

## Evidence for positive training effects of the acoustical environment on the auditory threshold

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The current opinion on the relationship between exposure to sound and auditory performance is that sound is basically detrimental for the auditory system. Powerful noise is damaging the ear, undoubtedly. And so it is a widespread assumption that those people hear best, who live in areas without noise. However, this relation has not really been tested. In order to do so, we studied various groups of volunteers. All are questioned as to education, job, military service, sound exposure, hobbies, music, sudden hearing loss, tinnitus, etc. The auditory performance is determined, using pure-tone audiometry up to 16 kHz. Persons without previous audiometric experience get an individual training session in audiometry. Over the years data on about ten thousand persons have been collected. Persons with sudden hearing loss or medical problems of the ear, have been excluded from this analysis.

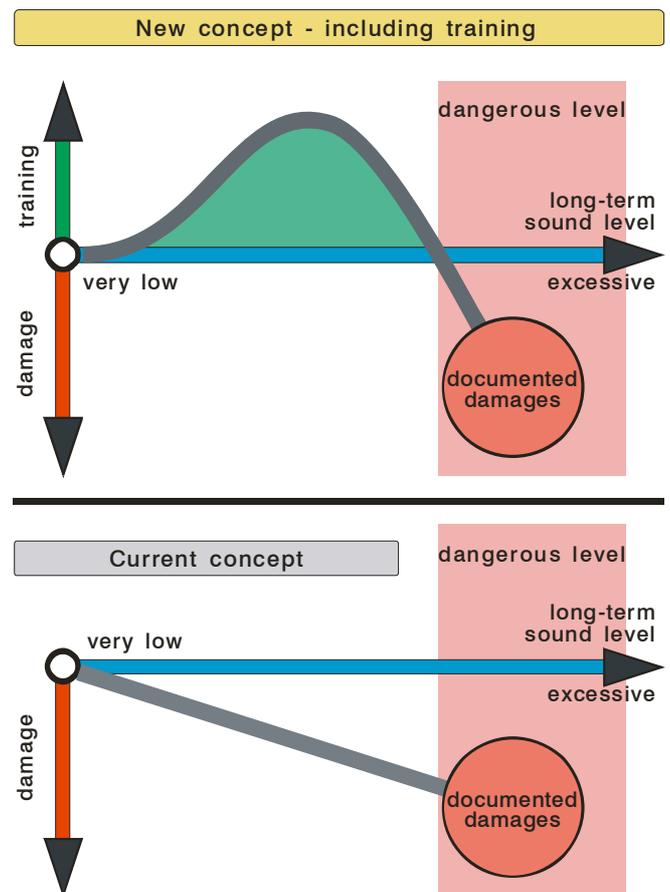
Exposure to sound varies enormously, and hence we examined a great variety of different groups while using the same procedures. Some of the major groups that have been dealt with, in central Europe : construction workers, office personnel, airline pilots, dentists, college students, university students, orchestra musicians, music teachers, amateur musicians, audio engineers, military recruits, military musicians, soldiers, military pilots, fans of discos, avoiders of discos. In China : Tibetan nomads, Tibetan monks, peasants in central mountains, persons in a metropolitan area. Nomads and peasants in remote parts of the central mountains live without technical noise, while life in big Chinese cities is very noisy from many aspects.

Comparing the sense of hearing among large numbers of persons, it is necessary to have special analytical tools. A new approach to this problem was developed. Typical ageing of hearing in Germany was worked out, and it turns out that it is similar to the ISO-values for persons not exposed to noise. This standard ageing extends up to 16 kHz, but the analysis was only applied up to 10 kHz, in order to avoid problems with persons of higher age. Next all audiograms were compared to the relevant ageing curve. If no audiometric value is more than 20 dB below the age-line, the ear is considered to have good hearing. However, if one or more audiometric values are more than 20 dB below the age-line, the ear is in the group with auditory damage. Hence, in every group, this procedure results in an automatic separation between good-hearing persons and those with auditory damage. Of course, good-hearing persons of various groups can be compared, and it is also easy to compare persons with auditory damage from various groups.

In order to determine the effect of noise on hearing, it is customary to have a noisy workplace and to determine the auditory performance of the persons who are exposed to these acoustic conditions. Because we are examining the sense of hearing in entire groups, we also used another procedure. We determined the auditory performance of the

various groups and worked out a ranking according to good hearing. After that we are asking in which acoustic environment are these persons living? To make a rough judgement about these acoustic conditions it is not necessary to have detailed Leq measurements.

### Auditory performance and acoustic environment



It turns out that the best hearing groups are all working in an environment that is characterized by a lot of sound. Typical are orchestra musicians and music teachers. But airline pilots are also hearing better than normal. Practitioners of dental medicine hear excellent. Analysing their curves indicates that their hearing is normal in the low-frequency range, but it is impressively improved at higher frequencies, where the drills and suction equipment produces the typical noise. While this sort of noise is really annoying, it appears to improve the sense of hearing in dentists. This shows that it is not necessary for sound to be judged as pleasant to improve the auditory threshold. But obviously sound can have positive training effects on hearing.

Looking at persons living in areas without technical noise - Tibetan nomads and peasants from remote parts of the central Chinese mountain range - do not hear as well as persons from loud environments, and they have much more auditory damage, caused by traditional fire crackers and other powerful impulses. But we see the same effect in Germany as well. Musicians, e.g. hear much better than office personnel from our University Hospital. – Persons in Germany, who go to the disco regularly, hear much better than, say, nomads.

Negative effects of discotheques are minor and not significant statistically. Persons who regularly go to discotheques and those who never go to discotheques hear practically equally well. Hence the discotheque is not training the hearing system, but a trained system can normally handle the acoustic onslaught of the disco.

Looking over all of the results indicates that sound affecting the ear repeatedly can have training effects, especially if it is not too loud, and if it has quiet periods in between. Interval training is obviously effective with the hearing apparatus.

The situation is similar to sports. Jogging, dancing, hiking, swimming, etc is good for the locomotory system, but high-powered sports is harmful and dangerous. It is the same with the auditory system. It apparently needs sound to fully develop its capacity and to remain in good shape. Music is good for the ear, however, it is not enough to sit in the grass and to look at the sheep and yaks, as nomads do for life.