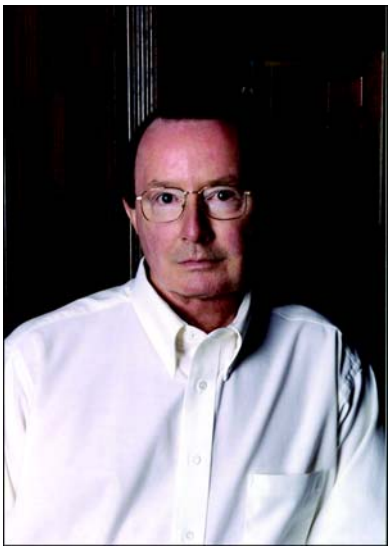

Raymond H. Hull, PhD, FASHA, FAAA

JRRD Guest Editorial

Environmental design—An expanding role in hearing rehabilitation for older adults

INTRODUCTION

The role of the audiologist in aural rehabilitation services on behalf of older adults with hearing impairment is expanding, just as our knowledge of hearing in aging likewise expands [1]. In the past, audiologists generally found that they could not do as much as they desired to assist their older patients in acoustic design modifications to alleviate or prevent environmental interference in communication. This was, in part, probably a result of a lack of academic preparation in the area of environmental design. Training in that area has, in most instances, not been generally available in the majority of preparatory programs. This lack of information has restricted audiology students from learning about an important service that can improve the communicative efficiency of many older adults with impaired hearing function.

Rather than letting colleagues continue to rely on a "seat of the pants" approach to environmental design, this editorial will introduce the concepts and principles of environmental design that take into account aspects of hearing impairment in older adults, including design concepts and the physiological bases for those design considerations.

AUDITORY CHANGES IN AGING

The complexities involved in the peripheral and central nervous system (CNS) auditory components of presbycusis, along with the compounding effects of the auditory environment, can negatively influence an older adult's ability to communicate in their frequented listening environments. Many public and private listening environments play havoc with aging peripheral and CNS auditory systems. Adults who, at an earlier age, may have noted only some difficulty in specific degraded listening environments may now be experiencing frustrating difficulty. They may blame the difficulties on the speaker, when the problem might be the reverberant characteristics of the meeting room, the anechoic environment of their home, or auditory distractions. These older adults with hearing impairment might begin to avoid places where they would otherwise like to be, increasing their social isolation. Changes in both the peripheral and CNS auditory systems can occur in conjunction with advancing age. The following classic example presents a concise summary of the insidiousness of those changes:

> "Unlike Dr. Oliver Wendell Holmes' New England Deacon who built the wonderful one-horse shay, the architect of the cochlea did not design it to give perfect service for 'a hundred years to a day,' or even

for the traditional three-score-and-ten. Its condition in old age, however, seldom represents the effects of aging alone, but rather the accumulative, combined assaults of noise and drugs, as well as time." [2, p. 139]

Many older adults experience a gradual decline in the CNS auditory system's ability to process the acoustic complexities of speech with the speed and accuracy that they possessed in their younger years. If the slightest decline in speed and precision at the level of the brain stem and/or auditory cortex needed to process the acoustic and linguistic components of speech is noted and if that decline in speed of processing is coupled with a peripheral hearing loss in the higher frequency phonemes of speech, which is typical of older adults, then the difficulties that they can experience in hearing and understanding speech will be compounded.

Peripheral Auditory System

The peripheral auditory system's functioning declines regularly over time. A person's lifestyle, noise exposure, heredity, diet, state of cardiovascular health, and other variables can result in some degree of negative change within the cochlea, with an accompanying sensorineural hearing loss—a gradually progressive sensorineural hearing loss that typically involves the higher frequencies. Since approximately two-thirds of American English phonemes possess important high-frequency acoustic components, a hearing loss that primarily involves a decline in the higher frequencies can negatively affect speech understanding. Older adults with high-frequency hearing loss who find themselves in a noisy or otherwise acoustically distracting environment that masks the lower frequencies or distorts the complex phonemes of speech can have even greater difficulty.

Central Nervous System Auditory System

The CNS auditory system also changes with age. Its ability to process the complex acoustic and phonemic elements of speech appears to decline slowly throughout life. Speech processing involves both the complex brain stem auditory pathways and the primary and association areas of the brain. Speech comprises the most complex set of acoustic signals that our CNS must process, and the CNS auditory system must process the acoustic, linguistic, informational, and emotional content of speech within microseconds to keep up with conversation. These CNS changes compound peripheral hearing loss.

PROBLEM ENVIRONMENTS

Acoustic and physical environmental factors may interact to cause difficulty in understanding speech. Sound distortion in listening environments that are not acoustically designed to support hearing and speech understanding can create even more dramatic difficulties for older listeners.

Homes

Homes are designed for comfort and generally furnished in such a way that there are few, if any, reverberant characteristics; essentially, they become anechoic chambers that do not give sound the "life" that it needs to travel well. Thus, sound such as speech is absorbed rather than transmitted. Rooms designed with comfort in mind restrict the movement of sound by absorbing it before it can travel, thereby deadening it with soft carpeting, thick window drapes, soft chairs and sofas, and heavily textured wallpaper and ceilings. People do not furnish their homes to purposefully be non-reverberant, but rather they do not understand the effect softness and absorbance have on speech transmission. Typically, such rooms are not ideal environments for conversation with an older adult with hearing impairment.

