Chapter 38
Using Hearing Assistance Technology to Improve School Success for All Children

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ABSTRACT

The acoustical conditions in the classroom play an important role in the learning process of children. Most daily instruction is verbal; therefore, all children in the classroom and other educational settings need access to auditory information. This chapter will provide information to teachers and administrators about hearing assistance technology that can facilitate classroom learning for typically developing children, second language learners, children who are hearing impaired, and children with normal hearing thresholds but significantly poorer auditory performance, such as children who are diagnosed with auditory processing disorder, autism spectrum disorder, attention-deficit hyperactivity disorder, and language disorder. Teachers and educational audiologists can collaborate on the use of technology to ensure children have access to auditory information in the classroom.

INTRODUCTION

The acoustical conditions in the classroom play an important role in the learning process of children. Most daily instruction is verbal, and it is vital that students be able to hear their teachers as well as their classmates. In addition, teachers may abuse their voices if they have to speak loudly in order to be heard by the children in a noisy classroom.

In reality, classrooms can be noisy places. Noise in classrooms is unwanted sound that is usually created by heating, ventilating, and air-conditioning equipment (HVAC), noise from outside the building leaking through windows and doors, noise from adjacent rooms and hallways leaking through walls and

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doors, and noise produced by the children themselves in the classroom. Classrooms are also reverberant places. Reverberation is the persistence of sound after its source quiets and arises from sound reflecting from hard walls, floors, and ceilings.

The American National Standards Institute (2010) guidelines pertaining to classroom acoustics suggest that the ambient noise level of an unoccupied classroom should not exceed 35 dBA and reverberation times should not exceed 0.6 seconds. Furthermore, the signal-to-noise ratio (e.g., how loud a person's voice is above background noise) ideally should be 15-20 dB $_{SPL}$ for typically developing children. Research has shown that children require higher levels of a signal, such as speech, in the presence of noise in order to recognize words as accurately as adults (Talarico et al., 2007). Additionally, children demonstrate more difficulty than adults in recognizing speech in reverberant conditions (Finitzo-Hieber & Tillman, 1978).

Consequently, if an acoustic environment allows for a +15 dB SNR (signal-to-noise ratio) throughout the entire classroom, students with normal hearing can hear well enough to receive the spoken message fully. Yet, by the time children are 5 years old, many of them have spent most of their day in classroom environments that exceed recommended noise levels (Acoustical Society of America [ASA], 2002a, 2002b). Typical classrooms do not allow for teachers' voices to be at least 15 dB $_{SPL}$ above classroom noise (Picard & Bradley, 2001) and speech intelligibility ratings are 75% or less, meaning that listeners with normal hearing can understand at best 75% of the words read from a list (Acoustical Society of America [ASA], 2000, as cited in American Speech-Language-Hearing Association [ASHA], n.d.). Excessive noise has detrimental effects on typically developing children's speech perception, attention, reading, spelling, behavior, and overall academic achievement (Jamieson, Kranjc, Yu, & Hodgetts, 2004).

Children also wrestle with significant difficulty with understanding speech that originates from a distance. This is because loudness decreases over distance. Specifically it drops 6 decibels (dBs) for every doubling of distance. For example, a teacher speaking at 60 dBs 3 feet out into the front of the classroom will be heard at 54 dBs 6 feet into the room and at 48 dBs 12 feet into the room and so on. Since the background noise levels often remain essentially the same, this decrease in the loudness of the teacher's voice, means that the signal-to-noise ratio will be declining over the distance of the room. Crandell and Bess (1986) measured the speech recognition abilities of 5 to 7 year-old children in a typical classroom environment. The children scored 89% correct on a word recognition test when the words were presented from six feet away. However, their scores decreased to 36% correct when the words were presented 24 feet away.

Given the effects of noise, reverberation, and distance on the speech perception and academic performance of typically developing children, what kind of effects might noisy classrooms have on the auditory and academic performance of non-typically developing children? For example, children learning English as a second language have significantly poorer scores when listening to speech in noise. The differences between them and monolingual English-speaking children increase as signal-to-noise ratios become poorer (Crandell & Smaldino, 1996a). Students with hearing disorders will have added limitations that will not allow them to understand speech as well as their normal hearing classmates, irrespective of the signal-to-noise ratio (Iglehart, 2009).

While it is evident that improving acoustics in classrooms used by children with hearing impairment is critical, there are benefits for children with normal hearing thresholds as well, including

- Students under the age of 15 who are still developing mature language and are less effective listeners for speech in noise (Nelson, Sacks, & Hinckley, 2009); and