A MUSIC LISTENING QUESTIONNAIRE
FOR HEARING AID USERS

A thesis submitted in partial fulfilment of the requirements for the Degree of Master of Audiology

in the University of Canterbury

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List of Abbreviations

ANOVA: Analysis of Variance

BM: Basilar Membrane

CI: Cochlear implant

dB: Decibel

dB HL: Decibel Hearing Level

dB SPL: Decibel Sound Pressure Level

DNR: Digital noise reduction

HA: Hearing aid

MTP: Music Training Program

OHC: Outer Hair Cell

IHC: Inner Hair Cell

MTP: Music training programme

PTA: Pure Tone Average

QOL: Quality of Life

RM ANOVA: Repeated Measures Analysis of Variance

SD: Standard deviation

SRT: Speech Reception Threshold

UCMLQ_CI: University of Canterbury Music Listening Questionnaire for Cochlear Implant Users

UCMLQ_HA: of Canterbury Music Listening Questionnaire for HA Users

WDRC: Wide Dynamic Range Compression

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Abstract

To date, very few studies have been conducted focusing on ratings of music and music listening experience of hearing aid (HA) users. This study aimed to collect more detailed and descriptive information via a questionnaire, on the music listening experience and ratings of musical sounds from postlingually deafened adults. The following hypotheses were posed: (i) ratings for music from HA users who have been assessed for a cochlear implant (HA-CI group) will be worse than those who have not been assessed for a CI (HA-NCI group); and (ii) HA users with a moderate or worse hearing loss (Moderate+ subgroup) will provide lower ratings for music than those with a mild hearing loss (Mild subgroup). A questionnaire by She (2008), was modified for this study, and subsequently called the University of Canterbury Music Listening Questionnaire – HA version (UCMLQ_HA). The questionnaire was divided into the following seven sections: music listening and music background, sound quality ratings, music styles, music preferences, music recognition, factors affecting music listening enjoyment, and a music training programme. Thirteen HA-CI recipients and 98 HA-NCI recipients returned the questionnaire. The HA-NCI group was divided into two subgroups: mild hearing loss (n = 51), and moderate or worse hearing loss (Moderate+; n = 47).

Essentially findings were consistent with hypothesis one, but only partially consistent with hypothesis two. The HA-CI group provided lower ratings for 'pleasantness' and 'naturalness' of instruments ($p = 0.007$), and found music styles to be less 'pleasant' ($p < 0.001$) than the HA-NCI group. For musical styles, the HA-CI group preferred solo performers whereas the HA-NCI group preferred groups of performers. In addition to ratings of music, the HA-CI group provided significantly lower ratings for music listening ($p = 0.001$), and overall music enjoyment ($p = 0.021$) than the HA-NCI group.

For the comparisons between the Mild and Moderate+ subgroups, the Mild subgroup found Instruments to sound significantly 'less noisy' ($p < 0.001$) and 'less sharp' ($p < 0.001$) than the Moderate+ subgroup. The Moderate+ subgroup provided higher ratings for overall enjoyment of listening to music with HAs than the Mild subgroup ($p = 0.044$). Both subgroups rated the drum kit (the lowest rated Instrument) to be significantly less pleasant and less natural than all other Instruments. It was also found that all musical styles were significantly more pleasant than Pop/Rock.

There were similarities between the groups for music preferences; the male singer was significantly preferred over female singers ($p = 0.021$), and low-pitched instruments were significantly preferred over high-pitched instruments ($p = 0.04$). Classical music was also selected as the style that sounded the best with their HAs and listened to the most often. Almost all of the respondents indicated that they would like music in general to sound it would to those with normal hearing (97.1%). Close to 30% indicated that they would be interested in an MTP and would like it to focus on a wide range of music and feature commonly known tunes. In addition, training sessions should consist of two 30 minute sessions per week.

Overall this study indicates that ratings of music differ with level of hearing loss to some degree. The general consensus was that music did not sound as they would expect it to sound to a person with normal hearing, and that respondents would like to enjoy listening to music more.

1. Introduction

1.1 The Ear and Hearing

The peripheral auditory system is comprised of three main parts: the outer, middle and inner ear (Figure 1). The outer ear collects the acoustic pressure waves which travel through the auditory meatus and vibrate the tympanic membrane. These vibrations are transmitted in the middle ear by the ossicles (incus, malleus and stapes). These vibrations cause the movement of the stapes footplate, which is attached to the oval window of the cochlea which initiates the movement of fluids in the inner ear. The pressure fluctuations of the fluids initiate a wave of displacement along the basilar membrane in the cochlea. On the basilar membrane (BM) there are two types of hair cells: outer hair cells (OHCs) and inner hair cells (IHCs). The OHCs increase the vibration of the BM and the IHCs detect this vibration and release neurotransmitters that cause the auditory neurones to fire. In effect, this translates mechanical information into neural information. Through these neural impulses, information regarding the acoustic stimulus is transmitted to the brain (1998; Wilson & Dorman, 2008).

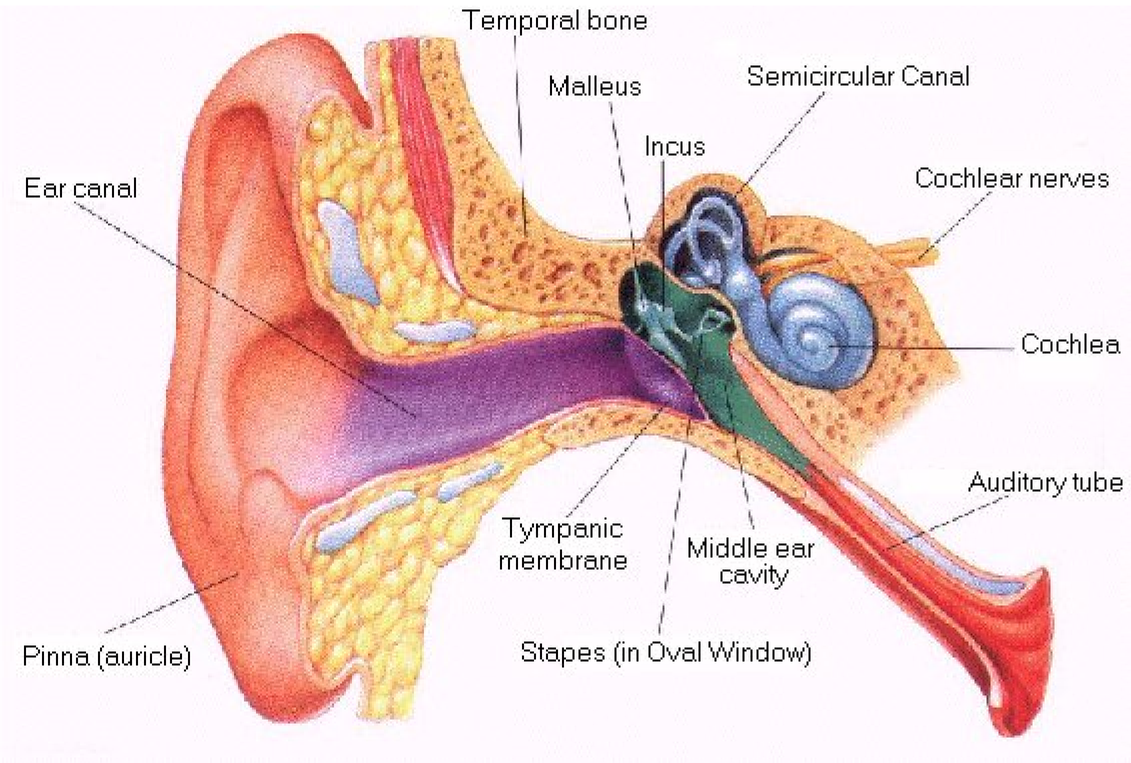


Figure 1: The outer, middle and inner ear (*The human ear*, 2008)

The cochlea is tonotopically arranged whereby high frequency stimuli reach maximum vibration amplitude at the basal end of the cochlea, which is narrow and stiff, and low frequency stimuli reach maximum vibration at the apical end of the cochlea, which is wide and flexible. Effectively, a normally functioning BM can be likened to a series of band filters, in which the input signal is divided into the specific frequency components (Moore, 2007a). If the stimuli consists of multiple frequencies, maximal displacement will occur at different points along the BM. Each point on the BM is tuned whereby certain regions of the cochlea is maximally displaced at a certain frequency, otherwise known as the characteristic frequency.

1.1.1 Classification of Hearing Loss

There are numerous causes of hearing loss. There are three main types of hearing loss: sensorineural, conductive, and mixed. A sensorineural hearing loss is typically caused by abnormality in the cochlea (e.g. reduced number of OHCs) and/or the neural structures. It is the most common form of hearing loss. A conductive hearing loss is characterised by the inefficiency of sound transmission through the outer and/or middle ear. In effect, sounds are attenuated before they reach the cochlea. In most cases, conductive losses can often be alleviated either medically or surgically. A mixed hearing loss is a combination of sensorineural and conductive components (Kim & Barrs, 2006; Margolis & Saly, 2007). Further, abnormality in the structures or neural systems beyond the cochlea is referred to as retro-cochlear hearing loss (Moore, 2007b). This study involves respondents with primarily with sensorineural hearing loss, but also conductive, and mixed hearing losses.

The audiogram is clinically used to describe hearing loss by illustrating measured thresholds of hearing (i.e. the minimum detectable level of a sound in the absence of any other external sounds) at particular frequencies. Hearing loss is also typically characterised by the audiogram configuration, severity and site of lesion (Margolis & Saly, 2007). Configuration refers to the shape or pattern of the hearing loss as depicted on the audiogram. Typical configurations defined Margolis & Saly (2007) are:

- *Flat* is a hearing loss where all thresholds are generally within a 20-dB range
- *Sloping* is a hearing loss that has a generally downward slope. A sloping hearing loss may be flat over a portion of the frequency range and typically worse in the higher frequencies than the lower frequencies
- *Rising* is similar to *Sloping* but in the reverse direction
- *Trough* is a hearing loss that is most severe in the middle frequencies

- *Peaked* is to the reverse of a trough but with best hearing in the middle frequencies

Hearing thresholds that are less than 20 dB HL are considered as within the normal range. Severity ranges in levels from mild to profound, as shown in Table 1.

Table 1: Severity Levels of Hearing Loss (Jerger & Jerger, 1980**)**

Normal Hearing	-10 to 20 dB HL
Mild Hearing Loss	21-40 dB HL
Moderate Hearing Loss	41-55 dB HL
Moderately Severe Hearing Loss	56-70 dB HL
Severe Hearing Loss	71 to 90 dB HL
Profound Hearing Loss	> 90 dB HL

1.2 The Effects of Cochlear Hearing Loss on Speech Discrimination

As mentioned earlier, a sensorineural is the most common type of hearing loss in adults. It can result from a range of cochlea pathologies including congenital causes, presbycusis, viral infections, exposure to ototoxic drugs, physical trauma, and cochlea malformations. In addition to reduced audibility other considerations include reduced frequency selectivity; loudness recruitment, distortion, reduced dynamic range; and dead regions of the cochlea (Moore, 2007a; Pickles, 1988).

Decreased audibility of acoustic sounds, means that certain speech and environmental sounds will be missed. Low frequency components of speech are typically stronger than the higher frequency components of speech (Byrne et al., 1994). Although hearing impaired people may be able to ‘hear’ speech, their comprehension may be poor as the other high frequency information may be masked by the low frequencies. Research suggests that audibility is essential for speech intelligibility; however it is not the sole cause of poorer performance in speech perception tasks (Moore, 1996, 2003b). If the speech spectrum is below a person’s threshold or masked by background noise, information is lost and intelligibility will suffer to some extent (Moore, 2003b). An example of speech and environmental sounds in relation to intensity and frequency are plotted on the audiogram below Figure 2. The extent to which one is affected depends on the degree and configuration of their hearing loss. For example, an individual with a severe to profound loss (unaided) may not hear any speech sounds, whilst a person with a mild hearing loss may be able to follow all conversations in good listening conditions.

