



Hyperacusis, Recruitment and Loudness Discomfort

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Continuous and loud noise is a source of irritation to most people. However some people have specially sensitive ears and are unable to tolerate ordinary levels of noise. Although this does occur in people with normal hearing, the commonest association of recruitment or loudness discomfort is with hearing loss. A situation familiar to many will be the response, often of an older person, having difficulty in hearing what you say, is, "Speak up a bit, I can't hear what you're saying !" and then "Don't shout ! I'm not deaf".

In this situation, hearing becomes impaired, usually due to the loss of tiny hair cells in the inner ear, most commonly for the high frequency sounds (bird calls, telephone bells etc.). Because the overall population of hair cells and nerve endings responsible for picking up sound in the inner ear is reduced, the ability to grade different intensities of sound is also impaired.

This means that as the intensity of sound increases above the threshold of hearing it very rapidly "switches on" (or "recruits") all remaining nerve fibres running from the cochlea producing a sensation of near maximum loudness.

Therefore even in the ear in which there is hearing impairment quite moderate intensities of sound in the environment may seem to be unbearably loud.

A normal ear is able not only to hear extremely quiet sounds (between 0 and 20dB hearing level) but can also tolerate very loud sound without discomfort (up to levels of 110dB hearing level). An ear with recruitment might well be unable to hear sounds, particularly high frequency sounds, below 50dB, but find any sounds above 80dB not only uncomfortable but liable to produce distortion.

Another way to look at this problem is to consider the ear rather like a musical instrument. Most instruments have what musicians call a dynamic range. They are able to play very softly (*pianissimo*) or very loudly (*fortissimo*). A normal ear is one not only with good hearing but with a full dynamic range for different intensities of sound. A recruiting ear is one in which the dynamic range is narrowed or contracted. If sounds are heard they are heard in musical terms as "*fortissimo*".

In addition to the recruitment effect in the cochlea, the brain plays a big part in

sensitivity to sound. When sounds reach the inner ear, they are coded into their individual frequency components. The 10,000 fibres in the auditory nerve carry information about the individual frequencies of each complex sound that we hear and 1/3 second later these reach the subcortex of the hearing part of the brain (in the temporal lobe) where conscious perception of sound occurs. Until the message reaches consciousness, no sound is heard.

During the passage of this coded signal it undergoes a great deal of processing, similar to a computer but more complex. The central auditory system is first of all concerned with extracting important messages from unimportant background noise. Often the signal is relatively weak in strength, but strong in meaning.

An example of this would be the detection of the quiet sound of a predator by an animal living in a hostile environment. Another example would be the ability to detect one's name across a crowded room, while other names, even if spoken quite loudly would go unnoticed.

Signal detection

In the subconscious part of the brain, an important signal is detected on the basis of previously learned experience. This signal may then be enhanced, and its passage facilitated in nerve pathways (referred to as neuronal networks) by changing of electrical resistance between nerve cells in the pathways. This is similar to the switching that occurs in the telephone exchange to allow one person to speak to another.

Pattern recognition

When the enhanced signal reaches the subcortex where conscious perception will occur, the electrical pattern has to be matched with another pattern that is held in our hearing memory. This pattern matching event may be very weak, resulting in a weak perception of sound. A strong pattern match results in a loud and intrusive sound perception.

The strength of pattern matching and consequent sound perception is governed by the limbic system (the centre of learning and emotion) and the prefrontal cortex (the part of the brain concerned with behaviour). The original purpose of this ability to amplify small signals and to suppress others was to facilitate the detection of potential threats in the environment.

The meaning of loudness

Although we usually hear more intense sounds as seemingly louder than quiet sounds, our perception of loudness is not dictated simply by the strength of intensity of the sound generating the perception. Some sounds become loud, intrusive and unpleasant because of their meaning or association.

This is almost universally true of the sound created by scratching chalk on a blackboard. In most cases the association has some threatening qualities; Will the sound damage ears? Will it disturb sleep? Will it reduce life quality by reducing periods of quiet recreation? Will they interfere with concentration? Very often the over-sensitivity for sounds is begun by an

irrational fear which nevertheless becomes a very strongly held belief.

This is commonly the source of distress in those who believe that their life is ruined by environmental noise from nearby factories, generators or low frequency sounds transmitted through the ground (which other people may be unable to hear). Because the central auditory processing mechanism is so powerful, it is possible to "train" it by constantly listening to, and monitoring small sounds. This turns them into very loud intrusive and unpleasant sounds which are constantly audible whether we like it or not.

The limbic system and emotional response

Changes in emotional state, particularly mood fluctuations or anxiety can increase overall arousal and make us more able to detect potential threats in our environment. These emotional changes can increase the apparent loudness and irritation of sounds to which we are already hypersensitive. In some people this results in the "global" hypersensitivity where all stimuli, whether they be visual auditory, olfactory (smell), taste or touch and pain are increased greatly in their perceived intensity.

Management of hyperacusis and loudness discomfort

Where there is hearing loss and a need for a hearing aid fitting, this must be done without overloading the ear with amplified sound. Many hearing aids, including most of those in the NHS range have "peak clipping", a form of

compression which stops loud sounds entering the hearing aid from being over-amplified. A more sophisticated form of compression known as automatic volume control is incorporated into the majority of private hearing aids.

It is adopted in the new range of NHS aids. In fitting hearing aids to sensitive ears, it is best to leave the ear canal as unoccluded as possible. Where there is simply a relatively small high frequency hearing loss, an "open" mould should be used. Where more amplification is needed, the mould should be vented to allow the escape of unwanted high levels or low frequency sound. Trials with different sorts of ear moulds can often be very helpful.

White noise generators

Recent research has shown that the use of white noise applied to the ear by a white noise generator (previously termed "masker") can in many cases help in the eventual abolition of abnormal discomfort from loud sounds.

This is particularly true in the group who have normal or near normal hearing. White noise needs to be applied very gently and gradually to the ear beginning at a very low level, and under the supervision of an audiologist with experience in this process of desensitisation.

The technique should be combined with appropriate counselling and behavioural techniques for controlling anxiety, such as relaxation therapy.

Counselling in hyperacusis

Where there is an irrational fear that normal environmental noises may be damaging, it is important to "retrain" the auditory system both at a conscious and subconscious level to respond in a more appropriate manner. This involves the examination and discussion of the reasons behind the development for the

hypersensitivity and the fears held by the individual, whether felt to be real or imaginary, about the effects of such noises and the strong emotions that they evoke.

The whole process of desensitisation can take quite a long time, commonly six months to a year, but is achievable in most cases.

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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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