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AUTHOR	Flexer, Carol
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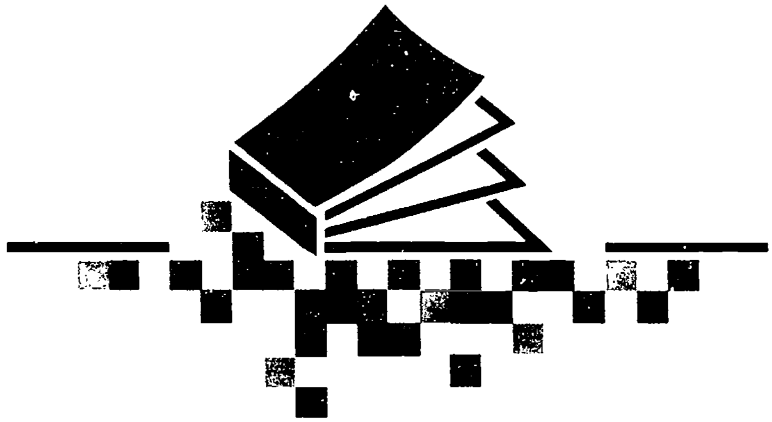
ABSTRACT

This document supplements a series of training modules that provides a basic introduction to using assistive technology with young children (ages 2 to 7) who have severe disabilities in more than one area of development. The supplement contains suggestions about hearing technologies and listening strategies that improve a child's opportunities to learn from his or her environments. It discusses the types of listening and hearing difficulties occurring among young children with severe disabilities. Hearing technologies, including hearing aids, personal frequency modulation (FM), sound-field FM, and mild-gain hard-wired systems, are described, along with practical suggestions for their use in a child's learning environment. Appendixes provide an assistive technology resource list, an outline of types of hearing loss, national resources for information on assistive listening devices, information on audiological assessment, and a list of 25 additional readings. A videotape, entitled "Assistive Technology: We Can Do It!," was developed to accompany this module and related modules. (Contains approximately 35 references.) (JDD)



Listening and Hearing

A Supplement to

Technology in the Classroom

Applications and Strategies for the Education of Children with Severe Disabilities

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Technology in the Classroom

Applications and Strategies for the Education of Children with Severe Disabilities

by

Carol Flexer

edited by

Nancy T. Harlan

Deborah M. Bruskin

AMERICAN SPEECH-LANGUAGE-HEARING ASSOCIATION

September 1992

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Dedicated to the families, teachers, and service providers who are untiring in their efforts to help young children with severe disabilities reach their full potential.

The purpose of this module is to give you information about assistive technology that will be helpful to you and your child or the children you serve. Therefore, make it work for you. Read only what you want to know now; read the rest later when it is pertinent to your needs.

Preface

With the advent of assistive technology, a new world opened up for children with severe disabilities. They now would be able to move about, communicate, and learn, often alongside their able-bodied peers. However, making this technology available to these children and teaching them how to use it was not, and is not, an easy task. How do you go about informing educators and related service providers about the intricacies, challenges, and benefits associated with using technology? How do you help them to become comfortable using assistive devices as tools that can enhance, rather than interfere with, their daily teaching and other responsibilities?

Technology in the Classroom: Applications and Strategies for the Education of Children with Severe Disabilities, a 3-year project funded in part by the U.S. Department of Education, tries to address these questions. The American Speech-Language-Hearing Association (ASHA) designed this project to develop, field-test, and evaluate the effectiveness of self-instructional materials that would improve the knowledge and skills of families, teachers, and related service personnel so that they could use assistive technology effectively in the educational programs of young children with severe disabilities. Development of these materials involved the collaborative effort of many individuals who contributed significantly to the final products.

Authors. These materials were authored by clinicians and teachers who have many years of experience in the field of assistive technology. Sarah W. Blackstone, E. Lucinda Cassatt-James, Elaine Trefler, and Carol Flexer all have seen young children struggle to walk, talk, learn, and listen before most of the assistive technologies available today existed. They know today's technology because their input helped to develop it. It was their vision and creativity that guided the direction of this project. Their respect for children, their skills in determining children's needs, and the depth of their knowledge regarding strategies to use in meeting those needs have been demonstrated in the content of the project materials, along with their ability to share this knowledge in a clear and understandable manner. We all are indebted to these women for their long-term dedication to, and advocacy for, children with disabilities.

Site Coordinators. Two field tests were conducted during the course of the project to help us determine whether the project materials were actually useful in providing families, teachers, and related service providers with strategies for incorporating assistive technologies into the educational programs of young children. A local field test was conducted in Montgomery County, Maryland; we are grateful to Tom O'Toole, Sandra Lebowitz, and Nancy Gould for helping us to conduct this field test and for facilitating a smooth working relationship with public school personnel. The second field test, which was conducted at the national level, was made possible by the willingness and gracious efforts of Peggy Locke in Minnesota, Richard Lytton in Rhode Island, Judy Montgomery in California, and Gail Van Tatenhove in Florida. Not only did they locate the field-test sites and

participants, but with their knowledgeable input they facilitated the fine-tuning of field-test evaluation instruments to better suit potential field-test participants. They also provided valuable input into the structuring of project materials. Their enthusiasm for the project, their care in completing tedious tasks, and their collective sense of humor all contributed enormously to the successful completion of the project.

External Advisors and Peer Reviewers. So many individuals gave freely of their time and energy to review the project materials, each contributing to the preparation of a better product. With heartfelt thanks we acknowledge Mary Brady, Linda Burkhart, Philippa Campbell, Cynthia Compton, Susan Elting, Don Goldberg, David Hawkins, Susan Hough, Mary Blake Huer, Bill Lee, Janice Light, Bill Lynn, Noel Matkin, Shirley McNaughton, Beth Mineo, Marion Panyan, Kathy Post, Susan Quinlisk-Gill, Eileen Raab, Mark Ross, Janis Speck, and Lana Warren.

Internal Advisors. This group (Stan Dublinske, Kathryn Nickell, Cassandra Peters-Johnson, Diane Paul-Brown, Helen Pollack, and Jo Williams) supported the project throughout all of its phases and provided insightful suggestions, for which we are extremely grateful.

Project Staff and Significant Others. Special thanks to Mary Anzelmo for getting the project started, and to Ellen Fagan, ASHA's director of continuing education, for helping us to develop the project's field-test tools that were so effective in demonstrating changes in field-test participants' attitudes. Ellen also was an appreciated counsel with regard to field-test procedures and data analysis. Tarja Carter, director of ASHA's graphic services, and her staff were a source of never-ending talent when it came to preparing text, brochures, posters, module covers, and all project artwork. Joanne Jessen, ASHA's director of publications, and her staff of editors who reviewed the project documents provided advice regarding publication issues and editorial questions. Personal thanks go to Charles Diggs (ASHA's director of consumer affairs) for his counsel in preparing the project videotape, and to Amie Amiot for her untiring efforts in formulating statements about public laws. If it had not been for James Gelatt and Camille Catlett, who were responsible for the original grant preparation, this project never would have begun. Acknowledgment also goes to our project officer, Patricia Hawkins, and the Office of Special Education Programs, U.S. Department of Education, for their continuing support.

Stan Dublinske, director of ASHA's Professional Practices Department, was a constant source of strength with his clear thinking and concise solutions to some of the thornier problems. Cheryl Wohl contributed liberally during the initial phases of the project and carefully saw to the preparation of field-test materials. Many thanks for her continued support.

The project, however, would never have come to completion without the guidance of the project manager, Deborah Bruskin, who held the hand of this project director until she knew the ropes of the National Office and procedures for interfacing with the Department of Education. This moral support continued and made

possible the project's movement through its more difficult times. Her excellent writing skills helped significantly in developing the written materials. Many thanks to a competent colleague and constant friend.

Personally, I have grown markedly from my involvement in the development of this project. Most certainly, it has changed the direction of my professional life, and I sincerely thank all those with whom I have had the pleasure of working for these past months.

We hope that the results of our efforts, including three modules, one supplement, and one videotape, will find their way into the hands of families and professionals eager to meet the technology needs of young children with severe disabilities. We present them to you with some measure of assurance that they will be helpful and that, hopefully, children's potentials will be better realized. In a world of such rapid technological changes, I challenge you to get started now! It may be your own insight and experience that contribute to a second publication of this sort.

Nancy T. Harlan

Nancy T. Harlan
Project Director

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Chapter I Introduction

Welcome to the world of assistive technology! If you are reading this module, you are undoubtedly curious about what assistive technology means and the role of this technology in the education and lives of young children with severe disabilities. As defined by the Education of the Handicapped Act Amendments of 1990: "The term 'assistive technology device' means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." [Sec. 101(g)]. Many of you may be from the "paper and pencil generation" or may have used technology in a business context only. Whether you are a family member, a teacher, or a related service provider, you consider yourself a novice in the use of technology for young children with severe disabilities.

To ease your entry into this new and exciting area, we have prepared a series of modules that provide a basic introduction to using assistive technology with young children (ages 2–7) who have severe disabilities in more than one area of development (i.e., motor, communication, and/or cognitive). However, the content of these materials may be extremely helpful to families, teachers, and related service providers of children who have a severe or even mild disability in only one area of development. The *Communication Module* delves into technology that gives children another way to communicate when speaking is difficult or impossible. The *Positioning, Access, and Mobility Module* gives readers ideas about how to position children comfortably so they can participate in the activities of life, as well as ideas about helping children activate technology and move about even when their arms and legs are inefficient or do not allow them to crawl or walk. The *Education Module* has descriptions of technologies that help children do pre-academic as well as academic tasks—tasks that help them learn how to learn. It also addresses computer terminology and adaptations to computers that make them usable by children with disabilities. A supplement entitled *Listening and Hearing* contains suggestions about hearing technologies and listening strategies that improve a child's opportunities to learn from his or her environments. The accompanying videotape, entitled *Assistive Technology: We Can Do It!*, provides an overview of the technologies and strategies discussed in the written materials and shows children using them successfully in learning environments.

Parents and professionals who reviewed the modules (as part of a national field test) agree the videotape is most helpful when viewed before reading a module. This national field test of project materials also revealed two statistically significant findings: (a) 62 family members as a group and 99 professionals as a group became more comfortable with their knowledge of assistive technology, and (b) the professionals as a group began to feel more competent in using assistive technology. Preliminary findings of a local field test (conducted before the national test) indicated findings similar to (a) above. Follow-up of local field test participants one year later indicated an increase in participants' (a) level of awareness of assistive technology, and (b) efforts to seek additional information and resources about assistive technology. Thus, we present these materials to you with some degree of confidence that they will be helpful.

Role of Technology

Technology has become an integral part of the lives of all children today. Two-year-olds are operating the remote control for the television, turning on lights, and pushing the button on the automatic garage door opener. Three-, four-, and five-year-olds, as well as first and second graders, are operating microcomputer-based toys, such as "Speak and Spell," and are playing computer games at home using their parents' or older siblings' computer.

Assistive technology enables children with severe disabilities to participate more fully in all aspects of life (home, school, and community) and helps them access their right to a free, appropriate, public education in least restrictive environments. Part B of IDEA* states that a child's needs for assistive technology services and devices must be considered by the team formulating his or her Individualized Education Program (IEP) or Individualized Family Service Plan (IFSP). If the team determines that the child needs assistive technology to receive a free, appropriate, public education in the least restrictive environment, the child's IEP/IFSP must include a specific statement of such devices and services, and these devices and services must be provided. This is a landmark decision that allows students with severe disabilities to be fully integrated into the educational system. Although this decision will improve the quality of education for children with disabilities, it also presents a great challenge to the teachers and families, as well as a variety of service providers, who must use the technology to assist these children as they strive to achieve independence in a difficult world.

The perspective of the authors is that assistive technology is an enabling tool that provides access to learning. It is most effective when applied in combination with traditional teaching techniques to achieve the best learning environment for children with disabilities. Alone or in combination with other techniques and strategies, assistive technology is not a panacea for all learning challenges. Experience has shown that a child's ability to operate a piece of equipment has little impact on his or her educational achievement. For example, simply using a switch to turn on a toy does not necessarily mean that an understanding of cause and effect has occurred. This ability is only one of many events in a child's life that may lead to the acquisition of such a basic cognitive skill. Likewise, pointing to symbols on a vocabulary overlay does not spontaneously translate into functional use of those symbols for purposeful communication.

Applied carefully and skillfully, assistive technology can play an important role in meeting the needs of children with severe disabilities. Technology can assist these children in participating in the educational curriculum and in acquiring social

* This is an amendment to the Education for All Handicapped Children Act of 1975 (P.L.94-142), which was first amended as P.L.99-457.

skills (now being able to interact with peers and siblings). It can help them master skills needed for independent living. They do not miss out on the fun and excitement of being children.

Myths About Technology

Myth # 1: Technology limits speech and mobility.

Almost anyone who has had to decide whether a child should be given technology has asked the following questions.

"Won't technology keep children from learning to walk or to talk? Won't it make them lazy so they don't try as hard to develop their abilities?"

- We need to think of assistive technology as *a supplement, not a replacement*, for skills that are not yet present. Assistive technology may actually facilitate the development of skills or at least allow for the development of parallel skills. For example, the lack of mobility could delay cognitive development or social independence. However, with the provision of a mobility system, children can explore their world, fulfill family responsibilities such as getting to the kitchen on time for meals, or participate in school routines such as delivering messages to the school office. If walking for short distances becomes possible, the mobility device might just be used for activities such as playing on the playground at recess. The idea of a "wardrobe of devices" can be helpful (i.e., providing the child with a collection or choice of mobility options). This is not unlike children without disabilities who use various methods of mobility, such as bicycles, scooters, skates, and so forth. It is vital to remember that a specific assistive device can always be discarded if and when a child acquires new skills.
- The early application of augmentative communication approaches does not inhibit the development of speech and language and may actually *prevent the establishment of maladaptive communication patterns* (Blackstone, 1990). If, for example, initial attempts at interaction get off to a bad start (either because the children's communication signals are not being sent or not being received), the probability of the children acquiring an awareness that what they do has a specific effect upon others in their world is very low. This set of circumstances is known to lead to "learned helplessness," behavior problems, or passivity, which constitute major barriers and handicap people well beyond their level of impairment later in life (Abramson, Seligman, & Teasdale, 1978). Assistive technology can facilitate children's communication so that their communication attempts are more accurately understood and responded to.

Viewing the success that other children with similar disabilities have had with assistive technology can be very beneficial. Videotapes, films, written materials, support groups, and live observations can all be helpful in seeing the long-term benefits of technology.

Myth # 2: New technology is very difficult to use.

Many of us are skeptical about our own ability to use complex equipment; just the thought of using assistive technology arouses feelings of anxiety and intimidation. However, it is important to remember that:

- To facilitate your child's use of technology, you do not have to be an expert in using computers or other such "high tech" devices. There are experts who are trained to help you understand how the technology works.
- You learn only the functions of the computer/device that your child needs now. When your child needs a new function, you both can learn how to do it.
- Don't be put off by the terminology that is used when discussing computers or technology in general. As you begin to understand how to make the device work for your child, you will learn the related vocabulary.
- Although the first few steps taken toward the implementation of technology may be difficult, competence comes gradually and will eventually provide you with a sense of accomplishment and pride, both for yourself and for your child.