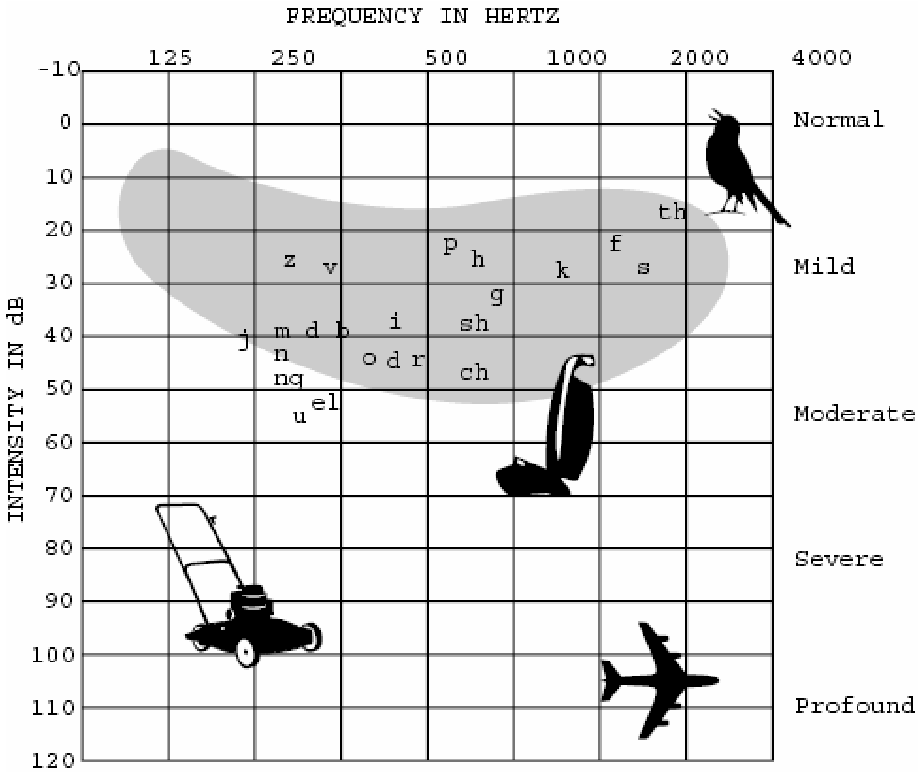


Figure 2: Audibility of speech sounds (*Hearing loss association California*, 2008)

Reduced frequency selectivity is another consequence of cochlear hearing loss. Moore (2003b) describes frequency selectivity as the ability of auditory system to effectively separate or resolve spectral information within a complex signal, particularly when frequencies are close together (e.g. speech). Frequency selectivity is dependent on the filtering that takes place in the cochlea. Research suggests that auditory filters tend to be broader in people with a cochlear hearing loss compared to a person with normal hearing (Moore, 1996, 2003b, 2007a), which means they may experience more difficultly in determining the spectral shapes of speech sounds and in separating components of speech from background noise compared to a person with normal hearing. The extent of difficulty depends on the degree of hearing loss (Moore, 2003b, 2007a).

Elevated hearing thresholds can also result in loudness recruitment. As sounds are increased in level above the person's absolute threshold, the rate of loudnesss growth of with increasing sound level pressure (SPL) is greater than normal. This is associated with having a reduced dynamic range which refers to the range between the absolute threshold and the level of discomfort. Hearing impaired individuals typically have reduced dynamic ranges compared to individuals with normal hearing; the absolute threshold is elevated, but the level at which sounds come uncomfortably loud is the same as a person with normal hearing (Moore, 1996). Research has shown that loudness recruitment can lead to distorted loudness relationships among the components of speech sounds (Moore, 2003b).

A dead region can be referred to as a region along the BM where IHCs are absent and/or neurones are not functioning (Kluk & Moore, 2006; Sek et al., 2005). Dead regions can be characterised in terms of the characteristic frequency of the adjacent IHCs and/or neurons of this region. This is referred to as off-place (off-frequency) listening, whereby the bordering functioning IHCs and or neurons respond to the acoustic stimuli (Kluk & Moore, 2005: Sek, et al., 2005). Dead regions are not easily detected by a pure tone audiogram. Consequentially, dead regions can impact the transduction of BM vibration (Moore, 2003b); tones with frequencies corresponding to a dead region often sound 'noise-like' or 'distorted' (Huss & Moore, 2005).

These characteristics affect speech intelligibility particularly in the presence of background noise. The loudness of speech typically comes from the lower frequencies, and although hearing impaired people may be able to detect the presence of speech, their comprehension is poor as the high frequency information is weak and often masked by the low frequencies. This is commonly referred to as the upward spread of masking (Dillon, 2001). Hearing aids are the main rehabilitative device used to help overcome some of these negative effects of hearing loss and will be discussed in the following section. For a more extensive review of the perceptual consequences of cochlear hearing loss refer to Moore (1996).

1.3 Hearing Aids

Hearing aids (HAs) are designed to increase and restore, through amplification, audibility of acoustic sounds and of those parts of the speech spectrum that are below the listener's threshold (Ching, Dillon, & Byrne, 1998; Dillon, 2001). Research suggests that HAs can enhance the quality of life of hearing impaired adults (Cohen, Labadie, Dietrich, & Haynes, 2004; Mulrow et al., 1990; Yueh et al., 2001). The amplification needs to be frequency dependent due to the typically varying degree of hearing sensitivity across frequencies (Kim & Barrs, 2006). The basic components of a HA are the microphone, amplifier and the receiver, as shown in Figure 3.

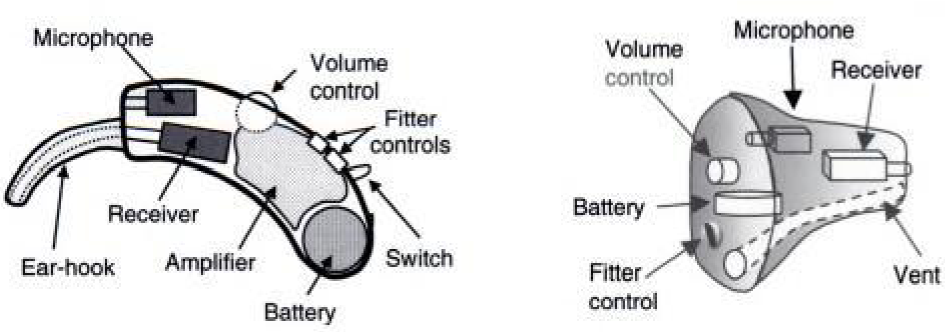


Figure 3: Typical location of Basic components of a BTE (left) and ITC (right) HA (Dillon, 2001)

1.3.1 Microphones in HAs

The microphone picks up the acoustic signal and transforms it into an electrical signal. There are two types of microphones: directional and omni-directional. Directional microphones endeavour to aid speech recognition by retaining the sensitivity of sounds coming from a certain direction (e.g. in front of the listener), whilst an omni-directional microphone (non-directional) has a single port which gathers sounds around the listener (Banerjee & Garstecki, 2003; Dillon, 2001). HAs with direction microphones create a polar pattern where a point relative to the microphone has greatest sensitivity, as illustrated in Figure 4, whereby the maximum amount of sensitivity occurs on the side of the person wearing the HA. There are also adaptive directional microphones which adapt in and out of omni-directional and directional modes depending on the environment the listener is in (Dillon, 2001; Kim & Barrs, 2006).

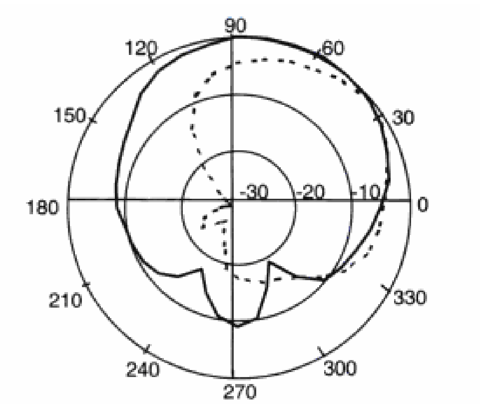


Figure 4: Polar responses for an omni-directional and directional microphone in a BTE HA (Dillon, 2001)(The solid denotes sensitivity omni-directional microphone. The dotted lines indicate directional microphone sensitivity, mounted on a head at 2 kHz)

1.3.2 Sound processing in digital HAs

Digital HAs use digital signal processing (DSP), which is a signal sampling technique which changes the acoustic signal via a series of mathematical computations as illustrated in Figure 5. The digital sample of the signal is processed according to an encoded algorithm in the central processing unit of the amplifier, where it can be manipulated in terms of a predetermined frequency response and overall level of gain. Algorithms refer to the processes or rules for the digital calculations involving the signal detection and analysis unit, decision rule and time constants involved in the execution of the decisions HAs make when they process sound (Chung, 2004a). DSP algorithms differ among manufacturers and whilst general descriptions of the algorithms and strategies are available on manufacturers websites, specific functional details are not readily available because the features are proprietary (Parsa, 2006). Processing in the amplifier also allows for the digital alteration of the original signal using automatic features such as compression, noise reduction, adaptive microphone directionality and feedback cancellation. Many of these adaptive and automatic features have been implemented into digital and are executed via signal processing algorithms as described above.

