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Music, Spoken Language, and Children with Hearing Loss: Definitions and Development

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Introduction

In the United States alone, 24,000 babies are born annually with a permanent hearing loss, making it the country's number one congenital birth defect (Beginnings, 2009). Hearing loss puts children at risk for delays in acquiring the necessary spoken language, social and cognitive skills needed to succeed in school and society (National Center for Hearing Assessment and Management, NCHAM; 2010). However, in areas with universal newborn hearing screening (UNHS), many of these children are now identified at birth and receive a complete diagnosis by three months and intervention by six months of age (Harrison, Roush, & Wallace, 2003). This early intervention has a tremendous positive impact on their future prognosis. Given that the overwhelming majority (>90%) of these children are born to hearing parents (Nicholas & Geers, 2007), many are enrolled in aural/oral programs with the ultimate goal of providing access to all the advantages their hearing peers enjoy. Certainly music enjoyment and participation would be one such advantage! Technological advancements in hearing aids (HA) and cochlear implants (CI) have opened the door even further for many of these children. In this article, hearing loss will be briefly defined, music and language development in typically hearing children will be discussed, the commonalities and differences between both domains will be examined, and current research regarding music and children with hearing loss will be highlighted.

Hearing Loss

Hearing loss can occur *bilaterally* (both ears) or *unilaterally* (one ear). It can be *symmetrical*, meaning both ears have the same degree and configuration of loss, or *asymmetrical*, where each ear is different. It can occur suddenly or progress over a period of time and the loss can fluctuate, as in the case of an ear infection. It is estimated that 30–40% of individuals with a hearing loss have other complicating factors (Almond & Brown, 2009; Robbins, 2009).

Range of Loss

To determine the degree of an individual's hearing loss, an audiologist will measure a person's *hearing threshold*, or the softest sounds a person hears at different frequencies (pitches) about 50% of the time. *Intensity* (loudness) is measured in decibels (dB) and *frequency* (high/low pitch) is measured in Hertz (Hz). Figures 1 and 2 illustrate how intensity and frequency relate to hearing. Plotted on a graph called an *audiogram*, intensity is on the vertical axis of the graph and frequency across the top.

Figure 1. **Intensity**

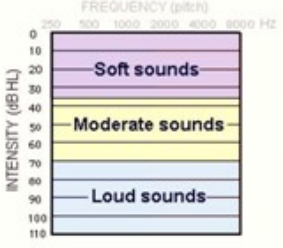
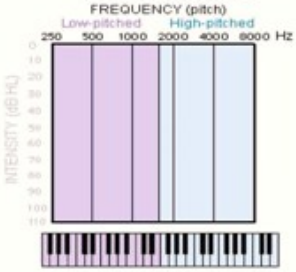


Figure 2. **Frequency**

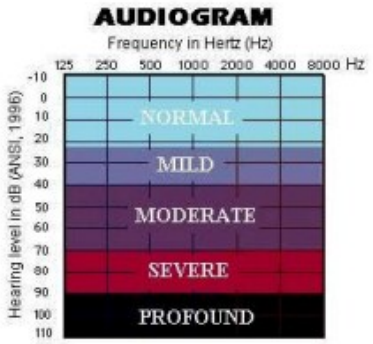


From "How to Read an Audiogram: Auditory Thresholds," by First Years, 2009a, http:firstyears.org/lib/howtoread.htm © 2009 by First Years. Reprinted with permission.

Click Here to View Larger Version of Figure 1 and Figure 2

The severity of a hearing loss typically falls into four categories, mild, moderate, severe, and profound. A mild loss means that any sound softer than 25-40dB will not be detected. A child with this loss will have trouble hearing speech in a noisy environment. Faucets dripping and birds chirping may not be heard. A moderate loss of 40-65dB means speech will only be understood if it is spoken loudly. Environmental sounds like a vacuum cleaner may not even be heard. A severe loss means sounds softer than 65-90dB will not be detected. Speech will only be heard if shouted into the ear. Dogs barking or phones ringing may be missed. With a profound loss no speech will be heard. An airplane can fly overhead undetected, unless the child actually sees it.

