PSYCHOACOUSTICS REVISITED

PERCEPTION OF TIMBRE:

Timbre is quality of sound that distinguishes one voice or musical instrument from other.

Timbre depends on:

- Whether the sound is periodic, having a tonal quality for repetition rate of 20-20,000 Hz or having a noise like quality.
- Whether it is continuous or interrupted.
- Distribution of energy over frequency i.e. its spectrum and changes that occur in this spectrum over time.
- Sounds containing predominantly high frequencies have a sharp timbre- whereas those containing mainly low frequencies sound dull or mallow.
- The components in a complex sound are partially separated by auditory filters and the distribution of the excitation at the output of the filters as a function of centre frequency-determines timbre.

TEMPORAL RESOLUTION OF THE EAR:

- Auditory system is well-defined to detecting change in sound as function of time. (Measuring threshold for detecting a temporal gap in sound). Many gap-detection experiments agree quite well with threshold value being 2 to 3 m seconds.
- A more general characterization of the temporal resolution can be obtained by measuring the threshold for detecting changes in amplitude of sound as a function of rapidity of changes.

LOCALIZATION OF SOUND:

Slight differences in sound reaching the two ears can be used as a cues in sound localization.

The major cues are:

- Differences in the time of arrival at the two ears.
- Difference in intensity at the two ears.
- For pure tone stimulation- a difference in time of arrival is equal to phase differences between the two sounds at the two ears. However, these differences are not usable over entire range. Phase difference becomes ambiguous at high frequencies. On the other hand, at low frequencies, human accuracy at detecting changes in relative time at the two ears is remarkably good.
- Intensity differences between the two ears are primarily useful at high frequencies.
- Low frequencies bend or diffract along head.
- At high frequencies head casts 'shadow' and at 2-3 KHz intensity differences are sufficient to provide useful cues.
- The idea, that sound localization is based on inter-aural time difference at low frequencies and inter-aural intensity at high frequencies has been called 'duplex theory' of sound localization.
- Since most sounds we encounter in everyday life are complex, have repetitive rates below 600 Hz. Inter-aural time differences are used for localization in most listening situation.

ROLE OF PINNA:

- Binaural cues are not sufficient to account for all sound localization capability. A simple difference in time does not explain our ability to determine whether sounds are coming to determine whether sounds are coming from which direction. Localization with one ear can be as accurate with two ears. The role of pinna in sound localization has been emphasized in recent years. They do so because spectra of sound entering the ear are modified by the pinnae in a way which depends on direction of sound.
- They also help to differentiate if sounds are coming from within the head or outside world.
- Pinnae alter sound spectrum at high frequencies. Only when the wave length of sound is comparable with dimensions of the pinnae, is the spectrum significantly affected. This is mostly above 6 KHz.
- People with high frequency loss cannot benefit from directional information provided by pinnae.
- Even if microphone is placed appropriately within pinna the response of most aids is limited to frequencies below 6 KHz.

PRECEDENCE EFFECT:

It plays an important role in localization and identification of sound in reverberant conditions. So that at high intensities sound appears as loud in the impaired as it would in the normal ear. The effect is most easily demonstrated when only one ear is affected, since loudness matching can be made between the two ears.

RECRUITMENT:

- The presence of recruitment can limit usefulness of conventional hearing aids (In these hearing aids gain is set to make low intensities clearly audible-high intensity sounds become uncomfortably loud).
- Recruitment can be because of impaired frequency selectivity. If tuning curves or auditory filters are broader than normal, then as intensity of a tone is increased above the threshold, then activity will spread across nerve fibres array more rapidly than normal. This rapid spread of activity could be the reason for rapid growth of loudness with intensity.
- The second view point is that recruitment is because of loss of active mechanism in cochlea. This mechanism boosts response to weak sounds in a normal ear but it has little influence on intense sounds. Hence when active mechanism is damaged, the response to weak sounds is reduced, making these inaudible but response to loud sound is almost normal.

PERCEPTION OF SOUND BY HEARING IMPAIRED:

In listeners with hearing impairment of cochlear origin there is loss of frequency selectivity. Its consequences are:

Greater susceptibility to masking by interfering sounds.

In every day situation at the output of auditory filters tuned to desired frequency, the signal is passed and much of background noise is attenuated. When auditory filters are broader than normal –rejection of background noise is much less effective. Thus background noise disrupts the detection and discrimination of sounds including speech.

Difficulty in understanding speech in noise is a feature of cochlear type of hearing loss.

Intelligibility of speech is related to frequency selectivity (especially in noisy background).

A related difficulty arises in perceptual analysis of complex sounds such music or speech.

Damage to the inner ear, often results in abnormality of loudness perception- known as loudness recruitment. Although absolute thresholds may be elevated, the rate of growth of loudness is more rapid.