Frequented Community Environments

Typical home environments interact with sound in a manner opposite of that found in the more reverberant environments of the community. Meeting rooms, classrooms, religious sanctuaries and fellowship halls, nursing home all-purpose rooms, auditoriums, bank lobbies, and many other environments that adults of all ages go to are generally not conducive to hearing and understanding speech. They resemble reverberation chambers with too many almost subliminal echoes. Many community

environments and places of business are constructed on the same principles: rooms square or rectangular in shape; hard floors (e.g., tile, concrete, marble, wood); sheetrock, concrete block, or brick walls; sound-reflective acoustic tile ceilings; whiteboards or blackboards in classrooms and meeting rooms; and uncovered windows, glass-covered pictures, or other sound-reflective surfaces. For example, most church sanctuaries have hard wooden pews, vaulted ceilings, stained glass windows, hard reflective walls, and hard floors (except for perhaps a strip of carpeting down the center aisle), all of which are sound-reflective or reverberant surfaces.

Reflective surfaces cause speech and other sounds to reflect, or "bounce," from one surface to another. This creates reverberant echoes that distort sound such as speech and play "acoustic havoc" on those with impaired peripheral and CNS auditory systems. Seats under the balcony of larger community spaces are also problematic, because speech does not travel well under balconies just as it will not travel though stairways or around corners.

DESIGN MODIFICATIONS

What audiologists do too frequently is recommend environmental design changes to the communicative environments of older adults with hearing impairment based on logic, very basic knowledge of the area, or "seat of the pants" ideas, all without being aware of why the environmental design changes work. In order to provide constructive services in environmental design to patients, audiologists and others who serve older adults with hearing impairment should become more familiar with this important area. Services in environmental design are very tangible and, in many instances, show immediate benefit to patients.

Improving listening environments for hearing and communication does not require extensive renovation. Even modest changes can have a positive difference. The service provider (audiologist or other) should coach their patients on making appropriate, simple environmental changes. The following suggestions should not be instituted simultaneously, particularly in the same room. Otherwise, the environment may become too reverberant rather than overly absorbent, or vice versa. Moderation is the key.

Homes

As stated previously, many homes are anechoic. While many community environments may be reverberation chambers, homes are generally without sound-carrying characteristics because of the softness and fabric of overstuffed furniture, drapes, carpeting, and other absorbent materials. Without asking patients to completely change their home to remove the texture and softness of the living environment, some minor changes can be made to enhance sound and speech:

- Replace heavy carpeting in primary social rooms with, for example, laminated wood and smaller throw rugs.
- Replace textured wallpaper with painted walls.
- Replace couches and overstuffed chairs with firmer furniture.
- Replace heavy drapes with lighter material or window blinds.
- Reduce auditory distractions by turning off or down the television or radio during conversation.

These problems highlight why people generally congregate in the kitchen to carry on conversations during social events. Kitchens typically have a harder floor and other hard surfaces such as the kitchen table, cupboards, and shelves.

Frequented Community Environments

The task in community areas is usually to reduce reverberation and echoes to enhance the transmission of sound and speech so that it is more easily heard and understood. The difficulties experienced by an older adult with hearing impairment can be caused by room reverberation, which results in distortions of the speech signal, therefore frustrating those with difficulties in understanding what is being said. The goal is to reduce the reverberation without removing all aspects of the room that support the natural transmission of sound from the speaker to the listeners. Avoid changing the listening environment from a state where there is too much

reverberation to one that is acoustically "dead" by adding too much absorbency to the room.

All the following suggestions are not intended to be made to the listening environment. One or two appropriate changes may suffice:

- Alter the square or rectangular shape of a room that causes natural reverberation by adding light ceiling-to-floor drapes in one or two corners of the room.
- Hang light drapes to the sides of windows but not over them.
- Hang decorative flagging periodically across the ceiling to reduce echoes.
- Muffle irrelevant noise. If a pop machine, ice maker, or water fountain is nearby, make sure that it is quieted to the degree possible. If an area used for food preparation is attached to or near the room, use heavy drapes or a wall to block off that area to reduce excess noise.
- Make sure that the public address (PA) system is adequate. A poor or misused PA system can be one of the greatest detractors to hearing. Most microphones are "high impedance," meaning that they resist the voice signal, so they must be held no farther than 2 to 3 inches from the mouth to work properly.
- Make use of a PA system mandatory when more than 10 people are in the listening area.
- Place PA speakers at ceiling level in both the front and back of the room, which will prevent feedback and carry sound more efficiently. Reverse the polarity of the "hot" and "ground" speaker wires between front and rear speakers to reduce "dead spots" in the room.
- Coach speakers to speak with clarity by slowing their rate of speech. The auditory system of an older adult with hearing impairment is not designed to process and comprehend speech above 125 words per minute.
- Ask those responsible for functions to avoid background music in the listening and/or communicating environment. It becomes a detractor to the transmission of speech and interferes with speech understanding.

CONCLUSIONS

To further prevent aggravating hearing impairments, we can incorporate the surrounding architecture, thereby avoiding unnecessary problems with hearing and speech understanding. Older adults with hearing impairment do not, of course, wish to appear that they are more impaired than they truly are. However, many environments for listening and communication can amplify impairments.

The role of the audiologist and others who serve older adults with impaired peripheral and CNS auditory function includes environmental design suggestions. It is a tangible service that provides almost immediate rewards for older patients in their social, business, and personal lives.

Raymond H. Hull, PhD, FASHA, FAAA
Professor of Audiology/Neurosciences, Coordinator–Doctor of Audiology Program, Department of Communication Sciences and Disorders, School of Health Sciences, College of Health Professions, Wichita State University, Wichita, KS

Email: ray.hull@wichita.edu

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