The Cascading Impact of Hearing Loss on Access to School Communication

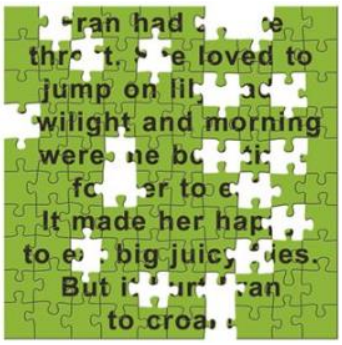
Fragmented Hearing -> Effort -> Listening Comprehension -> Fatigue -> Pace of Learning

It's About Access, Not Hearing Loss

Communication access is a key component of 504, IDEA and Title II of the ADA. A November, 2014 policy guidance from the US Department of Education and US Department of Justice clarified that, under Title II of the ADA, schools are responsible for ensuring that communication access is as effective for children with hearing loss as it is for their typically hearing peers. Each student's access needs must be determined individually, considering the communication used by the student, the nature, length, and complexity of the communication involved, and the context in which the communication is taking place. This of course requires school staff who are knowledgeable in assessing communication effectiveness and identifying needs and a school team who can creatively match auxiliary aids and services to student needs. For more information on ADA requirements for schools go to Frequently Asked Questions on Effective Communication for Students with Hearing, Vision, or Speech Disabilities in Public Elementary and Secondary Schools

Hearing loss is invisible. Someone observing a student with hearing loss may believe that he or she has an attention problem or a learning disability as hearing loss can also impact perceiving, language processing, processing speed, memory and attention. Unlike ADHD or LD, learning issues caused by hearing loss are not due to a disorder (an issue with brain processes). Instead the learning issues are secondary to delays because the child has incomplete access to speech occurring around him or her, especially soft speech or completely understanding someone talking from a distance further than 3-6 feet.

Fragmented Hearing



Our educational system is based on the assumption that students in the classroom will perceive, and therefore understand, all of what the teacher is saying. When much information received in school is fragmented because of hearing loss, learning consequences are likely. Even with the latest hearing technology, normal hearing ability is not restored by hearing devices. Even aided thresholds of 20 dB HL will cause soft speech, high pitch speech sounds and unemphasized brief words to be undetected or too quiet to process. It is not unusual for children with hearing loss to have a 20% 'listening gap' as compared to class peers who may miss only 5% of information[1]. The image shows a story about Fran the frog who has a sore throat. As you can see, comprehending the meaning of the story is impacted when 20% of the information missing. Even if a child is able to perform well in a quiet setting using hearing devices, a classroom setting is typically noisy, with fast-paced peer-to-peer conversations and teachers that move about the classroom, causing significant listening challenges**.** These conditions typically result in barriers to access.

Increased Effort

Effort refers to the exertion of physical or mental power. Listening effort refers to the attention necessary to understand speech. Even low noise in the environment will interact with the fragmented hearing to interfere with their speech understanding. Children with hearing loss work harder than their peers to listen leaving fewer cognitive resources to understand speech in the classroom as compared to class peers. It has been assumed that speechreading will help children to compensate for what is missed due to fragmented hearing. Research[2-4] results make it clear that speechreading (lipreading) help children to compensate for what was missed

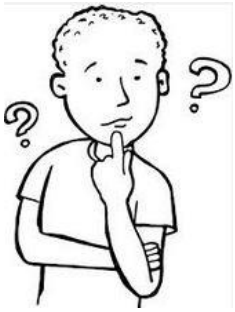
due to hearing loss but ONLY if a child is a GOOD speechreader AND he has typical or better working memory capacity[5]. Extracting speech in the presence of background noise reduces the listener's ability to mentally rehearse material that is heard so it can be remembered. Therefore it is important to assess speechreading ability (i.e., Functional Listening Evaluation[6]) and the memory capacity (in quiet and noise) of students with hearing loss (i.e., Test of Auditory Processing Skills – TAPS-3[7]).

Decreased Listening Comprehension

It is assumed that when the teacher is speaking that the students will comprehend what they have heard. Listening comprehension abilities of children with hearing loss are typically poorer than those of children with normal hearing due to the effort used to listen, which decreases the cognitive resources available to understand what was heard. **Unless the acoustic conditions of the classroom are considered, it is likely that the educational environment will be impacting the ability of the child with hearing loss to follow directions.**

Due to fragmented hearing and extra listening effort, children with hearing loss are already more vulnerable than their peers to missing and comprehending information – with or without excess noise, even if they have age-appropriate language. Performing tasks such as those included in the Listening Comprehension Test 2[8] provides valuable information about how the student with hearing loss comprehends what he hears. Using an FM while doing this test will provide the student's best possible listening comprehension performance on these higher cognitive tasks. Also asking the family to complete the Children's Hearing Inventory for Listening Difficulties (CHILD)[9] checklist for young children or having the student (age 8+) complete the Listening Inventory For Education-Revised Student Appraisal[10] will provide valuable information about specific types of situations that are challenging.