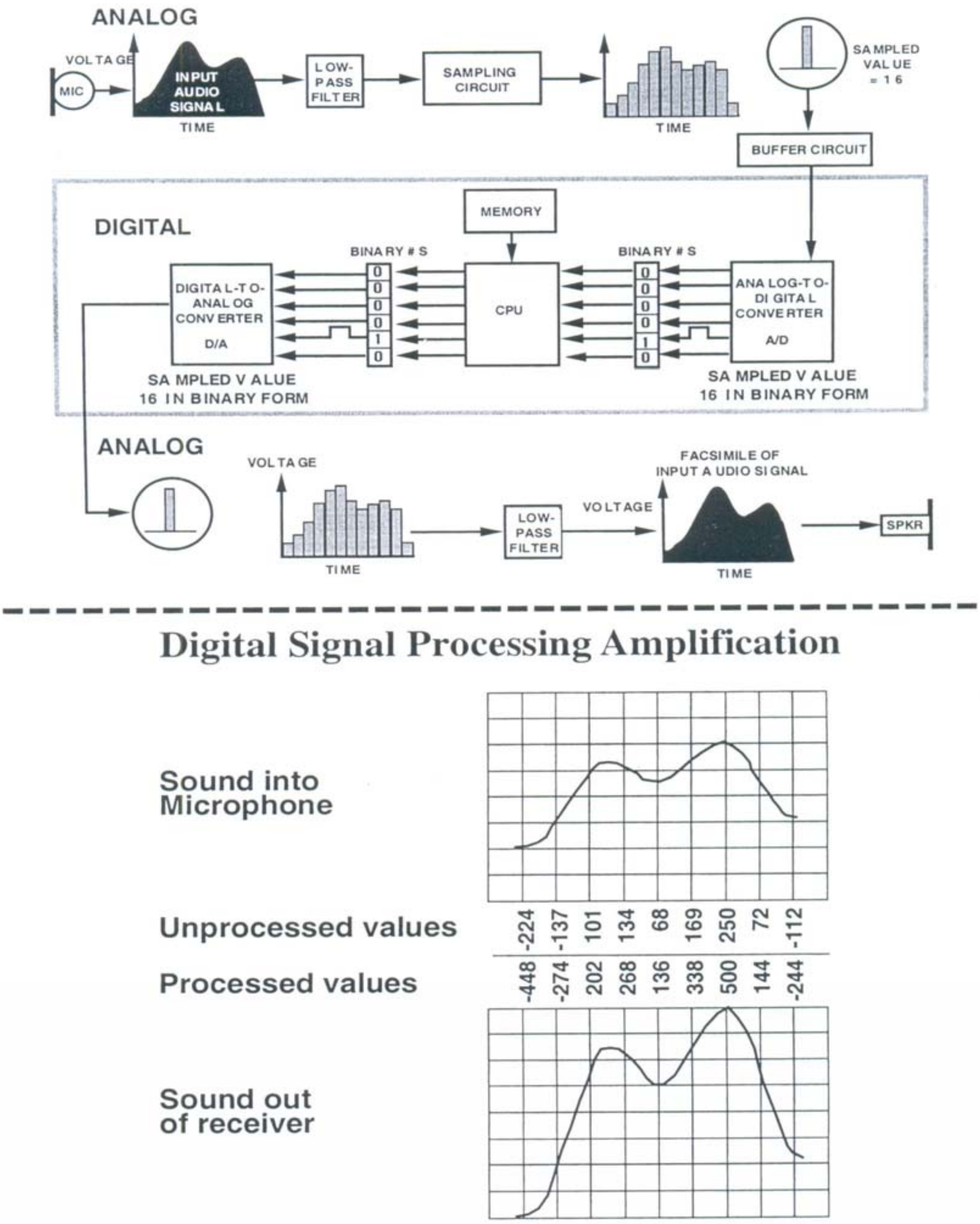


Figure 5: Digital Hearing Aid Block Diagram and Digital Signal Amplification (Staab, 2002)

The extent of manipulation is determined in a large part by the amount of gain prescribed for the individual's hearing loss, typically according to prescriptive formulae, in order to restore the audibility of soft, medium and loud sounds over as wide a frequency range as possible (Dillon, 2001; Staab, 2002). For a multi-channel HA, the signal can be divided into a number of different frequency bands, each of which can be adjusted independently. The filtered signal is then recombined and converted back into an acoustical signal and presented from the receiver (loud speaker) to the ear canal; these amplified signals stimulate the hair cells of the cochlea (Kim & Barrs, 2006; Palmer & Ortmann, 2005).

Difficulty hearing speech in noise is a common complaint amongst HA users (Chung, 2004a; Kochkin, 2002). Speech recognition of HA users in noisy or multi-talker situations is significantly poorer that for a single speaker in a quiet listening environment (Baer & Moore, 1994; Van Tasell & Yanz, 1987). As previously stated, HAs endeavour to preserve the speech signal and present it at a level that is audible and comfortable for the listener. Compression is one feature that is designed to prevent sounds from becoming uncomfortably loud for the listener by providing high level gain for low-level sounds, whilst reducing the gain of high level sounds. It is used in HAs to compensate for the issues of loudness recruitment and reduced dynamic range (Dillon, 2001; Moore, 2008). Typically, digital HAs are set up to amplify using wide dynamic range compression (WDRC). WDRC endeavours to improve speech intelligibly via fast automatic gain adjustments providing a lower amount of gain at higher input levels to aid comfort for loud sounds and gain for lower speech sound to improve audibility. It allows a wider input dynamic range to be amplified than other compression strategies (Davies-Venn, Souza, & Fabry, 2007). Since algorithms vary among manufacturers, there are various WDRC strategies involving differing input/output relationships as a function of input intensity, and different compression attack and release times for different input signals. Generally, brief rapid- onset intense input sounds are dealt with using very brief compression attack times, whereas speech signals lead to typically slower release times to minimise the distortion of the speech signal (Dillon, 2001).

Noise reduction is another strategy which aims to increase listening comfort and speech intelligibility. Noise reduction strategies can be employed via directional microphones or through digital noise reduction (DNR) algorithms. Directional microphones focus on the spatial differences between speech and noise whereas DNR algorithms focus on the temporal separation and spectral differences between speech and noise (Chung, 2004a). There are various manufacturer-specific DNR algorithms which acoustically analyse the incoming signal and adjust the gain and output characteristics according to a set of pre-determined rules. In multi-channel HAs, the input signal is filtered into several frequency bands, and the analysed individually so that level in reduced in the bands that are dominated by noise (Bentler & Chiou, 2006). Although DNR can increase listening comfort in noise some research suggests it provides little change in speech understanding (Walden, Surr, Cord, Edwards, & Olson, 2000).

Feedback cancellation systems are another feature which endeavour to increase comfort for the HA wearer. Feedback occurs when sound escapes the ear canal and is fed back to the input (microphone) where the sound is amplified with signals arriving simultaneously at the input (Dillon, 2001) (Figure 6).

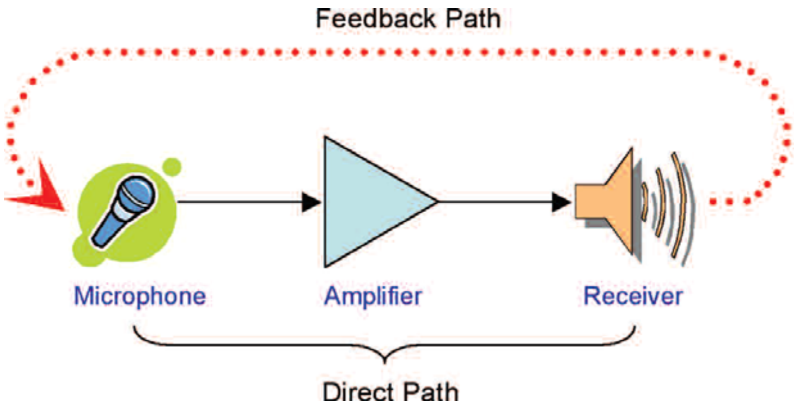


Figure 6: Block diagram of the acoustic feed back path in HAs (Parsa, 2006)

Feedback occurs at certain frequencies, depending on the gain characteristics of the HA and the attenuation features of the feedback path (e.g. environment, ear canal characteristics). The feedback path can be dynamic, whereby the feedback signal differs in accordance with changes in the environment (Parsa, 2006). Feedback cancellation or feedback management aims to eliminate acoustic feedback in HAs. Although there are many different kinds of feedback algorithms, the main methods include notch filtering and phase cancellation, which includes independent adjustment of the amplitude and phase so that the signal created within the HA is inverted to the phase of feedback and is effectively cancelled at (Levitt, 2007; Parsa, 2006).

Although the above strategies are designed to provide comfort for the listener in noisy environments and enhance speech perception, it is important to note their practical implications. Firstly, the HA may classify other signals such as music as noise and activate these features automatically. The activation of the features may reduce the sound quality of the signal of interest. For example, feedback reduction systems may remove tonal components from the input signal which have an adverse affect on the sound quality of the signal, especially harmonically rich signals such as music (Parsa, 2006). It is also important to take into account that different manufacturers have their own strategies and formulas for the processing features mentioned above. These affects may be more apparent in HAs which have a general listening programme that automatically changes its characteristics according to the acoustic environment, such as directionality and noise management. Some manufacturers have also incorporated individual listening programmes for different listening environments (i.e. music, background noise, outdoor/sports) as options in their HAs which may reduce the effects described above. In the latter case, HA wearers have the option to select the desired programme for the listening environment they are in by pressing a button on the HA or via a remote. Some HAs may have a volume control that can be manually adjusted.

1.3.3 Frequency and Output Responses of Digital Hearing Aids

The frequency output responses of HAs may also impact on the sound quality of various acoustic stimuli. In audiology it is widely regarded that frequencies between 500 and 4000 Hz are the essential frequency region for speech intelligibility (Dudley, 1939; Dunn & White, 1940; Fletcher & Galt, 1950; French & Steinberg, 1947; Mueller & Killion, 1992). The typical frequency responses of HAs is approximately 150 Hz (typical low frequency limit of a HA) to about 6500 Hz (typical high frequency limit of a HA) as seen in Table 2 below. Although these frequency ranges and outputs may be suitable for speech they may not be satisfactory for all other acoustic stimuli.

Table 2: ANSI S2.22 (2003) specifications of selected HAs

Hearing Aid Model	Maximum Output (OSPL90)	Frequency Range
Widex Aikia AK-9 BTE	103 dB SPL	100 - 7100 Hz
Unitron Element 8 e8 BTE	125 dB SPL	200 - 6000 Hz
Oticon Delta 6000 BTE	105 dB SPL	100 - 6000 Hz
Oticon Go Pro ITE	112 dB SPL	100 - 5900 Hz

Generally, wide band frequency responses are more desirable as they closely mimic the auditory response of a normal hearing listener. Most modern HAs do not provide useable gain above 6 kHz. Research by Ricketts, et al. (2008) indicates that there is a preference for wider bandwidth than those typically used in current commercial hearing aids in some listeners with a mild to moderate hearing loss. Ricketts, et al. (2008) suggest that this may be a factor contributing to the limited use of HAs by listeners with mild-to-moderate hearing loss. For those with a severe to profound level of hearing loss, fitting HAs may become a difficult challenge, due to factors such as reduced audibility and distortion. Cochlear implants are designed for those with severe to profound levels of hearing loss and no longer receiver benefit from HAs. Cochlear implants will be discussed further in the following next section.

1.4 Cochlear Implants

Cochlear implants (CIs) are surgically implanted devices which aim to provide electrical stimulation to the auditory nerve, in order to bypass the damaged hair cells for those with a severe to profound hearing loss.

1.4.1 Components of a CI

CIs are comprised of both internal and external components (Figure 7). Internal components consist of a receiver/stimulator (RS) with a magnet and receiving coil that are connected to an array of electrodes (Holden, Vandali, Skinner, Fourakis, & Holden, 2005). The array of electrodes (consisting of multiple electrodes) is surgically inserted into the cochlea from the basal end to a depth of one and a half turns of the cochlea (Zeng, 2004). The electrode array is connected to the RS which is placed under the skin (Loizou, 1998).

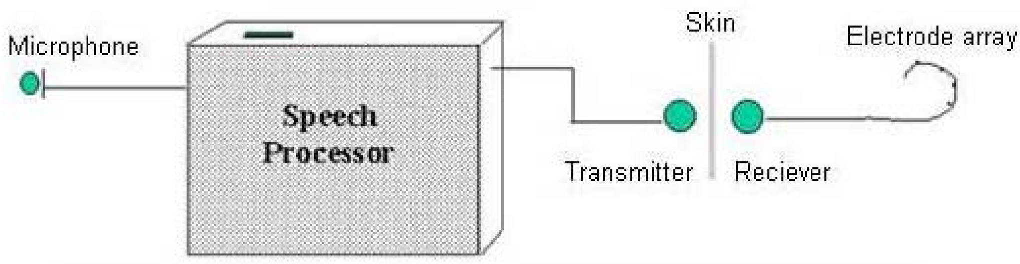


Figure 7: Basic Components of a CI (Louizou, 1998)

External components include the speech processor, microphone, transmitter coil and cables (Figure 8). There are both ear level and body worn speech processors. CI microphones can be directional or omni-directional depending on the manufacturer of the device. Acoustic stimuli are transmitted to the speech processor via the microphone. The speech processor converts the acoustic signal into encoded electrical signals that are transmitted to the RS to activate the electrodes via controlled, non overlapping electrical pulses (Holden et al., 2005). A set of bandpass filters divides the acoustic waveform into channels; the number of channels depends on the manufacturer. Speech processing strategies are mapped into the speech processor to specify the parameters of electrical stimulation (Holden et al., 2005; Louizou, 1998).

