



Noise and the Ear

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The Ear

The human ear is a remarkable organ. Essentially it is a very sensitive vibration sensor but is particularly designed to receive the minute longitudinal vibrations in air that make up sound waves.

The human ear is broken down into 3 parts: the outer, middle and inner ears. The outer ear is in essence a funnel that 'catches' and focuses sound waves down onto the ear drum or tympanic membrane. The middle ear takes the relatively low intensity vibrations of the eardrum and 'magnifies' them through 3 little bones: the malleus, incus and stapes respectively. Finally the vibrations of the stapes are transmitted through the oval window membrane to the fluids of the inner ear (cochlea). It is here, in the inner ear, that the fluid vibrations lead to bending of the minute hair cells of the cochlea. It is this bending that causes tiny electrical signals to be passed through the auditory nerve to the brain where they are interpreted as sounds that we can then make sense of.

The human ear can detect sounds from 20Hertz (very low pitch) to 20,000Hertz (very high pitch) but is particularly

sensitive to sounds in the range of 500-5000Hertz. These are the so-called speech frequencies and are especially important for human social communication.

The ear is also able to deal with a huge range of sound intensity (volume) from the quietest whisper or rustle of grass, to the sound of a jumbo-jet taking off! As the range of sound intensities (volume) which the ear can hear is so great, a logarithmic scale is used to measure the sound levels. This scale is called the decibel scale. So a sound of 20dB is not twice as loud as a sound of 10dB but in fact is 10 times as loud!

Unfortunately, the ear, and in particular the cochlea or inner ear, can also be damaged by exposure to too much of the energy it was designed to detect. In other words, too much noise can cause damage to the ear and even make you deaf!

Sound and noise

As examples of sound levels, a whisper is about 30dB, normal conversation is about 50dB, a busy bar 80-90dB and a noisy club can be 100dB or more. If, to have a conversation with a friend in a

club, you have to shout by their ear, the background noise level must be in the region of 100-105dB. This is a noise level that is 'safe' for less than 30 minutes!

To help work out how much noise the ear can safely cope with, scientists have developed something called the 'equal energy principle'. There is good evidence that the human ear can tolerate sound levels below 85dB almost indefinitely but with increasing sound levels above this, the chance of ear damage rises. Research suggests that 90dB is safe for about 8 hours (the typical working day). The equal energy principle then says that for every doubling of sound intensity above this, the safe time of exposure must half. As sound intensity is measured logarithmically, this means that a 3dB increase corresponds to a doubling of intensity. So, 93dB is therefore safe for 4hours, 96dB for 2 hours, 99dB for 1 hour and so on.

In the ear

At first, after relatively short periods of loud noise exposure, the ear suffers from something called 'Temporary Threshold Shift' (TTS). Most people have experienced this as the short-lasting upset to hearing and ringing in the ears (tinnitus) after say, an evening in a loud bar or club. Usually by the next day everything is back to normal. It is believed that TTS is due to metabolic exhaustion of the hair cells of the cochlea. This can recover with a period of 'rest' as the background noise levels fall.

However, if this type of noise exposure continues, over a prolonged period of

time, permanent changes may occur. This is called 'Permanent Threshold Shift' (PTS) and typically affects the higher speech frequencies around 4-6000Hertz. Initially the sufferer might not notice a hearing loss as such but rather a difficulty understanding what people are saying, particularly in the presence of background sound. As the high-tone hearing loss worsens, eventually an obvious hearing loss appears.

PTS is due to actual damage or even death of the delicate hair-cells of the cochlea.

One of the additional, and often more troublesome problems that follows permanent noise-damage to the inner-ear is tinnitus. This tinnitus is due to the damage to the hair-cells which then leads to an upset or alteration in the tiny electrical signals that pass up the auditory nerve to the brain. If the affected individual is unlucky, this new pattern of electrical signals may be recognised by the brain as a sound. The sound itself is as individual as the person suffering with it, but common descriptions include: a whistle, a whine, a high-pitch ringing or even a buzzing. For many people, tinnitus can be a far more troublesome symptom than any hearing loss which may be very mild indeed. Tinnitus can affect sleep, concentration and even one's mood. Luckily, although tinnitus is quite common, it is usually quite mild. For some people it can be very troublesome indeed.

Avoiding damage

Nowhere does the old adage of 'Prevention is better than a cure' apply more than to noise damage to the ear.

This is especially true as there is no cure as such; once the damage has been done, it is permanent. In reality the equal energy principle probably slightly underestimates the durability of the human ear. This means that the ear can probably stand relatively high noise levels for a period of 2-3 hours provided it doesn't have to do so too often. Once or twice a week in a loud club is probably reasonable; every night is not and is likely to lead to problems. If you are going to be exposed to high noise levels on a regular basis then you should use earplugs. People often worry that this might spoil their enjoyment of the music but in fact the research evidence suggests that if the noise levels are very high, then in fact you may hear things better with the earplugs in! The scientific basis for this is that in very high noise levels, the ear becomes 'saturated' with sound. If you block some of the sound out, then the ear is no longer 'saturated' and some of the receptors are 'freed-up' to listen to other things.

Try to take 'time-out'. Take a few minutes in every hour when you try and

go somewhere quiet, to literally give your ears a 'rest'.

Also important is to keep well hydrated. People often sweat in clubs and at parties and dehydration is not good for inner-ear function. So make sure you take plenty of fluids. And avoid too much alcohol in a noisy environment as this causes a specific fluid shift out of the inner ear which also causes problems and predisposes to damage. (It also explains why people often feel quite dizzy if they have drunk too much as the same process affects the fluid in the balance-controlling, semi-circular canals of the inner-ear.)

Finally, it is worth remembering that as we get older, everyone's ears and hearing deteriorate. This can add to a mild (and previously un-noticed) hearing loss picked up when younger. This can mean the appearance of a hearing problem much sooner in later life than normal and may be a real nuisance.

Your ears need to last a lifetime – look after them and they will!!

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This information is not a substitute for medical advice. You should always see your GP / medical professional

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