

The Importance of Early Identification and Intervention for Children with Hearing Loss. Part 1: Human Development

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Abstract

Hearing loss is invisible and therefore historically has not been given the attention needed. If hearing loss is undetected and/or “rehabilitative” efforts are not begun as soon after birth as possible, then a child’s language, emotional and cognitive development will be affected. This will then contribute to later literacy difficulties and other academic difficulties. This is the first article of a two-part series that discusses the importance of early identification of hearing loss and its implications, discussed in the context of human development. In this first article, hearing loss in general will be discussed including the terms “Deaf”, “hard of hearing” and “deaf” and how early identification is important for all three groups. Tests that are available for testing the hearing of infants will also be discussed. In Part 2 further discussion of differentiating “deaf” and “hard of hearing” will occur and more information about the relationship between early identification and child development will be presented. This article presents the case that early identification of hearing loss is critical, not just for communication purposes, but for a child to reach their maximum human development and self-actualization.

Keywords: Human development; Self-actualization; Early identification; Universal screening; Residual hearing; “Deaf”; “Hard-of-hearing”; Early identification tests

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Introduction

Hearing loss is arguably one of the most prevalent disabilities in the United States. Conservative statistics estimate that at least 1.4 to 3 million children have a hearing loss significant enough to interfere with speech and language development and academic success. Also, approximately every 2.5 to 3 children born per thousand have a significant hearing loss, arguably making it the most prevalent congenital disability [1]. A more realistic estimate is that approximately 10 million children in the United States have a significant hearing loss [2-4]; with some estimates being even higher [5,6].

Experimental

Hearing loss is also invisible and therefore can easily go undetected. If hearing loss goes undetected and procedures are not put into place to assist a child as soon after birth as possible then a child’s language, emotional, and cognitive development will be affected negatively. This will contribute to literacy

difficulties, and other academic difficulties, later. Without some form of intervention hearing loss that begins early in life can also lead to difficulties with social interactions which will contribute to language difficulties in most of their forms: phonological, morphological, semantical, syntactical and pragmatical. It is during the first 3 years of life that children’s speech and language develops most rapidly [7].

Support for the preceding premise comes from several sources. Yoshinaga-Itano [8] presented information from several studies supporting that the early identification of hearing loss within the first six months of life leads to better speech, language and social-emotional development than children who were identified after 6 months of age. Yoshinaga-Itano argued that the first 6 months of life is a particularly sensitive period. Children identified within the first 6 months of age had language abilities within the range of their peers with normal hearing whereas children identified from 7 to 30 months did not. The measurement scale used was the Minnesota Child Development Inventory. Her data seemed to indicate that identification and intervention from 7 to 30

months did not allow children to achieve language performance equivalent to their peers with normal hearing, although it prevented children with hearing loss from falling further behind.

Moller [9] provided data consistent with that of Yoshinaga-Itano. Moller presented data on 112 children tested at 5 years of age using the Peabody Picture Vocabulary Test, the Preschool Language Assessment Inventory, and the Reynell Test of Language Development. The data she presented showed that the age of intervention, level of parental involvement and nonverbal intelligence were all important predictors of language ability at 5 years of age.

Calderon and Naidu [10] also presented data indicating that children who began intervention before 12 months of age performed better on measures of receptive language, expressive language, auditory discrimination and speech production than children who began intervention between 13 and 24 months of age. Also, children who began intervention between 13 and 24 months of age performed better than children who began intervention between 25 and 36 months of age.

It is important to know that hearing is not an “all-or-none” event. It is not that someone can hear or not hear at all. There are very numerous amounts of hearing loss that exist ranging from a mild amount to a severe amount with very little hearing remaining (called residual hearing). There are also different pitches that can be affected, again all with different amounts of hearing loss. The most typical pattern is for someone to have a greater loss of hearing for the high pitches than the low pitches in speech, often with normal hearing for the low pitches. This will be discussed further in a second related article “Factors Influencing Future Auditory Function and Human Development in Infants with Hearing Loss”.

Terminology: “deaf”, “hard of hearing”, “Deaf”

Related to the idea that hearing is not an all-or-none event it is important to discuss terminology. The most common terms that refer to people who have hearing loss are “Deaf”, “deaf” and “hard of hearing” (standard professional term although it is used for lack of a better term). The most important factor in the use of these terms is to consider a person’s and family’s cultural attachment and identity. The term “Deaf” is used for people who are part of a Deaf Culture which has a rich cultural identity with the art, writing, entertainment media and social history of other Deaf people. The terms “hard of hearing” and “deaf” are best differentiated functionally by the use of a person’s hearing (although the terms are also used for legal and medical purposes).