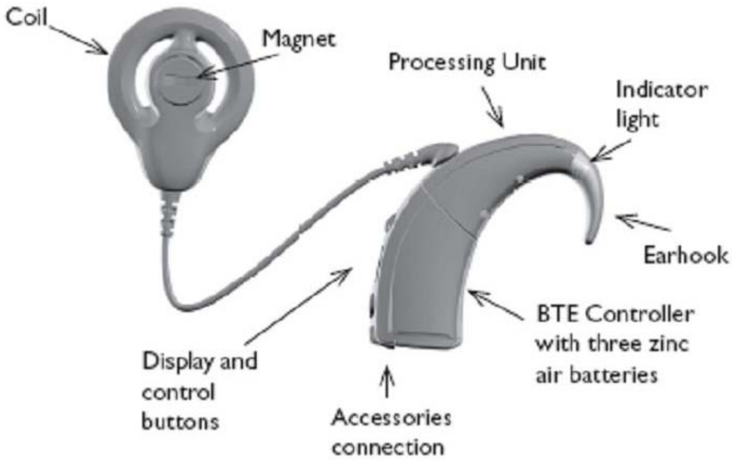


Figure 8: External components of the CI. Retrieved from BrownBioMed (n.d.)

CIs and HAs perform similar functions in that both devices process and deliver acoustic stimuli to the listener in a form that is more audible to the impaired auditory system. They each seek to represent and compress a large natural dynamic range of sound into a smaller tolerable range of acoustical or electrical stimulation via their various sound processing strategies. The main difference is that CIs stimulate residual neurons in the cochlea via electrical stimulation whilst HAs stimulate the residual hair cells via acoustic stimulation (Blamey, 2005). The sound processing undertaken by a CI affects the sound perceived by the wearer, as it is in HAs. Like HAs, CIs are programmed to optimise speech perception which may have deleterious effect on music perception.

Research suggests that postlingually deafened CI recipients generally find communication in quiet environments relatively uncomplicated, with the majority of CI users achieving excellent open-set speech discrimination scores for speech in quiet (Fetterman & Domico, 2002; Hochmair, Nopp, & Schößer, 2006). However, many users experience difficulties with speech perception in noise, the pitch perception of tonal languages, as well as with music perception (Fetterman & Domico, 2002; Gfeller, Knutson, Woodworth, Witt, & DeBus, 1998; Kong, Cruz, Jones, & Zeng, 2004).

1.5 Music Perception and Appreciation

Gfeller & Knutson (2003) describe music as “a powerful form of communication that connects us with our families, our friends, and our culture” (p.11). Music includes a variety of structural elements presented in multiple combination and styles, occurring within a cultural context (Leal et al., 2003). According to Krumhansl & Iverson (1992) music comprises of four fundamental elements: pitch, duration, loudness and timbre. Pitch is often correlated with fundamental frequency and can be influenced by aspects such as timbre, and loudness (Russo, 2006). Timbre is often referred to as the tone quality of music sounds (Krumhansl & Iverson, 1992). It is a multidimensional factor, some components of which include spectral energy distribution, synchronicity of transients of the higher harmonics, and onset characteristics (e.g. attack time) (Grey, 1977). In a musical sense these elements allows the listener to differentiate between two instruments when the same note is played at the same level. In a highly controlled manner, pitch and duration are used to create complex musical patterns, such as melodies, harmonic progressions and rhythms (Krumhansl & Iverson, 1992). Thus music perception refers to the ability to discriminate patterns of rhythm, pitch, melody, and timbre (K Gfeller et al., 2002; Leal et al., 2003).

1.5.1 Differences between music and speech

The frequencies important for music perception and enjoyment encompass a much wider range than required for speech perception (Gfeller & Knutson, 2003). Chasin & Russo (2004) highlight the differences between the spectral requirements for speech and music. Everyday speech has a well-controlled spectrum and intensity range with well-established and predictable perceptual characteristics. In speech there is usually a single sound source (the speaker). On the other hand the spectra in music are highly variable and the perceptual requirements can vary based on the musician, type of music, and the instrument being played. It usually requires the processing of multiple input sources simultaneously. Another difference is the differing intensity levels for speech and music. The typical levels for normal conversational speech can range from 53 to 77 dB SPL, and shouted speech can reach 83 dB SPL at the listener's ear (Chasin & Russo, 2004). For music, intensities can range from very soft sounds of 20-30 dB SPL to sounds exceeding 120 dB SPL. In effect the dynamic range for music as an input to a HA can be close to 100 dB, compared to 30-35 dB for speech (Chasin, 2007). Further, the frequencies salient for music perception and enjoyment encompass a much greater range than those required for speech. The ranges of fundamental frequencies are often higher for music than for speech. For example, the essential region for speech is 500-4000 Hz, whereas the fundamental frequency can be lower than 20Hz for a low piano tone and the upper partials of violin tones can exceed 20,000 Hz (Russo, 2006).

Further, in research by Moore and Tan (2003) an experiment was conducted to measure the relationship in perceived quality and frequency response irregularity and/or bandwidth in 10 normally hearing subjects. They determined how the perceived naturalness of music and speech signals was affected by different linear filtering methods such as variations in the upper and lower cut-off frequency. They found that for music, the highest rating for naturalness was achieved for the broadband signal (55-16854 Hz) (i.e. signal with the largest bandwidth); changes in the lower and upper cut-off frequencies to decrease the bandwidth resulted in significantly lower sound quality ratings ($p < 0.001$). For speech, there was no significant effect of increasing the lower cut-off frequency from 55 to 123Hz or of decreasing the upper cut-off frequency from 16 854 to 10 869 Hz, thus a bandwidth of 123-10869 Hz was preferred for speech. These findings support that a wider bandwidth and frequency response may enhance the naturalness of music and, that a wider bandwidth was favoured for music.

The difference between peak intensity and average intensity is considerably higher in music than it is in speech, and the preferred bandwidth is noticeably wider for music that it is for speech. Since musical stimuli differ from speech stimuli it is reasonable to propose that they are processed differently through HAs. Consequently there are many implications which may occur which will be discussed in the following section.

1.5.2 Music and HAs

Although speech perception through HAs is well researched (Blamey, Fiket, & Steele, 2006; Buuren, Festen, & Houtgast, 1996; Chang, Tseng, Chao, Hsu, & Liu, 2008; Ching et al., 1998; Gabrielsson, Schenkman, & Hagerman, 1988; Jenstad & Souza, 2005; Moore, 2003b; Turner & Cummings, 1999; Vinay & Moore, 2007; Yund & Buckles, 1995), music listening and enjoyment levels through HAs is significantly less reported (Chasin & Russo, 2004; Feldmann & Kumpf, 1988; Franks, 1982; Leek, Molis, Kubli, & Tufts, 2008; Looi, McDermott, McKay, & Hickson, 2007; Looi, McDermott, McKay, & Hickson, 2008; Punch, 1978).

Punch (1978) measured different frequency responses in HAs for 10 normally hearing and 10 hearing impaired subjects with a high frequency sensorineural hearing loss, whilst listening to music. Preferences for those with a hearing impairment were similar to the normal hearing listeners, and concluded that both groups preferred frequency responses that the comprised of a strong representation of low frequencies. This is consistent with Franks (1982), who also found preference for low frequencies in both hearing impaired and normal hearing listeners.

Franks (1982) conducted paired comparison perception and preference judgements of HA processed music in 20 subjects with a mild to moderate hearing loss and 20 control subjects with normal hearing. The subjects listened to music in various conditions which included extended and reduced, high and low frequency ranges. Those with normal hearing reported a preference towards extended ranges for both conditions i.e. both high and low frequencies, whereas those with a hearing loss, only some indicated a preference for high-frequency ranges, with the majority demonstrating accurate perception and preference for extended lower-frequency adjustments. In regards to implications for HA design the author recommended that HA manufacturers consider the option of enabling HA wearers to switch between different settings optimised for different environments (i.e. one environment maximizing speech intelligibility and another for improving sound quality of music).

More recently, anecdotal reports by both hearing impaired musicians and non musicians indicate that sound quality is reduced when listening to music through their digital HAs (Chasin & Russo, 2004). They propose that peak input limiting levels on HAs that are adequate for speech (typical settings 85-90 dB SPL on conventional HAs) are not necessarily adequate for and that specific electro-acoustic characteristics such as peak input-limiting level, compression levels and the number of channels can all affect perception of music through HAs as illustrated in their study below.

Chasin and Russo (2004) performed a study involving 53 hearing impaired professional musicians. The musicians wore HAs where the peak input limiting could be altered in distinct steps from the original 115 dB SPL, to (i)105 dB SPL, (ii) 96 dB SPL, and (iii) 92 dB SPL. The subjects listened to pre-recorded levels of music presented at 90 dB SPL and 100 SPL. Measures of sound quality were obtained using five perceptual scales relevant to music-loudness, fullness, crispness, naturalness, and overall fidelity. The sum of the five scales was plotted against the measured signal-to-distortion ratios for the four input-peak limiting levels. There was a statistically significant difference between the two upper levels of 105 and 115 dB SPL ($p < 0.001$), as well as between the two lower levels of 92 and 96 dB SPL ($p < 0.001$). However when the sum totals of the two upper levels (i.e. 115 and 105 dB SPL) were combined and compared to the sum total of the two lower levels (i.e. 96 and 92 dB SPL) there was no significant difference. Anecdotally, all subjects preferred the 115 dB SPL and 105 dB SPL levels with some reporting that the higher levels to sound “more natural”(Chasin & Russo, 2004). Additionally, in regards to fine tuning the settings on a HA for listening to music, Chasin & Russo (2004) recommend that one channel, or a multi channel device where gain is set at a similar level at each channel, may be optimal for listening to music through HAs, and the peak input limiting level should be set to at least 105 dB SPL, in order to get a broader input spectrum that is required for music. In addition Keidser, Dillion & Bryne (1996) recommend a flat frequency response for a music programme settings in HAs.

The dynamic range of music is typically 50 to 70 dB greater than that for speech (Chasin, 2007). As previously mentioned in WDRC signal processing amplification is increased across the frequency range to make sounds audible automatically. Research by Chasin (2003) suggests that, since the spectrum of music is more variable than speech, WDRC could improve the audibility of low-level notes that would otherwise be inaudible to the listener, and may be preferable for music stimuli that contain wide intensity variations. In this regard, a study by Davies-Venn, Souza & Fabry (2007) evaluated quality ratings for speech and music stimuli processed using peak clipping (PC), compression limiting (CL), and wide-dynamic range compression (WDRC) HA circuitry in 18 participants with a mild to moderate sensorinerual hearing loss. With the exception of several subjects who reported piano or voice lessons, all of the participants listened to music for pleasure, with no participants had professional music training. Each participant was fitted binaurally with behind-the-ear (BTE) HAs and were asked to rate the quality of speech using various compression/limiting techniques for two genres of music. For the music ratings, participants listened to a segment each of classical music and popular music. They were asked to rate the sound quality on a scale from 1 to 10 for the following dimensions: loudness, sharpness, fullness, pleasantness, and overall impression. Classical music was significantly preferred overall ($p = 0.001$), significantly softer (i.e. less loud) ($p = 0.002$), significantly less sharp ($p = 0.021$) and significantly more pleasant ($p = 0.003$) than popular music. Both genres were rated as equally full. For each genre, ratings were higher for WDRC compared to the respective linear amplification strategies. Although these studies have investigated the effects of electro-acoustics settings such as peak clipping and WDRC and demonstrate the impact of altering different acoustical parameters and amplification strategies of HAs whilst listening to music, few studies have looked at the musical appreciation and listening habits of HA users (Feldmann & Kumpf, 1988; Leek et al., 2008).