Figure 3. **Audiogram**



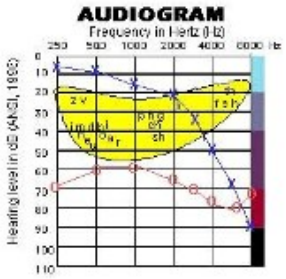
From "How to Read an Audiogram: Auditory Thresholds," by First Years, 2009a, http:firstyears.org/lib/howtoread.htm © 2009 by First Years. Reprinted with permission.

Click Here to View Larger Version of Figure 3

The Better Hearing Institute website offers audio simulations of normal, mild, and moderate hearing loss.

Perhaps the most useful audiogram for those of us working with children who have hearing loss is one that includes the speech banana. This is the area on an audiogram that plots the frequency and intensity of the sounds of conversational speech from a distance of six feet from the listener. When shaded, the resulting "shape" looks like a banana. The value of such an audiogram is that it shows whether or not a child is hearing all of the sounds that are necessary for speech. For example, in the audiogram in Figure 4, the testing results for both the right ear (in red) and left ear (in blue) show that the child can hear no conversation in the right ear, but can hear all but the soft, upper frequency sounds in the left ear.

Figure 4. **Audiogram Illustrating the Speech Banana**



From "The Speech Banana," by First Years, 2009c, http:firstyears.org/lib/banana.htm © 2009 by First Years. Reprinted with permission.

Click Here to View Larger Version of Figure 4

Figure 4 shows the speech sounds in relation to common environmental sounds (First Years, 2009b). At the FIRST YEARS website, you can also hear this author's musical interpretation of the speech banana titled, *I'm a Speech Banana*.

Types of Hearing Loss

Conductive - If sound cannot get from the outer and middle ear to the inner ear, it is called a conductive hearing loss. Excess wax or fluid in the middle ear space can cause a conductive loss. It is estimated that in the first three years of life, 75% of children will have at least one bout of *otitis media* (OM), commonly known as an ear infection (American Speech-Language-Hearing Association, ASHA; 2008a). Most conductive hearing loss can be treated medically or surgically. However, repeated cases of OM can lead to permanent conductive or sensorneural damage. OM is the most frequently diagnosed health issue in infants and young children (ASHA, 2008b). A conductive loss often affects access to lower frequencies, so instruments that are higher pitched may be more pleasurable to the listener.

Sensorineural - If the hearing loss is due to a problem with the inner ear (or auditory nerve), neither medicine nor surgery will repair it. Hearing aids can be effective amplification strategies. And, in some cases, provided the auditory nerve is intact, cochlear implants may be the best option. With this type of loss, high frequency sounds are difficult to hear, so perhaps lower sounding instruments would be more appealing and accessible.

Mixed - If there are problems with both middle and inner ear, then the child is said to have a mixed hearing loss. Sometimes this is a temporary condition as when a child has an OM infection on top of an existing sensorineural loss.

Spoken Language Development

The path to spoken language may begin in the womb as early as five to six months gestation. Intrauterine exposure

to the maternal voice may be responsible for the newly born infant's preference for his or her own mother's voice over that of other mothers (Locke, 1993). That first relationship, as well as others that develop over time, provides the context within which linguistic communication develops. The infant must have access to spoken language and be "motivated to be like people who talk" (Locke, 1993, p. 20); otherwise there will be no reason for the infant to work at it.

There are a number of prelinguistic behaviors that infants pass through, sequentially, on their way to spoken language acquisition: crying, cooing, babbling, using jargon, and finally speech. Called *milestones*, these linguistic skill sets build upon one another until the child is fully adept at spoken language. Keep in mind that these language skills are developing concurrently with those in motor, cognitive, music, hearing, and social domains.