“Hard of hearing” refers to those people who possess enough remaining (residual) hearing so that their auditory system can be used as the primary modality for the development and/or use of spoken language. For people who function as if they are “hard of hearing”, vision is still useful, as in speechreading (lipreading), or could be useful as in using signs to supplement hearing. However, the key point is that vision is still secondary and supplemental to hearing.

The term “deaf” refers to those people whose auditory system

is so damaged so that it prevents the development and/or use of spoken language even with the best hearing aid or cochlear implant. For people who function as if they are “deaf”, vision is the primary modality and hearing is secondary and supplemental to vision. This does not necessarily mean that hearing is unimportant (although for many Deaf people it does). Hearing can still be used to give people auditory awareness of the world around them, which can be important for safety reasons. Hearing can also be used to allow people to communicate using spoken language to at least some extent.

Regardless of whether a child eventually ends up functioning as if they are “deaf”, “hard of hearing”, or part of a Deaf culture, it is imperative that children who have a hearing loss be identified as soon after birth as possible so that their human development can be maximized. (The factors involved in whether a child functions as if they are “deaf” or “hard of hearing” will be discussed further in the second part of this series “Factors Influencing Future Auditory Function and Human Development in Infants with Hearing Loss”.)

This should be the penultimate rationale for why the Joint Committee on Infant Hearing [11,12] has stated that infants should have their hearing screened before leaving the hospital and no later than 1 month of age, that the hearing loss should be diagnosed no later than 3 months of age and that children with significant hearing loss should be enrolled in early intervention programs no later than 6 months of age. (This Joint Committee is composed of professionals from audiology, deaf education, otolaryngology, pediatrics and speech and language pathology). The Early Hearing Detection and Intervention (EHDI) Act [13], also known as “Universal Screening”, provides federal funds for states to develop infant hearing screening and intervention programs including screening for hearing loss before the infant leaves the hospital. Some data indicate that about 95% of babies born in the United States are screened before leaving the hospital [14]. It is important to realize, however, that this does not mean that all children will be diagnosed with hearing loss for the following reasons in addition to approximately 5% of newborns not being screened. First, the screening protocol is not perfect and thus there is a significant percentage of children with hearing loss who will be missed. Second, the current protocols are least effective for identifying children with mild (but still significant) hearing loss. Third, the hearing loss may develop after the infant has left the hospital. And fourth, the protocol is not effective enough for identifying those children who have a misfiring or dysynchrony of their auditory nerve fibers (often called “auditory neuropathy”).

The imperativeness of early identification can be understood by considering the effects of hearing loss on language and human development by discussing the work of psychologists like Rogers, Maslow and Erikson.

Results and Discussion

Hearing loss in the context of human development

The penultimate goal for all human beings can be thought of as being able to have what psychologists have called “self-actualization” [15-17]. That is, to have a life where we feel we have reached our full potential and have high self-esteem. It

can be argued that with self-actualization we achieve a state of enlightenment and have feelings that we are secure, free of anxiety, and filled with a sense of purpose and achievement. Although it could be argued that this can be achieved through avenues like meditation and religion, and although this can be true, it is also true that for most of us the primary way that we find our place in the world is through our interactions, using communication, with other people and to be part of a culture or a society. Language is the tool for the process of communication which can contribute greatly, perhaps most importantly, to achieving self-actualization.

Related to the preceding paragraph, Erikson discussed stages or crises that human beings must get through. It is necessary to successfully navigate these crises to be able to reach levels of security and fulfillment in life [18,19]. Erikson stated that the first stage is the crisis of "trust versus mistrust" which occurs within approximately the first year of life. When an infant first leaves the womb, it goes from a serene, protected place into a chaotic world where it is bombarded with sensory stimuli. The natural biological/psychological reaction is for the infant to have anxiety and fear. However, with the care, love and nurturance of parents/caregivers the developing infant learns that they can trust the world. And it is important to note that the bathing, feeding and attendance to bodily needs given to an infant are usually linked with the parents/caregivers communicating with the infant. Therefore, communication, whether it be through spoken language or sign language, becomes conditioned/associated with feelings of security and trust. Thus, communication itself becomes a source of comfort and a stimulus that triggers feelings of security and hence trust.