And there are resources that can help. Federal legislation has mandated that all states be funded to develop consumer-responsive, statewide, technology-related service delivery. Those states funded to date and their respective addresses and telephone numbers appear in Appendix A, "Assistive Technology Resource List." Also included in Appendix A are listings of organizations and agencies that provide assistance about applications of assistive technologies, pertinent publications, funding resources, and databases of assistive technology resources (e.g., manufacturers, products, publications, and services).

Realities About Technology

Reality # 1: Assistive technology is still being developed.

Assistive technologies for young children have not yet been developed/refined to the level of the television or the telephone. Because of this, limitations, "bugs," breakdowns, problems, and irritations exist, and we need to be prepared for them.

Reality # 2: Funding for assistive technology is a challenge.

Although funding is and will no doubt continue to be a challenge, this situation has improved in recent years. Funding sources now include federal and state programs, private insurance, and other sources, such as philanthropic groups. The Funding Resources section of Appendix A contains a list of current manuals and references that can help families and professionals sort through this funding maze. Equipment manufacturers also frequently provide information about funding resources.

Reality # 3: Applications of assistive technology take time and effort.

Utilizing assistive technology is time-consuming. For example, many, many symbol displays/overlays must be developed to enable one child to communicate at school. This child also requires displays/overlays for communicating at home and in the community. The child's communication aid also will require programming. In addition, planning and meeting time must be provided if assistive technologies are going to be fully integrated into a child's learning environments.

As this technology becomes more sophisticated, it also is becoming easier to use. For example, communication symbol displays now can be created and then produced on a printer. Some communication aids can be programmed by pressing buttons and speaking into a built-in microphone. Manuals are user-friendly, and manufacturers offer workshops and videotapes to help people understand how to use the equipment that they purchase.

In spite of these advances, it is necessary for administrators to understand that preparation, planning, and meeting time is needed if assistive technologies are going to help children be successful in reaching their full potential.

Reality # 4: Assistive technology should be used with care.

Assistive technologies are wonderful tools, but if they are used without discretion or inappropriately, they can harmful. For example, providing a child with an assistive listening device without input from an audiologist regarding amplification settings can result in permanent hearing loss. A child using an electric wheelchair without instruction from the occupational or physical therapist may be unable to stop the device before it rolls into a busy street or hits other children. Choosing augmentative communication aids without the expertise of a speech-language pathologist who knows the broad range of options and their suitability for children with different language capabilities can result in such frustration that a child's overall desire as well as ability to communicate may be diminished rather than increased. It is very important to seek out knowledgeable guidance from trained professionals so that the right decisions can be made about assistive technology devices and their applications.

Technology Team

It is essential that decisions about a child's use of technology be made by a team of professionals and family members to ensure that the child will benefit from a broad perspective of knowledge and experience. Members of a child's team change over time; only the child and, sometimes, the family remain constant. Thus, although each team member plays an important role along the way, the job of a team is to empower the child and the family to make decisions, to take control of the process, and to seek out new resources when they need them.

Research and practice suggest that teams function best when roles and responsibilities are clearly delineated. The members who usually make up a child's team are described below*:

- **Child** – Children are the only constant on the team, bringing with them their unique personalities, abilities, challenges, and fantasies. The children are active participants, and their opinions must be respected and valued. After all, they are the ones who will or will not benefit from technology, and will or will not use it.
- **Family** – The family provides support and helps to develop the child's world knowledge base. It is important to realize that many families have concerns unrelated to their children with disabilities that will affect their level of participation. In some cases, cultural issues and existing family dynamics may even inhibit active involvement. Varying degrees of participation are understandable and acceptable. The family can be a child's best advocate and can develop a child's sense of confidence, self-esteem, and independence.
- **Aides/instructional assistants** – These individuals work with teachers to implement the curriculum and make learning possible. They play a key role in fostering peer interaction, self-confidence, and independence.
- **Audiologists** – Audiologists test hearing, recommend hearing technologies, and provide instruction in the use of hearing technologies. They also give suggestions for enhancing children's listening skills.
- **Classroom teachers** – The classroom teacher is responsible for the child's total education program. Teachers must balance the activities and time available during the school day and collaborate with the family and other professionals to ensure that the "educational path" is followed. They develop and implement educational strategies that allow assistive technology users to participate in classroom activities so that functional, academic, and social goals can be accomplished.
- **Occupational therapists** – Occupational therapists, like physical therapists, evaluate children's posture and mobility. Occupational therapists then recommend and implement procedures and devices that will meet seating and mobility needs. In addition, occupational therapists help determine which devices and strategies children can use to access other technologies, such as those for learning and communicating, as well as moving.
- **Peers** – Children's peers may be friends, classmates, helpers, and tutors. Peers provide emotional support and a special link to certain aspects of children's lives in which adults have little involvement. They provide models for learning and communicating.

* Except for the child and the family, potential team members have been listed in alphabetical order.

- **Physical therapists** – Physical therapists evaluate children's posture and mobility and are subsequently involved in recommending and implementing a variety of techniques, devices, and strategies that will appropriately position the children to facilitate their comfort, proper development, and safety, and that will increase their mobility.
- **Physicians** – Physicians address medical issues and monitor medical complications. They are involved in the prescription of the seating and, often, the mobility device. The physician helps to procure funding from third-party payers (e.g., insurance companies).
- **Psychologists** – Psychologists assess children's intellectual abilities and learning styles. They must be skilled at making necessary adaptations to determine a child's cognitive functioning, taking into account present physical disabilities and behavioral characteristics.
- **School principals, directors of special education, superintendents** – These designated leaders have job descriptions that involve management of educational programs and fiscal issues. They are leaders and set the tone. They understand the school system and often can make things happen. They have the authority to allocate staff time as deemed appropriate. Their support is often critical to the successful implementation of assistive technology.
- **Special educators** – Teachers with special education backgrounds develop an in-depth understanding of each child's cognitive profile and learning style as they relate to the curriculum. Based on this knowledge, the special educator can modify curriculum goals and materials and provide additional resource support, such as recommending software that enables children to participate in classroom activities (e.g., art projects, creative writing).
- **Speech-language pathologists** – Speech-language pathologists suggest ways to maximize a child's speech, language, and communication during each activity (e.g., use of a communication device during circle time and a mini-board at home during bathtime). They often help develop vocabularies, design overlays, suggest strategies to facilitate interaction, and integrate speech and language development into the educational curriculum.
- **Team facilitator** – This individual possesses the knowledge and the skills to coordinate team meetings, ensure follow-through of team goals, see that time lines are met, and generally manage team activities so that no activity deemed important "falls through the cracks."
- **Technical resource personnel** – Rehabilitation engineers and/or technologists and assistive equipment suppliers/manufacturers help make decisions when specific technology is being considered. They can assist in procuring, designing, fitting, and maintaining the equipment and can also help in setting up/modifying equipment and software and designing work stations.

The individuals cited above play an important part in helping children use technology effectively. The roles they play often vary; those who implement the use of technology are not always the same as those who prescribe or design it. The level of expertise among these people in using technology also varies. Each person contributes his or her own unique skills, talents and personality; together they make assistive technology work. And, it is important that teams provide continuity and plan for smooth transitions as the child grows and moves through the educational system.

Service Delivery Models

Service delivery to children with severe disabilities can generally be categorized according to different "models," three of which are described below. Within each model, note how the focus of attention and the responsibilities change. Professionals and families vary as to the model with which they feel most comfortable. As families' needs change or as they learn more about dealing with their children's technology needs, they may change their model of choice. In some settings a certain model may be required, but within each circumstance there should be flexibility to meet the needs of both the children and their families.

- **Family-centered model:** This model is designed to
  - empower and enable the family as a system,
  - promote independence, not dependence, and
  - support and strengthen the family's competence in negotiating its own course of development.

  In the United States, the family-centered approach is an integral part of service delivery in infant and toddler programs with funding under the Individuals with Disabilities Education Act (IDEA).
- **Medical model:** This model is child-centered (i.e., the professional focuses on bringing about changes in the child). Families are often not expected to take an active role.
- **Educational model:** The educational model reflects the regulations inherent in P.L. 94-142. Intervention is child-centered, and success often is measured by whether discipline-specific goals are met. Families are expected to be part of the decision-making and training process; the training of family members and the development of home programs are inherent to this model.

No matter which model is used, unless there is collaboration among the team members, the implementation of assistive technology is doomed.

> In the collaborative model, it is assumed that no one person or profession has an adequate knowledge base or sufficient expertise to execute all the functions (assessment, planning, and intervention) associated with providing educational services for students. . . . All team members are involved in planning and monitoring educational goals and procedures, although each team member's responsibility for the implementation of procedures may vary. Team members can be considered as sharing joint ownership and responsibility for intervention objectives. (ASHA, 1991)

Listening and Hearing Supplement

Now that you have a brief background in assistive technology, you are ready to delve a little deeper into the specific ways it can be used to help young children with severe disabilities. This supplement discusses the listening and hearing difficulties occurring among young children with severe disabilities. Hearing technologies, including hearing aids, personal FM, sound-field FM, and mild-gain hard-wired systems, are described, along with practical suggestions for their use in a child's learning environments. Strategies to encourage listening also are included.

So read on, and be assured that with appropriate technology and support, all children, even those with severe disabilities, can grow up to be happy, participating members of their communities and society.

Chapter II Listening and Hearing

Listening is important for all children. Indeed, hearing and listening are the "root systems" for language and concept development. Hearing refers to the physiological status of the ear (i.e., the ability to receive sound), while listening refers to one's ability to pay attention to sound. Listening is crucial for children with normal hearing as well as for children with hearing loss. If speech is used to impart information to a child, then the status of the child's hearing must be established and hearing and listening abilities maximized. In addition, the child's attention must be drawn to the speech signal. Specific technologies are available that can create an improved listening/learning environment by enhancing the reception of a clear speech signal. Listening strategies also can be implemented to focus the child's attention on sound. These technologies and listening strategies can play an important role in a child's ultimate success.

Technology is being used in new and exciting ways to help young children with severe disabilities communicate, learn, and move about. Success at these tasks, however, is directly affected by the child's ability to hear. The assistive technologies necessary to enhance input, as well as those necessary for facilitating output, must be considered. It is not an exaggeration to say that virtually all young children with severe disabilities experience listening or hearing problems due to less than optimal listening environments as well as impairments, such as conductive hearing loss caused by ear infections. If a young child cannot "hear clearly," learning is more difficult. Receiving incomplete or distorted information is like hitting the wrong keys on a computer keyboard—the message is garbled and hard to understand.

Maximizing a child's ability to listen and to hear often involves the use of one or more types of hearing technologies. Before listing the various technologies that are available, some background information about hearing loss will be presented.

Chapter III Hearing Loss

Hearing loss is not an all-or-nothing condition; it occurs along a broad continuum, ranging from mild hearing loss to profound hearing impairment. But, all degrees of hearing loss can affect a child's development. Speech may be "audible" to a child with a hearing loss; he or she may know that a sound has been made. However, hearing loss almost always interferes with "intelligibility," the ability to hear word-sound differences. Hearing loss has a negative impact on a child's development of language, reading, academic skills, and ultimately on his or her ability to function independently. Being alert to possible hearing impairment can facilitate early identification and management.

Factors that identify those children who are at risk for sensorineural hearing impairment (see Appendix B) include the following (ASHA, 1991):

- family history of childhood hearing loss;
- congenital infection known or suspected to be associated with sensorineural hearing impairment such as toxoplasmosis, syphilis, rubella, cytomegalovirus, and herpes;
- unusual ear, eye, head, or neck development;
- birth weight less than 1500 grams (i.e., less than 3.3 lbs.);
- severe jaundice;
- use of certain medications (known to damage hearing) for more than 5 days (e.g., gentamicin, tobramycin, kanamycin, streptomycin) and loop diuretics used in combination with these;
- bacterial meningitis;
- birth Apgar scores of 0–3 at 5 minutes, a history of failing to initiate spontaneous respiration by 10 minutes after birth, or a history of reduced muscle tone persisting to 2 hours of age;
- prolonged mechanical ventilation for a duration equal to or greater than 10 days;
- indicators associated with a syndrome known to include sensorineural hearing loss (e.g., Waardenburg or Usher's syndrome);
- head trauma;
- neurodegenerative disorders such as neurofibromatosis, myoclonic epilepsy, Werdnig-Hoffman disease, Tay-Sach's disease, infantile Gaucher's disease, Nieman-Pick disease, any metachromatic leukodystrophy, or any infantile demyelinating neuropathy; and
- childhood infectious diseases known to be associated with sensorineural hearing loss (e.g., mumps, measles).

Some indicators that a child may be experiencing hearing difficulty (or more difficulty than usual) include

- failing to respond or responding inconsistently to environmental sounds and/ or soft or normal speech,
- preferring loud volume on audio equipment or placing ear on a speaker,
- turning head to one side to hear better,
- withdrawing from activities, and
- appearing to be in discomfort in noisy situations.

Any concern generated by this list of indicators or other factors that make one suspect hearing difficulties warrants referral to an audiologist to further determine the status of a child's hearing.

Warning signs that a child currently may be experiencing middle ear problems include

- pulling at the ear,
- head shaking,
- discharge from the outer ear,
- irritability, and
- other associated symptoms (e.g., fever, vomiting, disturbed sleep, lack of appetite).

Note that middle ear problems may be present *without* these symptoms. In the case of middle ear problems, referral to a pediatrician or an ear-nose-throat doctor is in order for medical treatment, and referral to an audiologist is in order for monitoring hearing status.

Remember, if speech or the output from an augmentative communication device is the means of communication/instruction/intervention, optimal hearing is never irrelevant. Unless the speaker is able to serve as the amplifier by speaking in a full, clear voice into the ear of the child at all times, some form of amplification technology is necessary. *Amplification technology should always be considered, no matter how minor the hearing loss or how severe the disability.*

Hearing technology can enable a child to focus attention on and be able to understand a more complete auditory signal. It can be used for a range of hearing/ listening impairments to help the child receive a more complete and clear auditory signal. The hearing aid is not the only hearing technology available, and the hearing aid may not be the first or only choice for amplification.

When considering hearing technologies, keep in mind the following:

- Technology is a means to an end, not an end in itself. Hearing technology serves as an interface between the child and the auditory-communication environment. Hearing devices can facilitate a child's access to auditory information so that he or she can develop and expand language and receive the environmental information necessary to acquire knowledge about the world. Once the opportunity to receive clear sound has been provided, the child then must be taught how to derive meaning from the sound.

- To be of value, hearing technology must fit appropriately and must be operational. In fact, inappropriate or malfunctioning equipment can be detrimental because the child may not be receiving optimum or even adequate auditory input.
- The team audiologist explains the function and use of hearing technologies. The audiologist can provide information about which environmental and speech sounds are audible and intelligible as a function of distance, and with and without hearing aids and other hearing technologies.

  He or she can explain the consequences of using or not using hearing technology and can provide hands-on experience to teach troubleshooting techniques for checking the operation of the equipment. Ensuring that a child's hearing is not ignored or bypassed due to lack of information is the responsibility of families, teachers, and related service providers.