Children with a hearing loss will follow the same developmental path as children with normal hearing and typical development. However, the process will be delayed. How much of a delay depends on the severity of the loss, the time of identification, and intervention. A rule of thumb is one year of progress for every year of access to spoken language with a goal of increasing that progress so that at some point there will be no gap (Sindrey, 1997).

Milestones should be viewed as general guidelines rather than hard and fast rules of development. The Centers for Disease Control and Prevention (CDC; 2009) offers language development timelines for young children from birth to five. These can be found at their website: www.cdc.gov/ncbddd/actearly/milestones/index.html.

Music Development

As is the case with language, music development also follows a time-ordered sequence of skills or musical milestones (Barton, 2006). To be able to sing *Happy Birthday* all the way through on pitch, a child must first gain expertise in beat, rhythm, pitch, tonal center, melody, and enough language to sing the lyrics. (*Tonal center* is the "home key." When a child has a sense of tonal center, he or she can sing a song all the way through in the same key.) Hearing children should be able to accomplish this by the time they head off to kindergarten. This happens without formal training! How early does this process begin? It starts at birth when mothers (and fathers) all over the globe engage in "motherese," also known as *infant directed* (ID) *singing* (Trehub, 2000.) Hallmarks of this technique include a higher pitched tone of voice, a slower rate of speech and emotional expressiveness. It is this *prosody* of speech, or the sing-song nature of communication, that conveys the emotional intent of the caregiver to the child and creates a bond, regulates affect, and sets the stage for both language and music development. It is these auditory patterns of phrases, rhythm, and grouping that teach the baby the processing skills necessary to decode speech (Bergeson, Miller, & McCune, 2006).

The table below is representative of the sequence of stages a child with typically developing hearing masters on his or her way to becoming musically competent. Since children develop and grow at varying rates, the charted time frames may vary slightly, but the developmental sequence follows these established patterns. For children who are deaf/hard-of-hearing, the timelines may need to be adjusted, but again, the skill sequence is the same.

Language milestones appear alongside music milestones. Again, recall that as the child matures, speech, language, music, cognitive, social, and physical domains develop concurrently and interdependently. **It is important to note that children learn their native language by hearing it, then speaking it, and finally reading and writing it. Music learning follows the same sequence.**

Table 1. Music and Language Milestones

Age	Music	Language
Birth-3 months	Alerts and calms to music; prefers infant-directed singing; coos/cries	Moves to the sound of a familiar voice; looks at speaker's mouth; coos/cries
3-6 months	Musical babbling; repetitive movements in response to music; turns to the source of music; prefers higher pitched voices	Babbles; laughs; smiles; vocalizes pleasure and displeasure
6-9 months	Occasionally matches pitch; larger repetitive movements; recognizes familiar melodies; uses descending vocalizations	Smiles at speaker; uses voice and gestures to show displeasure; responds to own name
9-12 months	"Sings" spontaneously; recognizes and attempts to sing along with familiar songs	Recognizes names of family members; waves bye-bye; says one to two words; babbles with inflection; responds to "no"
12-18 months	Dances to music; pays attention to lyrics; sings snippets of learned songs; matches to pitch more; starting to match movements to music	Jargon-like utterances with some words included; follows one-step directions; 20-100 words
18-24 months	Looks for dance partners; spins, marches to music; spontaneous songs have steady rhythm; able to imitate songs; lyrics more accurate than pitch	Two-word phrases; uses question intonation; repeats overheard words; starts using pronouns; understands "where?" and "what's that?"; > 200 words
2-3 years	Learns singing vs. speaking voices; sings in different keys and meters; matches pitches consistently; some instrument discrimination	Three-word phrases; refers to self as "me"; starts to use verb endings; answers questions with yes or no; follows two-step command; >900 words
3-4 years	Begins to discriminate among familiar instruments; uses rhythm instruments to accompany their songs; melodic contour is intact; makes up songs	Uses many more pronouns; names colors; uses sentences 5-6 words in length; tells stories; expresses feelings; enjoys poems; sense of humor starts to develop; > 1500 words
4-5 years	Makes larger purposeful movements; sings imaginative songs and tells stories; beginning to recognize familiar melodies without lyrics; matches beat to others	Asks what, who, where, why questions; answers why and how questions; uses future tense; tells name and address; uses longer sentences; > 2500 words
5-6 years	Maintains steady beat while moving to music; sings melody with pitch accuracy; plays melodies on simple instruments; remembers songs in head; begins to read and write rhythmic notation	Uses past tense verbs, pronouns, prepositions correctly; sentences much longer; begins to read and write; knows time sequences; likes rhymes; >2800 words
6-7 years	Develops tonal center; starts to sing harmony and rounds; vocal range focused around 5-6 notes; expands rhythmic and melodic written notation	Uses many more verb tenses; can tell right from left; makes comparisons; tells well-crafted, imaginative stories; > 13,000 words
7-9 years	Expands vocal range; uses more complex meters and harmonies; demonstrates music preferences	Exaggerates; explains ideas in detail; likes vocabulary and word play; understands jokes, riddles and idioms; > 20,000 words

