Noise Pollution (Noise-Scape) Among School Children

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Students' daily noise exposure presents an underlying threat in many classrooms that undermines student engagement, access to curriculum, and other important indicators of achievement. Students with and without hearing loss are at risk. Educational audiologists are uniquely positioned to promote awareness and work collaboratively to improve student outcomes.

Introduction

The 2015 reauthorization of the Elementary and Secondary Education Act of 1965 (Pub. L. 114-95, S.114, Stat. 1177), otherwise known as the Every Student Succeeds Act, and the 2004 reauthorization of the Individuals with Disabilities Education Act (20 U.S.C. 1400 et seq.) are designed to ensure that all students achieve their maximum potential. Thus, promoting student access to and improving student engagement and achievement in the education curriculum is of paramount concern for all educators. However, noise presents an underlying threat in many classrooms that undermines student engagement and access to the curriculum (Crandell & Smaldino, 2000; Flexer, 1999; Klatte, Hellbruck, Seidel, & Leistner, 2010; Nelson, Smaldino, Erler, & Garstecki, 2007-2008; Schafer, Bryant, Sanders, Baldus, Lewis, Traber, et al., 2013). Further, there is increasing evidence that students' daily exposure to low and moderate noise in and out of school negatively impacts their ability to learn (Bess, Gustafson, & Hornsby, 2014; Klatte et al., 2010), and "may evoke substantial impairments in performance because their cognitive functions are less automatized and thus more prone to disruption" (Klatte, Bergstrom, & Lachmann, 2013).

For example, Klatte and her colleagues provide evidence that students' chronic exposure to noise, across the day, can be viewed as their daily "noise-scape." Albeit limited, there is emerging research linking poorer student outcomes to some daily noise-scapes. The poorer outcomes include both academic achievement and educational performance, as well as general well-being for those with normal hearing and hearing loss (Crandell & Smaldino, 2000; Flexer, 1999; Klatte et al., 2010; Nelson et al., 2007-2008; Schafer et al., 2013). Yet, few educators receive training in noise-related concerns and promoting auditory access within their classrooms (Squires, Pakulski, Diehm & Glassman, 2016), and as a result, may not recognize the profound impact of their students' daily noise-scape. The aim of this article is to examine variations in students' noise-scape, the effects it may have on readiness and ability to learn in a typical classroom, and to discuss strategies for monitoring and reducing the negative impact of noise.

Despite the profound impact noise may have on both students and teachers, it often goes unnoticed or ignored. A student's daily noise-scape may be made up of sounds that range from moderately loud to harmful. The sounds may occur at school, in recreational contexts, and in and around the home (American Speech Language Hearing Association [ASHA], 2015; Bittel, Freeman, & Kemker, 2008; Fligor, 2009; Klatte, et al., 2010). Further, there is "second-hand" noise that arises from car stereos, traffic, yard work equipment, and many other sources (United States Environmental Protection Agency, n.d.) that adds to the daily noise-scape. Examples of typical noise-scapes encountered during common daily experiences among students are provided in Table 1. Albeit limited, there is convincing evidence of the detrimental effects of the daily noise-scape of many students, including chronic exposure to moderate noise (Occupational Safety and Health Administration [OSHA], 2014).

Table 1. Intensity and Permissible Exposure Time of Common Noise Sources Among Students

Sound source/experience	dBA*	Maximum permissible exposure time+
Computer	37-45	Unlimited
Typical conversation	50-65	Unlimited
Laser printer	58-65	Unlimited
Video/electronic games in the home	68-76	Unlimited
Household appliances	40-103	Unlimited ranging to 7.5 minutes
Personal listening device (iPod, Mp3) – *varies by earphones and volume level*	45-110	Unlimited ranging to < 2 minutes
Telephone	60-75	Unlimited
Alarm clock	60-80	Unlimited
Television	70-90	Unlimited ranging to 2 hours
Squeeze toy	81-97	Unlimited ranging to 30 minutes
Train/Subway	75-102	Unlimited ranging to 5 minutes
Indoor sports facility	77-112	Unlimited ranging to 1 minute
Recreational vehicles (e.g., snowmobile, motorcycle)	90-120	2 hours ranging to not permissible
Lawn equipment: mower, leaf blower, weed trimmer	95-115	1 hour ranging to 30 seconds
Restaurant	105-112	5 minutes ranging to 1 minute
School Dance	100	15 minutes
Busy Video Arcade	110	~1 minute
Concerts (e.g., Band, Rock, Symphony)	110-120	~1 minute ranging to not permissible
Stadium Football Game	117	Not permissible
Car Stereo (factory installed; at full volume)	125	Not permissible
Bicycle Horn	143	Not permissible
Firecracker	150	Not permissible
Cap gun	156	Not permissible
Balloon Pop	157	Not permissible
Fireworks (3 feet away)	162	Not permissible
Shotgun	170	Not permissible