Chapter IV Hearing Technology

Signal-to-Noise Ratio

(also called Speech-to-Noise Ratio)

Before discussing specific hearing technologies, a brief discussion of signal-to-noise ratio (S/N) is necessary because it is a key issue involved in determining the selection of appropriate hearing devices. S/N is the relationship between the primary or target signal (typically the family member's, clinician's, teacher's, or child's own vocalizations/word attempts) and background noise. Background noise is everything that competes with or degrades the auditory signal and can include other talkers, fans, classroom and traffic noises, internal biological noises, computer noise, sounds of mobility technology, television, lawn mowers, wind, and other sounds.

The more favorable the S/N (that is, the louder the primary auditory signal relative to background sounds), the more intelligible that auditory signal is for the child. Persons with hearing loss—even mild hearing loss—need the S/N to be much more favorable than people with normal hearing (Finitzo-Heiber & Tillman, 1978). The best way to improve the S/N is to reduce the distance between speaker and child. In fact, the family member, teacher, or clinician needs to be within 6 inches of the child's ear or hearing aid microphone at all times to be reasonably sure that the child is receiving a complete auditory signal (Leavitt & Flexer, 1991). Such close positioning is especially important for children who must have maximum redundancy to learn.

Continually positioning a child within 6 inches of the speaker is obviously impractical in many settings; thus, there is a need for hearing technology that allows the family member and professional to function as if they were within 6 inches of the child's ear at all times. The following sections contain a description of this technology.

Because the purpose of hearing technologies is to optimize the listening environment and thereby enhance learning, the selection of hearing technologies depends on the child and on the demands of the listening situation. That is, listening one-on-one is different from listening in a noisy classroom, at the zoo, in a car, or over the telephone. Please bear this in mind as we progress through the following hearing technologies: hearing aids, personal FM units, sound-field FM equipment, and a mild-gain hard-wired unit.

There are other hearing technologies, such as cochlear implants, vibrotactile devices, telephone amplifiers, and 3-D loop systems (Compton, 1989). The four selected for discussion here have been found particularly effective for children who have severe disabilities. However, there are others that may be appropriate for a specific child. To obtain a complete list of assistive listening device manufacturers/vendors, see Appendix C.

Hearing Aids

Description

- Hearing aids are like miniature, customized amplifiers that are worn on the person.
- Hearing aids do not correct the hearing loss or "fix" the person's ear. Rather, they make sounds louder and shape them to make them accessible to the ear with a hearing loss. Shaping means that if a person has more of a hearing loss in the high frequencies or pitches, more amplification is provided for those high frequencies than for the mid or low pitches. Conversely, if a person has more of a hearing loss in the low frequencies, more amplification is provided for the low frequencies.
- Hearing aids are typically the first amplification devices employed. However, because hearing aids function best in a quiet environment when the speaker is very close, additional hearing technologies are needed to access diverse and difficult listening environments (e.g., in classrooms, in the car, outdoors). In fact, a hearing aid might not be the first or only choice for amplification; a personal FM unit might be fit before, instead of, or in conjunction with a hearing aid because it better meets the child's needs.
- A hearing aid must be selected and adjusted by an audiologist for each child individually and must be worn only by the child for whom it is fit.
- Once children have been provided access to the auditory environment and to verbal communication, they then can be taught the meaning of incoming sounds. Thus, hearing aids are just the first step in the learning process; they facilitate the *reception* (rather than the *perception*) of sounds.

Parts of a hearing aid

Regardless of style, all hearing aids have the following components:

- **Microphone** – receives the acoustic signal (sounds from the environment) and changes the sounds into an electrical signal.
- **Amplifying circuit** – shapes the sound, now in the form of an electrical current, and makes it louder.
- **Receiver** – changes the amplified and shaped electrical signal back into an acoustic signal (sound) that can be heard. A receiver is a microphone in reverse.
- **Battery** – provides power for the hearing aid.
- **Earmold** – the part that fits in the ear to hold the hearing aid in place and to deliver the newly amplified and shaped sound to the ear of the wearer. The earmold is an important part of the hearing aid. For a child, the earmold is usually made of soft material to fit comfortably and snugly and is acoustically tuned to allow the most appropriate signal to be sent to the eardrum (Byrne, 1986). Modifications in earmolds can help shape the signal produced by the

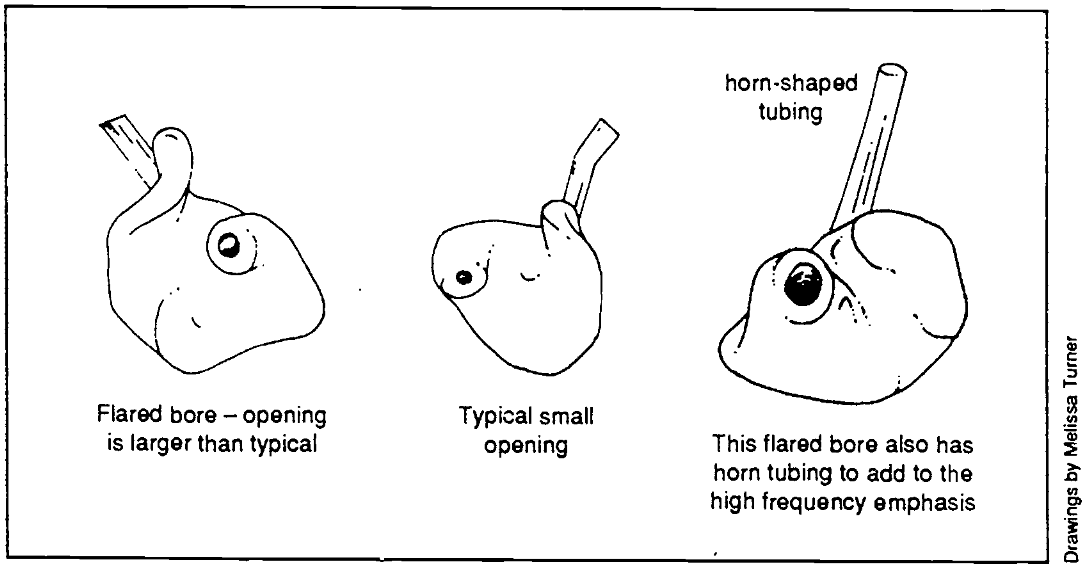

Figure 1 – Earmolds

hearing aid (see Figure 1). For example, earmolds with flared bores (wide openings) best amplify the higher pitches that are necessary to hear consonant sounds.

Styles of hearing aids

- **Behind-the-ear (BTE)/ear-level/over-the-ear** – fits comfortably and snugly behind the ear with tubing and earmold connecting the hearing aid to the ear (see Figure 2). This is typically the most appropriate style of hearing aid for children because it can have flexible tone and output controls and can attach readily to an FM unit.

  The most suitable ear-level hearing aids have
  - flexible internal controls that change the amplifying characteristics of the hearing aid (see Figure 3),
  - strong telecoils to pick up electromagnetic energy from loops or telephones,
  - direct input to allow coupling to an FM unit, and
  - DAI (direct input) -only switches to allow for control of the hearing aid's microphone when used with an FM unit.

  In addition, the external settings on the hearing aid should include a volume control wheel and three switches: *M* (to turn on the microphone), *T* (to activate the telecoil), and *MT* (to turn on the microphone and telecoil at the *same* time). Some hearing aids, such as the one illustrated in Figure 3, use a "+" (plus) sign to denote the MT position. The child's team audiologist can explain the settings/wheels/switches on the hearing aids as well as the proper positioning of all switches, including the volume control wheel. "Baby-size" earhooks can be

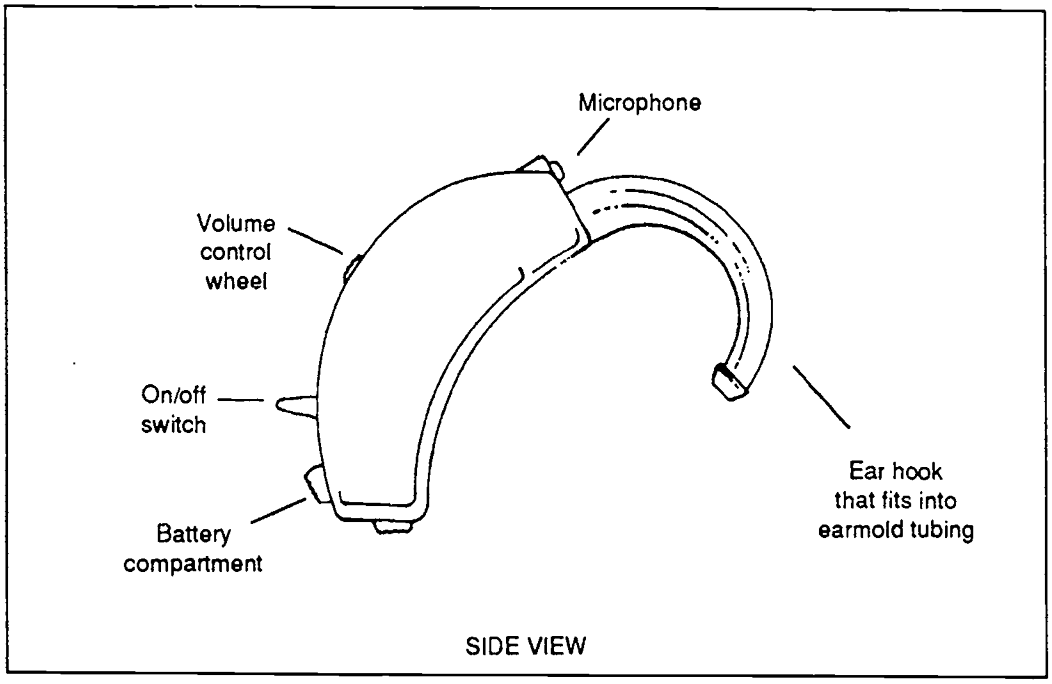

Figure 2 – Ear-level hearing aid (also called BTE or over-the-ear)

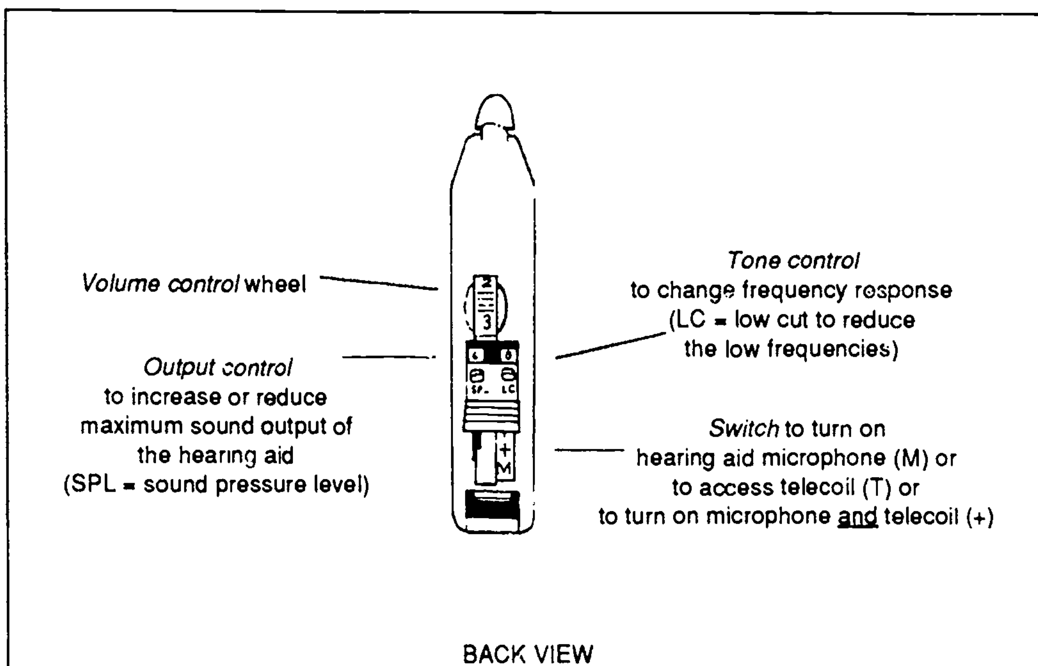

Figure 3 – Hearing aid controls of a flexible BTE

specially ordered. Their advantage is that they hold an ear-level hearing aid snugly on a young child's tiny ear.

- **Body-style** – the microphone, amplifying circuit, and battery are located in a case the size of a small portable radio that is worn on the body in a pouch or harness, with connecting wires to a button receiver that snaps into the earmold. Body hearing aids used to be the most common style for children because they could provide the most power and could be secured to the child. However, body-style hearing aids are rarely used today because ear-level hearing aids (BTE) generally provide enough power for even profound hearing losses and because the microphone location of the ear-level hearing aid is acoustically superior to a microphone location on the body.
- **In-the-ear (ITE)** – all hearing aid components are built into the earmold that fits in the ear. Although in-the-ear hearing aids are very popular with adults, they are rarely appropriate for children because
  - they often need to be changed, sometimes every few months, because a child's ear grows;
  - they rarely have the flexible tone, output, and telecoil adjustments needed for children;
  - at this time, they are not powerful enough for severe-profound hearing losses;
  - they often feed back (squeal) on children, regardless of degree of hearing loss;
  - they are built into hard earmolds that, if broken, may cut and damage the child's ear;
  - they cannot easily be coupled to the assistive listening devices that must be used in the classroom; and
  - they are difficult to secure in the soft and small ear of a child, and they may fall out; they thus tend to be lost or damaged more often than ear-level hearing aids.
- **Canal** – similar to in-the-ear (only smaller), the entire hearing aid fits deeper in the ear canal; however, the instrument is still visible. Fitting children with canal hearing aids involves the same (or more) problems as fitting children with in-the-ear hearing aids.

What you need to know about hearing aids worn by children in your program

- **Speech reception** – It is important to know the specific speech sounds that a child can hear only while wearing his or her hearing aids. The audiologist can provide the child's audiogram that compares aided and unaided sensitivity to speech sounds spoken at an average conversational level of loudness.
- **Binaural fitting** – If the child has a hearing loss in both ears, two hearing aids should be worn. Wearing a hearing aid on each ear is called a binaural fitting.

If the child has only one hearing aid, ask the audiologist why one hearing aid is preferable to two hearing aids.

- **Preferable earmold characteristics** – Take a close look at the child's earmolds. They should be made of a soft, clear, hypoallergenic material and be clean and free of earwax. A clear earmold, rather than a tinted one, often is suggested because some persons have allergic skin reactions to the pigments used in tinted earmolds, and clear earmolds and tubing may be more visually pleasing. Earmolds should be removed from the hearing aid, preferably washed daily with a mild detergent, and thoroughly dried before being replaced on the hearing aid. Ask your audiologist if the earmolds are acoustically tuned or if any earmold modifications could facilitate reception of speech sounds. In addition, if the child has had ventilating tubes surgically inserted in the eardrums to medically manage ear infections, then vents or holes in the earmolds might be necessary to allow air into the ear canal. If you have any questions about how or why certain earmold designs have been selected, your audiologist can provide answers. Note that new earmolds may need to be made every few months for very young children because ear growth interferes with effective earmold fit.
- **Battery life** – Hearing aid batteries may last a few days or several months depending on the power requirements of the hearing aid and how often the hearing aid is worn. The majority of hearing aid malfunctions can be traced to the battery. If the hearing aid is not working or not working appropriately, first try to change the battery. Opening the battery door or removing the battery nightly will keep the battery from draining when the hearing aid is not in use.
- **Moisture hazard** – Moisture can be a real problem, especially in humid environments and for individuals who perspire; the hearing aid can stop working until the moisture is dried out. When not worn, hearing aids should be kept in a container with moisture-absorbing material. A teacher might want to have extra moisture-absorbing containers at school for hearing aid storage during nap time.
- **Checking and troubleshooting** – Hearing aid checking and troubleshooting techniques are essential to ensuring that a child is hearing optimally. A non-functioning hearing aid is worse than nothing at all because the earmold may act as an earplug. Over 30% of children's hearing aids malfunction or are not working optimally on any given day because of dead batteries, earwax in the earmold, cracked earmold tubing, improper control settings, moisture, and other problems. (Bess & McConnell, 1981). If a child is wearing a hearing aid that is squealing, there could be a problem with the earmold fit. When a child wears a hearing aid, his or her "ear" begins at the microphone of the hearing aid.