Sources for music milestones: Campbell & Scott-Kassner (1995); Gordon (2003); McDonald (1979); National Association for Music Education (MENC, 2010); Moog (1976); Silbruatt (2008)
Sources for language milestones: ASHA (2009); CDC (2009); First Years (2009b); National Institute on Deafness and Other Communication Disorders (NIDCD; 2001); Sindrey (1997)

Click Here to View Larger Version of Table 1

The Music-Language Connection

> *"The central role of music and language in human existence and the fact that both involve complex and meaningful sound sequences naturally invite the comparison between the two domains"* (Patel, 2008, p. 86).

In his book, *Music, Language and the Brain* (2008), Aniruddh Patel makes a compelling argument for deep connections and the overlap in the neural mechanisms that create and maintain music and language domains. With the advent of neuro-imaging technologies, it is now possible for scientists to peer into the brain of individuals while they are engaged in listening to or creating music. There is some evidence for specialization of the auditory cortices for processing *temporal* (rhythm) and *spectral* (pitch) elements of speech and music (Zatorre, Belin, & Penhune, 2002). They suggest that the rapid timing of speech relies more on the left hemisphere, while the slower, but more melodic aspects of music rely on the right hemisphere. However, these specializations are more subtle than first thought and do not contradict the possibility of shared neural mechanisms (Patel). Given that both language and music are unique to humans and are found in every known culture, that one should exist without the other is hard to conceive.

Music-Language Similarities

Researchers and authors discuss the following music-language similarities.

- *All children are born with the capacity to learn music and language.*

  Music aptitude is a trait that occurs at the same rate across all populations (Gordon, 2003). This means that the majority of individuals will learn music to a certain degree just fine, a small portion of the population will excel, and a small portion will have some difficulty. But, the key idea is this: everyone, given access to it, has the ability to learn music.

- *Music, like language, follows a time-ordered, sequential developmental path.*

  As stated previously, music develops in a predictable way as do language and learning to walk. In fact, involvement in music can enhance other areas of development (Schwartz, 2008). If the reader compares both the language development and music development presented in Table 1, it will be obvious that certain milestones in both domains intersect.

- *The environment, especially early on, is crucial to development.*

  Perhaps the biggest predictor in a child's success in learning music or spoken language is having it available from an early age (Gordon, 2003).

- *Speech and music share terminology.*

  When discussing the acoustic features of both speech and music, pitch, timbre, and timing are the terms used to describe these properties (Kraus, Skoe, Parbery-Clark, & Ashley, 2009).