A German study by Feldmann & Kumpf (1988) comprised of a questionnaire investigating the music enjoyment and listening habits of 265 postlingually deafened adults with HAs. Thirty-six per cent of the respondents reported that they had formerly played an instrument or had enjoyed singing. A substantial majority (79%) of respondents felt that their hearing loss hindered their enjoyment of music. Common complaints included difficulty understanding words of songs as well as distortions in pitch and melody. In addition, having to continually adjust the volume on their HAs in accordance to volume changes in music was reported to be the 'most annoying feature'. Other reported problems which hindered music listening enjoyment were that overall the music was either too loud or soft (40%) and difficulty with melody recognition (37%). However despite this, a large proportion (67%) indicated that HAs have made listening to music enjoyable again and most of the respondents (74%) used their HA 'more or less regularly' when listening to music.

In a more recent study, Leek et al. (2008) conducted telephone interviews with a group of HA wearers (n = 68), investigating the music listening habits and the prevalence of music listening difficulties. The mean age of participants was 75 years (SD = 13, range 24-91). Subjects were asked 37 questions concerning characteristics of hearing loss and HA use, musical habits and music training, and use of HAs when listening to music. Many of the questions were comparable to the previous study by Feldmann & Kumpf (1988). Leek et al. (2008) found that 28% of respondents felt that their hearing loss interfered with their enjoyment of music. They also found that most HA users (78%) wore their HAs when listening to music, in which 41% reported that music was more enjoyable when wearing their HAs, 6% found music listening with HAs less enjoyable and 37% indicated no difference. Overall 70% of respondents indicated that listening to music was a significant part of their lives. Many technological developments in the quality of HAs have advanced over the past two decades since the Feldmann & Kumpf (1988) study was published. Modern HAs incorporate sophisticated compression algorithms such as WDRC which reduce the need to rely on adjusting the volume control, which may explain the fewer complaints expressed by respondents in the latter study. However as suggested by Leek et al. (2008) additional research is needed to corroborate whether these algorithms effectively preserve the dynamic quality of music.

1.5.3 Music Perception and CIs

Although this thesis in on the ratings of music and music listening of HA users, a section on the music perception of CI users is provided below for the following reasons: (i) there is very little research into the music perception of HA users, with comparatively more research for CI users, and (ii) the thesis will compare the results from this study with HA users to those of CI users, which may help counselling prospective CI users. A more comprehensive review of music perception of CI users is provided by Looi (2008).

According to the literature, CI recipients generally enjoy music less post-implantation than prior to acquiring a profound hearing loss (Gfeller, Christ et al., 2000; Lassaletta et al., 2007). Research indicates that whilst certain aspects of music can be effectively transmitted through a CI which help rhythm perception, CIs are less than optimal for perceiving the frequency-based elements of music in part due to the lack of fine-structure information preserved by the speech processing strategy. The sound processing in the CI extracts the envelope information only, discard the fine structure information. Research has shown that although this envelope information is sufficient for speech perception in quiet, it may not necessarily be sufficient for music perception (Arnoldner et al., 2007; Fu, Shannon, & Wang, 1998).

Gfeller et al. (2000) described the listening habits and musical enjoyment of 65 postlingually deafened CI recipients via a questionnaire. Generally respondents tended to listen to music less post-implantation than before their hearing loss. They also found that musical enjoyment varied greatly amongst recipients, with 43% reporting that music over time was improving and was 'better than no music at all', although it was less pleasant than prior hearing loss. Twenty-three % of respondents indicated little satisfaction in listening to music post implantation, but 23% reported that music, now with a CI, sounded as pleasant as before hearing loss. They postulate that musical enjoyment is influenced by the listening situation and environment (e.g. quiet room), familiarity with the music, as well as features of music such as the rhythm or beat.

Mirza, Douglas, Lindsey, Hildreth & Hawthorne (2003) also used a questionnaire to assess the appreciation of music after cochlear implantation in 35 postlingually deafened CI recipients. The found that although a large proportion of the respondents listened to music often before becoming deaf, only 46% of respondents listened to music post-implantation. In this study those who listened to music after implantation ($n = 16$) were significantly more likely to be: younger ($p = 0.012$); have a shorter duration of deafness ($p = 0.026$), or have higher speech recognition scores ($p = 0.002$).

Looi, McDermott, McKay & Hickson (2007) compared quality ratings for musical sounds provided by experienced CI users and HA users with the same level of hearing loss - i.e. postlingually acquired moderately-severe to profound hearing losses. There were 15 subjects in each group. Additionally there was a third group of subjects on the waiting list (WL) for a CI (n = 9) who also participated in this study. The WL group were assessed both pre- and post-implantation. In this study subjects were required to provide a rating out of 10 according to which extract sounded the most pleasant, whereby a rating of 10 was "very pleasant" and 1 was "very unpleasant". Three types of musical stimuli (single instrument, solo instruments with background accompaniment, and ensembles) were used. For each type of music 12 different instruments or ensembles were presented four times each. The authors found that although the experienced CI users provided higher quality ratings than the experienced HA users for the three sets of stimuli, the difference was not statistically significant. However for the WL subjects, their ratings were significantly higher post-implantation than pre-implantation ($p = 0.026$), for all three subtests. Subjects in the WL group reported that the CI enabled them to hear the higher pitches of melodies and instruments compared with the HA pre implantation. All subject groups preferred listening to single instrument stimuli as opposed to multiple instrument stimuli (CI and HA subjects $p < 0.001$; WL subjects $p = 0.044$). The authors concluded that although neither the CI or HA provided accurate music perception, CI users judged music to sound more pleasant than HA users with the same level of hearing loss (Looi et al., 2007).

Another study by Looi, McDermott, McKay & Hickson (2008) investigated the music perception of CI and HA users. The same subject groups of 15 CI users and 15 HA users, that were used in the previous study were used for this study. Subjects were required to complete four separate music perception tasks including: discrimination of pairs of rhythms; pitch ranking; instrument recognition, and recognition of melodies. It was found that HA users performed significantly better than CI users on the pitch and melody tests ($p < 0.001$ for both tests), whilst both groups performed similarly on the rhythm and instrument recognition tests. The authors surmised that HA users with a similar level of hearing loss perform at least equal to, and in regards to pitch perception, better than CI users in these specific music tests. Although the HA users preformed significantly better than the CI users in certain tasks, both groups were essentially unable to achieve accurate music perception (Looi et al., 2008).

She (2008) assessed the music enjoyment and appreciation of CI users via a detailed questionnaire. The questionnaire forms the basis of the current study and will therefore be discussed in more detail in the methods section. However, the results obtained from CI users indicated that music sounded significantly different to their expectation of how it would be heard by a normally hearing person. In regards to music listening and musical background there was a significant decrease in the self-reported enjoyment of music now with a CI than prior to deafness ($p = 0.003$). Both the enjoyment of music and the amount of time spent listening to music for CI users were lower for time just before implantation to now with CI. Although respondents generally found music to be less enjoyable post implantation, they also reported that there was a slight (although significant) increase in the amount of time spent listening to music since first being implanted ($p = 0.05$). The study also revealed that CI users prefer low-frequency to high-frequency instruments, and a smaller number of performers compared to a larger group of performers. In regards to preferred musical styles, respondents rated country & western music significantly more favourably for the combined ratings than the musical styles of classical-orchestra ($p = 0.007$), pop/rock ($p = 0.008$), jazz ($p = 0.016$), and classical-small group ($p =0.047$).

In summary, it seems that music perception of HA and CI users with a severe to profound loss, is largely unsatisfactory, as signified by their low ratings of music, although the above studies demonstrate that there is wide variability. This may be due to a range of considerations that factors related to the physiological changes associated with hearing loss (i.e. reduced frequency selectivity, reduced dynamic range, dead regions) that affect speech perception , may also contribute to inaccurate music perception, and also that HAs and CIs are predominantly designed for speech input rather than music.

1.6 Rationale for current study

Although some studies have investigated the effects of electro-acoustics settings of HAs for listening to music (Chasin & Russo, 2004; Davies-Venn et al., 2007; Franks, 1982; Punch, 1978), overall enjoyment of listening of HAs as a general population has been less reported (Feldmann & Kumpf, 1988; Leek et al., 2008); with several studies involving HA users with an equivalent hearing loss to CI users (Looi et al., 2007; Looi et al., 2008). Feldmann & Kumpf (1988) looked at how hearing loss influences the enjoyment and habits in listening to music, whilst a more recent study (Leek et al., 2008) investigated music listening habits and prevalence of music listening difficulties. Further, one study assessed quality ratings for those with a mild and moderate hearing loss (Davies-Venn et al., 2007), in which only two musical genres (classical and popular music) were considered and preferences were made on the basis of comparative compression strategies. Although, collectively studies investigated factors contributing to musical listening and sound quality ratings of some genres of music, they have not assessed sound quality ratings of a wide range of musical styles and instruments.

This current study aimed to collect more detailed and descriptive information on music listening and the ratings of musical sounds from postlingually deafened adults who use HAs. This study also sought to investigate whether there were any differences in music ratings from HA users that have been assessed for a CI (HA-CI group) compared to HA users who have not been assessed for a CI (HA-NCI group), and for HA users with a mild hearing loss compared pared those HA users with a moderate or worse hearing loss. The questionnaire is a modification of an existing questionnaire (She, 2008) that was developed for CI users.

It differs from the above studies on HA users, as in the current study HA users were asked to provide ratings on how instruments and music styles sound with HAs compared to how they *expect* them to sound to a person with normal hearing. This is in contrast to previous research which has compared how music sounds prior to hearing loss (Feldmann & Kumpf, 1988; Leek et al., 2008). In the current study, the ratings of music encompass a wide range of music instruments, instrumental families and singers, as well a range of musical genres, in contrast to previous research where only two musical genres were used (popular style and classical) (Davies-Venn et al., 2007).

Further, there is an ever-increasing level of interest in the topic from manufacturers and clinicians, in response to patient's interests and preferences. Hence, the overall aim of this study is to collect more detailed and descriptive information on music perception and enjoyment from postlingually deafened adults who use HAs. It is hoped that this information could then be used to assist manufacturers and clinicians in developing 'music listening' programs for the HA. The information could also help with the development settings of aural rehabilitation programs (e.g. a specific music training program), fine-tuning settings for additional listening programs (e.g. a music-listening program), as well as for counselling patients.

Based on the existing research findings the following hypotheses were posed:

1. Ratings for music from HA users who have been assessed for a CI (HA-CI group) will be worse than for those who have not been assessed for CI (HA-NCI group).

2. HA users with a moderate or worse hearing loss (Moderate+ subgroup) will provide lower ratings than those HA users with a mild hearing loss (Mild subgroup).

2. Method

Ethical clearance for this study was obtained from the New Zealand Health and Disability Multi-region Ethics Committee and from the University of Canterbury Human Ethics Committee. All procedures were conducted in accordance with this clearance.

2.1 Materials

The University of Canterbury Music Listening Questionnaire for cochlear implant users (UCMLQ_CI) (She, 2008) was modified for this study and subsequently called the University of Canterbury Music Listening Questionnaire for Hearing Aid Users (UCMLQ_HA). Questions were amended and added so that the questionnaire was specific to HA users. Minor changes were also made to the response scales in order to further improve the questionnaire. These changes were undertaken after considering the original implementation of the questionnaire for CI users, as well as further to professional advice from a specialist survey designer. The visual analogue rating scales were adjusted to reduce the number of major subdivisions from ten to five, with labels at two or more divisions on each scale. For example two of the original scales from the sound quality section are shown in Figure 9, and the adapted versions in Figure 10. A list of the exact changes of from the original version (UCMLQ_CI) for the UCMLQ_HA is provided in Appendix 1.