The ability to have trust in the world then allows the infant to successfully navigate what Erikson called the stage of "autonomy" which he said occurs from approximately 18 months to 3 years of age. This means that the infant is not afraid to explore the world, take chances and use their senses to grow cognitively, physically and socially. If an infant does not have trust and does not become as autonomous as possible they will not develop maximally in these areas. Related to this is the concept that language cannot be taught, it can only be learned. Using spoken language as an example, we do not sit down with babies and teach them individual sounds and how these sounds are put together to form words and how these words are put together to form sentences and how these sentences are put together in various ways to convey deeper and deeper meaning. Rather, infants have an auditory-neurological-linguistic "sponge" to soak up all of what starts off as random, meaningless acoustic information and this "computerized sponge or system" extracts the rules naturally. This is consistent with Chomsky's [20] and Lenneberg's [21] belief that humans have an innate biological capacity for learning language. But most importantly, the practical application is that infants need to hear these speech sounds repetitively, linked in the context of real-world events, objects, experiences and emotions. This must happen so that the system (including the sound, i.e. phonological, system) learns to be able to naturally extract the rules of spoken language and develop. This same process applies to sign language except that it would be signs that need to be seen repetitively linked in the same real-world

contexts. This concept about how a child's language will develop maximally if s/he is autonomous and unafraid to explore the world around them is supported by the principles of Montessori [22]. Montessori developed principles and an educational approach that were based on a child's cognition developing from absorbing information about the world. Central to her approach is that children are given freedom to explore and choose using materials that allow the child to integrate information from different senses. This integration is achieved through multiple experiences and repetition. There is some evidence that language abilities can be improved using these Montessori principles [23].

The discussion in the preceding paragraph is consistent with Piaget's theory that cognitive development, and in my opinion language development, involves an interaction between biological maturation and environmental experience [24]. Piaget believed that language development was dependent on a child's knowledge and that knowledge is acquired due to their cognitive development. But it could also be argued that cognitive development occurs as an interaction with language development, consistent with the thinking of Vygotsky [25] and Bruner [26]. But in either case the key point is that knowledge of the world is acquired through an unflinching exploration of the world. This unflinching exploration can occur only if a child is autonomous. Furthermore, Piaget's postulations are consistent with Montessori's principles and the concept that language cannot be taught but can only be learned, in that he believed one of the forms of intelligence he discussed involves an interaction of perception, language, imitation, mental imagery and drawing. Piaget's "sensorimotor stage" specifically involves gaining knowledge of the world by coordinating senses while having physical interactions with objects. Piaget believed that further developmental stages are dependent upon a child successfully passing through the sensorimotor stage, even though the process may not be linear. These stages that Piaget postulated primarily include pre-operational, concrete operational, and formal operational stages. Moreover, adding the value of sociolinguistic influences that the present paper espouses is consistent with recent theorists [27-29].

Erikson talked about how the next stage, "initiative versus guilt" is an extension of the stage of "autonomy" and occurs from approximately 3 years to 5 years of age. Erikson discussed how during this stage a child plans and initiates activities that have consequences, sometimes negative ones that they can learn from, if they feel autonomous or independent. Implicit in this is that the child will experience failures and frustration at times and that parents and others must support the child to continue to pursue activities that show their independence. Erikson's view is that if parents do not do this a child will develop guilt about their needs and desires. This can lead to a child decreasing their exploration of the world which will then limit opportunities for linguistic, cognitive, emotional and social growth. In addition, it is beyond the scope of this paper to discuss the implications of guilt, except to say that guilt can have a negative impact on lives. Sometimes when parents have a child who has difficulties, such as due to hearing loss, they feel responsible for the child's difficulties in some way and therefore have guilt. This can lead to overprotection of the child, thus interfering with the child

progressing through the stages that Erikson discussed. This also provides a model that shows a child that guilt can be a strong motivator in life. This can only have negative consequences for the child. This is one reason why counseling or parent support groups for families of children with hearing loss can have a positive impact. There is a classic clinical psychology example regarding discipline and guilt. The axiom is that a child who has a parent who chases them down the street with a knife saying, "If you do that I'll kill you" will be emotionally healthier than a child who has a parent who says, "If you do that you'll kill me".

The ability to be autonomous and have initiative (which contributes greatly to maximum language, cognitive, motor and social development) will then allow a child to master the stage that Erikson calls a "crisis of competence" or the battle between "industriousness" and "inferiority". Erikson believed that this occurs around the time a child is 5 or 6 years old and continues until they are approximately 10-12 years old. This is the time when the child begins to confront learning complex academic material. Since almost all academic material is language-based in some way, it is imperative that a child have a strong language base, whether it is through spoken language or sign language. Erikson makes the point that a child's ability to have success in the age range of approximately 5-10 or 12 years will set them up for being "industrious" throughout life with concomitant feelings of success and self-esteem. Alternatively, if a child does not have success during this time it will lead to feelings of "inferiority" and by extension, diminishment of productivity and self-esteem throughout life.

The preceding discussion is applicable to either the development of spoken language or sign language. It is also useful to examine what determines whether a child ends up functioning as if they are "deaf" or "hard of hearing" and this will be discussed in the second article in this series "Factors Influencing Future Auditory Function and Human Development in Infants with Hearing Loss".

