

## Sensorineural hearing loss & digital hearing aids

### Sensorineural hearing loss

A sensorineural hearing loss due to presbycusis typically develops very gradually. As a result, people often tend to be unaware that they have developed a hearing loss, without conscious denial of the hearing loss necessarily being an issue. Many clients present for a hearing assessment at the urging of their partner/families who may be more likely to notice misheard conversations as well as being at the receiving end of impaired communication. High frequency hearing is initially affected, with typical early symptoms being a reduced ability to follow speech in competing noise.

### Technological considerations

Digital signal processing hearing aids are no longer a new innovation and are the primary choice of technology used today. With a digital hearing aid, the hearing aid circuit is based on a computer chip providing clear, undistorted sound amplification, which can be readily manipulated to suit individual requirements. The technology continues to rapidly develop, particularly in improving speech perception in noise. Contemporary hearing aids automatically adjust and set the required volume for each sound heard, providing sufficient volume for soft speech sounds, while at the same time restricting the growth in loudness of louder environmental sounds. This eliminates the need for a volume control, unless required for a fluctuating hearing loss or preferred by the client.

Sophisticated algorithms available in digital hearing aids assist frequency and temporal resolution, improving speech intelligibility. This is of particular benefit when listening to speech in competing noise.

### Frequency Selectivity

Frequency selectivity is our ability to hear or separate the different frequency components in a complex sound. It is important in the perception of loudness, timbre and pitch, and is commonly impaired in sensorineural hearing loss. This leads to considerable difficulty in understanding speech, particularly in noisy situations.

Hearing aids with multi-channel amplifiers have the capacity to selectively amplify specific regions of the speech signal, so that the low and high frequencies may receive a completely different amplification strategy.

### Temporal Resolution

Temporal resolution is our ability to follow changes in the time pattern of sounds, and a decline in temporal resolution ability is common in sensorineural hearing loss. Without it we cannot detect or analyse the rapid changes that are crucial in distinguishing different speech sounds. Poor temporal resolution ability can cause speech to sound blurred or indistinct, as if people are mumbling all the time.

## Directional microphones

Directional microphones amplify sound in front of the wearer only, improving the signal to noise ratio. This offers improved intelligibility even in reverberant environments. The more sophisticated hearing aids provide adaptive directional microphones, automatically limiting amplification from the direction of greatest noise.

## Multiple listening programs

Most hearing aids offer multiple, different programs for various listening environments (eg: conversation in quiet, conversation in noise, telephone, telecoil, music, FM listening), which in most cases can be separately adjusted and fine-tuned. Some models automatically select the appropriate listening program depending on the noise level and types of sounds in the environment.

Some people prefer to maintain a higher level of control over the performance of their hearing aids, using a program selection switch. Some brands offer program and volume adjustment with a remote control.

## Hearing aid styles

Hearing aids are available in either a behind-the-ear (BTE) style or are fully contained in the ear. The choice of hearing aid style will be determined by the technology required for the client's communication needs and level of hearing loss; by their preferences with regard to the appearance and relative visibility of the hearing aids; by the client's manual dexterity ability; and by the size and shape of their ears.

Slim tube, micro BTE hearing aids have been designed for people with a mild, ranging to severe, mid and high frequency hearing loss. They are the most commonly used hearing aid style nowadays, because of their many advantages and because this is the most common pattern of hearing loss.

These aids significantly improve speech discrimination in noise, without fully occluding the ear canal. As a result they are more comfortable, clients adjust to the amplification provided more quickly, and own voice distortion is minimal. They were designed to be discreet and look more attractive than traditional BTE hearing aids.

These aids are highly effective for clients who have rejected hearing aids in the past due to difficulties adapting to amplification and/or occlusion.

While not all clients with a mild hearing loss need (or will recognise their need for) technological support, those that do can now be easily helped.

The popularity of the slim tube, micro BTE hearing aid has resulted in the hearing aid manufacturers competing to produce the smallest possible BTE size hearing aid. A greater degree of miniaturisation has been made possible by placing part of the hearing aid circuitry inside the ear canal. Apart from this cosmetic advantage, this style of hearing aid allows low frequency or bass amplification if this is required to suit the pattern of hearing loss.

A disadvantage is that the circuitry component partially blocks the ear canal creating a greater degree of occlusion or blockage, and is more vulnerable to moisture, wax and debris from the ear canal.

Those with a severe to profound hearing loss will not obtain sufficient amplification with micro BTE hearing aids and slim tube, and will require a larger BTE hearing aid, wider tubing and a mould that fills more of the ear.