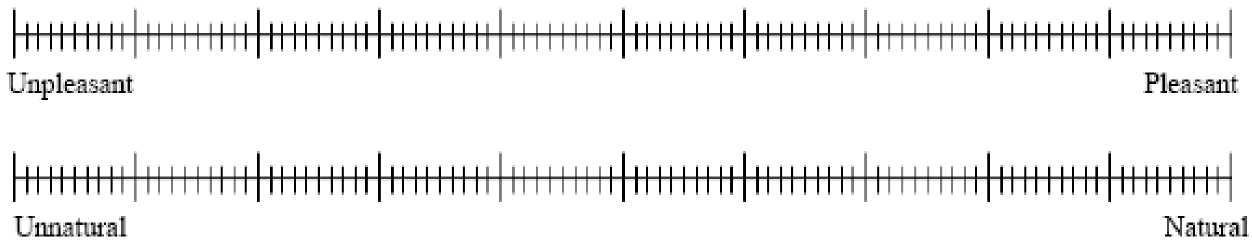


Figure 9: Two original rating scales for judging sound quality from the UCMLQ_CI

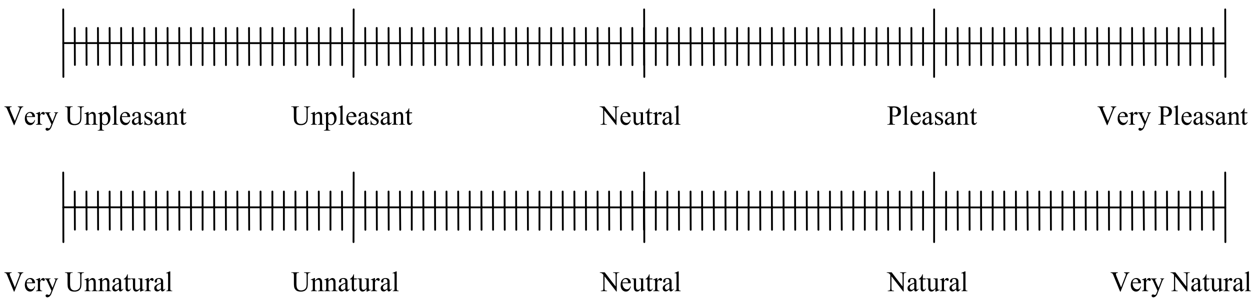


Figure 10: Two adapted rating scales for judging sound quality from the UCMLQ_HA

The UCMLQ_HA is a 51-item questionnaire, which is divided into the seven subsequent sections listed below:

- Section 1. Music Listening and Music Background
- Section 2. Sound Quality
- Section 3. Musical Styles
- Section 4. Music Preferences
- Section 5. Music Recognition
- Section 6. Factors Affecting Music Listening Enjoyment
- Section 7. Music Training Program

Each section incorporated a combination of response modes including closed-set answers, open-set comments and visual analogue rating scales. There were specific instructions for each section of the questionnaire, along with space to write additional comments. A copy of the questionnaire is included in Appendix 2, however a summary of the contents of each section is provided below.

In the section 'Music Listening and Music Background' respondents were asked questions regarding their hearing loss and HAs e.g. when they were first diagnosed with a hearing loss, when they were first considered for HAs, and the length of time they have used HAs. Respondents were asked to rate the overall benefit (or otherwise) they receive from their HAs in general e.g. in terms of speech perception, hearing environmental sounds, and their overall quality of life. They were also asked to rate their interest in, and enjoyment of music at two points in time: (i) prior to having a hearing loss (or being diagnosed with a hearing loss), and (ii) at present with HAs. Respondents were finally asked to select their preferred device or equipment for listening to music, and if they had received formal music training or took part in musical activities before and after they were fitted with HAs.

In the section on ‘Sound Quality’ respondents were asked to rate the overall sound quality of how musical instruments (i.e. piano, drum kit, and guitar), instrumental families (i.e. strings, woodwind and brass), and singers (i.e. male and female) sounded with their HAs using the visual analogue scales ‘very unpleasant – very pleasant’ and ‘very unnatural – very natural’ as seen in Figure 10. They were also asked to provide ratings for the following specific sound qualities:

- emptier-to-fuller
- duller-to-sharper
- more noisy-to-less noisy
- tinnier-to-richer
- rougher-to-smoother

These sound qualities were included to try and address the multi-dimensional concept of ‘timbre’. Research by Bismarck (1974), as well as pilot testing of the original UCMLQ_CI, guided the selection of the terms used in these five scales. For these five scales, respondents were asked to make their judgements based on how they would expect it to sound to a person with normal hearing.

In the section ‘Musical Styles’ respondents were asked to rate the musical styles of classical-orchestra, classical–small group, classical-choir, pop/rock, country and western, and jazz, as heard through HAs. The following bipolar scales were provided:

- very unpleasant – very pleasant
- simple – complex
- can *never* follow a melody-line – can *always* follow a melody-line
- can *never* identify this style by *listening alone* – can *always* identify this style by *listening alone*
- sounds *nothing* like I would expect it to sound to a person with normal hearing – sounds *exactly* like I would expect it to sound to a person with normal hearing

As in the ‘Sound Quality’ section, respondents were asked to make comparisons based on how they would expect these musical styles to sound to someone with normal hearing.

Respondents were also given the opportunity to specify a further musical style and rate it accordingly, if there was another style which they frequently listened to.

In the ‘Music Preferences’ section, respondents were asked: (i) to rate the aforementioned musical instruments and instrumental families in terms of their naturalness; (ii) to circle their preferred types of singer (male or female), instrumental sound (low-pitched or high-pitched) and instrumental grouping (instrumental-only, voice-only, or voice with instrument); and (iii) to rank the number of preferred performers of a musical group from ‘most preferred’ to ‘least preferred’. The latter two questions also provided a ‘no preference’ option.

In the ‘Music Recognition’ section, respondents were asked what tunes and instruments that they could always recognise, as well as those they would like to be able to recognise with and without their HAs. Extra space was provided for respondents to provide further details for these questions if they wanted.

In the ‘Factors affecting music’ section, respondents were provided a list of variables that could impact on their music listening experience. For each factor respondents were asked to assign a ‘+’ if a factor improved music enjoyment; a ‘-’ if a factor hindered music enjoyment; a ‘0’ if a factor made no distinguishable impact, or ‘NA’ if they did not know or had not tried it. Variables could be broadly classified into the following groups:

- factors that are related to music listening equipment and environment
- factors related to respondents’ past listening experiences and contextual cues
- factors related to features of music such as volume, rhythm and beat

A space was provided where respondents could list other factors that impacted on their personal music listening experience.

Lastly, the ‘Music Training Programme’ (MTP) section was designed to obtain information regarding interest in and the implementation of such a programme. For example, respondents were asked if a MTP became available, what features they would like the programme to provide and which skills they would like to improve. They were also asked about the length and frequency of the programme, and their preferred mode of delivery (e.g. DVD, MP3, CD-ROM etc).

Results from the original questionnaire (UCMLQ_CI), showed that respondents reported the questionnaire took approximately an hour to complete (She, 2008). Therefore it was anticipated that the UCMLQ_HA would take approximately the same time to complete.

2.2 Participants

Various audiology clinics were invited to provide clients for this study. One clinic in Auckland, three clinics in Christchurch and one clinic in Brisbane, agreed to partake in the study. Participants were recruited, via each individual clinics database. The following inclusion criteria:

- postlingually deafened adults (>18 years) who had used two HAs currently for at least six months
- no other major impairments e.g. major intellectual or physical impairments
- any level of bilateral hearing loss from mild to profound
- speak English as their main form of communication

There were two groups of participants:

i. HA-CI: Postlingually deafened adults who wore HAs for at least six months AND whom have been assessed for a CI
ii. HA-NCI: Postlingually deafened adults who have worn HAs for at least six months full time (i.e. use HAs approximately 5-8 hours per day), with any level of hearing loss in both ears, and who have not been assessed for a CI.

The hearing threshold used to establish severity levels of hearing loss were based on the better ear pure tone average (i.e. the average of hearing thresholds at 0.5, 1, 2, and 4 kHz of the better hearing ear); 4 Hz was included to account for sloping hearing losses. The better hearing ear and these thresholds were chosen as are used clinically and in previous research (Davis, 1989; Lin et al., 2007; Margolis & Saly, 2007; Sindhusake et al., 2001).

2.3 Procedure

Different procedures were used for the New Zealand clinics and Brisbane clinics.

2.3.1 Procedure for Auckland and Christchurch Clinics

For the participating New Zealand clinics, copies of the questionnaire were posted out during June and July, 2008. Each questionnaire was accompanied by a covering letter from the clinic, a consent form, a letter to accompany the questionnaire from the researcher, an information sheet, and a prepaid return envelope. Recipients were asked to complete the questionnaire and return both the questionnaire and consent form to their clinic, in the return envelope, within two weeks of receiving it. A follow-up letter was sent to the recipients who did not return the questionnaires and/or consent forms approximately three weeks after the initial post out. The final date for receiving questionnaires from these clinics was the end of October 2008. The consent form also enabled the researcher to access each patient's audiology file in order to obtain information required for this study.
This included the respondent's age, gender, most recent audiogram, progression of hearing loss, speech perception scores, type of HAs, date first fitted with HAs, date fitted with current HAs, duration of hearing loss, aided thresholds, and the listening programmes on their HAs.

A tracking system was used to maintain patient confidentiality. Each clinic was labelled with a letter (e.g. clinic A, clinic B). The tracking system involved the clinic compiling a list of their patients who met the criteria listed above, and assigning each patient a number (or a code). Therefore each respondent was assigned a letter and a code (e.g. A001). The questionnaire, consent form and return envelope were coded accordingly before being posted. Therefore, when the questionnaire and consent form were returned to the clinic, the consent form was detached and the patient was marked off the list. The questionnaire had the patients tracking number on it without any personal information. This tracking system also allowed for the follow-up letter to be sent out. Audiological information was transferred to a form with the respondents' code on it so any identifying information was removed.

2.3.2 Procedure for Brisbane Clinic

Due to the logistics of dealing with an overseas clinic, a different procedure was required for the Brisbane clinic. The questionnaire was distributed in the following two ways: i) the questionnaire was given to patients assessed for a CI by their audiologist, when they came to the clinic for their assessment; ii) questionnaires, and associated forms, were also posted to appropriate HA clients on the clinics' database. In both cases patients were asked to complete the questionnaire at home and return it, along with the consent form, to the clinic once completed. No follow-up letters were sent from the Brisbane clinic. When the questionnaires were returned to the clinic, appropriate audiological information was transferred to a form, by the clinician and attached to each of the completed questionnaires. Information that may have potentially identified the respondents was removed before the questionnaires were provided to the researcher in August 2008.

In total, 471 questionnaires were sent/distributed to clients from all of the participating clinics.

2.4 Data Analysis

In regards to collating the scores from the visual analogue rating scales, each scale consisted of 100 points with 5 major subdivisions. Each minor subdivision corresponded to 1 point with the main subdivisions at 0, 25, 50, 75 and 100. For example, the cross in Figure 11 denotes a score of 23.