However, to give one example of how early identification and intervention can influence spoken language, there is research evidence that even children with very limited hearing (i.e. a severe to profound hearing loss) who are identified early in life and provided with good quality auditory-linguistic input early in life can achieve speech-language skills and academic performance equivalent to their peers who do not have hearing loss [30,31] particularly if this is done before six months of age [32].

Given the importance of early identification and subsequent intervention it is useful to briefly discuss how hearing loss can be diagnosed early in life. This is discussed in the next section.

Tests for Early Identification of Hearing Loss

There are two physiological tests that can be used to assess an infant's hearing shortly after birth and one behavioral test that can be used when a child reaches approximately 6 months of age and therefore get the child on the road to maximum human development and self-actualization.

One electrophysiological test is the "Auditory Brainstem Response (ABR)". In this test electrodes are placed on a baby's skull and changes in ongoing neurophysiological activity in response to sound can be measured. This leads to the generation of a typical waveform or pattern that can be visually displayed. This procedure allows one to approximate the softest sound (threshold) an infant would respond to behaviorally if a behavioral task could have been performed. Therefore, one can reasonably estimate the amount (degree) of hearing loss that exists. These measurements, including the use of automated instrumentation, have become possible clinically because of the development of computer technology.

A second electrophysiological test involves the measurement of "Otoacoustic Emissions". Otoacoustic Emissions are low-intensity sounds generated by the sensory receptors for hearing located in a part of the inner ear called the cochlea. The name for these sensory receptors is "outer hair cells". These hair cells vibrate in response to sound and their vibration creates another sound that travels back out the auditory pathway which finally causes the tympanic membrane (eardrum) to vibrate causing the sound to be present in the ear canal. Using a microphone in the ear canal coupled to a computer these low intensity sounds can be measured. Almost everyone with normal or near-normal hearing will generate these otoacoustic emissions. Therefore, using current computer-driven clinical instrumentation, if these emissions are present one can be very confident that the infant at least has normal or near-normal hearing (better than approximately 30 dB HL). It is also a faster test than the ABR. There are 3 limitations with this measure. First, one only knows that there is at least a mild hearing loss or a more severe amount of hearing loss, but one cannot determine how much hearing loss exists. Second, some children with mild amounts of hearing loss may be missed. And third, this test only gives us information about the integrity of the auditory system through the cochlea. It tells us nothing about if there is pathology of the auditory nerve or within the central auditory nervous system.

The third procedure is a behavioral one, called Visual Reinforcement Audiometry (VRA). This is a procedure that cannot be used until the infant is about 6 months old and usually can be used until the child is two years old, sometimes two and a half. Use of this procedure is based on 3 things: 1) by 6 months of age the child has developed adequate neck control and can localize where sound is coming from; 2) infants and young children are very interested in novel visual events; and 3) operant conditioning. Specifically, a child is sitting on a parent/caregiver's lap, with an assistant having an object that will keep the infant's head in the midline. On the side of the room is a loudspeaker through which different pitches can be played. On the loudspeaker is one, and sometimes a few, interesting "visual reinforcer(s)" that initially cannot be seen. The most common reinforcer used is a toy monkey inside a darkened plexiglass box. The audiologist begins by presenting a loud sound through the loudspeaker and pairs it with the monkey becoming illuminated and moving via an audiologist pushing a button in another room.

Babies almost always will turn their head to look at the monkey and laugh and be amused. The audiologist does this several times. Then the audiologist will present the sound but will not activate illumination of the monkey. But the baby will turn their head anyway because they have been conditioned such that they will be reinforced with this interesting visual display if they turn their head. Thus, if they turn their head it is only because they heard the sound. If they did not hear the sound they would not have turned their head. Then the audiologist lowers the intensity of the sound. When the infant turns their head in response to sound the audiologist continues to then light the darkened plexiglass and illuminate the moving monkey. The child will continue to turn their head when they can hear the sound even if the sound is very soft. Therefore, by utilizing this procedure the amount of hearing loss for different pitches can be determined close to what would have been obtained by an older child who raises their hand when they hear a sound.

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Conclusion

Hearing loss is an invisible “disability” yet it is highly prevalent. If undetected, it can lead to difficulties in many aspects of a child’s life such as language, socialization, academics and most importantly their human development and self-actualization. There are measurement tools available that allow a child’s hearing to be tested shortly after birth, and if a hearing loss is diagnosed then the child can be immersed in language and interpersonal relationships whether it is through the development of auditory skills and spoken language, through sign language, or some combination of both. Although there is debate about whether language is the foundation for cognition or cognition is the foundation for language (as Piaget has argued), there is no doubt that there is an interaction and synergy between language and cognition. If a child is given the opportunity and the autonomy to develop both their cognition and language, through early identification of hearing loss and subsequent intervention, they will be able to conquer the crises of child development that Erikson presented and achieve their self-actualization.

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