THE POWER OF HEARING

Carol Flexer, Ph.D.

Hearing is powerful! Child development is positively influenced if "hearing" is emphasized and negatively impacted if hearing is minimized. And the foundation of auditory development is brain plasticity.

Studies in brain development show that sensory stimulation of the auditory centers of the brain is critically important, and indeed, influences the actual organization of auditory brain pathways (Boothroyd, 1997; Chermack and Musiek, 1997; Musiek and Berge, 1998)

The same brain areas – the primary and secondary auditory areas – are most active when a child listens and when a child reads. That is, phonological or phonemic awareness, which is the explicit awareness of the speech SOUND structure of language units, forms the basis for the development of literary skills (Gilbertson and Bramlett, 1998)

Anything that we can do, therefore, to access and "program" those critical and powerful auditory centers of the brain with acoustic detail will expand the child's opportunities.

This article will provide evidence that "hearing" is the most effective modality for the teaching of spoken language (speech), reading, and cognitive skills. Furthermore, with today's amplification technologies, cochlear implants and early identification and intervention, auditory brain access and development are available for babies with even the most profound deafness.

Functional definitions: hearing-impaired, hard-of-hearing, and "deaf"

Three of the terms most commonly used to describe hearing loss are: hearing impairment, hard of hearing, and deaf. These terms can have a variety of meanings. The definitions proposed by Mark Ross, an audiologist and a person who experiences a severe to profound hearing loss, are very useful (Ross, Brackett, and Maxon, 1991). He used the term "hearing impairment" to describe any type and degree of hearing loss. The terms hard of hearing and deaf are used *functionally*. These terms are not associated with time of onset of the hearing loss or with the audiometric degree of hearing loss. Rather, a person is *functionally hard of hearing* if they learned language primarily by hearing and listening and if they receive information from the environment primarily by hearing and listening. So, a person could have been born with a profound hearing loss, but if amplification technology and auditory-verbal intervention enabled them to learn language primarily by hearing and listening, then they would be *functionally hard of hearing.*

A person is *functionally deaf* if that person learned language primarily through vision and receives information from the environment primarily through vision. Visual input includes lip-reading, cued speech, and sign language. Many traditional "oral" programs are as visually based in assumptions and teachings as are manual programs. Both assume that children with hearing impairments cannot use amplified auditory input as their *primary mode* of learning and that they must focus on vision.

Mark Ross further elaborates on his proposed functional definitions by stating that a child or anyone with a hearing impairment who is *functionally hard of hearing* is much more like a typical hearing person relative to how the information is learned, than they are like someone who is *functionally deaf*. A person who is *functionally hard of hearing*, through hearing aids or cochlear implants, accesses and develops the auditory centers of their brain like someone with typical hearing. A person who is *functionally deaf* does not. So, grouping children who are deaf and children who are hard of hearing into a single educational program does both an unfortunate disservice. The hard of hearing child is often put into an intervention program that has a visual emphasis, due to the inaccurate assumption that the child who is hard of hearing is the most like the child who is deaf.

In this new millennium, the degree of hearing loss ought not determine the functional outcome for infants and children who are young enough to have brain neural plasticity; these children's auditory brain centers can be accessed, stimulated, and developed through the early use of amplification or cochlear implant technologies. A primary desired outcome of auditory-verbal intervention is to enable children who are audiometrically deaf to be *functionally hard of hearing* (hearing), rather than *functionally deaf* (visual). The reality is that being *functionally hard of hearing* accesses the auditory centers of the brain, and that critical auditory brain access opens a world of choices and opportunities for listening, learning and lifestyle.

Acoustic filter effect of hearing impairment

Hearing loss of any type or degree that occurs in infancy or childhood can interfere with the development of a child's spoken language, reading and writing skills, and academic performance (Davis, 1990; Ling, 1989). Hearing loss can be described as an *invisible acoustic filter* that distorts, smears or eliminates incoming sounds, especially sounds from a distance – even a short distance. The negative effects of a hearing loss may be apparent, but the hearing loss itself is invisible and easily ignored or underestimated.