*The dBA scale represents relative loudness of sounds as perceived by the human ear by reducing low frequencies with a correction factor. Sound level data were primarily adapted from the Center for Hearing and Communication online: http://chchearing.org/noise/common-environmental-noise-levels/

+ Represents permissible exposure before possible damage can occur for continuous time weighted average noise. Adapted from Dangerous Decibels online: http://dangerousdecibels.org/education/information-center/decibel-exposure-time-guidelines/

While people generally consider harmful noise as the extremely loud sounds that can cause immediate hearing loss, research indicates that chronic noise exposure even at moderate levels can also result in irreversible damage (OSHA, 2014). Specifically, psychological and physiological effects of chronic noise exposure, which can impact health, brain development, and learning, have been demonstrated. Moreover, chronic noise exposure is now considered a topic for action among children (World Health Organization [WHO], 2010) because of its adverse effects on cognition, attention, reading acquisition, and memory, as well as other physiological and psychological mechanisms (Flexer, 1999; Haines, Stansfeld, Berglund, & Head, 2001a; Haines, Stansfeld, Soames, Berglund, & Head, 2001b; Klatte et al., 2010; WHO, 2004). Nevertheless, an increasing number of school children routinely experience chronic overexposure to noise (Klatte et al., 2010; Lercher, Evans, & Meis, 2003).

The unfavorable academic, psychological and physiological outcomes associated with chronic noise exposure are often overlooked by parents and educators. Possible reasons for this oversight include: a) negative consequences of noise overexposure are not widely recognized; b) symptoms may be subtle, and vary widely, and c) students may compensate, at least initially. Further, more commonly recognized student concerns, such as attention deficit disorder or behavior problems, may be blamed. Even if noise-scape is suspected, some parents and educators may consider the effects of chronic noise exposure to be unavoidable.

Student Noise-Scapes

Classroom Noise

Noise at school, in and around the classroom, is insidious, and difficult for educators to quantify and control (Squires et al., 2016). Consequently, it poses a serious threat in many classrooms, and it negatively impacts teachers and their students' ability to listen and learn, whether the student has normal hearing or hearing loss (Crandell & Smaldino, 2000; Flexer, 1999; Klatte, Hellbruck, Seidel, & Leistner, 2010; Mealings, Demuth, Buchholz, & Dillon, 2015; Mealings, Dillon, Buchholz, & Demuth, 2015; Nelson et al., 2007-2008). Classroom acoustics are influenced by several factors including ambient background noise, speech-to-noise ratio at the student's position, and reflected or reverberated sounds (Crandell & Smaldino, 2000; Flexer, 1999; Knecht, Nelson, Whitelaw, & Feth, 2002). Background noise includes undesirable sounds that affects the targeted sound (Nelson et al., 2007-2008) which, in the classroom, can include noise generated from electronic equipment, heating and cooling systems, and shuffling papers and chairs along with noise generated by the students (Crandell & Smaldino, 2000; Flexer, 1999; Nelson et al., 2007-2008; Yang & Bradley, 2009). Though the acoustics of classrooms throughout the day are highly variable, poor classroom acoustics, overall, in the U.S. and other countries are well documented (Blair & Larsen, 2011; Crandell & Smaldino, 2000; Nelson et al., 2007-2008). Furthermore, there is significant research on the detrimental effects of noise and sound reverberation on all students, with and without hearing loss (Bess, Gustafson, & Hornsby, 2014; Klatte & Hellbruck, 2010; Klatte et al., 2010; Mealings, Deluth et al., 2015; Mealings, Dillon et al., 2015; Schafer et al., 2013; Sullivan, Thibodeau, & Assmann, 2012).