A study[11] required typically hearing students to answer comprehension questions about a story that was presented in a lecture format and also when parts of the story were presented from locations around the student, to simulate listening to classroom discussion. In a typical classroom listening environment (+7 S/N noise, 0.6s reverberation), the average results for 11-year olds when listening to lecture was 80% accuracy and 75% for discussion, whereas for 8-year-olds it was 40% and 33% respectively. If the noise level was reduced (+10 S/N – a really quiet classroom) the scores for understanding discussion improved from 33%/75% to 60%/90% for 8/11 year-olds respectively. Students with hearing loss are more greatly impacted by noise and reverberation than their typically hearing peers. Even though an FM system will optimize listening to a lecture in the presence of excessive noise and reverberation, only a good acoustic classroom environment will allow the student with hearing loss to access classroom discussion.



Increased Fatigue from Listening/Processing

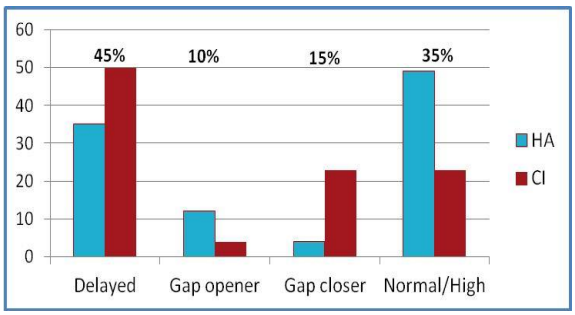
Another area related to effort is the fatigue experienced as a result of difficult listening situations. Fatigue refers to the weariness resulting from exertion. Mental fatigue relates to one's ability to attend or concentrate and refers to a general feeling of being tired. There is a connection between increased cognitive processing demands when listening to speech in noise and fatigue-related changes in cognitive processing ability. Because fatigue has an impact on cognitive processing, it is not surprising that recurrent fatigue (which can be caused by the added strain of listening with hearing loss) is associated with reduced academic performance in children.

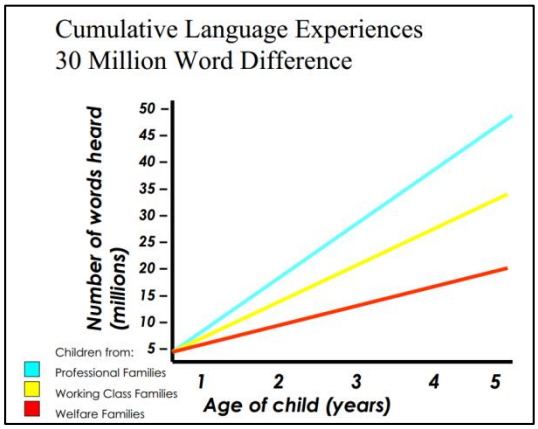
Researchers[11-13] who examined the question of fatigue in children with hearing loss found that even children with hearing loss subjectively report a greater level of fatigue than those with typical hearing and they also truly exert more effort on listening tasks than their typically hearing peers. This was found to NOT be related to difference in language ability. Any degree of hearing loss, with or without amplification, resulted in greater effort. The fatigue experienced by children with hearing loss *is* substantial, even when compared to children with other chronic health conditions, such as cancer, diabetes, and rheumatoid arthritis. The **Informal Assessment of Fatigue and Learning**[9, 14] can help to quantify if there is a learning effort-reward imbalance and overall level of fatigue.

Pace of Learning Decreases

Hearing loss creates barriers to learning in the typical classroom environment and impacts social interactions. This *invisible* barrier typically causes CUMULATIVE learning gaps due to incidental learning/overhearing deficits. A review of the collected post-universal newborn hearing screening research[15] revealed important outcomes including (1) children who are identified early and receive early intervention have been found to demonstrate language development in the "low average" level compared to hearing children, and (2) many if not most children with hearing loss who use listening and speaking for learning fail to keep pace with hearing peers (even those with cochlear implants). Although we live in a time when the potential of children with hearing loss is more likely to be reached than ever before, the reality is that the gains of early childhood are often eroded by the challenges of learning in a non-supportive auditory environment.

As a follow up to studies of language development of early identified children with hearing loss who received early intervention services, researchers[16] examined the continued trajectory of language learning once children entered school. Language was assessed every 6 months between ages 4 and throughout age 7 for 135 cognitively normal children with hearing loss of all degrees from English-speaking families. There were 49 cochlear implant users and 38 hearing aid users (mild-profound loss). As the table shows almost half (45%) of the children had delayed language at school entry and continued to have language delays at age 7. Only 15% of children who had language delays closed their gap in language learning by age 7. Over 1/3 had typical language at age 4 and continued to do so at age 7. Finally, of the children who entered school with 'normal' language development, but the time they were in second grade 10% had noticeable language gaps. Experience tells us that the percent of 'gap openers' only increases as the curriculum and new vocabulary is introduced at a faster pace. As the graph shows, more children with hearing aids were gap openers and more children with cochlear implants were gap closers.