It is critical to note that as human beings we are neurologically "wired" to develop spoken language (speech) and reading skills through the central auditory system. Most people think that reading is a visual skill, but recent research on brain mapping shows that primary reading centers of the brain are located in the auditory cortex – in the auditory portions of the brain (Chermack & Musiek, 1997). That's why many children who are born with a hearing loss and who do not have access to auditory input when they are very young (through strong hearing aids and auditory teaching), tend to have a great deal of difficulty reading even though their vision is fine. Therefore, the earlier and more efficiently we can allow a child access to meaningful sound with subsequent direction of the child's attention to sound, the better opportunity that child will have of developing spoken language, literacy, and academic skills. With the technology and early auditory-verbal intervention available today, a child with a hearing loss CAN have the same opportunity as a child with typical hearing to develop audition, speech, language, cognition, competence in conversation and academic skills.

Audibility/intelligibility distinctions

There is a big difference between an "audible" signal and an "intelligible" signal. Speech is audible if the person is able simply to detect its presence. For speech to be intelligible, however, the person must be able to discriminate the word-sound distinctions of individual phonemes or speech sounds. As Mark Ross often has said, "The major problem with having a hearing loss is that you can't hear so good!" Consequently, speech might be very audible, but not consistently intelligible to a child with even a minimal hearing loss, causing the child to hear, for example, words such as "walking", "walker", and "walks" all as "ah".

Vowel sounds (such as o, u, ee, etc) are low frequency sounds and they are the most powerful sounds in English; they cause speech to be audible. Consonant sounds (like sh and s) are high frequency sounds and are much weaker; consonants allow speech to be intelligible. In order for speech to be heard clearly, both vowels and consonants must be acoustically available. Persons with hearing losses typically have the most difficulty hearing the weak, high frequency consonant sounds.

Computer analogy and amplification technology

One way to illustrate the potentially negative effects of any type and degree of hearing impairment on a child's language and overall development and to explain the role of amplification technology, is to use a computer analogy. The primary concept is: data input precedes data processing.

An infant or toddler (or anyone) must have information/data in order to learn. A primary avenue for entering information into the brain is through the ears, via hearing. So, the ears can be thought of as analogous to a computer keyboard, and the brain can be compared to the computer "hard drive". Remember, as human beings we are neurologically wired to code and hence to develop spoken language and reading skills through the auditory centers of the brain, the "hard drive". Therefore, auditory data input is critical, and it is worth our time and effort to make detailed auditory information as available as possible to a child with any degree of hearing loss. If data are entered inaccurately, incompletely, or inconsistently, analogous to using a malfunctioning computer keyboard or to having one's fingers on the wrong keys of the computer keyboard, the child's brain or hard drive will have incorrect or incomplete information to process. How can a child be expected to learn when the information that reaches his or her brain is deficient? Amplification technology such as hearing aids, personal FM systems or sound field FM systems, and biomedical devices such as cochlear implants can all be thought of as keyboards…as means of entering acoustic information to the child's hard drive. So, all that technology is, really, is a more efficient keyboard. Unfortunately, technology is not a perfect keyboard and it does not have a life of it's own, anymore than a car has a life of its own. Technology is only as effective as the use to which it is put, and only as efficient as the people who use it. Conversely, without the technology, without acoustic data input, auditory brain access is not possible for persons with hearing impairment.

To continue the computer analogy, once a keyboard is repaired or the figurative “fingers” are placed on the correct keys of the keyboard allowing data to be entered accurately, (analogous to using amplification technology that enables a child to recognize word-sound distinctions), what happens to all the previous inaccurate or incomplete information? Unfortunately, all of the corrected data need to be reentered. Thus, the longer a child’s hearing loss remains unrecognized and unmanaged, the more destructive and far reaching the snowballing effects of the hearing impairment. Early intervention is critical. . . the earlier the better!