  The only way to know if the hearing aid is working is to listen to it—at least once a day in the morning. You will need a hearing aid stethoscope (to listen to the hearing aid and FM equipment [see section on Personal FM unit]), a battery tester, and an air blower (to dry moisture out of the earmold and ear

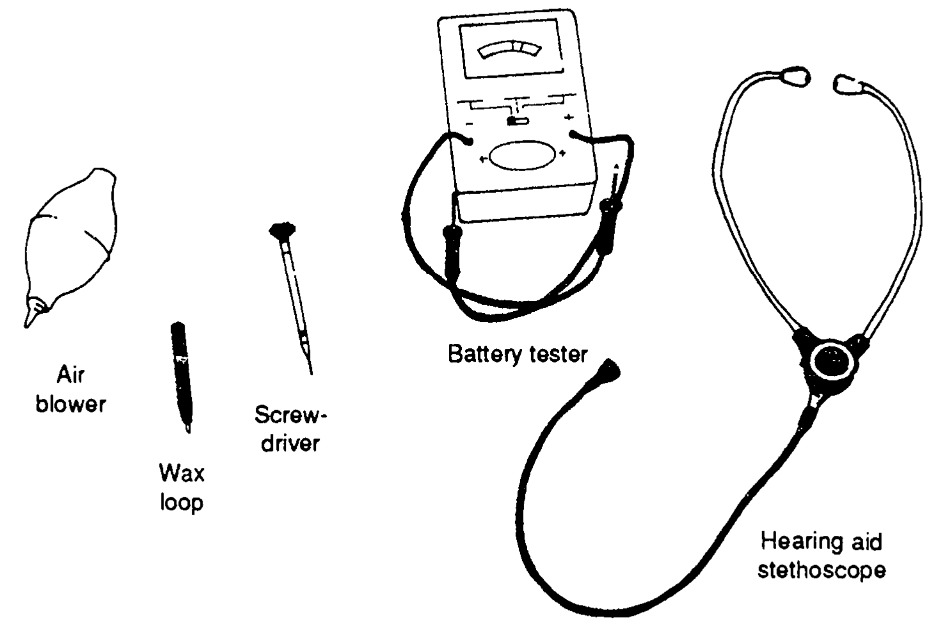

Figure 4 – Troubleshooting equipment

hook), a pipe cleaner or "wax loop" (to remove earwax from the earmold), and extra batteries (see Figure 4). A screwdriver might be needed to adjust the frequency response or output characteristics of the hearing aid. Your audiologist can provide in-service training to allow you to practice with these tools.

The Ling 5 Sound Test can be used to perform a listening check. The Ling 5 sounds are OO, AH, EE, SH, and S; these sounds were selected because they contain speech energy that is representative of the range of English speech sounds. To conduct this test, cover your mouth and say each of the Ling 5 sounds to the child when the hearing aid has been replaced in the child's ear and observe the child's behaviors. Any changes in a child's responses may indicate hearing aid malfunction.

A thorough electroacoustic analysis of output, frequency response, and distortion typically is done every 3 to 12 months by an audiologist—or any time the hearing aid is malfunctioning and battery problems have been ruled out. Hearing aids of very young children ought to be analyzed at least four times a year. *Remember, the hearing aid is the device that allows the child to interface with the environment. If it is not working properly, valuable intervention time is lost and learning is sabotaged.*

- **Assistive listening devices** – Because a hearing aid is most effective if the speaker is in close proximity and the environment is quiet, work with the audiologist to determine which assistive listening devices (ALDs) (e.g., personal FM unit, sound-field FM, or a hard-wired unit for individual instruction) are most appropriate in the child's various learning situations. The hearing aids, which are often fit at the same time as the assistive listening device, should be able to connect to the ALDs.

Who might benefit from a hearing aid?

Hearing loss is not an either/or issue. Even a "mild" hearing loss can interfere with the intelligibility of speech. Any time a permanent or long-standing hearing loss is identified (even a mild hearing loss), a child is a candidate for amplification, no matter what the disability might be. It is important to know that even children with severe cognitive and physical disabilities can have their hearing tested (see Appendix D).

There are some situations (e.g., when a child has a fluctuating hearing loss, a unilateral hearing loss [hearing loss in one ear], or a mild permanent hearing loss) in which it might be more effective to fit a personal FM unit or a sound-field system instead of, before, or in addition to a personal hearing aid. That is, a child with the above type(s) of hearing loss(es) might do very well in a quiet one-to-one learning situation, but probably will have difficulty in a typical, noisy, distracting classroom.

Responsibilities involved in using a hearing aid

When reading this section, it is important to keep in mind that some children, because of their disabilities, may accomplish only the first or perhaps the first two tasks on this continuum. Responsibilities beyond the capabilities of the child with severe disabilities should then be assumed by the child's family, teacher, or peer buddy.

- **Keep the hearing aid on.** Once the audiologist has determined that the earmold fits well and that the amplification is appropriate, the child should wear the hearing aid(s) during all waking hours. Some children will reach this level within 24 hours of fitting. Others will require up to 1 month to adapt to the physical feel of the earmold and to the change in their acoustic environment caused by hearing amplified sound. If the child refuses to wear the hearing aid(s), work with the audiologist to rule out outer or middle ear infection (which may require medical consultation), pain or discomfort caused by the earmold, inappropriate amplification (too loud, too soft, or wrong shaping of the sound), malfunctioning of the hearing aid (it may be shorting-out, it may have static, or it may not work at all), or a change in the child's hearing status (hearing may have worsened or improved).
- **Indicate that the hearing aid is malfunctioning.** You can help a child gain this skill by teaching him or her how to indicate that the hearing aid is on or off (e.g., by touching a hearing aid symbol on his or her communication device or by using appropriate gestures or eye movements). Then progress to having the child indicate intermittent or inappropriate function (again in whatever communication mode he or she uses). Hearing aids break, and batteries die. If a

listening check is performed by family members and teachers only once a day, and if the child cannot notify them when the hearing aid is off or malfunctioning between checks, valuable learning time may be lost.

- **Insert or remove the earmold/hearing aid.** Ideally, as a child matures, he or she is able to insert and remove the earmold/hearing aid. This may never be possible for some children with severe disabilities. In fact, a significant goal for some children is to learn *not* to touch the hearing aid. However, symbols, gestures, or signs should be identified that the child can use to remind those in the environment to put the earmold/hearing aids in or to take them out.
- **Regulate the volume of the hearing aid.** Different acoustic environments require lesser or greater amounts of amplification. A child can be taught to request more or less volume by some agreed upon communicator/indicator that sounds are too loud or too soft. With some children, idiosyncratic facial expressions/head postures may be established as indicators to all care providers and service personnel that the volume of the hearing aid needs to go either up or down. In other cases, the child's communication device could contain symbols to request changes in the volume of the hearing aids. For some children, a remote-control volume adjustor may facilitate their making volume adjustments themselves.
- **Check and change the battery.** Hearing aid batteries typically do not have long lives; the greatest source of hearing aid malfunction is related to batteries. It is essential to know that batteries are poisonous if put in the nose or mouth or if swallowed. To protect some children, it may be necessary to order hearing aids with tamper-resistant battery compartments. A child's family and teachers can learn to check the charge of the battery by using a battery checker and to appropriately position the battery in the battery compartment of the hearing aid. Some children with certain motor abilities may learn to do these tasks themselves.
- **Conduct hearing aid maintenance.** It is necessary to keep the earmold free of ear wax and to wash it daily. In addition, every time the hearing aid is removed, it should be safely placed in a container with moisture-absorbing material. Symbols on a communication device can make it possible for a child to remind family members, teachers, etc., to perform these tasks as well as tell them when new batteries need to be purchased.
- **Demonstrate basic hearing aid troubleshooting skills.** The child's family and teachers can learn some simple techniques to locate the source of the problem if the hearing aid is not working at all, working intermittently, or squealing. Troubleshooting includes checking the battery, earmold, tubing, case, and other parts of the hearing aid.
- **Decide when to use different hearing technologies.** Because different listening environments demand different types of hearing technologies, the child might eventually learn to determine the use of appropriate devices. For example, the child might request (via his or her own mode of communication) an assistive listening device in addition to his or her hearing aid.

Your child's team audiologist can assist you in learning about and managing these responsibilities.

To review, hearing aids are most effective in quiet surroundings when the speaker is in close proximity to the hearing aid microphone. The hearing aid microphone is part of the hearing aid that is on the child—the microphone is not remote. Therefore, hearing aids can be very useful in enhancing intelligibility in one-on-one interactions in quiet, small rooms. However, in classrooms, outdoors, in crowds, in the car, in very large rooms where the sound reverberates (creating an echo), or in situations in which the speaker cannot be close to the child, the hearing aid alone is not enough. A variety of assistive listening devices need to be considered.

Assistive Listening Devices

Assistive listening devices (ALDs) can be categorized into different groupings (Compton, 1989; Leavitt, 1987): (a) those that enhance the signal-to-noise ratio, (b) those that facilitate telecommunications, or (c) those that serve as signal alerting/warning devices.

The signal-to-noise ratio devices are the most important for learning. The personal FM unit, the sound-field FM unit, and the mild-gain hard-wired unit all function to improve the intelligibility of the speech signal through the use of a remote microphone that can be placed close to the speaker or sound source. Don't be fooled by mistaking improvement in audibility for improvement in intelligibility. As with all assistive technologies, a team approach is needed to make decisions about ALDs. The child, the family, the teachers, and the audiologist together must establish the needs of the child and the demands/constraints of his or her listening environments. With this collaboration, appropriate decisions can be made regarding the selection and installation/fitting of the hearing technology.

Personal FM Unit

Description

- *FM* stands for frequency-modulated radio transmission. After being changed into an electrical signal, speech is superimposed on a radio signal that is then transmitted. Thus, a personal FM unit is like having your own tiny, private radio station that both transmits and receives on a single radio frequency band (see Figure 5).
- An FM unit is one type of ALD that improves the S/N (signal-to-noise ratio) by the use of a remote microphone transmitter that can be placed close to the speaker or sound source.
- There are no wires connecting speaker and listener, thereby allowing free mobility for both parties with a transmission range of approximately 200 feet or more.
- The family member, teacher, clinician, or peer wears the small transmitter microphone clipped on clothing, no more than 6 inches from his or her mouth.

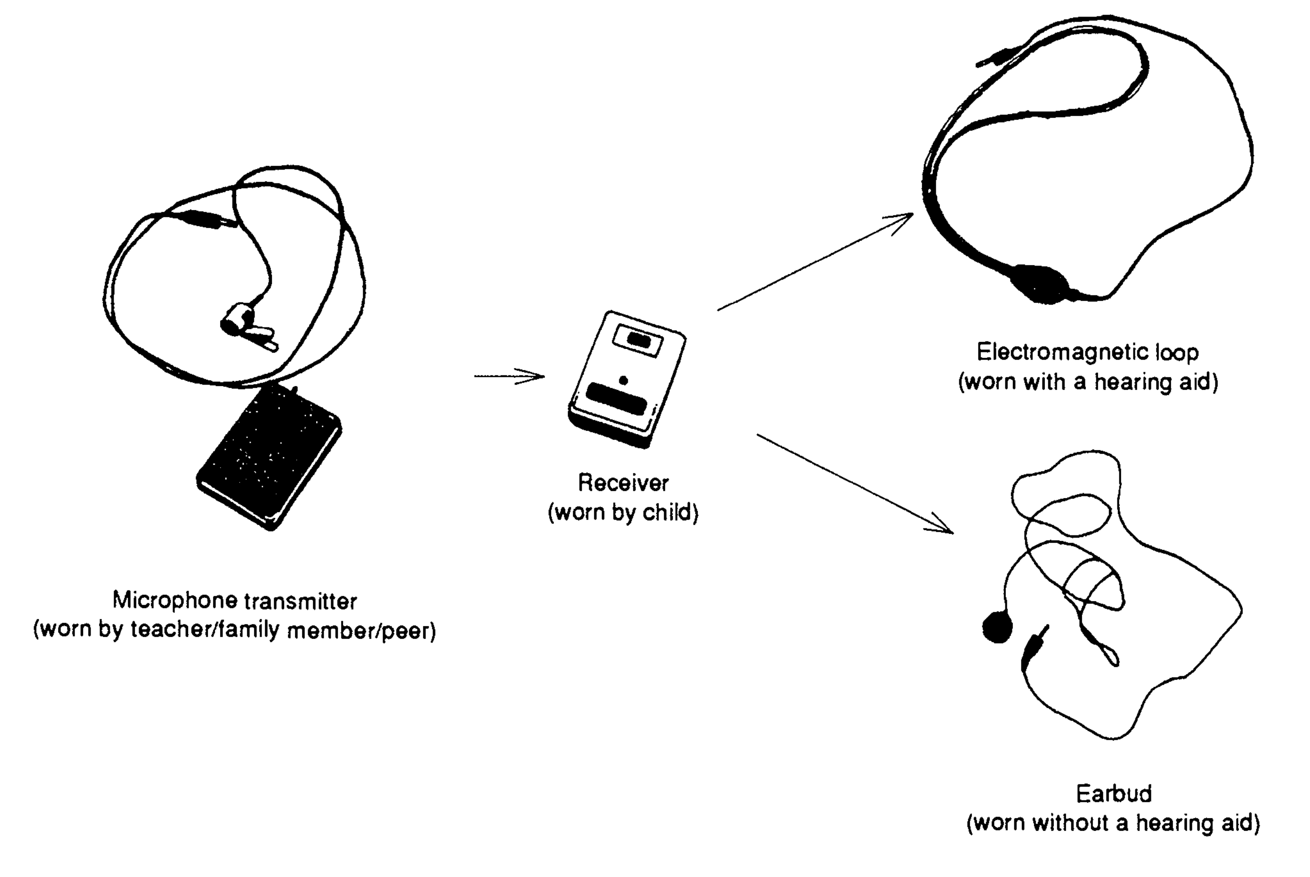

Figure 5 – Personal FM unit

The microphone also can be placed close to the speaker of a television, video monitor, stereo, or computer.

- The FM receiver is worn by the child and must be set to the same radio frequency as the microphone/transmitter for the child to receive the radio signal. There are many models of FM equipment available (Ross, 1992).

Features of personal FM units

- FM units have a number of setting and fitting options to appropriately fit a child. Consequently, there are many decisions to be made. Again, a team approach, involving the child, family, teacher, and audiologist, must be used to determine appropriate FM settings and function.
- There are many models of FM units available that have multiple options for internal and external settings. With the audiologist, decisions can be made about which FM unit and which connecting arrangement to use. "Connecting" refers to the means by which the electrical signal from the FM receiver reaches the child's ear.