To address this issue, the American National Standards Institute (ANSI) established acceptable criteria for classroom noise levels, and in 2015, the International Code Council (ICC) added an amendment to include the ANSI standards to the International Building Code A117.1 building standards. However, this legislation allows for voluntary compliance on previously constructed school buildings. Despite these standards, researchers continue to find that neither new nor old general education classrooms are in compliance with the ANSI classroom background noise standard, and that larger, open-concept classrooms are particularly troublesome (Crandell & Smalldino, 2000; Nelson et al., 2007-2008). Common causes of unfavorable noise levels include hard reflective surfaces (such as drywall and cinderblocks walls, vinyl or cement floors, multiple windows without coverings), unattached desks with movable chairs, and electronic equipment such as projects or multiple computers as well as HVAC systems.

The use of classroom amplification systems can improve select student outcomes by increasing the intensity of the desirable signal over the noise, but may do so at the expense of increasing the overall noise-scape (Anderson, Pakulski, & Alo, 2014; Crandell, Smaldino, & Flexer, 1995; Rosenberg, Blake-Rahter, Heavner, Alllen, Redmond et al., 1999; Squires et al., 2016). In a series of small scale studies, researchers noted that when teachers and their students utilized a classroom amplification system, aimed at improving the signal-to-noise ratio, they often found it necessary to do so at high intensity levels to off-set the classroom noise level, which further contributed to the overall noise-scape of the classroom (Andersen, Pakulski & Alo, 2014; Squires et al., 2016). In a related study, Blair & Larsen (2011) reported the actual signal-to-noise levels of classroom amplification systems ranged greatly from +5 to +23 dB across grades in an elementary building while classes were in session, and also found that teachers are willing to increase sound levels in an effort to be heard by their students. Thus, while a positive signal-to-noise ratio is generally considered to be an indicator of a favorable listening environment, in many cases the increased intensity levels of voices through classroom amplification systems in order to be heard above the noise, may also contribute to an unsafe daily noise-scape.

In addition to added and competing noise with a classroom, educational shifts toward open-concept classrooms (Nelson et al., 2007-2008), and a more student-driven, collaborative learning environment (Wolf, 2012) perpetuate the concept of the "café effect" (Klatte & Hellbruck, 2010). Klatte and Hellbruck (2010) describe the "café effect" as an increase of noise due to reverberation (i.e., a manifestation of the Lombard effect in social situations): "When separate groups of students are working in the room, each group competes with the reverberant noise from other groups (p. 2)." Though not conclusive, small-scale studies have found that the type of overlapping vocalizations present in the café effect can be seen in larger general education and smaller intervention or resource classrooms, and may be worsened with the use of classroom

amplification systems (Anderson, Pakulski & Alo, 2014; Squires et al., 2016). This poses an additional concern for students who work with a paraprofessional or educational interpreter in the general education classroom, who may be subject to overlapping instruction as well (Anderson, Pakulski & Alo, 2014).

Sports and Recreational Noise

Outside of school, students also experience chronic overexposure to noise that contributes to their daily noise-scape from toy play, recreation activities, and sporting events both as participants and spectators (ASHA, 2015). According to the Sight and Hearing Association (2015), which publishes a list of toys that exceed safe sound levels annually, many common toys pose a noise danger including toy guns, musical instruments, talking dolls and stuffed animals, and vehicles with horns and sirens. Recreational and sporting events also pose a threat, and contribute to the daily noise-scape. Crowd noise, air horns, and music played prior to events or during down time have the potential to exceed recommended safe listening standards. Peak noise levels during sporting events have been recorded well beyond safe listening levels. In addition to game time exposure, student athletes also attend practices where the same or additional (other sports or teams practicing) noise may be present. In fact, after documenting the noise levels of collegiate basketball games, England and Larsen (2014) suggested that spectators be warned of the dangers of being exposed to extreme noise, especially if experiencing chronic exposure throughout the day prior to the sporting event. Other common examples of recreational noise that may exceed safe sound levels include arcade games, personal listening devices such as iPads and phones (Portnuff, Fligor, & Arehart, 2011), motor sports such as snowmobiling, motorcycling, and car races (Rose, Ebert, Prazma, et al., 2008), concerts, and cheering crowds (Engard, Sandfort, Gotshall, & Brazile, 2010; Serra, Biassoni, Richter, Minoldo, Franco, et al., 2005). Table 1 includes a list of noise levels of common recreation and sporting events and current standards for permissible exposure. It should be noted that these time limits are based upon the notion of a single high-intensity exposure and do not reflect growing concern of chronic exposure to low and moderate sounds.

