a typically noisy classroom environment. The practicality of passing the microphone transmitter to every speaker, including brief peer conversations and comments, is contraindicated. Attention to reverberation and background noise in the classroom is essential if children who are hard of hearing are to effectively access cooperative learning and peer communication opportunities.

(5) Although sound field amplification improves the signal-to-noise ratio of the teacher's voice over background noise, it appeared that this S/N level was insufficient for these students to follow directions effectively as academic demands increased.

(6) Cosmetic concerns can seriously hamper use of FM hearing technology. A sound field system was more socially acceptable to these students; however, they were without the benefit of superior S/N enhancement of the teacher's voice. Abner, who was in a school that housed a relatively large number of students with hearing loss, was highly accepting of utilizing a personal FM system once it was ear-level. Conversely, Polly, who moved to her home school and was the only child wearing amplification in the school, refused to utilize even ear-level FM technology due to cosmetic and social concerns. Without peer and parental acceptance of hearing technology as a requisite to learning, cosmetic concerns will continue to undermine the success of many students.

In conclusion, a hard of hearing child's successful development of academic and social skills cannot be guaranteed by the use of any certain type of hearing technology. Classroom acoustics, intrinsic capability, family support, teaching style, and peer acceptance all contribute to how well a child will be able to achieve his or her potential. The benefits of sound field amplification for students with normal hearing and mild, unilateral or high frequency hearing loss have been convincingly supported by professional literature (e.g., Rosenberg, 1998). Anecdotal evidence suggests that students with mild hearing loss are good candidates for classroom sound field amplification, especially when no other disability is present. In light of the experience derived from the case studies described above, this audiologist will avoid the use of sound field amplification for students with moderate, severe, or profound loss, in preference of a personal FM system, regardless of their apparent capabilities at a young age. Research is needed to confirm these suppositions.

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