Choices of FM units and connecting arrangements to hearing aids are based upon the needs of the child, the demands of the listening environment, and the flexibility of the child's hearing aid. (Hopefully, the hearing aid will have many features that allow it to receive signals from an FM unit.) No single connecting arrangement is automatically superior for all children because there are many variables (including the child, the FM unit, the environment, and the hearing aid).

- An FM unit may be fit *instead of* a hearing aid. That is, the FM receiver contains an amplifier similar to that in a hearing aid. The amplified sound is sent from the FM receiver directly to the listener's ear through one of several options:
  - An earpiece (earbud) that is connected to the FM receiver by a wire.
  - Walkman-type monaural (not stereo, because the same signal needs to go to each ear) headphones that also have a wire connection to the FM receiver.
  - A button-type earphone that snaps into a custom-made earmold that fits into the child's ear. A wire connects the FM receiver to the external button earphone.
- The FM unit may be connected to the child's personal hearing aids via a neckloop or direct-input arrangement. The signal from the FM receiver is fed to the child's ear through the child's own hearing aids:
  - Neckloop – The signal from the FM receiver is sent to a wire loop that is attached to the FM receiver and worn loosely around the child's neck. The neckloop generates a magnetic field that is picked up by the T (telecoil) circuit in the child's hearing aid (provided, of course, that the child's aid is equipped with an appropriate telecoil circuit). There are no wires connecting the neckloop with the hearing aid, and the neckloop can be worn under clothing.
  - Direct Input – The signal from the FM receiver can be sent via a direct input cord that connects the FM receiver to the child's hearing aid. The hearing aid must be equipped with a special "direct input" feature. The boots and cords that are used for direct input are generally not interchangeable across hearing aids and FM systems (Thibodeau & McCaffrey, 1992). Your team audiologist can demonstrate the variety of boots and cords that can be used; they are not illustrated in Figure 5.

What you need to know about personal FM units worn by children in your program

- **Audiological results** – You should ask the audiologist for results of audiological assessments with and without hearing technologies.
- **The "6-inch" rule** – Think of the FM microphone transmitter as the child's "third" ear, and put that third ear within 6 inches of whatever you want the child to hear at any point in time. That is, you do not have to physically move the child close to each relevant speaker or sound source; simply move the microphone transmitter close to it.

- **FM advantage** – Remember that the hearing aid microphone is always on the child, while the FM microphone is always (or ought to be) close to the speaker or sound source. Thus, the remote microphone transmitter of an appropriately fit FM unit will always have an advantage over the microphone of a hearing aid.

- **Interference** – Radio signals from modular telephones and pagers may be picked up by an FM unit if they are on the same radio frequency. In addition, electromagnetic interference in the form of a 60-cycle "hum" in some instances can be picked up from computers and fluorescent lights when using an FM unit with the hearing aid's telecoil. Regular equipment checks help to determine if this is happening. The only way to be sure that an FM unit is transmitting and receiving properly is to *listen to it*—at least once a day in the environment(s) in which it is used. The team audiologist can demonstrate FM checking and troubleshooting techniques to children, families, and educators. (You will need a hearing aid stethoscope to listen to the receiver if an earmold is being used. Ask your audiologist to provide in-service training to allow you to practice checking the device.)

  When using several FM units in the same building, it is necessary to coordinate transmission frequencies to avoid interference.

- **Modifications** – Modifications of FM settings or use can be made if you want the child to be able to hear his or her own voice as well as the voice of a teacher or family member.

Who might benefit from a personal FM unit?

- Any time a child with a hearing problem is in a classroom setting, an FM unit is necessary to provide an improved S/N and thus enhance the intelligibility of the teacher's speech. A hearing aid alone is never enough in a classroom setting or any situation in which the speaker cannot be in close proximity to the child. Also, a child with listening/attending difficulties who does not need hearing aids might benefit from the more favorable S/N provided by a personal FM unit.

- There are other environments in which a child with a hearing problem could benefit from a personal FM unit. Such environments include those where the speaker, whose verbal communication is important, cannot be close to the listener, such as during outdoor field trips, when riding in a car in which the family member is in the front seat and the child is restrained in the back seat, and during mobility training when the clinician cannot or does not want to be close to the child.

- There are some instances (e.g., when a child has a fluctuating hearing loss, a unilateral hearing loss, or a mild, permanent hearing loss) when it might be more effective to fit a personal FM unit (using Walkman earphones or special earmolds) or a sound-field system instead of (or before) a personal hearing aid. That is, a child with any of the above types of hearing losses might do fine in a quiet, one-on-one learning situation, but *will* have difficulty in a typical, noisy, distracting classroom.

It should be noted that a personal FM system is not the same as a sound-field FM system. The systems are not interchangeable; different decisions govern the use of each. Sound-field systems will be discussed in greater detail later in this section.

Responsibilities involved in using a personal FM unit*

The child is expected to be able to participate in some way in the use and maintenance of the FM unit. The nature of this participation depends upon each child's unique abilities.

- **Keep the FM unit on.** If an FM unit is being used to supplement hearing aid function, the child first might need to adjust to the hearing aid before adjusting to the feel and sound of the FM unit.
- **Indicate to family members or teachers (via a communication device or whatever mode of expression is available) that the FM unit is malfunctioning.** You can help a child gain this skill. Begin by having him or her indicate when the FM unit is on or off. Then progress to having the child indicate intermittent or inappropriate function.
- **Regulate the volume of the FM unit.** It is unrealistic to assume that a single volume setting is appropriate for all sound sources. Ideally, a child can decide if a soft-spoken teacher needs more FM volume, whereas a louder video system necessitates reduced volume. The child can indicate his or her preference through established symbols or words on a communication device.
- **Remind teachers and family members that the FM unit must be put in the battery charger at key points during the day.** Some FM rechargeable batteries may not retain their charge for even 1 full day. As the battery weakens, the FM transmission range decreases, and interference, static, and buzzing occur.
- **Remind families and educators to provide basic FM maintenance and troubleshooting.**
- **Make decisions regarding the use of different hearing technologies in different learning environments.**

Sound-field FM Equipment

Description

- Like a high-fidelity, wireless, public address system, sound-field FM transmission offers a way to amplify an entire classroom through the use of two, three, or four wall- or ceiling-mounted loudspeakers (see Figure 6).
- The teacher wears a wireless FM microphone transmitter, just like the one worn for a personal FM unit, and the radio signal is sent to an amplifier that is connected to the loudspeakers. There are no wires connecting the teacher with the equipment, thus allowing free mobility.

* Because FM and hearing aid use frequently are interconnected, please refer to the previous discussion of the child's responsibilities for hearing aids.

- All of the children in the classroom benefit from an improved and consistent S/N, no matter where they or the teacher are located.
- Sound-field FM increases the loudness of speech, relative to background noise, throughout the classroom.

<u>Features of sound-field FM systems</u>

- Sound-field FM systems offer exciting promise for giving children (with or without a hearing loss) access to intelligible speech, thereby offering the opportunity for better learning.
- A major difference between a personal FM unit and a sound-field (classroom) FM system is that the personal FM can provide a more favorable S/N (about +20 dB), whereas the sound-field FM typically provides a S/N of only about +10 dB. A S/N of +10 dB may not be sufficient for children with more than mild-moderate hearing losses or for those who have great difficulty focusing their attention. However, because a typical elementary classroom has an inconsistent S/N of only +4 dB, sound-field FM could be beneficial for many children.

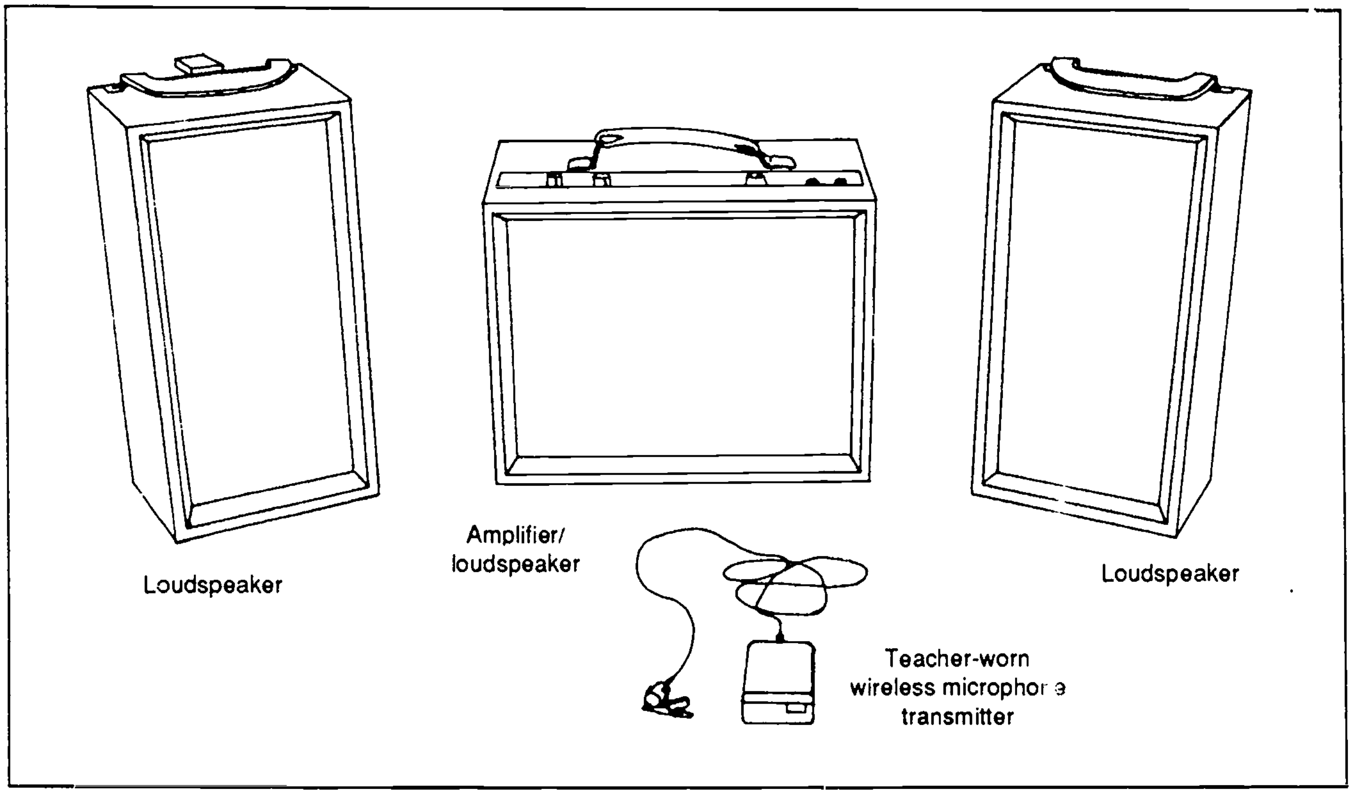

Figure 6 – Sound-field FM equipment

- Amplifying the entire classroom via sound-field FM equipment can benefit those children with normal hearing as well as those with mild, fluctuating hearing losses. At the same time, children in the classroom who have hearing aids and a more severe hearing loss could wear personal FM receivers tuned to the same frequency as the sound-field amplification; thus, the teacher only needs to wear a single, wireless microphone transmitter. Because sound-field systems benefit the entire classroom (all children hear the amplified sound), the equipment does not call attention to those children who particularly need the amplification.
- FM sound-field systems have significant value for teachers as well as for students. Surveys have reported very positive teacher reactions, including less voice fatigue, lower rates of teacher absences, and greater efficiency in teaching (Flexer, 1989). In short, classroom amplification appears to make the teacher's job easier.
- Sound-field FM is most effective for group instruction. Individual, small group instruction is more difficult to orchestrate with sound-field equipment unless a loudspeaker can be moved close to the group receiving instruction or unless some of the loudspeakers can be turned off to avoid unnecessarily amplifying the entire classroom.
- Speaking students can talk into the microphone transmitter when they are addressing the class, such as for "show and tell." Nonspeaking students can use the microphone transmitter to pick up the spoken output of their communication devices.

What you need to know about sound-field FM equipment

- **Loudspeaker positioning** – The loudspeakers should be positioned to allow the most even and consistent improvement in S/N throughout the classroom. Improper positioning can increase classroom reverberation or cause feedback (a high-pitched squeal), thereby interfering with speech intelligibility.
- **S/N improvement** – You need to determine, in collaboration with the team audiologist, how much S/N improvement has been obtained in the particular classroom in question and what this S/N improvement means relative to hearing the teacher's speech.
- **Modification for small groups** – You also need to determine how the equipment can be modified for small group instruction (e.g., by disconnecting some of the loudspeakers). Or all of the loudspeakers might be left on to facilitate passive learning and redundancy.
- **Interference** – The frequencies of all personal FM units and sound-field systems throughout the building must be coordinated to avoid chaos. If several sound-field FM units are in use in the same building, all must be on different radio frequencies to avoid cross-talk.

Cellular telephones and pagers also can cause acoustic interference if they are on the same radio frequency as the sound-field FM equipment.

- **Troubleshooting** – The function of a sound-field FM is much easier to troubleshoot than the function of hearing aids or personal FM units. Because everyone hears the sound-field FM, interference, feedback, static, or distortion are immediately obvious to all.
- **Limitations** – The sound-field system may not provide sufficient amplification for all children in the classroom. Some of the children also may need hearing aids and/or personal FM units.

Who might benefit from sound-field (classroom) amplification?

- Children with normal hearing can benefit from sound-field FM because the improved S/N creates a more favorable learning environment. If children can hear better and listen more easily, they have an opportunity to learn more efficiently.
- Children with fluctuating conductive hearing losses (primarily caused by middle ear infections) can benefit from sound-field FM.
- Children with unilateral hearing losses (hearing loss in only one ear) also will benefit from classroom amplification. It is important to note that a unilateral hearing loss can pose significant difficulty when trying to hear in a classroom.
- Children with "minimal" permanent hearing losses may benefit more from sound-field FM than from a hearing aid because their main problem is classroom listening, not one-on-one listening.
- Children with mild-moderate hearing losses who wear hearing aids might do as well with sound-field FM as they would with a personal FM system.
- Children who have normal hearing but who have difficulty listening, "processing," or understanding speech might benefit from sound-field FM. However, as previously stated, a child with these problems might need the more favorable S/N provided by a personal FM.

Responsibilities involved in using the sound-field equipment

- **Indicate preferred volume.** The child could be taught to indicate, in ways previously discussed, if the amplified sound is too loud, too soft, or not clear enough. Otherwise, the child has no responsibility for using sound-field equipment.
- **Set and troubleshoot equipment.** Working together with the team audiologist, family members and teachers can determine (a) proper equipment settings for specific rooms, and (b) troubleshooting techniques.

  (Remember, the primary cause of static and distortion is a weak battery in the teacher's microphone/transmitter.)

Mild-gain Hard-wired Unit

Description

- *Mild-gain* means a small amount of volume or amplification.
- *Hard-wired* means that the speaker and listener are connected by wires; there is no radio transmission (see Figure 7).
- There are many hard-wired devices available: for example, the Williams Sound PockeTalker, the Audex SounDirector, or a device assembled using component parts from Radio Shack (Flexer & Savage, 1992). The team audiologist can explain hard-wired unit options and make recommendations about device appropriateness for each child.