Environmental Noise and Noise In and Around the Home

Environmental noise exposure and its adverse effects have long been well-documented among adults. More recently, researchers have turned their attention to students and reported on the impact of noise from traffic, trains/subways, and airports (e.g., Klatte et al., 2007; van Kempen, van Kamp, Lebret, Lammers, Emmen et al., 2010). However, much less is known about the daily noise-scape of the home because it is not easy to quantify, as it is so variable. Considering the decibel levels of everyday sounds within and around the home as reported in Table 1, it is likely that students have substantial noise exposure of at least a moderate intensity level, and possibly more throughout their day. Considering the cumulative nature of noise exposure, each and every occurrence of moderate and high intensity noise can create a significant impact. In other words, noise dose never decreases over time, but individuals do vary in their susceptibility to noise damage. As explained by Johnson (n.d.), "While sound levels may go up and down over time, noise dose only increases or plateaus over time. This is because you can't remove the exposure once it has occurred, much the same way you can't undo sun exposure after the fact (p.8)."

Impact of Daily Noise-Scape

Noise and Health

While there are no standards for acceptable daily noise-scapes regarding students, emerging research and anecdotal reports provide clear linkages between chronic noise exposure and physical and psychological health, which ultimately impacts general well-being. For example, both students with normal hearing and hearing loss report high levels of fatigue, stress and annoyance from the demands of speech processing in noisy conditions (Bess, Gustafson, & Hornsby, 2014; Hornsby, Werfel, Camarata & Bess, 2014; Mealings, Dillon, et al., 2015). Further, there is sufficient evidence to link noise exposure among students with endocrine secretion changes, negative effects on cognition that may impact long-term memory, higher-level thinking skills such as reasoning and the ability to absorb details and understand messages, as well as general well being (Bess, Gustafson, & Hornsby, 2014; Blair & Larsen, 2011; Hornsby et al., 2014; Klatte, Bergstrom, & Lachmann, 2013; Stansfield & Clark, 2015). Albeit limited, there is also growing evidence for an association with increased hyperactivity symptoms as well as potential changes in cardiovascular functioning (Stansfield & Clark, 2015).

Impact of Noise on Classroom Learning

In addition to health concerns, robust evidence exists linking noise with students' ability to access and engage in the education curriculum, ultimately impacting their achievement. Both students with normal hearing and hearing loss with undesirable noise-scapes perform more poorly on tasks of academic learning, classroom performance, and reading that ultimately impact standardized academic test scores (Bess, Gustafson, & Hornsby, 2014; Blair & Larsen, 2011; Hornsby et al., 2014; Klatte, Bergstrom, & Lachmann, 2013; Stansfield & Clark, 2015). This research is based upon several well-established premises about learning: (a) most classroom instruction is delivered orally, and thus, facilitating listening is a necessity for successful learning (Flexer & Rollow, 2009), (b) optimal acoustical conditions for instruction are essential to learning facilitation (Crandell & Smaldino, 2000; Flexer, 1999; Larson & Blair, 2008), (c) children are more negatively affected by poor signal-to-noise ratio because their communication and listening skills are not fully developed until adulthood (Klatte et al., 2010; Shield & Dockrell, 2008; Talarico, Abdilla, Aliferis, Balazic, Glapakis et al., 2007; Yang & Bradley, 2009), and (d) those skills are more likely to be compromised when hearing loss exists (Daud, Noor, Rahman, Sidek, & Mohamad, 2010; Lieu, Tye-Murray, Karzon, & Piccirillo, 2010; McFadden & Pittman, 2008). Highlights of this work are summarized in Table 2.