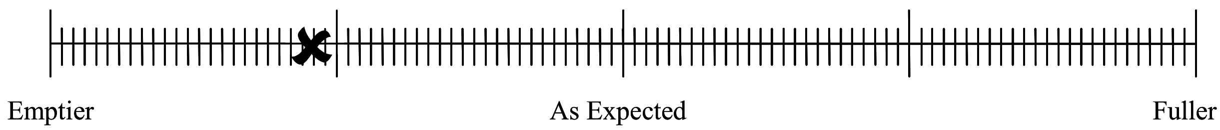


Figure 11: Example of a marked rating scale

The data extracted from the questionnaire was transferred to Microsoft Access databases. A separate table was developed for each section. For each entry the respondent's code was entered followed by their responses. Respondents' comments and answers to qualitative questions were recorded on a separate chart with the question number, respondents' code and their comment and/or answer. A list of these qualitative answers and comments are provided in Appendix 3.

<u>2.42 Statistical Analysis</u>

Descriptive statistics were calculated for demographic characteristics and audiological information including age, gender , speech perception scores , cause of hearing loss (if known) , type of hearing loss , pure tone thresholds , length of time with hearing loss , and length of time with HAs. Appropriate parametric and non-parametric two-tailed statistical analyses were performed using SPSS software, versions 15 and 16. A significance value of p

< 0.05 was regarded as statistically significant. For the correlations, Pearsons R values were calculated to assess whether any associations existed between the subject factors of age, pure tone average (PTA), experience with their HAs, and several music listening factors addressed in UCMLQ_HA.

3. Results

The results are organised in the same sections as per the questionnaire (UCMLA_HA), as listed in the previous chapter. Due to the quantity of the data only some of the results that are directly relevant to the aims and hypothesis of this thesis are presented here. These are: respondents' demographic characteristics (Section 3.1 of this chapter), music listening habits (Section 3.2) of instrumental sounds (Section 3.3) and music styles (Section 3.4) respondents' music preferences (Section 3.5), music recognition (Section 3.6), factors that impact on music listening enjoyment (Section 3.7), and the MTP (Section 3.). The descriptive statistics for each part of the questionnaire (including means, standard deviations and the number of respondents for each question) are presented in Appendix 3. The qualitative responses and any additional comments are provided in Appendix 4.

It is important to note that the number of respondents differed for each question as some respondents did not answer all of the questions. Therefore, the numbers of respondents (n) are reported for each question. Where suitable, two-tailed statistical tests with a significance value of $p < 0.05$ were used. For the correlations, the Pearsons R values were calculated.

3.1 Response Rate and Demographic Characteristics

As mentioned in the previous chapter, 471 questionnaires were sent. Of these 185 (39.3%) questionnaires were returned. These were 111 (23.6%) fully or semi-completed questionnaires, which were included in the study; with 16 (3.4%) insufficiently completed and excluded and twenty-two (4.7%) recipients contacted the researcher to say they were unable to participate due to poor health or because they did not listen to music. There were also 36 (7.6%) questionnaires returned blank unopened.

Participants were assigned to the HA-CI group ($n = 13$) or HA-NCI group ($n = 98$) based on the inclusion criteria discussed in the previous chapter. Of the participants in the HA-CI group, five (38.5%) met the CI criteria, one was under going assessment, two had operations booked, and five did not meet criteria at the time the questionnaire was completed. The HA-NCI group participants were divided into two subgroups - Mild ($n = 51$) and Moderate or worse ($n = 47$). The Moderate or worse subgroup will be referred to as 'Moderate+'.

In some of the statistical analyses in the following sections, respondents are separated into their respective groups with between-groups comparisons being made. However for the latter sections of 'music recognition', 'factors of music listening' and the 'MTP', all respondents are analysed as one population (i.e. HA wearers) as between-group comparisons provide little clinically useful information. Question numbers will be abbreviated by 'Q'.

3.1.1 Demographics and HA use

No significant differences were found between the subgroups for at which they were diagnosed with a hearing loss or length of time with hearing loss. Six (54.5%) pariticpants in the HA-CI group were unilateral HA users: all participants in the HA-NCI group were bilateral users.

The descriptive statistics for age of respondents, age diagnosed with hearing loss, length of time with hearing loss, and length of time with HAs, for the groups and subgroups are presented below in Table 3.

Table 3: Descriptive statistics for participant characteristics

		Overall	HA-CI	HA-NCI		
			Overall	Overall	Mild	Moderate+
Age (years)	M	66.93	53.61	68.69	65.47	72.20
	SD	12.58	13.07	11.46	11.08	10.93
	n	111	13	98	51	47
	Range	23-89	23-68	30-89	30-82	37-89
Age diagnosed with hearing loss (years)	M	52.54	25.61	56.11	55.41	56.87
	SD	19.95	16.70	17.51	16.29	18.89
	n	111	13	98	51	47
	Range	2-85	2-51	6-85	6-79	7-85
Length of time with hearing loss (years)	M	14.39	28.00	12.58	10.05	15.32
	SD	14.08	11.44	13.43	10.65	15.57
	n	111	13	98	51	47
	Range	0-72	15-51	0-72	1-48	0-72
Length of time with HAs (years)	M	6.98	19.94	5.27	3.33	7.36
	SD	9.13	14.34	6.61	4.61	7.77
	n	111	13	98	51	47
	Range	0.5-48	1.25-48	0.5-29	0.5-23	0.5-29

As can be seen, respondents ranged from 23 to 89 years of age (M = 66.9, SD = 12.6, n = 111). Independent samples t-tests showed that the HA-CI respondents:

- were significantly younger than the HA-NCI group ($p < 0.001$)
- were diagnosed with a hearing loss at a significantly younger age than the HA-NCI group ($p < 0.001$)
- have had a hearing loss for a significantly longer period of time than the HA-NCI group ($p < 0.001$)
- have had HAs for a significantly longer period of time than the HA-NCI group ($p < 0.001$)

For the subgroups of the HA-NCI group, Independent samples t-tests showed that respondents in the Moderate+ subgroup:

- were significantly older than the Mild subgroup ($p = 0.003$); and
- have had HAs for a significantly longer period of time than the Mild subgroup ($p = 0.002$)

No significant differences were found between the subgroups for age diagnosed with hearing loss or length time with hearing loss. Six (54.5%) respondents in the HA-CI group were unilateral HA users; all participants in the HA-NCI group were bilateral users.

3.1.2 Audiological Background

The configuration and type of hearing loss for overall respondents are shown below in Table 4.

Table 4: Configuration type of hearing loss for overall respondents

Hearing Loss			%
Configuration	Flat	25	22.5
	Sloping	83	74.8
	Trough	3	2.7
	n	111	
Type	Sensorineural	93	83.8
	Conductive	9	8.1
	Mixed	9	8.1
	n	111	

Audiograms representing the unaided pure tone average (PTA) thresholds for the HA-CI and HA-NCI groups and are shown in Figure 12 and Figure 13 respectively.

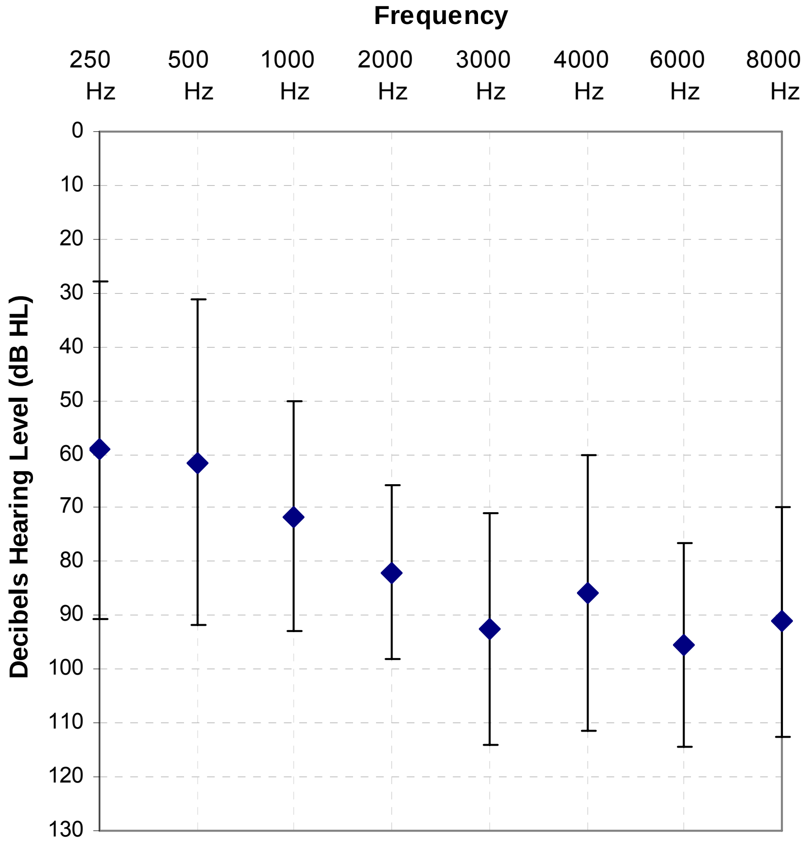


Figure 12: Mean PTA thresholds for better hearing ear for the HA-CI group
[n = 13; Error Bars = 1 SD]

Note: Testing was carried out on various audiometers. As the limit of most audiometers extend to a maximum of 110 dB HL at 250 and 8000 Hz, and 120 dB HL at 500 to 6000 Hz, no responses obtained at the limit of the audiometer were recorded as 115 dB HL for 250 and 8000 Hz, and as 125 dB HL for 500 to 6000 Hz.

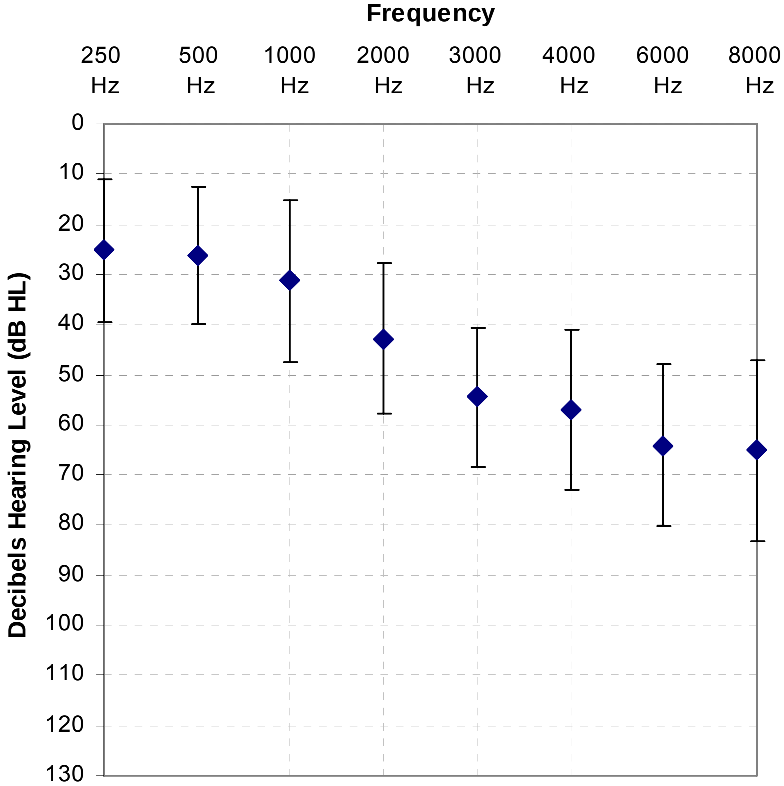


Figure 13: Mean pure tone average (PTA) thresholds for better hearing ear for the HA-NCI group
[n = 98; Error Bars = 1 SD]

Note: Testing was carried out on various audiometers. As the limit of most audiometers extend to a maximum of 110 dB HL at 250 and 8000 Hz, and 120 dB HL at 500 to 6000 Hz, no responses obtained at the limit of the audiometer were recorded as 115 dB HL for 250 and 8000 Hz, and as 125 dB HL for 500 to 6000 Hz.