In-the-ear hearing aids are fully contained in the ear, customised to fit, and block or occlude the ear canal. They are available in a range of sizes: completely-in-the-canal CIC, in-the-canal ITC, in-the-ear ITE. These aids use the natural direction-finding features of the external ear to locate sounds, and can provide sufficient power for most mild to moderately-severe hearing losses, but are not powerful enough for a more severe/profound hearing loss.

## One or two hearing aids?

There are many binaural psychoacoustic phenomena that improve speech perception:

- Binaural listening gives a loudness summation of up to 6 dB.
- The ability to localise speech sounds can be reduced if the interaural hearing threshold difference is as little as 10 dB.
- Binaural hearing enables speech intelligibility to be significantly enhanced when either the speech signal or the noise is out of phase, providing improved speech discrimination over monaural hearing in a noisy environment.
- With a severe hearing loss, a period of central auditory deprivation due to an unaided ear can make it difficult to adjust to amplification from that side.

Binaural hearing aid fitting is therefore preferable to monaural, unless the hearing loss is markedly asymmetric; speech discrimination is poor in one ear; or medical reasons contra-indicate the use of a hearing aid in one ear.

## Hearing aid selection

There is a broad range of hearing aids available, with six major companies to choose from in Australia. Ideally, the client is guided in making an informed choice, taking into account the required level of technological sophistication, the size and the cost.

Hearing aid companies generally offer a period ranging up to 90 days after purchase to return hearing aids if the client is not satisfied with their choice, and this should be clarified when the hearing aid is selected. In our opinion, the dispenser should indicate the reasons for recommending a particular company, and include a return/exchange option.

The level of technological sophistication should be matched to the client's communication needs, handling abilities and budget. People who rarely communicate in groups or significant levels of background noise may not require a sophisticated and expensive level of hearing aid technology.

Cosmetic concerns, ease of handling/dexterity and degree of hearing loss will influence the choice of size and appearance of the hearing aids. Inappropriate hearing aid choice can increase the level of hearing disability experienced by the client if they cannot manage the complexity or size of their hearing aids.

### Neural adaptation to amplification

The central auditory processing of sound includes the subconscious selection and highlighting of sounds that are important to us. Unimportant sounds are heard, but not fully perceived, unless we consciously pay attention to them. Because of the gradual onset of most sensorineural hearing losses, a person with a hearing loss will slowly change their concept of "normal" hearing.

With an initial hearing aid fitting, the client's concept of "normal" hearing will need to be redefined and the process of subconscious selection will need to be re-learned, which can take up to several months. They will notice that unimportant sounds will seem both loud and unnaturally prominent through their hearing aids at first. This is a major reason for hearing aid rejection in an unprepared client and rehabilitative support during this period is essential for successful hearing aid fitting.

Gradually easing clients towards the level of optimum amplification for their hearing loss will help acceptance of amplification. The programming software with most brands allows for a series of adaptation levels to be set up in the aids, so the clinician can easily carry this out.

Many people approach hearing aid use as likely to be required on an occasional basis only. However, encouraging clients to wear their hearing aids most of the time will ensure that their concept of "normal" hearing will be successfully redefined. A result of this process is that the client will become reliant on their hearing aids and notice increased difficulties communicating without them, as they lose any mechanisms and strategies they had automatically developed to compensate for their hearing loss. Reassurance is needed that this is an inevitable part of a successful hearing aid fitting, and that hearing aid use has not caused their hearing to deteriorate.

### Competent dispensing

Hearing aid technology has become increasingly sophisticated, so that the skills required by the clinician fitting and finetuning hearing aids have substantially increased. There is no formal regulation of the minimum level of training and experience required by hearing aid dispensers to protect the consumer. University trained audiologists have the diverse range of skills and training to be able to adequately apply this technology.

The consumer alone rarely has a sophisticated enough level of understanding of the process to protect them from inadequate hearing assessment, inappropriate advice with regard to hearing aid selection, uncomfortable fit, inadequate application of the technology, overcharging and lack of rehabilitative support. There is no recommended retail price on hearing aids, and each dispenser is free to charge what they wish.

Hearing aids cannot totally overcome the perceptual distortions produced by a sensorineural hearing loss - they are an aid, not a solution. Clients and their families should be made aware of both the advantages and the limitations of hearing aid use generally, as well as with their particular hearing aid choice.

### Finally....

Communication is a complex process, and the fitting of appropriate hearing aids is only one part of an effective aural rehabilitation program.

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