Table 2. Evidence of Academic Concerns Linked with Unfavorable Noise-Scapes
Compromised oral language comprehension and reading acquisition (Haines et al., 2001a and 2001b; Schafer et al., 2013) and difficulty categorizing speech sounds (Klatte et al., 2007)
Poorer scores on standardized tests of literacy, mathematics, and science (Shield & Dockrell, 2008)
Decreased intelligibility of speech (Crandell & Smaldino, 2000; Yang & Bradley, 2009), and poorer performance on phonological discrimination tasks (Klatte et al., 2005)
Negative effects on cognition including short- and long-term memory (Klatte et al., 2010), intentional, incidental, and recognition memory (Lercher et al., 2003), and disrupted memory for nonwords (Klatte et al., 2007)
Increased levels of fatigue, stress and annoyance (Bess et al., 2014; Klatte & Hellbrück, 2010; Klatte et al., 2010; Mealings, Dillon et al., 2015)
More difficulty communicating with teachers and peers (Klatte et al., 2010; Mealings, Dillon et al., 2015)

Noise Induced Hearing Loss

Although daily noise doses may not reach intensity levels commonly associated with noise induced hearing loss (NIHL), there is evidence that chronic exposure to moderate levels may cause permanent damage to the sensory cells of the ear (Johnson, n.d.). Further, the increasing use of personal electronic devices may leave some children exposed to harmful levels of noise (Stansfield & Clark, 2015). In fact, research suggests that as many as one in 5 US adolescents aged 12 to 19 years have minimal or mild hearing loss (Shargorodsky, Curhan, Curhan, & Eavey, 2010). Urban minority youth are especially at risk, and represent an under-reported and under-studied group (Henderson, Testa, & Hartnick, 2011; Mehra, Eavey, & Keamy, 2009).

Regardless of the causation factors, when hearing loss is present, it may result in additional problems in listening, language acquisition, and learning. According to the American Speech-Language-Hearing Association (n.d.a), there are four major ways in which a permanent hearing loss affects students: (a) it causes delay in the development of receptive and expressive communication skills (speech and language); (b) the resultant language deficit causes learning problems that lead to reduced academic achievement; (c) communication difficulties often lead to social isolation and poor self-concept; and (d) it may impact vocational choices. When hearing loss is coupled with an unfavorable daily noise-scape, the potential for serious academic and social concerns that jeopardize quality of life are exacerbated (Bess, Gustafson, & Hornsby, 2014; Hornsby et al., 2014; Kochkin, Luxford, Northern, Mason, & Tharpe, 2007; McFadden & Pittman, 2008). This is especially true for minimal and mild hearing losses that may go undetected or untreated.

Despite students' daily noise-scape, educators need their students to be prepared to learn, and to be able to effectively listen, process, and comprehend complex messages in order to achieve academic success (Schafer et al., 2013). Thus, educational audiologists are well-positioned to support educators in recognizing unfavorable noise-scapes, signs and symptoms of chronic noise exposure as well as hearing loss, and reducing students' daily noise dose and overall classroom noise levels. Given the limited background of most educators on these topics, it is important to recognize the best ways to collaborate and support students.

COLLABORATION AMONG PROFESSIONALS

As described, a classroom's acoustic environment has the potential to significantly impact both students and teachers (Klatte, Meis, Sukowski, & Schick, 2007; Mealings, Demuth et al., 2015; Mealings, Dillion et al., 2015). Within classrooms, instruction is generally provided to students through spoken language, and students spend as much as 75% of their time in school engaged in listening activities (Flexer & Rollow, 2009). Because most classroom instruction is conveyed from teachers to students through spoken language, classroom noise is an important issue that must been adequately addressed (Bess, Gustafson, & Hornsby, 2014; Schafer et al., 2013).

As explained by the American Speech-Language-Hearing Association (n.d.b), "audiologists, acoustical consultants, speech-language pathologists (SLPs), classroom teachers, and administrators can and should work closely together in order to improve acoustic conditions in schools." As this important issue receives more attention, educational audiologists (EAs) will have an increasingly important role in identifying and managing issues related to hearing and classroom acoustics (Bess, Gustafson, & Hornsby, 2014). Part of this role includes working collaboratively with teachers and other professionals to identify classroom noise sources that have a negative impact on teachers and students, especially those with hearing loss. Educational audiologists are equipped with the knowledge and skills necessary to lead a team of professionals in accomplishing this multi-step task. However, because EAs are not often available in a classroom, or even a building, on a daily basis, teachers, speech-language pathologists (SLPs), and other professionals are also responsible, thus necessitating a teaming approach.