What you need to know about a hard-wired unit

- **One-on-one instruction** – Hard-wired units restrict mobility because of the connecting wires between the microphone, the miniamplifier, and the headset; thus, they are not suitable for classroom instruction. They work best in one-on-one instruction or in very small groups.
- **S/N improvement** – The amplification improves the S/N, thereby focusing the child's attention on the auditory input.
- **The "6-inch" rule** – The microphone is placed within 6 inches of the speaker or relevant sound source. If appropriate, the microphone can be moved back and

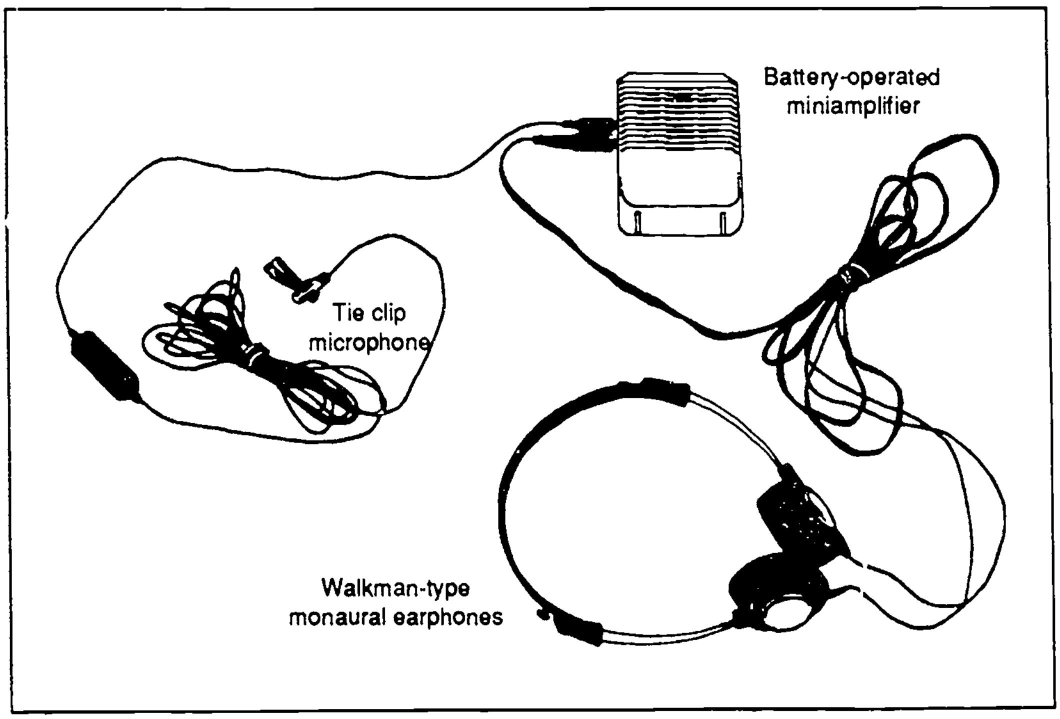

Figure 7 – Example of a mild-gain hard-wired unit

forth from the teacher to the child to facilitate turn taking and to enhance both the teacher's speech and the child's vocalizations or the voice output from his or her communication device, thereby emphasizing the auditory modality.

- **Troubleshooting** – Always listen to a unit before using it to make sure that it is functioning appropriately.

Who might benefit from a hard-wired unit?

- Children with normal hearing who have trouble focusing on auditory input or who are easily distracted during individual instruction. Remember, hard-wired units are not for large group or classroom instruction.
- Children who have fluctuating hearing losses caused primarily by middle ear infections.
- Children with unilateral hearing losses.
- Children with mild permanent hearing losses.

Children who use sound-field FM equipment for classroom instruction could benefit from the use of a hard-wired unit during individual treatment or instruction. (Children who use a personal FM unit in the classroom also can use that same FM unit during individual treatment or instruction; they would not need a hard-wired unit.)

Responsibilities involved in using the hard-wired unit

As with the other hearing technologies, the responsibilities of the child are a function of his or her abilities. The expectation is that the child will be able to participate in some way in the use and maintenance of the equipment.

- **Keep the Walkman earphones on his or her ears.**
- **Indicate if the unit is malfunctioning.**
- **Regulate the volume of the hard-wired unit.** Until the child can indicate his or her comfort level, the teacher or family member sets the volume at the recommended setting (usually at a comfortable listening level for a person with near-normal hearing).
- **Remind a family member or teacher to take the unit out prior to instruction and to put it away when the instruction is completed.**
- **Remind family members and educators to check the battery at the first sign of static or distortion.** (Remember, because there is no radio transmission, there is no interference from other pieces of equipment operating via radio signals.)

A hard-wired unit is not intended to replace hearing aids, personal FM units, or classroom amplification. Instead, the unit has the specific function, in limited contexts, of improving the S/N and thereby improving the intelligibility of the speech signal.

Summary

To summarize, we have reviewed four hearing technologies: hearing aids, personal FM units, sound-field (classroom) FM systems, and mild-gain hard-wired systems. The audiologist is a key member of the team, particularly when decisions have to be made regarding which hearing technology is most appropriate for a given child in a given learning situation.

Chapter V Listening Strategies

The following are principles for all teachers/clinicians/family members who use speech as a means for imparting information. Listening—focusing attention on speech and meaningful sounds—is important for all children, whether or not they have a hearing loss. Remember, technology is simply a tool—a means to an end. Once children can "hear" sounds, they need to learn the meaning of those sounds.

- **Have the environment as quiet as possible.** Eliminate competing sounds (e.g., turn down the television, or shut a window that is next to a busy street).
- **Use the technology recommended by the team** to make sure that the child is receiving the best possible speech/sound signals.
- **Be mindful of appropriate positioning.** You should be as close as possible to the child.
- **Use words and phrases that encourage listening.**
- **Provide children with meaningful listening experiences** at their own developmental level.
- **Focus on integrating listening skills into daily life.**
- **Recognize that listening skills are not separate from learning and communication,** but that they are the means of learning.

There are many listening strategies that can be employed by educators in natural communication and learning situations. Additional references for listening skills training and for auditory learning include Berg (1987), Cole and Gregory (1986), Erber (1982), Estabrooks and Edwards (1986), Goldberg (1987), Ling (1989), Nevitt and Brelsford (1987), Pollack (1985), Ross, Brackett, and Maxon (1991), and Vaughn (1981).

Listed below are some general suggestions for facilitating listening:

- **Cue listening by saying the word "listen" and then by pointing to your ear or the child's ear.** The word listen often is used mistakenly to mean "pay attention." If you say "listen," then emphasize audition, and encourage the children to focus on what you are saying.
- **Use a melodic, natural (not falsetto or breathy) voice.** Such voicing patterns are pleasing to the child. Avoid the tendency to use an unnatural, monotonous, or staccato speech pattern.
- **Provide the child with meaningful contexts for repetitious listening experiences.** Remember, months of interactive listening input with many different people in a variety of settings are necessary before listening skills can be generalized.
- **Reinforce the child's utterances and utterance attempts by imitating them and expanding them** (when appropriate) and then by pointing to your ear and saying, "I heard you." This activity also can encourage vocal play.

- **Emphasize speech as the primary auditory signal while also directing the child's attention to meaningful environmental sounds,** like a telephone ring, a dog bark, a car horn, a door knock, music, etc. For example, when the telephone rings, get the child's attention; say "listen," and point to your ear; then, take the child to the telephone to better hear the ring and to show the child what is making the sound; and, finally, encourage the child to touch the phone. The identification and localization of sounds with their sources is an important task and part of learning to meaningfully interpret the acoustic signal. Nevertheless, beware of emphasizing environmental sounds at the expense of speech.
- **The teacher can use the microphone of assistive listening devices to draw attention to crucial word/sound differences,** which can be exaggerated to assist young children in hearing differences among speech sounds. For example, a teacher might say, "Listen, Mary, I said sssssss – 'sit,' not bbbb – 'bit.' Did you hear the difference?" The child can give a yes/no response via his or her communication device or via designated head/body movements. Such activities are important for achieving literacy.

Chapter VI Summary

This overview of listening and hearing and of hearing technologies has emphasized that for the nonspeaking child with severe disabilities (as for all children), listening and hearing are basic to a child's learning. We have presented a variety of hearing technologies to help families, teachers, and related service providers facilitate learning. Hearing is a powerful input modality; we must understand it, respect it, and enhance it to provide children with the opportunity to learn to listen and listen to learn.

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Appendix A Assistive Technology Resource List

State Resources

Pursuant to federal legislation, the following states have been funded to develop consumer responsive, statewide, technology-related service delivery. For information about this project, contact

Carol G. Cohen
Rehabilitation Program Analyst
National Institute on Disability and Rehabilitation Research (NIDRR)
U.S. Department of Education
400 Maryland Avenue, SW
Washington, DC 20202-2645
(202) 732-5066

Alaska
Joyce Palmer
Program Coordinator
Alaska Assistive Technology Services
Division of Vocational Rehabilitation
400 D Street, Suite 230
Anchorage, AK 99501
(907) 274-0138
FAX (907) 274-0516

Arkansas
Sue Gaskin
Project Director
Department of Human Services
Division of Rehabilitation Services
Increasing Capabilities Access Network
2201 Brookwood Drive, Suite 117
Little Rock, AR 72202
(501) 666-8868
(800) 828-2799 (in state)
FAX (501) 666-5319

Colorado
Bill West
State Coordinator for Assistive Technology
Rocky Mountain Resource and Training Institute (RMRTI)
6355 Ward Road, Suite 310
Arvada, CO 80004
(303) 420-2942
FAX (303) 420-8675

Connecticut
Jon A. Alander
Commissioner
Connecticut State Department of Human Resources
Bureau of Rehabilitation Services
1049 Asylum Avenue
Hartford, CT 06105
(203) 566-3318

Delaware
Beth A. Mineo
University of Delaware
Center for Applied Science and Engineering
1600 Rockland Road
Wilmington, DE 19899
(302) 651-6834

Florida
Jay E. Yourist
Department of Labor and Employment
Division of Vocational Rehabilitation
Bureau of Client Services
Rehabilitation Engineering Technology
1709-A Mahan Drive
Tallahassee, FL 32399-0696
(904) 488-6210

Georgia
Joy Kniskern
Georgia Department of Human Resources
Georgia Division of Rehabilitation Services
878 Peachtree Street, NE
Room 702
Atlanta, GA 30309
(404) 853-9151
(404) 894-7593

Hawaii
Laurie Hirohata
Project Director
HATS (Hawaii Assistive Technology System)
1000 Bishop Street, Suite 302
Honolulu, HI 96813
(808) 521-8489

Idaho
Bryce Fifield/Lee Parks
University Center on Developmental Disabilities
Professional Building
129 W. Third Street
Moscow Latah, ID 83843
(208) 885-6849

Illinois
Terri Dederer
Project Liaison
Illinois Assistive Technology Project
Department of Rehabilitation Services
Division of Planning and Special Initiatives
411 East Adams Street
Springfield, IL 62701
(217) 785-7091
(217) 522-7985

Indiana
Sandra Metcalf
Project Manager
Indiana Department of Human Services
Office of Vocational Rehabilitation
Technology Assistance Unit
150 West Market Street
PO Box 7083
Indianapolis, IN 46207-7083
(317) 233-3394

Iowa
James C. Hardy
Director
Iowa Program for Assistive Technology
University Hospital School
Iowa City, IA 52242
(319) 353-6386
FAX (319) 356-8284

Kentucky
Janice Weber
Director
Kentucky Assistive Technology Service (KATS) Network
KATS Network Coordinating Center
427 Versailles Road
Frankfort, KY 40601
(502) 564-4665
(800) 327-KATS
FAX (502) 564-3976

Louisiana
Jill Rivers
Project Director
Louisiana State Planning Council on Developmental Disabilities
Department of Health and Hospitals
PO Box 3455
Baton Rouge, LA 70821-3455
(504) 342-6804

Maine
Kathleen Powers
Project Director
Division of Special Education
Maine Department of Education
State House Station #23
Augusta, ME 04330
(207) 621-3195
(207) 289-2550 (TDD)
FAX (207) 289-5900

Maryland
Mary Brady
Executive Director
Maryland Technology Assistance Project
Governor's Office for Handicapped Individuals
300 West Lexington Street
1 Market Center - Box 10
Baltimore, MD 21201
(301) 333-3098
FAX (301) 555-3280

Massachusetts
Judy Brewer
Project Coordinator
MATP Center
Gardner 529
Children's Hospital
300 Longwood Avenue
Boston, MA 02116
(617) 735-7820
(617) 735-7301 (TDD)

Michigan
Peter P. Griswold
Michigan Department of Education
Michigan Rehabilitation Services
PO Box 30010
Lansing, MI 48909
(517) 373-3391

Minnesota
Rachel Wobschall
Executive Director
Star Program
Minnesota State Planning Agency
300 Centennial Building
658 Cedar Street
St. Paul, MN 55155
(612) 297-1554
FAX (612) 296-3698

Mississippi
Pete Martin
Project Director
Division of Rehabilitation Services
Department of Human Services
PO Box 1698
Jackson, MS 39215-1698
(601) 354-6891

Missouri
Diane Golden
Director
Missouri Assistive Technology Project
UMKC, School of Education
5100 Rockhill Road
Kansas City, MO 64110
(816) 235-5337

Montana
Peter Leech
MonTech
Rural Institute on Disabilities
The University of Montana
52 Corbin Hall
Missoula, MT 59812
(406) 243-4597

Nebraska
Mark Schultz
Project Director
Assistive Technology Project
Nebraska Department of Education
Division of Rehabilitation Services
301 Centennial Mall South
PO Box 94987
Lincoln, NE 68509-4987
(402) 471-0735
(800) 742-7594
FAX (402) 471-2701

Nevada
Donny Loux
Chief
Program Development
Rehabilitation Division, PRPD
505 East King Street, Room 502
Carson City, NV 89710
(702) 687-4452

New Hampshire
Joan Bergman
Project Coordinator
New Hampshire Technology Partnership Project
Institute on Disability
#14, Ten Ferry Street
The Concord Center
Concord, NH 03301
(603) 224-0630

New Jersey
Howard Luckett
New Jersey Department of Labor
Office of the Commissioner
Commissioner Raymond L. Bramucci
Labor Building, CN 110
Trenton, NY 08625
(609) 984-6550

New Mexico
Andy Winnegar
Director
New Mexico Technology-Related Assistance Program
435 St. Michael Drive, Bldg. D
Santa Fe, NM 87503
(505) 827-3533

New York
Deborah V. Buck
Project Manager
NY State Office of Advocate for the Disabled
TRAID Project
One ESP - 10th Floor
Albany, NY 12223-0001
(518) 474-2825

North Carolina
Ricki Cook
Project Director
North Carolina Assistive Technology Project
Department of Human Resources
Division of Vocational Rehabilitation Services
1110 Navaho Drive, Suite 101
Raleigh, NC 27609
(919) 850-2787

Ohio
Linda McQuistion
Ohio Rehabilitation Services Commission
Division of Public Affairs
400 E. Campus View Blvd.
Columbus, OH 43235-4604
(614) 438-1236