We know[16] that it is not unusual for a child from a home in poverty to have heard 30 million fewer words by school age than the child of professional parents. Children from impoverished families can show

language delays by 2 years of age, as can any child with hearing loss who has not received the advantages of hearing technology and/or appropriate early intervention services. Pretty much, the children with early delays are the same children with academic delays in kindergarten, grade 7 and in high school. So the fact that children with hearing loss who enter school with delays continue to experience delays is not a surprise. This is why there is so much emphasis on early intervention – quality early intervention by professionals trained in the impact of hearing loss on learning. It is also why it is absolutely necessary for access to classroom communication to be optimized if children with hearing loss are to have 'a level playing field' as they compete in the mainstream with their typically hearing peers.

Because hearing loss is invisible, it is easy to understand that the effects of fragmented hearing on effort, listening comprehension and fatigue are often ignored by educators. It is erroneous to assume that a good start to typical language learning inoculates a child from the learning challenges caused by being educated in a typical classroom environment. We must ensure equal, effective access to communication, and the requirement of Title II of the ADA is the vehicle that will require the necessary attention to accomplish this goal.

References for the Cascading Impact of Hearing Loss on Access to School Communication

1. Bodkin, K., Madell, J., & Rosenfeld, R. (1999). Word recognition in quiet and noise for normally developing children. American Academy of Audiology Convention, Miami, FL, Poster session. Download *Speech in Noise Norms for Typical Children* from http://successforkidswithhearingloss.com/speech-perception
2. Picou, E. M., Ricketts, T. A, and Hornsby, B. W. Y. (2011). Visual cues and listening effort: Individual variability. *Journal of Speech. Language, and Hearing Research,* 54, pg 1416-1430.
3. Fraser, S., Gagne`, JP., Alepins, M., & Dubois, P. (2010). Evaluating the Effort Expended to Understand Speech in Noise Using a Dual-Task Paradigm: The Effects of Providing Visual Speech Cues. *Journal of Speech, Language, and Hearing Research*, 53, 18-33.
4. Howard, C. S., Munro, K. J., & Plack, C. J. (2010). Listening effort at signal-to-noise ratios that are typical of the school classroom. *International Journal of Audiology*, 49(12), 928-932.
5. Beaman, C.P. & Roer, J. P. (2009). Learning and failing to learn in immediate memory. In 31st Annual Meeting of the Cognitive Science Society, Austin, Texas, USA. http://www.academia.edu/2407326/Learning_and_failing_to_learn_in_immediate_memory
6. Functional Listening Evaluation – find information at http://successforkidswithhearingloss.com/tests and http://successforkidswithhearingloss.com/fle-recorded
7. Martin, N. A., & Brownell, R. (2005) *Test of Auditory Processing Skills, Third Edition* (TAPS-3). Novato, CA: Academic Therapy Publications. Available from http://successforkidswithhearingloss.com/taps-3
8. Schafer, E., Bryant, D., et. al, (2013). Listening comprehension in background noise in children with normal hearing. *Journal of Educational Audiology*, 19, 58-64.
9. The following checklists can be found at http://successforkidswithhearingloss.com/tests : CHILD, Starting School LIFE, SIFTERs (Screening Instrument For Targeting Educational Risk), Informal Assessment of Fatigue and Learning
10. LIFE-R Teacher Appraisal can be found at http://successforkidswithhearingloss/tests/life-r
11. Valente, D. L., Plevinsky, H. M., Franco, J. M., Heinrichs-Graham, E. C., & Lewis, D. (2012). Experimental investigation of the effects of the acoustical conditions in a simulated classroom on speech recognition and learning in children. *Journal of the Acoustical Society of America,* 131(1), 232-246.
12. Hornsby, B., Werfel, K., Camarata, S., & Bess, F. (2014), Subjective fatigue in children with hearing loss: Some preliminary findings. *American Journal of Audiology, 23,* 129-134.
13. Hicks, C. B., & Tharpe, A. M. (2002). Listening effort and fatigue in school-age children with and without hearing loss. *Journal of Speech, Language, and Hearing Research*, 45, 573-584.
14. Fukuda, S., Yamano, E., Joudoi, T., Muzuno, K., Tanaka, M., Kawatani, J., Takano, M., Tomoda, A., Imai-Matsumura, K., Miike, T., & Watanbe, Y. (2010). Effort-reward imbalance for learning is associated with fatigue in school children. *Behavioral Medicine,* 36(2), 53-62.
15. Spencer, P. E. & Marschark, M. (2010). Evidence-Based Practice in Educating Deaf and Hard-of-Hearing Students. Oxford University Press, New York, NY.
16. Yoshinaga-Itano, C. (2010). The longitudinal language learning of infants and children with hearing loss. ASHA Virtual EHDI Conference, October.