Teaming in educational settings is supported by both legislation (the Individuals with Disabilities Act Amendments [IDEA] of 1997 [PL 105-17]) and research (Sheldon & Rush, 2013). The concept of a trans-disciplinary teaming model was first introduced into the literature by Haynes (1976). Trans-disciplinary teaming can be defined as a group of professionals who work collaboratively, sharing responsibilities in evaluation, planning, and implementing services (Meyers, Meyers, Graybill, Proctor, & Huddleston, 2012). One of the six stages of trans-disciplinary teaming involves a process of role enrichment in which team members develop an understanding of terminology and core practices of other disciplines represented on the team through team meetings, colleague coaching, and the sharing of information and resources (Meyers, Meyers, Graybill, Proctor, & Huddleston, 2012).

Educational audiologists can use a collaborative teaming approach to provide role enrichment to educators, SLPs, and other professionals on topics related to classroom noise, noise-scape and hearing loss. To accomplish this, EAs may assist teachers and SLPs in identifying sources of classroom noise that have a negative impact on student success. This may include identifying and considering the following factors that can contribute to unfavorable classroom acoustics: surfaces that increase reverberation times, sources of background noise (e.g., HVAC systems, shuffling chairs, traffic noise), sources of the "café effect," and poor signal-to-noise ratio.

Another important topic that EAs can discuss with educators, SLPs and other professionals is the impact that classroom noise has on the academic success and general well-being of students with and without hearing loss. While many educators are familiar with hearing loss, there is growing concern about the combined effects of poor acoustics and minimal hearing loss (MHL), which is on the rise among school students. Goldberg and McCormick Richburg (2004) reported anecdotal evidence of frequent misperceptions about MHL among professionals and the corresponding need to "educate parents and professionals who work with students with [minimal] hearing loss, including teachers, administrators, audiologists, SLPs, and school nurses (p. 159)." Goldberg & McCormick Richburg (2004) documented common misperceptions:

(1) "Minimal hearing loss (MHL) does not exist. In essence, these students have hearing within normal limits

(2) Students with MHL will be identified through school hearing screenings

(3) If students with MHL pass the hearing screening, they should have no difficulties learning in the classroom

(4) Preferential seating is a sufficient recommendation or modification for students with MHL

(5) Hearing conservation programs are not needed in school settings (p.153-158)."

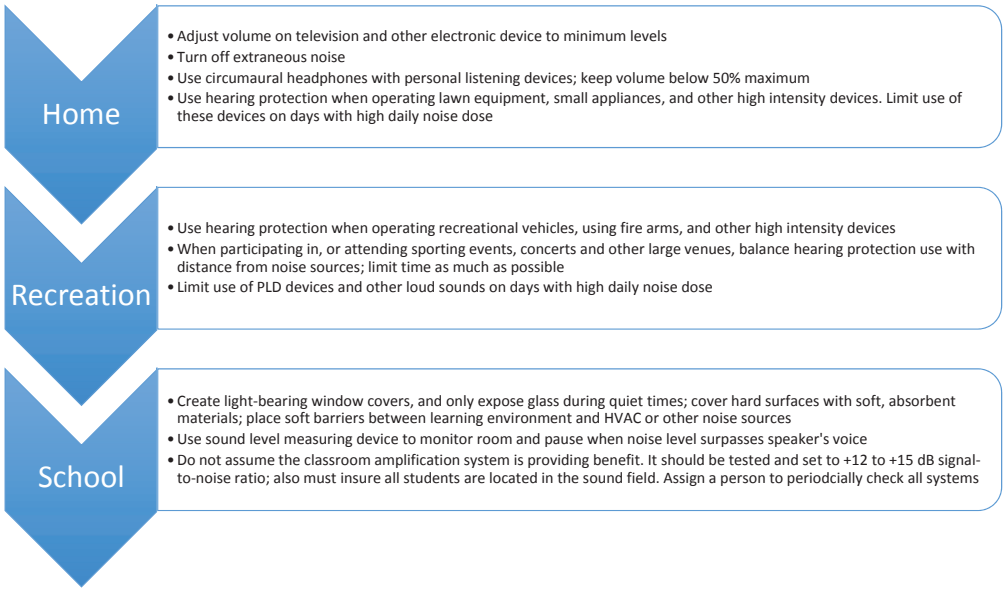
In a follow-up study, McCormick Richburg and Goldberg (2006) surveyed teachers' perceptions about MHL with respect to the five myths previously stated. The authors concluded that school personnel play an important role in identifying and addressing the needs of students with MHL. Moreover, through collaboration, team members can contribute accurate information and provide effective intervention for students with MHL.

