How the Acoustical Environment May Alter Handicap

Comment l'environnement acoustique peut changer le handicap

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Abstract

All human activities take place in an acoustical (or sound) environment. The characteristics of the environment have a direct impact on people and their activities. If the acoustical environment is not optimal, the impact will be detrimental to people with normal hearing, but all the more so to the hard of hearing. A non-optimal acoustical environment reduces the hearing accessibility of the world, increases handicap, and leads to the social discrimination of the hard of hearing. This article reviews ways in which the acoustical environment affects people in their everyday activities. Topics include the relevant characteristics of acoustical environments, the auditory functions impacted, and how these functions are affected by hearing loss. Examples are given of environments and activities, and the problems that non-optimal environments can cause.

Abrégé

Toutes les activités humaines ont lieu dans un environnement acoustique (sonore). Les caractéristiques de l'environnement ont un impact direct sur les gens et leurs activités. Un environnement acoustique non-optimal aura des conséquences négatives sur les gens avec une audition normale, et d'autant plus sur les personnes malentendantes. Il réduit l'accessibilité au monde sonore, augmente le handicap et fait en sorte que les personnes malentendantes subissent une discrimination effective. Cette présentation fait le tour de cette question. Les sujets à être abordés incluent les caractéristiques pertinentes des environnements acoustiques, les fonctions auditives affectées et comment ces fonctions peuvent être affectées par une perte d'audition. Des exemples seront donnés d'environnements et d'activités ainsi que les problèmes qu'un environnement non-optimal peuvent causer.

Acoustical Environments

Regardless of a person's activities—watching television, working, talking, or sleeping—he or she is exposed to an acoustical environment. The acoustical environment can be defined as the totality of sound to which an individual is exposed. The acoustical environment has a direct impact on normal-hearing and hard-of-hearing people. A non-optimal acoustical environment makes the world less accessible. This results in disability which, in turn, leads to handicap, especially for the hard of hearing. The magnitude of the impact and handicap depends on the exact characteristics of the environment, on the individual, and on the activity the individual undertakes in the environment. The state of the acoustical environment is an ecological or ergonomic issue. The environment must be adapted to the situation, taking into account human capabilities and the demands placed on people (that is, there must be a good match between capabilities and demands).

Characteristics of Acoustical Environments

Energy (perceived as loudness). How much energy does the sound contain (that is, how loud is it)?

Frequency content (perceived as pitch). What frequencies does the sound contain? Sound frequencies range from low (bass) to high (treble). Sounds may contain single, several, or all audible frequencies in various proportions.

Temporal variation. How does the sound vary with time? A particular example of temporal variation is reverberation or echo in a room. In this case, the question becomes: how long does it take for the sound to die away?

Direction. From what directions does the sound come?

Inter-aural differences. For a person with two functioning ears, what are the differences between the sounds arriving at the two ears?

Signal-to-noise ratio. In the case of a *signal* (any useful sound) in the presence of noise (any interfering sound), what is the level of the signal compared to that of the noise?

Auditory Functions

Basic Auditory Functions

The act of hearing involves the following basic auditory functions (among others).

Detection. Can the sound be heard? Can it be distinguished from the noise?

Discrimination. Can the signal be distinguished from other potential signals?

Recognition. Can the signal be identified? Can the signal's meaning be understood?

Localization. Can the direction of the sound be determined?

Complex Auditory Functions

Hearing is also involved in more complex auditory, perceptual, and cognitive processes, including the following.

Auditory scene analysis. This is the ability to construct an image of a situation from purely auditory information;

Speech perception. This is the ability to understand speech;

Warning-signal recognition. This is the ability to recognize warning signals in the presence of noise; and

Cocktail-party effect. This is the ability to discern one meaningful signal in a lot of noise (for example, to hear one's name in a crowd at a party or to hear the sound of one particular instrument in an orchestra).

Consequences of a Non-Optimal Acoustical Environment

A non-optimal acoustical environment results in a mismatch between human capabilities and the demands placed on people. Such an environment may be detrimental to exposed individuals' health, intellectual development, safety, economic status, communication, enjoyment, social interactions, and emotional well-being.

The effect of a non-optimal environment may be significant for normal-hearing people, but is generally worse for the hard of hearing.

Effects of a Non-Optimal Acoustic Environment

Health. The effects of excessive noise on health include fatigue, stress, anxiety and, in an extreme situation, hearing loss.

Intellectual development. A non-optimal acoustical environment may result in compromised intellectual development (for example, compromised learning in education).

Safety. A poor acoustical environment may lead to a reduced ability to identify and respond to warning signals (for example, in industrial or traffic situations).

Economic status. Noise has been shown to compromise motor- and intellectual-task performance. It may lead to reduced productivity at or increased absenteeism from work.

Communication. A non-optimal acoustical environment may result in compromised verbal communication, particularly in an open-plan office setting.

Social interactions. Poor acoustical environments can result in compromised social development, compromised social interactions, and social isolation with an associated reduced quality of life.

Emotional well-being. Noise causes annoyance, frustration, discomfort, and dissatisfaction.

Examples of the Effects of a Non-Optimal Acoustical Environment

Industrial workshops. Noise in an industrial workshop causes workers to be exposed to fatigue, stress, hearing loss, danger of accidents and compromised verbal communication; it also leads to reduced productivity, and causes annoyance and frustration.

Classrooms. Students and instructors in classrooms with non-optimal acoustical environments experience fatigue, increased effort, compromised verbal communication and learning, and the inevitable ensuing annoyance and frustration.

Seniors' residences. Staff and residents may experience fatigue, stress, anxiety, compromised verbal communication, compromised social interaction, isolation and, again, annoyance and frustration. This may lead directly to decline in the residents' health.

Movie theatres. Poor acoustics in a performance space such as a movie theatre causes compromised verbal communication, annoyance, and frustration.

Effects of Hearing Loss on Auditory Functions

Reduced Sensitivity. A higher-energy sound is required to elicit a given sensation of loudness.

Reduced Frequency Resolution. The ability to discriminate between two sounds with similar frequencies is compromised.

Reduced Temporal Resolution. The ability to discriminate between two sounds occurring at almost the same time is compromised.

Reduced Spatial Resolution. The ability to identify the direction from which a sound comes is negatively affected.

Reduced Ability to Separate Signal from Noise. Hearing loss—especially a unilateral (single-ear) loss—results in a reduced ability to separate signal from noise; thus it results in an effective decrease in the signal-to-noise ratio. A similar problem is often experienced by hard-of-hearing people who wear only one hearing aid.

A hearing loss magnifies the impact of a non-optimal acoustical environment and the associated disability and/or handicap. It magnifies the mismatch between capabilities and demands.

Optimizing the Acoustical Environment

All hearing professionals must aim to optimize the environment to best adapt it to the situation. The characteristics of acoustical environments must be matched to the human activity and auditory functions involved. The requirements are generally more stringent for hard-of-hearing people than for normal-hearing people.

The optimization of acoustical environments is the subject of ongoing research. More is known about optimizing acoustical environments for normal-hearing people; less is known about optimizing them for hard-of-hearing people.

The acoustical environment is optimized by behavioural, administrative, and engineering control measures. Engineering control involves optimizing layouts and controlling noise at the source or as it propagates between sound sources and noise-sensitive people. Computer models exist for predicting acoustical environments. These can be used to optimize such environments.

Cost-effectiveness is one final aspect to consider when trying to improve the acoustical environment. To find financial support for optimizing an acoustical environment, one will likely have to prove first that an optimal environment costs less, in the long run, than a non-optimal environment.

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