Oklahoma
Paul Bowerman
Oklahoma Department of Human Services
Rehabilitation Services Division
DHS, RS #24
PO Box 25352
Oklahoma City, OK 73125
(405) 424-4311

Oregon
Gregory Fishwick
Project Director
Technology Access for Life Needs (TALN)
Oregon Vocational Rehabilitation Division
Department of Human Resources
2045 Silverton Road, NE
Salem, OR 97310
(503) 378-3830, ext. 386 (Voice/TDD)

Pennsylvania
Diane Nelson Bryen
Temple University of the Commonwealth System of Higher Education
Institute on Disabilities/UAP
13th Street & Cecil B. Moore Avenue
Philadelphia, PA 19122
(215) 787-1356

South Carolina
Lanelle C. Durant
South Carolina Vocational Rehabilitation Department
PO Box 15
West Columbia, SC 29171-0015
(803) 822-5404

South Dakota
David Miller
Department of Human Services
Division of Rehabilitation Services
Kneip Building
700 Governors Drive
Pierre, SD 57501
(605) 773-3195

Tennessee
Jimmie Williams
Project Director
Tennessee Technology Access Project
Department of Mental Health and Mental Retardation
3rd Floor, Doctors' Building
706 Church Street
Nashville, TN 37243-0675
(615) 741-7441

Texas
William A. Myers
The University of Texas at Austin
UAP of Texas
Department of Special Education
PO Box 7726
Austin, Travis County, TX 78713-7726
(512) 471-7621

Utah
Marvin Fifield
Director
Utah Assistive Technology Program (UATP)
Utah State University
Developmental Center for Handicapped Persons
Logan, UT 84322-6855
(801) 750-1982
FAX (801) 750-2044

Vermont
Jesse Barth
Director
Assistive Technology Project
Department of Aging and Disabilities
Agency of Human Services
103 South Main Street
Waterbury, VT 05676
(802) 241-2620
FAX (802) 244-8103

Virginia
Kenneth H. Knorr, Jr.
Director
Virginia Assistive Technology System
Department of Rehabilitative Services
4901 Fitzhugh Avenue
PO Box 11045
Richmond, VA 23230
(804) 367-2445
(804) 367-0315 (TDD)
FAX (804) 367-9256
(800) 552-5019

West Virginia
Tom Minshall
Division of Rehabilitation Services
West Virginia Rehabilitation Services
Capital Complex
Charleston, WV 25301
(304) 766-4698

Wisconsin
Judi Trampf
Director, WisTech
Division of Vocational Rehabilitation
1 West Wilson Street, Room 950
PO Box 7852
Madison, WI 53702
(608) 267-6720
(608) 266-9599 (TDD)

Organizations/Agencies*

Activating Children Through Technology (ACTT)
c/o Western Illinois University
27 Horrabin Hall
Macomb, IL 61455
(309) 298-1634

This university-based center supports a technology resource center that offers information dissemination, training, and evaluation services in microcomputer applications and related technology areas to individuals who are disabled.

Alliance for Technology Access
Apple Computer, Inc.
20525 Mariani Avenue, MS 43S
Cupertino, CA 95014
(415) 528-0747

The alliance was developed in association with the Disabled Children's Computer Group by Apple Computer's Office of Special Education Programs. This organization conducts research and provides information dissemination, database resources, referral services, and training related to the implementation of microcomputer technology with children and adults who are disabled. The alliance currently is developing model assistive technology sites across the United States.

American Occupational Therapy Association (AOTA)
1383 Piccard Drive
PO Box 1725
Rockville, MD 20850-0822
(301) 948-9626

American Physical Therapy Association (APTA)
1111 N. Fairfax
Alexandria, VA 22314
(703) 684-2782

American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(800) 638-6868 (members) (voice or TDD)
(800) 638-8255 (consumers) (voice or TDD)

* This listing was compiled by the American Speech-Language-Hearing Association (ASHA). It does not attempt to be all-inclusive nor does it imply ASHA endorsement.

Apple Computer, Office of Special Education
20525 Mariani Avenue, MS 43S
Cupertino, CA 95014
(408) 974-8601

Through this office, Apple Computer works with rehabilitation, education and advocacy organizations nationwide to identify computer-related needs of individuals who are disabled and to assist in the development of responsive programs. Apple maintains a database of hardware, software, publications, and organizations involved in the use of assistive technology.

Association for Retarded Citizens (ARC)
ARC National Headquarters
500 E. Border
Suite 300
Arlington, TX 76010
(817) 261-6003
(817) 277-0553 (TDD)

ARC is the nation's largest volunteer organization solely devoted to improving the lives of all children and adults with mental retardation and their families. The association also fosters research and education regarding the prevention of mental retardation in infants and young children.

Blissymbolics Communication International
250 Ferrand Drive, Lower Concourse
Don Mills, Ontario M3C 3P2 Canada
(416) 421-8377

This organization is dedicated to the development and dissemination of Blissymbolics as a communication system for people who do not speak.

Carolina Literacy Center
Department of Medical Allied Health Professions
Campus Box #8135
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599-8135
(919) 966-7486

In addition to other services, this center strives to meet the needs of people with severe speech and physical impairments through literacy symposiums/workshops and to make available publications on the topic of literacy.

Closing the Gap, Inc.
PO Box 68
Henderson, MN 56044
(612) 248-3294

This organization offers regional and national conferences, workshops, and training. CTG also publishes a newspaper dedicated to the application of assistive technology with individuals who are disabled.

Committee on Personal Computers and the Handicapped (COPH-2)
PO Box 7701
Chicago, IL 60680-7701
(708) 866-8195

This consumer organization disseminates information, provides technical consultations, and sells adaptive computer devices. The organization also publishes information resources and supports an electronic bulletin board.

Hear Our Voices
105 W. Pine Street
Wooster, OH 44691
(216) 262-4681

A national patient advocacy group run by Prentke Romich Company. Any augmentative communication aid user or family member can join this organization.

IBM National Support Center for Persons with Disabilities (IBM-NSCPD)
PO Box 2150
Atlanta, GA 30055
(800) 426-2133

This IBM support center provides information, referral, advocacy, and demonstration center services. The center provides specific IBM computer applications and resources for individuals who are disabled.

International Society for Augmentative and Alternative Communication (ISAAC)

United States Society for Augmentative and Alternative Communication (USSAAC)
PO Box 1762, Station R
Toronto, Ontario M4G 4A3 Canada
(416) 737-9308

The purpose of these organizations is to facilitate the international and national advancement of the transdisciplinary field of augmentative and alternative communication.

National Federation for the Blind
1800 Johnson Street
Baltimore, MD 21230
(301) 659-9314

A national organization with more than 500 state and local chapters. The organization provides information dissemination, advocacy, referral services, database, and resource support services to persons who are visually impaired.

National Lekotek Center
CompuPlay
711 E. Colfax
South Bend, IN 46617
(219) 233-4366

CompuPlay provides computer play sessions for family members and children with special needs ages 2 to 14. Adaptive equipment and software are employed to allow children to play and learn. The organization provides a software lending library and computer demonstration center.

RESNA – Association for the Advancement of Rehabilitation Technology
1101 Connecticut Avenue, NW, Suite 700
Washington, DC 20036
(202) 857-1199

RESNA plans and conducts scientific, technical, and educational meetings and programs; serves as a forum for the development of standards, terminology, and guidelines; and provides consultation and coordination concerning matters of interest to RESNA members. It also publishes and disseminates information on technology and service delivery.

TASH – The Association for Persons with Severe Handicaps
11201 Greenwood Avenue North
Seattle, WA 98133
(206) 361-8870

The purpose of TASH is to create a community where no one is segregated and everyone belongs. TASH is dedicated to research, education, dissemination of knowledge and information, legislation, litigation, and excellent services.

Technology and Media Division (TAM)
Council for Exceptional Children
1920 Association Drive
Reston, VA 22091-1589
(703) 620-3660

This division of the Council for Exceptional Children keeps abreast of advances in special education technology. The organization provides information dissemination and referral services and offers several publications on the use of technology.

Trace Research and Development Center
1500 Highland Avenue, S-151 Waisman Center
Madison, WI 53705
(608) 262-6966
(608) 263-5408 (TDD)

The Trace Center develops and disseminates information related to nonvocal communication, computer access, and technology to aid individuals who are disabled. The center also conducts research and training in technology.

UCLA Intervention Program for Handicapped Children
1000 Veteran Avenue, Room 23-10
Los Angeles, CA 90024
(213) 825-4821

This university-based technology program has developed software for use with individuals who are disabled. The program also supports a resource center and is actively involved in technology training activities.

Periodicals*

Accent on Living
Published by
Cheever Publishing
PO Box 700
Bloomington, IL 61701

American Journal of Audiology: A Journal of Clinical Practice
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

American Journal of Speech-Language Pathology: A Journal of Clinical Practice
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

American Occupational Therapy Journal
Published by the
American Occupational Therapy Association
1383 Piccard Drive
Rockville, MD 20850-0822
(301) 948-9626

Assistive Device News
Newsletter published by
Central Pennsylvania Special Education Regional Resource Center
150 S. Progress Avenue
Harrisburg, PA 17109
(717) 657-5840

Assistive Technology
Published by
Demos Publications
156 Fifth Avenue, Suite 1018
New York, NY 10010
(212) 857-1199

Assistive Technology Quarterly
Published by
RESNA Press
1101 Connecticut Avenue NW, Suite 700
Washington, DC 20036
(202) 857-1140

Augmentative and Alternative Communication (AAC)
Sponsored by the
International Society for Augmentative and Alternative Communication (ISAAC)
Published by
Decker Periodicals Publishing, Inc.
PO Box 620, Station A
Hamilton, Ontario L8N 3K7 Canada
(416) 522-7017

Augmentative Communication News
Published by
Augmentative Communication, Inc.
One Surf Way, Suite #215
Monterey, CA 93940
(408) 649-3050

Closing the Gap
Newspaper
Address correspondence to:
Closing the Gap
PO Box 68
Henderson, MN 56044
(612) 248-3294

Communication Outlook
An Affiliate of ISAAC.
Published by
Communication Outlook
Artificial Language Laboratory
Michigan State University
405 Computer Center
East Lansing, MI 48824-1042
(517) 358-0870

Communicating Together
An affiliate of ISAAC.
Published by
Sharing to Learn
PO Box 986
Thornhill, Ontario L3T 4A5 Canada

Computer-Disability News
Published by
National Easter Seal Society
5120 S. Hyde Park Blvd.
Chicago, IL 60615
(312) 667-8400

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Computer Teacher (The)
Published by
International Society for Technology in Education
1787 Agate Street
Eugene, OR 97403-1923
(503) 346-4414

Educational Technology
Published by
Educational Technology
720 Palisade Avenue
Englewood Cliffs, NJ 07632
(201) 871-4007

Exceptional Parent
Published by
Boston University, School of Education
605 Commonwealth Avenue
Boston, MA 02215

Journal of Applied Behavior Analysis (JABA)
Published by the
Society for the Experimental Analysis of Behavior, Inc.
Address correspondence to
Business Manager, Mary Louise Wright
Department of Human Development
University of Kansas
Lawrence, KS 66045

Journal of Speech and Hearing Research (JSHR)
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

The Journal of the Association for Persons with Severe Handicaps (JASH)
Published by the
Association for Persons with Severe Handicaps (TASH)
7010 Roosevelt Way, NE
Seattle, WA 98115

Language, Speech, and Hearing Services in Schools (LSHSS)
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

Physical Therapy
Published by the
American Physical Therapy Association
1111 N. Fairfax
Alexandria, VA 22314
(703) 684-2782

Research in Developmental Disabilities
Published by
Pergamon Press, Inc.
Maxwell House
Fairview Par
Elmsford, NY 10523
or
Pergamon Press plc
Headington Hill Hall
Oxford OX3 0BW, England

Team Rehab Report
Published by
Miramar Publishing Company
6133 Bristol BHW
PO Box 3640
Culver City, CA 90231-3640
(213) 337-9717
(800) 543-4116

Technology and Disability
Published by
Andover Medical Publishers, Inc.
80 Montvale Avenue
Stoneham, MA 02180
(800) 366-2665

Topics in Language Disorders
Published by
Aspen Publishers, Inc.
7201 McKinney Circle
Frederick, MD 21701
(800) 638-8437

TRACES Newsletter
Published by
Teaching Research Division
Western Oregon State College
345 N. Monmouth Avenue
Monmouth, OR 97361
(503) 838-8778

VOICES
Newsletter published by
Hear Our Voices
105 West Pine Street
Wooster, OH 44691
(216) 262-4681

Funding Resources*

Assistive technology: A funding workbook (1991)
By: Morris, M., & Golinker, L.
RESNA Technical Assistance Project
1101 Connecticut Avenue, NW, Suite 700
Washington, DC 20036
(202) 857-1140

Part I of this workbook is a road map to funding sources, and Part II is an outline of federal laws and rules.

Funding excuses (1991)
By: Golinker, L.
United Cerebral Palsy Associations
1522 K Street,
Suite 1112
Washington, DC 20005
(800) 872-5827

This free memorandum lists 17 common "excuses" offered by four funding programs to deny requests for augmentative and/or alternative communication devices and services in particular, and many other types of assistive technology in general. The four funding programs are Medicaid, special education, vocational rehabilitation, and private insurance. A response is provided for each excuse. The intent is to help in preparing initial applications so that funding will be approved and to provide a strategy for appealing an initial funding denial.

Assistive technology and the Individualized Education Program (1992)
By: RESNA Technical Assistance Project
RESNA Technical Assistance Project
1101 Connecticut Avenue NW, Suite 700
Washington, DC 20036
(202) 857-1140

This product provides information on how to incorporate assistive technology into an IEP for children and youth with disabilities.

Handbook of assistive technology (1992)
By: Church, G., & Glennon, S. (Eds.)
Singular Publishing Co.
4284 41st Street
San Diego, CA 92105-1197
(619) 521-8000

The many faces of funding (1986)
By: Hofman, A.
Phonic Ear, Inc.
250 Camino Alto
Mill Valley, CA 94941
(415) 383-4000

This textbook focuses on funding strategies for communication devices. The information it gives is also applicable to funding for other types of assistive technology aids. It highlights sources of funding on the federal, state, local, educational, and private levels.

Medicaid coverage of AAC (available late fall 1992)
By: Golinker, L.
United Cerebral Palsy Associations
1522 K Street, Suite 1112
Washington, DC 20005
(800) 872-5827

This free set of materials explains Medicaid coverage of augmentative and alternative communication through Early Periodic Screening, Diagnostic, and Treatment Services (EPSDT); existing state policies regarding AAC coverage; and model complaints to gain AAC coverage through Medicaid/EPSDT. The materials will be distributed to UCPA affiliates, state Protection and Advocacy Groups, federally funded state Assistive Technology Centers, and state Developmental Disabilities Planning Councils. They may also be obtained by calling UCPA at the number listed above.

Summary of Existing Legislation Affecting Persons with Disabilities (1992)
By: Department of Education
Clearinghouse on Disability Information
U.S. Department of Education
Room 3132 Switzer Building
Washington, DC 20202-2524
(202) 732-1241 (voice or TDD)
(202) 732-1723 (voice or TDD)

This booklet describes many federal laws and programs that affect people with disabilities.