Educational audiologists can help teachers identify students who demonstrate signs of unfavorable noise-scapes as well as MHL, and can support teachers in implementing strategies in the classroom that accommodate the educational needs of their students. This can be accomplished with tools that explain the negative impact of unmanaged classroom acoustics on student performance, outline the relationship between various severities and types of hearing problems and the corresponding impact on students' listening and learning needs, and provide teachers with clear instructions on how to use and troubleshoot classroom soundfield devices as well as personal hearing technology.

RESOURCES FOR EDUCATORS AND RELATED PERSONNEL

In the absence of comprehensive guidelines for educators and parents to create safe and comfortable daily noise-scapes for their students, EAs can make a profound impact by promoting awareness and developing training materials for teachers, administrators, SLPs and related professionals, along with providing direct services. Hearing health and noise education are underdeveloped in most curriculums, but with support of the EA, can be implemented in simple steps by all educators (Thompson, Pakulski, Kleinfelder, Price & Mondelli, 2013). While the EA should address each classroom individually, there are general ways in which educators and students can be taught to monitor and improve the daily noise-scape; these are highlighted in Figure 1.

Figure 1. Solutions for Educators and their Students to Improve Daily the Noise-Scape



A second, but equally important issue is training educators and parents to recognize the signs and symptoms of acute and chronic over exposure to noise, as well as the often subtle signs of hearing loss. It is important to promote awareness among educators and related professionals of the significant impact a hearing loss in childhood may have, even if it is considered a minimal or mild loss. Identifying and intervening early will help students achieve their maximum potential.

Fortunately, there are many available resources that EAs can use as guides when working with classroom teachers and students who may have unfavorable daily noise-scapes, or be at risk or have hearing loss. These tools include checklists of important considerations that should be made when developing educational programs. In addition to national organization websites, one of the more comprehensive resources, developed by Karen Anderson, can be found online: http://successforkidswithhearingloss.com/

CONCLUSION

Noise-scapes develop from all areas of life: classroom noise, indoor sports and recreational noise, and home and environmental noise. The level and intensity of these noise sources vary from person to person based on exposure, and individual susceptibility also varies. Nevertheless, action should be taken to reduce the daily noise dose of students, particularly when it may permanently damage hearing, and when it interferes with physical and psychological health and development, and academic learning. Much like sun exposure, it may contribute to permanent and irreversible damage.

It is important to remember that classroom noise is inescapable for students. They have no options for choosing an alternate setting, nor do they have the autonomy to reduce their risk. Increasing the signal-to-noise ratio by amplifying the primary speaker, often the teacher, has resulted in an increase in some academic outcomes for students. However, the increased ambient noise and additional reverberation can be distracting for some students. Further, it may contribute to the "café effect." Similarly, students already receiving assistance from paraprofessionals may have the additional difficulty of differentiating from two primary speakers (teacher and para) through the competing ambient noise.

Recreational and sporting events can also contribute to the daily noise-scape and impact student learning and achievement. Variances in the home exposure could include but are not limited to: television volume and duration of viewing time, computer sound output, personal listening device use, neighborhood, ventilation (heating and cooling), and proximity to traffic or industrial areas. Yet, educators do not have control over their students' listening experiences outside of school. Nevertheless, they have the opportunity to incorporate hearing and noise health into the curriculum and their daily activities to promote awareness and self-improvement. The educational audiologist is uniquely positioned to team with the educators and related professionals to bring about change.

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