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Acoustics: What We Need to Know About Our Environment

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Singing teachers and their students perform in a variety of spaces. Some are acoustically excellent; in others, however, it is difficult for the intended listeners to hear the presenter. In such environments, the teacher, singer, or other presenter must struggle in order to be heard. Singing teachers address such issues routinely, since their students may be called upon to sing in gymnasiums, outdoor theaters, acoustically deadened lecture halls, and exceedingly noisy surroundings (such as with orchestras, choirs, or rock bands). However, while we have made great efforts to teach our students how to survive acoustically challenging environments, we have exerted surprisingly little effort toward understanding and altering room acoustics.

In addition to singing, many of our students teach. Their teaching may be in classrooms, or in multiple different classrooms, in several schools throughout a school district. Other students work in various voice-intensive professions, such as law, sales, the clergy, and others. No matter how well they sing, if their voices are constantly strained during speech because of difficulty being heard in their acoustic settings, they are at risk for vocal strain and injury. Much of our concern revolves around our ability to communicate through speech, and nearly everybody speaks more frequently than he/she sings. Many vocal injuries (such as nodules) arise as a result of efforts to be heard. Environmental acoustics are among the most important factors that determine audibility. Yet, most singing teachers raise few (if any) questions about the environments in which our students are trying to be heard (or about our own acoustic environments), and even fewer of us routinely investigate ways to improve our students acoustic environments or to advocate for expert acoustical architectural consultation in the design of new structures such as school, studios, and office buildings. Regrettably, otolaryngologists are not particularly attuned to this important issue, either.[1]

Otolaryngologists remain committed to helping people with impaired hearing. We have championed hearing screening, fought for routine hearing screening in our school systems throughout the country, developed laws to prevent noise-induced hearing loss in industry, raised awareness of the need for hearing protection during noise exposure, and increased public awareness of the impact of hearing loss upon quality of life. Otologists and neurotologists have made great strides in identifying and treating medical causes of hearing loss,

improved techniques of otologic surgery, and have participated in research into nearly all aspects of hearing impairment and any options that we can imagine that might restore hearing. We have been justifiably proud of advances in cochlear implantation, hearing aid performance, increases in the availability of closed caption television and movies, genetic analysis and gene therapy, research in hair cell regeneration, stem cell research and many other advances. However, most of us have devoted little attention to one exceedingly important factor; and, as physicians, we have been virtually absent as advocates. The factor is environmental acoustics.

Much of our concern about hearing revolves around our ability to communicate through speech. Even our formulas to determine monetary compensation following occupational hearing loss were based on estimates of the impact of hearing loss upon the ability to communicate on a daily basis through conversation. However, there are many factors other than pure tone thresholds or even speech discrimination that determine our ability to hear and understand speech. Environmental acoustics are among the most important. Yet, most otolaryngologists include few (if any) questions in our routine history about the environments in which our patients are trying to hear; and even fewer of us to routinely investigate ways to improve our patients' acoustic environment, or to advocate for expert acoustical architectural consultation in the design of new structures (such as classrooms and office buildings).

In the real world, speech intelligibility is influenced in large measure by masking effects of environmental sounds that compete with the speech that we are trying to hear. The masking effects of background noise depend not only upon the noise source (other speakers, children talking, noise coming from adjacent rooms), but also upon room design and the surface materials in the room.

The signal-to-noise ratio (relationship between the sounds we are trying to hear and the environmental noise competing with those sounds) can be altered substantially in a variety of ways. One is used fairly frequently: amplification. Infrared systems used in theaters or attached to televisions, allow a hearing-impaired person wearing ear-level receivers to hear better because the signal is increased. In some cases, the devices also decrease the noise. The effect is different from that of traditional hearing aids, which increase both signal and unwanted background noise, although some digital programs have improved the ability to alter signal-to-noise ratio.

However, there are many other ways to solve the problem in addition to, for example, asking teachers to use infrared or other amplification systems in classrooms. Suboptimal acoustics can make speech intelligibility difficult even for people with normal hearing, especially those who also have auditory processing disorders, as well as for people with hearing impairment. Therefore, it is surprising that most teachers (and otolaryngologists) routinely have not been interested or active in collaborating with acoustic engineers to assist our students, employers or schools in determining whether reasonable, cost-effective room modifications can be made that will improve speech intelligibility and consequently decrease teachers' vocal demands.

Acousticians can change room characteristics such as the reverberate field level, which is related to the total sound in room and the room constant (the amount of absorption related to the surfaces in the room). Changing room acoustics is not usually as simple as throwing down or removing a thick carpet; but an acoustician can determine whether, for instance, acoustic panels added to the ceiling and walls will create enough acoustic modification to measurably change intelligibility in the given space. Whether the room is a classroom, meeting room, courtroom, restaurant, theater, or other venue, room acoustics should be considered wherever our students have difficulty hearing.

Singing teachers should advocate for the involvement of acoustic architects and engineers in the design phase of virtually any new construction involving work places, schools or theaters (as well as other buildings). Overall, everyone (especially an architect), wants to create a space that is striking in its beauty. Nevertheless, sometimes beautiful hard surfaces should be modified to improve hearing function. Acoustically, excellent room design can make an enormous difference for anyone trying to hear conversation or to be heard. We should consider supporting acoustic awareness among teachers of all subjects, raising our own awareness about the problem, and helping to increase public awareness about the importance of room design upon conversational efficiency and comfort. Similar concerns should be stressed in the future

design of spaces other than rooms, as well, including transportation vehicles such as planes, trains and cars.

As our society continues to age, the number of people inconvenienced by beautiful but unnecessarily noisy spaces will only increase. While we are trying to learn new ways to preserve voice and optimize hearing, singing teachers should also make every effort to create environmental conditions that will allow our students and audiences to enjoy the best possible auditory perception with the least possible phonatory effort.

[Modified from *Ear, Nose and Throat Journal*, with permission from Vendome Group, L.L.C.]

NOTE

1. R.T. Sataloff, "Room Acoustics: Are We Paying Attention?" *Ear, Nose and Throat Journal* 86, no. 11 (2007): 644–646.

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