  > *Pitch* is the psychological term for frequency and refers to how high or low a sound may be.
  >
  > *Timbre* (rhymes with amber) is also called "sound color" and allows us to be able to discriminate different voices, instrumental, or environmental sounds.
  >
  > *Timing* encompasses elements such as duration, beat, rhythm patterns, and meter in music and speech.

- *Music and speech have melodic contour and timbre.*

  It is the rising and falling contour of the voice that gives it expressiveness and emotional saliency. Voices, just like instruments, have unique signature sounds. It is our ability to discern these differences that allows us to know through audition alone which person is talking or which instrument is playing.

- *Similar strategies are used when listening to music or spoken language.*

  Noted music educator, Edwin Gordon has said:

  > "Music is like language. We hear the sound of the voice first, and then we give meaning to the sounds we hear by dividing them into words, phrases and sentences. The difference is that music uses tonal and rhythmic patterns as language uses words" (Gordon, 1991, p. 3).

  By recalling tonal and rhythmic patterns that heard before, individuals can predict what will happen next. This is one reason why children prefer to hear music and spoken language of their own culture. They have learned the rules necessary to access both and to become successful participants.

Music/Language Differences

Researchers and authors also share the following music-language differences.

- *Music encompasses a greater spectral (frequency) range than speech.*

  Refer back to Figure 4 to see that speech typically occurs between 500-2000Hz. Imagine now that a piano's frequency range is 28-4000Hz. For some with hearing loss in the higher frequencies, lower sounding instruments may still be recognized and appreciated.

- *Music can exist without language.*

  Music can be created by instruments alone. This is extremely valuable for those who are preverbal or have language delays or disorders.

- *Language can be altered in music without changing the music itself.*

  Think of all the times words are stretched or contracted to fit the melody. It doesn't change the appeal of the music, but it certainly is not the way we would converse with one another.

- *Spoken language surrounds most children whereas music may not.*

  It is true that music is pervasive in our culture. However, the amount of music an individual child has exposure to early in life varies greatly. Early access to both language and music is critical to development; the rest of this article will address ways in which this can be provided.

Music and the Child with Hearing Loss

Thus far, this article has presented developmental milestones for children who have typical hearing. But, how does this translate to children with hearing loss?

Imagine that just as we speak of a "hearing age," meaning the developmental level from the time of the first hearing aid or implant activation, we can also speak of a "musical age" (Barton, 2006). This would mean that regardless of chronological age, a child with aided hearing (HA) or a child with a cochlear implant (CI) would pass through the music milestones in sequence, but at a delayed pace, beginning at the time of amplification. There is a small amount of research, summarized below, that has looked at how children with hearing loss fare.

1. Children with HA and CI perceive rhythm nearly as well as their hearing peers (Gfeller, 2000).

2. Children with CI are less accurate than hearing peers on their ability to recognize familiar songs when lyrics are not present (Stordhal, 2002).

3. Students who are deaf are less able to associate basic emotions (happy, sad, fear and anger) with selected pieces of music specifically composed to elicit these primary emotions (Darrow, 2006).

4. CI processors provide insufficient spectral detail for some aspects of music perception, but they do not preclude young implant user's enjoyment of music (Vongpaisal, Trehub, & Schellenberg, 2006).

5. Mothers adjust their vocal style to match the hearing experience rather than the chronological age of their child with CI (Bergeson, Miller, & McCune, 2006).

6. Child implant users enjoy music more than adult CI users and their initiation of music listening at home is associated with younger ages at implantation and higher word recognition scores (Mitani et al., 2007).

7. Although child implant users were less accurate than hearing children, they successfully identified all versions of familiar TV theme songs at above-chance levels (Vongpaisal, Trehub, & Schellenberg, 2009).