Hearing is only the first step in the chain of intervention. Once hearing has been accessed as much as possible through appropriate amplification or biomedical technology, the child will have an opportunity to discriminate word-sound distinctions as the basis for learning language, which in turn provides the child with an opportunity to communicate and acquire the knowledge of the world. All levels of the acoustic filter effect discussed previously need to be understood and managed. Simply the wearing of hearing aids or a cochlear implant does not ensure development of an effective language base.

The longer a child’s data entry is inaccurate, the more damaging the snowballing acoustic filter effects will be on the child’s overall life development. Conversely, the more intelligible and complete the data entered are, the better opportunity the child will have to learn language that serves as a foundation for later reading and academic skills. That cannot be stated often enough – early intervention is paramount!

From the inception of early intervention programming, comprehensive audiologic management is the necessary first step for a child of any age with any type of hearing or listening difficulty to have an opportunity to learn.

A critical caveat is that, although amplification technology can provide a better “keyboard”, a more efficient and consistent route of data energy, that keyboard will not be perfect. Thus, systematic listening and learning strategies need to be implemented; hence the importance or auditory-verbal intervention.

The exciting news is that the cochlear implant can provide a much more complete and efficient keyboard than can hearing aids for a child who is audiometrically deaf . . .even if that child is obtaining some benefit from hearing aids and FM systems.

Distance hearing

Children with hearing losses, even minimal ones, cannot receive intelligible speech well over distances. This reduction in earshot has tremendous negative consequences for life and classroom performance because distance hearing is linked to passive/casual/incidental listening and learning. Research in the field of developmental psychology tells us that about 90% of what very young children know about spoken language and the world, they learn incidentally (Flexer, 1999). Very young children learn a great deal of information unintentionally because they have access to overhearing conversations that occur at distances. Thus, any type and degree of hearing loss can present a significant barrier to an infant or child’s ability to receive information from the environment.

Because of the reduction in acoustic signal intensity and integrity with distance, a child with a hearing challenge has a limited range or distance of hearing; that child may need to be taught directly many skills that other children learn incidentally.

Conclusion

The stimulation of “hearing” literally means the stimulation of brain growth. The earlier we get meaningful sounds to the brain, the more dramatic will be the brain growth due to neural plasticity. Thus, early identification and auditory management are essential. Once hearing loss is identified, an appropriate “keyboard” must be provided – hearing aids, cochlear implant and FM systems. Once a baby has keyboard access to the hard drive, auditory data must be entered ongoing. Hearing is indeed powerful! Hearing – auditory brain development – is the means to the desired outcomes of spoken language, literacy skills, and academic competencies.

References

Boothroyd, A. (1997) . Auditory development of the hearing child. Scandinavian Audiology, 26(Suppl. 46) , 9-16.

Chermack, G.D., & Musiek, F.E. (1997) . Central Auditory Processing Disorders: New Perspectives. San Diego, CA: Singular Publishing Group.

Davis, J. (Ed.) (1990) . Our Forgotten Child: Hard-of-Hearing Pupils in Schools. Bethesda, MD: Self Help for Hard of Hearing People.

Flexer, C. (1999) . Facilitating Hearing and Listening in Young Children (2nd ed.). San Diego, CA: Singular Publishing Group.

Gilbertson, M., & Bramlett, R.K. (1998) . Phonological awareness screening to identify at-risk readers: Implications for practitioners. Language, Speech, and Hearing Services in Schools, 29, 10906

Ling, D. (1989) . Foundations of Spoken Language for Hearing Impaired Children. Washington, DC: The Alexander Graham Bell Association for the Deaf.

Musiek, F.E., & Berge, B.E. (1998) . A neuroscience view of auditory training/stimulation and central auditory processing disorders. In M.G. Masters, N.A. Stecker, & J. Katz (Eds.), Central Auditory Processing Disorders: Mostly Management (pp. 15-32) . Boston: Allyn and Bacon

Ross, M., Brackett, D., & Maxon, A. (1991) . Assessment and Management of Mainstreamed Hearing- Impaired Children. Austin, TX: Pro-Ed.