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Databases*

Database resources are large clearinghouses for information on a wide variety of assistive technology, including new and existing hardware, software, and related resources. These databases provide information via on-line electronic networks, floppy disks, CD-ROM, audiocassettes or printed material.

ABLEDATA—Database of Assistive Technology Information
National Rehabilitation Information Center (NARIC)
(operated by Macro International Inc.)
Silver Spring Centre
8455 Colesville Road, Suite 935
Silver Spring, MD 20910
(800) 346-2742
(301) 588-9284

ABLEDATA is an extensive database that contains listings of assistive technology available both commercially and non-commercially from domestic and international manufacturers and distributors. It is an information system that enables people with disabilities and their families to identify and locate devices that will assist them at home, work, school, and in the community; it also serves as a resource for practitioners, researchers, engineers, and advocates in the rehabilitation field.

Some of the areas that can be searched in the database are mobility, seating, communication, and environmental controls. Database citations provide product brand name and generic name, manufacturer name and address, price, and a detailed description of the product. Search results are available in regular print, enlarged print, Braille, audio cassettes, diskettes, CD-ROM, and in Spanish. The ABLEDATA classified service is also available for buying or selling used assistive devices or equipment.

Accent on Information
PO Box 700
Bloomington, IL 61702
(309) 378-2961

A computerized database of product, publication, and related resource information on how to adapt assistive technology equipment. The database contains over 6,000 product entries.

Access/Abilities
PO Box 458
Mill Valley, CA 94942
(415) 388-3250

A database of technology resources for individuals who are physically disabled. The database contains information on services, hardware, and software aids.

Assistive Device Database System
Assistive Device Center
California State University
Sacramento, CA 95819
(916) 278-6422

This database contains information on assistive devices and related resource listings. It focuses on the educational implications of using assistive technology with disabled populations.

Adaptive Device Locator System
Academic Software, Inc.
331 West Second Street
Lexington, KY 40507
(606) 233-2332

This floppy-disk-based system provides descriptions and pictures of assistive devices and lists of sources for products and product information. The system can generate mailing labels and form letters to vendors. The database includes over 600 generic device descriptions, categorized by over 350 functional goal descriptions and cross-indexed with over 300 vendors.

Compuserve
5000 Arlington Centre Blvd.
PO Box 20212
Columbus, OH 43220
(614) 457-8600

The system contains a users' database that contains information on all aspects of technology used by individuals who are disabled.

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DEAFNET
508 Bremer Bldg., 7th and Roberts Streets
St. Paul, MN 55101
(612) 223-5130

DEAFNET is a nonprofit organization that serves technology users who are hearing impaired. It has a nationwide electronic mail service with international links.

ECER
Council for Exceptional Children
1920 Association Drive
Reston, VA 22091-1589
(703) 620-3660

ECER is the ERIC database for technology users who are disabled. The database contains bibliographic information on books, articles, teaching materials, and reports on the education of individuals who are disabled.

Handicapped Education Exchange (HEX)
11523 Charlton Drive
Silver Spring, MD 20902
(301) 681-7372

The HEX database offers resource information on the use of technology with individuals who are disabled. The database contains information on products, organizations, and related information on training and service.

HYPER-ABLEDATA-PLUS
Trace Center Reprint Service
1500 Highland Avenue, S-151 Waisman Center
Madison, WI 53706
(608) 263-6966

The CD-ROM version of the on-line version of ABLEDATA. This disk provides information on over 16,000 assistive technology products. The system also provides pictures and sound samples of many database items, and it has an access system for users who are blind or visually impaired.

National Technology Center
American Foundation for the Blind, Inc.
15 W. 16th Street
New York, NY 10011
(212) 620-2000

The center maintains three database systems: National Technology Database, Evaluations Database, and Research and Development Database. Each database focuses on resources for individuals who are blind or visually impaired and professionals who work with them.

Solutions
Apple Computer, Inc.
20525 Mariani Avenue, MS 43S
Cupertino, CA 95014
(408) 973-2732

The database contains information on hardware, software, organizations, and publications maintained by Apple Office of Special Education Programs. The database can be accessed via SpecialNet or AppleLink.

SpecialNet
2021 K Street, NW, Suite 215
Washington, DC 2006
(202) 835-7300

The largest computer network in the United States devoted exclusively to the information needs of professionals in special education.

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Appendix B Types of Hearing Loss

The auditory system is a fascinating and complex structure. (For a thorou 'ı discussion of anatomy and physiology and ear pathologies, the reader is referred to: Martin [1986] and Northern and Downs [1991]). Before we discuss types of hearing loss, a brief lesson on the anatomy of the ear is in order.

Basically, the auditory system can be divided into the peripheral and the central systems. The peripheral system, which is comprised of the outer, middle, and inner ear, functions to receive incoming sound. The central system, which is comprised of the brainstem and cortex, processes the sounds that have been received by the peripheral system.

Obviously, sounds must be received before they can be understood. A child's inability to process, perceive, or understand information may be due solely to the fact that the auditory information has not been received completely in the first place.

There are different types of hearing loss that interfere with the reception of sound.

A conductive hearing loss occurs because of disease or damage in the outer and/or middle ear; such damage interferes with the efficient conduction of sound to the inner ear, where sound is actually received by specialized sensory cells called *hair cells*.

- The most common cause of conductive hearing loss is otitis media (or middle ear infection). As many as 80% of infants and young children with disabilities may have middle ear fluid all or part of the time (Berman, Balkany, & Simmons, 1978; Dahl & McCollister, 1986; Downs, 1980; Flexer, 1989).
- Because the presence of middle ear fluid *always* causes a hearing loss (the degree of hearing loss varying with the volume of middle ear fluid), ear infections represent a significant educational problem (Northern & Downs, 1991; Wiederhold, Zajtchuk, Vap, & Paggi, 1980). Unfortunately, children with otitis media typically are referred for medical treatment only; the hearing loss caused by the fluid is not taken into consideration.

A sensorineural hearing loss is caused by disease or damage located in the inner ear or auditory nerve and results in a permanent hearing loss.

A mixed hearing loss indicates the presence of disease or damage in several different locations in the auditory system, from the outer ear to the inner ear. For example, a child with otitis media also can have a sensorineural hearing loss caused by lack of oxygen at birth.

An auditory processing disorder or perceptual problem is caused by disease or damage to the brainstem or cortex. It interferes with the *perception or understanding* of the incoming sound; damage to the central system typically does not cause a *hearing loss* or a problem with receiving the sound.

Hearing losses can occur to varying degrees, ranging from mild to profound. Remember, even a mild hearing loss can present a significant barrier to the clear reception of the auditory signal. In fact, *mild* or *minimal* hearing loss are misleading terms. *Minimal* implies that the hearing loss is insignificant. In fact, even a minimal hearing loss, including a unilateral hearing loss, can greatly reduce the child's ability to receive and process auditory information (Northern & Downs, 1991).

Because hearing loss is measured in decibels (dB) and the dB is a logarithmic scale, a 20 dB hearing loss means that there is a 10-fold decrease in hearing sensitivity from the prepathological state. That is, a child who has middle ear fluid that causes an average hearing loss of 20 dB hears 10 times worse than he or she hears when there is no fluid present; a 40 dB hearing loss means that the child's hearing is 100 times less sensitive.

A research team in Pittsburgh recently found that young children who have the typical 20 dB hearing loss caused by ear infections experience more negative consequences than older children with the same degree of hearing loss (Nozza, Rossman, Bond, & Miller, 1990). Thus, it appears that young children need better hearing sensitivity and a quieter listening environment than older children and adults to discriminate word/sound differences. Such research generates concern that young children with a history of recurrent ear infections may have significant auditory deficits and may have a great deal of difficulty "listening."

It is critical to remember that if a young child has otitis media in addition to a minimal sensorineural or unilateral hearing loss or an auditory processing disorder, the child will have significant hearing and listening problems. Otitis media makes all other existing hearing problems much worse than expected (Cargill & Flexer, 1989).

Appendix C National Resources for Information on Assistive Listening Devices

Gallaudet University
Assistive Devices Center
Audiology and Speech-Language Pathology
School of Communication
800 Florida Avenue, NE
Washington, DC 20002-3695
(202) 651-5328 (voice or TDD)

New York League for the Hard of Hearing
71 W. 23rd Street
New York, NY 10010-4162
(212) 741-7650 (voice
(212) 255-1932 (TDD)

Self-Help for Hard of Hearing People, Inc. (SHHH)
7800 Wisconsin Avenue
Bethesda, MD 20814
(301) 657-2248 (voice)
(301) 657-2249 (TDD)

Appendix D Audiological Assessment

An audiological assessment provides essential information for the educational management of young children with severe disabilities. Some basic facts about the assessment include:

- **The hearing ability of a child of any age and with any disability can be evaluated.** It may take many test sessions, several different tests, and multiple environmental observations to obtain thorough audiometric information.
- **The hearing assessment tests the range of hearing ability and auditory function by utilizing a test-battery approach**, which is comprised of both behavioral and objective or (electro)physiological tests selected on the basis of the child's developmental age (Jerger, 1984).
- **Family members (and other members of the team, when possible) should observe the audiological test sessions** because it is often possible to elicit definite auditory behaviors in the controlled, quiet setting of a sound room that are not noticed in classroom or home environments.
- **A thorough audiological evaluation can provide answers** to the following questions:
  - Is hearing sensitivity normal, or is there a peripheral hearing loss interfering with the reception of sound?
  - If a hearing loss does exist, what is the type and degree of the hearing loss?
  - How does the child respond to sound, and how do the displayed auditory behaviors relate to the child's chronological and developmental age?
  - How does the child's hearing loss affect the reception of specific speech sounds? For example, will the child have more difficulty hearing voiceless consonants (s, sh, t), nasal sounds (m, n, ng), or fricatives (f, th)?
  - How will environment and distance from the speaker affect the child's ability to receive speech?
  - Which hearing technologies will assist the child in different environments?
  - What strategies can be employed to develop listening behaviors?
- **The audiologist can assist in separating hearing loss from other problems** that display symptoms similar to hearing loss.
- **The child should be evaluated audiometrically while wearing any recommended hearing technology** because that is the only way to determine which sounds the child is receiving through the device (and the intensity of these sounds). The audiologist then can provide comparative information about which speech sounds the child is receiving with and without the use of hearing technology.

Behavioral Audiological Tests

The behavioral test, which is part of the pediatric test battery, utilizes the following steps: a behavior is elicited by a specific sound that is presented through an audiometer; the behavior is interpreted as a response; and the subsequent function of the auditory system is inferred. For example, a loud calibrated sound is presented; the young child is observed to startle and look for the sound; and the inference is made that the child heard the sound.

Behavioral tests are selected by the audiologist on the basis of the child's ability to respond to auditory stimuli and to perform necessary tasks. Families or service providers who know the child well and who accompany the child on the day of testing can provide the audiologist with information about the child's response modes and abilities. This information is essential if test results are to be accurate. Audiologists also must be aware of impeding involuntary motor movements that may restrict the child's voluntary responses during testing. In other words, test stimuli must be presented at optimal times for the child. Keeping this in mind, commonly used pediatric audiological behavioral tests include the following:

- **Behavioral observation audiometry (BOA)** – BOA is the lowest developmental-level procedure. An auditory stimulus is presented, and the child's unconditioned response behaviors (e.g., eyeblink, headturn, arousal, quieting) are observed (Flexer & Gans, 1986). Although precise thresholds cannot be obtained, Minimum Response Levels (MRL) can be determined.
- **Visual reinforcement audiometry (VRA) or conditioned orientation reflex audiometry (COR)** – The terms VRA and COR often are used interchangeably, even though there are some differences. Both are the most commonly used visual reinforcement tasks. In a VRA procedure, a sound is presented, and specific response behaviors (typically localization responses) are rewarded by an interesting visual display, such as a dancing toy monkey with flashing lights. Thus, the child is conditioned to look for the lighted toy whenever a sound is presented.
- **Tangible reinforcement operant conditioning audiometry (TROCA)** – TROCA is another behavioral test that can be used with very young children or with some children who experience disabilities. The TROCA procedure employs tangible reinforcers, such as candy or cereal, for appropriate responses to sound. The child is conditioned to push a response button or lever on a feeder box whenever he or she hears a sound. Careful positioning of this response button is necessary to ensure it is accessible to the child with physical disabilities.
- **Conditioned play audiometry (CPA)** – CPA is a higher developmental-level task than those described above because it demands active cooperation from the child, such as dropping a block in a basket or indicating a symbol on a communication device every time a sound is heard.

- **Traditional methods** – For a child who is more mature and has the motoric and cognitive abilities to respond with standard hand raising, conventional methods of assessment are appropriate.

(Electro)physiological Tests

(Electro)physiological tests do not require a behavioral response and are used to measure the auditory system directly. These tests are used in conjunction with behavioral information to obtain a complete evaluation of the individual's hearing function and auditory system integrity.

Two frequently used types of (electro)physiological tests include: (a) auditory evoked potential testing, most commonly the auditory brainstem response (ABR), and (b) acoustic immittance testing. A third, newer procedure is called otoacoustic emissions.

- **Auditory brainstem response (ABR)** – ABR involves the use of several electrodes that are placed on the head and earlobes to measure the small electrical charge produced by the auditory system and the brain in response to sound stimuli presented through earphones. ABR test results must be interpreted carefully because middle ear pathology and brain damage can obscure or eliminate ABR responses (Worthington & Peters, 1980). It is important to note that a lack of ABR responses does not necessarily mean that the child has no residual or remaining hearing. This is true because of the limits of the testing equipment itself, as well as the effects of middle ear pathology or brain damage, cited above. One needs to remember that hearing technology (hearing aids, FM units) still could be beneficial to young children who do not show identifiable ABR tracings. The audiologist makes recommendations on the basis of all available information and audiological measures.

- **Acoustic immittance testing** – Acoustic immittance testing, also called impedance and admittance testing, is performed to directly evaluate middle ear function, not hearing sensitivity. In one acoustic immittance test, called tympanometry, a soft rubber probe is placed in the outside of the ear canal; middle ear pressure and ear drum mobility are measured; and the presence of a conductive pathology can be determined (ASHA, 1990). Abnormal acoustic immittance results typically indicate an ear problem (most commonly otitis media or ear infection) that requires medical treatment.

  There is an unfortunate tendency to refer a child with abnormal acoustic immittance results to the physician only. Although medical management is important, medical treatment may not clear the hearing problem. Both the ear problem and the hearing problem need to be acknowledged and treated by the appropriate professionals. A medical doctor manages the ear problem, and an audiologist manages the hearing problem.

- **Otoacoustic emissions** – After many experiments, it has been determined that the cochlea (inner ear) emits sounds that can be recorded in the ear canal; these sounds are called otoacoustic emissions. A small probe is inserted in the ear canal, and sounds are presented. If otoacoustic emissions are present, it is determined that the cochlea is able to respond to sound in the normal way. Otoacoustic emissions appear to have promise as a clinical tool for understanding inner ear (cochlear) function and pathology. Presently, more studies are necessary before otoacoustic emissions can be used as a valid and reliable means of evaluating auditory function in young children.

Appendix E Additional Readings

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Busenbark, L., & Jenison, V. (1986). Assessing hearing aid function by listening check. *The Volta Review, 88*, 263–268.

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