Thus, research shows that children with hearing loss enjoy and participate in music formally and informally, and are rhythmically capable on a level commensurate with their peers. As yet, cochlear implants do not replicate pitch as well as hearing aids do, so pitch perception and production may be problematic for some of those children. Clinically, however, this author has seen tremendous progress in that area for children with early implants who undergo music and pitch training.

To hear a recording of this author's song, I've Got an Implant, click below. It tells the story of receiving a cochlear implant from a child's point of view.

I've Got an Implant

Resources

There are a number of organizations dedicated to supporting families and individuals with hearing loss. Among them are:

- The Alexander Graham Bell Association for Deaf and Hard of Hearing Individuals (AG Bell) (agbell.org)

  Named for its founder, Alexander Graham Bell, whose wife and mother were both deaf. Its mission *"Advocating independence through listening and talking!"* is carried out through the organization's extensive advocacy work, educational training materials and programs, research and financial aid. It has an international scope.

- Home Page of Chris Barton (christinebarton.net)

  Obtain more information about music therapy practice, publications, recordings, presentations, and performances.

- Beginnings (ncbeginnings.org)

Is a nonprofit agency located in North Carolina. It provides a nonbiased approach to helping parents find the right resources and services for their children with hearing loss. Their knowledgeable staff provides technical, as well as emotional support for families and professionals.

- The Better Hearing Institute (betterhearing.org)

  Is an organization dedicated to erasing the stigma of hearing loss. The institute has solicited the help of many celebrities who are willing to share their own stories of living with a hearing loss. It has a number of educational materials available, provides resources to medical professionals, and operates a call center for consumers.

- FIRST *YEARS* (firstyears.org)

  Is a graduate, distance education, certificate program committed to enhancing the knowledge and skills of professionals who are practicing in the fields of deaf education, speech-language pathology, audiology, and early intervention. FIRST *YEARS* combines clinical mentorships with cutting-edge academic training, ranging from counseling to speech acoustics, audiology diagnostics, sensory technology, speech-language development, and emergent literacy. This author is currently enrolled in the FIRST YEARS certificate program —and highly recommends it.

- Gallaudet University Research Institute (GRI) (aaweb.gallaudet.edu/Gallaudet_Research_Institute.html)

  Conducts and disseminates data related to demographics and educational issues that affect individuals with hearing loss and those who interact with and support them.

- John Tracy Clinic (johntracyclinic.org)

  Founded in 1942 by Spencer and Louise Tracy after their son was found to have a severe hearing loss. It is a worldwide organization and provides, without fee, educational services to young children, their parents and educators. Many of their educational materials have been translated into other languages.

- My Baby's Hearing (babyhearing.org)

  Is a valuable website sponsored by Boy's Town National Research Hospital and the National Institute on Deafness and Communication Disorders (NIDCD). Its contributors include: audiologists, speech-language pathologists, teachers of the deaf, geneticists, physicians, and parents. The website is also available in Spanish.

- National Center for Hearing Assessment and Management (NCHAM) (infanthearing.org)

  Is located on the campus of Utah State University and serves as a multidisciplinary National Resource Center that oversees the Early Hearing Detection and Intervention (EHDI) systems. Their goal is to effectively identify infants with hearing loss before three months of age and ensure audiologic, educational, and medical intervention before six months of age.

Summary

Hearing loss affects many young children. The earlier it is diagnosed and remediated, the greater the chance that spoken language and music development will one day catch up to their hearing peers. Access to both music and spoken language from an early age is crucial to the development of both. The fact that both speech and music develop in a parallel fashion and that similar neural substrates are involved in their processing make them ideal companions. Sophisticated technology in the form of digital hearing aids and cochlear implants has made music enjoyment and participation a reality for many children with hearing loss. Some will go on to excel at a particular instrument, while others may enjoy the social aspect of singing in a choir or playing in a band. Others will listen to music informally and sing the occasional Happy Birthday or YMCA, just like their hearing friends. The outcomes will be varied and unpredictable, but without exposure, there will be no outcomes.

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