Presented below in Table 5 are the means of the best available speech perception scores of the better hearing ear, as recorded in the patient's files. The overall mean across all subjects was 92.4% (SD = 15.1, n = 104). An independent samples t-test showed that the speech perception scores for the HA-NCI group were significantly better than that of the HA-CI group (p = 0.007). There was no significant difference between the 'Mild' and 'Moderate+' subgroups.

Table 5: Descriptive Statistics for Speech Perception Measures
Monosyllabic phonetically balanced words presented at a range of levels. Best available score recorded.

	Overall	HA-CI	HA-NCI		
		Overall	Overall	Mild	Moderate+
M	92.4%	72%	95 %	96%	94%
SD	15.1	24.3	11.1	13.3	8.3
n	104	12	92	47	45

3.2 Section 2: Music Listening and Music Background

Respondents were asked what difference their HAs made to their ability to hear speech (Q13), environmental sounds (Q14), and for their overall quality of life (Q15). They were asked to rate their responses on a scale where 0 = greatly worsened, 50 = no difference, and 100 = greatly improved. For Q13, the overall mean rating across groups was 83.9 (SD = 12.7, n = 106); Q14, the overall mean rating was 83.6 (SD = 14.6, n = 109); Q15, the overall mean rating was 80.4, SD = 15.8, n = 108).

Respondents were also asked questions regarding their music listening habits. Of the108 respondents across both groups who answered Q12, significantly more respondents (76.8%) did not have a programme specifically set up for music (Chi-square test, $\chi^2 = 31.45$, n = 25, $p < 0.001$, n = 108). The respondents that did have a programme specifically set up for music (n = 25) were also asked how often they used this programme (Q12i) using a scale where 0 = never, 50 = sometimes when listening to music, 100 = every time when listening to music. The overall mean rating was 47.7 (SD = 33.6, n = 24).

Respondents were also asked which programme provided them with the best sound quality for listening to music. As can be seen in Figure 14, a significantly larger proportion of respondents (69.3%) reported that the everyday listening programme on their HAs provided them with the best sound quality for listening to music (Chi-square test, $\chi^2 = 162.1$, n = 101, $p < 0.001$).

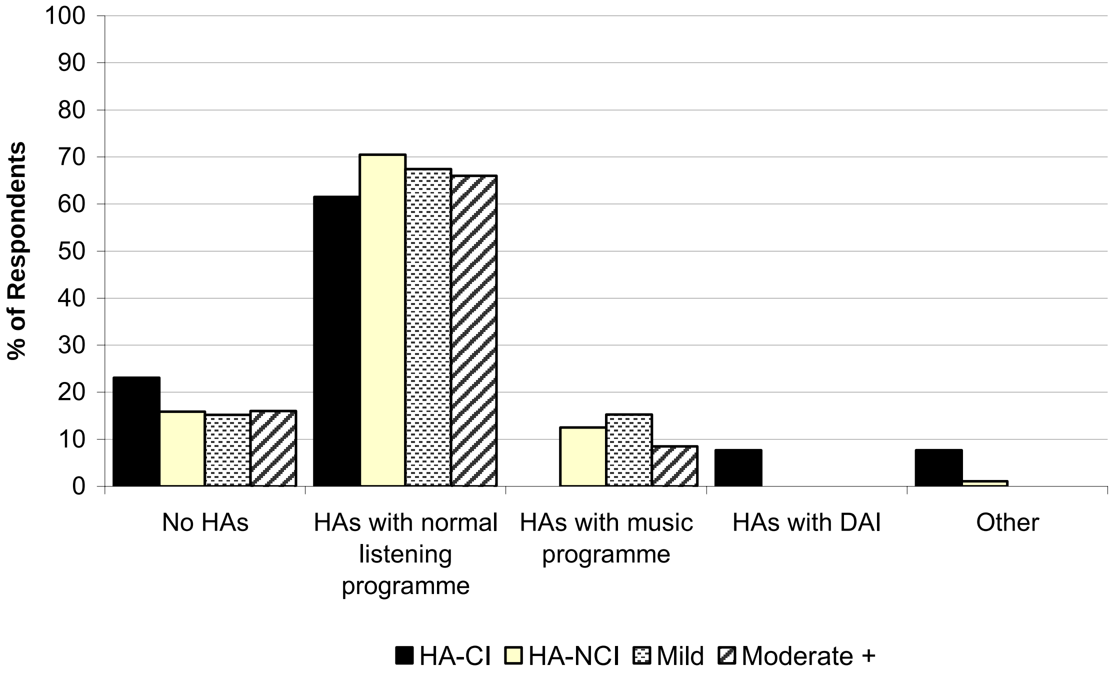


Figure 14: Device that provides best sound quality for listening to music

Respondents were also asked to rate how the amount of time spent listening to music had changed since when they were first fitted with HAs (Q16c) on a scale where 0 = greatly decreased, 50 = no difference, 100 = greatly increased. The overall mean rating was 52.3 (SD = 18.9, n = 110). Independent samples t-tests indicated no significant difference in ratings between the groups or subgroups.

Respondents were also asked which style of music sounds best with HAs (Q27); they listen to most often with HAs (Q28), and sounded best before being diagnosed with hearing loss (Q29). As seen below in Table 6, a significantly larger proportion of respondents (35.8%) reported classical as the musical style that sounded the best with HAs (Chi-square test, $\chi^2 = 150.07$, n =11, $p < 0.001$), listened to the most often with HAs (34.6%; Chi-square test, $\chi^2 (11, N = 104) = 160$ $p < 0.001$), and was the musical style which sounded the best before being diagnosed with a hearing loss (35.6%; Chi-square test, $\chi^2 = 1411$, n = 104, $p < 0.001$).

Table 6: Listening to music styles with HAs

	Q 27		Q28		Q29	
	n	%	n	%	n	%
Classical	38	35.8	36	34.6	37	35.6
Jazz	4	3.8	5	4.8	6	5.8
Folk	1	0.9	0	0	2	1.9
Rock 'n' Roll	0	0	1	1.0	0	0
Heavy Metal	2	1.9	1	1.0	1	1
CW	12	11.3	9	8.7	8	7.7
Opera	2	1.9	1	1.0	3	2.9
Easy Listening	22	20.8	27	26.0	22	21.2
Religious	3	2.8	2	1.9	3	2.9
Rap	0	0	0	0	0	0
Modern Pop (1980s to now)	1	0.9	2	1.9	2	1.9
Older-style Pop	7	6.6	9	8.7	8	7.7
Musicals	9	8.5	4	3.8	8	7.7
Other	5	4.7	7	6.7	4	3.8
Overall number of respondents	106		104		104	

In response the question 'if possible, would you like music to sound (with the HAs) like you think it would sound to a normally hearing person?'(Q34), 97.1% (n = 99) responded 'yes' and 2.9% responded no (n =3). A Binomial test revealed this difference to be significant ($p < 0.001$).

3.2.1 Correlations

Pearson's R correlations were calculated to assess whether there was any significant associations between the subject factors of age, PTA (average of 500, 1000, 2000 and 4000 Hz of the better hearing ear) or experience with their HAs, and the following music listening factors addressed in the UCMLQ_HA:

- 'How often do you listen to music, now, with HAs?' (Q16b)
- 'How much do you enjoy listening to music, now with your HAs?' (Q17b)
- Mean rating for 'pleasant' scale across all instruments, instrumental families and singers (Section 3)
- Mean rating for 'pleasant' scale across all musical styles (Section 4)

The only significant result was a weak correlation between length of time with HAs and the mean pleasant rating for musical style ($r = -0.24$, $p = 0.013$).

3.2.2 Music enjoyment: HA-CI vs. HA-NCI Group Comparisons

Both groups showed similar mean scores for the questions regarding the difference HAs have made to their ability to hear speech (Q13 HA-CI: M = 87.3, SD = 14.4, n = 13; HA-NCI: M= 83.5, SD = 12.5, n = 93) and their ability to hear environmental sounds (Q14 HA-CI: M = 83, SD = 16.5, n = 13; HA-NCI: M= 83.7, SD = 14.4, n = 96). Similarly, for the question regarding the difference HAs have made on their overall quality of life (Q15), both groups showed similar mean ratings (HA-CI: M = 85, SD = 16.6, n = 12; HA-NCI: M = 80.1, 15.8, n = 96). Independent samples t-tests showed no significant difference between the groups for all three questions (Q13-15).

The mean (M) and standard deviation (SD) for the 'amount of time spent listening to music' and 'music listening enjoyment' for the two points in time: 'prior to hearing loss'; and 'now, with HAs', along with the 'overall enjoyment of music' ratings are shown in Table 7.

Table 7: Descriptive Statistics for the Amount of Time Spent Listening to Music and Music Listening Enjoyment

			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
Q16. Amount of time spent listening to music (0 = never, 50 = sometimes, 100 = very often)	a. Prior to hearing loss	M	74.2	74.1	74.1	74.4	73.9
		SD	22.7	25.5	22.4	22.3	22.9
		n	110	13	97	50	47
	b. Now, with HAs	M	69.6	48.4	72.4	71.3	73.6
		SD	24.6	26.9	23.0	23.1	23.0
		n	110	13	96	50	46
Q17. Music listening enjoyment (0 = did/do not enjoy at all, 50 = neutral 100 = greatly enjoy(ed))	a. Prior hearing loss	M	79.3	80.2	79.1	79.9	78.3
		SD	20.8	20.7	20.9	16.6	24.8
		n	109	13	96	49	47
	b. Now, with HAs	M	76.9	63.2	78.6	76.2	81.3
		SD	20.8	30.2	20.4	20.9	19.8
		n	110	12	98	51	47
Q23. Overall enjoyment of music (0 = greatly decreased, 50 = no effect, 100 = greatly increased)		M	69.1	51.4	71.4	66.9	76.4
		SD	24.3	27.9	23.0	20.3	25.0
		n	107	12	95	50	45

Note: the range for all the scores is 0 - 100

Independent samples t-tests revealed that the HA-NCI group reported significantly higher scores for current levels of music listening (Q16b) and current music listening enjoyment (Q17b) than the HA-CI group ($p = 0.001$ and $p = 0.021$ respectively). For the overall enjoyment of music, an independent samples t-test showed that the HA-NCI group provided higher scores than the HA-CI group ($p = 0.007$).

For Q23, respondents were asked "how much have your HAs *impacted* on your overall enjoyment to music?". The mean ratings were higher for the HA-NCI group (M = 71.4, SD = 23, n = 95) than for the HA-CI group (M = 51.4, SD = 27.9, n = 12). An independent samples t-test indicated a significant difference between these scores ($p = 0.007$).

Respondents were asked to rate how tunes (or melodies) sound with HAs using a visual analogue scale ranging from 0 to 100 where 0 = monotonic and 100 = melodic. The overall mean rating was 73.5 (SD = 26.5, n = 103). The mean ratings given by the HA-CI and the HA-NCI groups were 54.25 (SD = 35.8, n = 12) and 76 (SD = 24.1, n = 91) respectively. An independent samples t-test showed this difference to be statistically significant ($p = 0.007$), indicating that the HA-NCI group rated tunes as sounding significantly more 'melodic' than the HA-CI group.

3.2.3 Musical Enjoyment: Mild and Moderate+ Subgroup Comparisons

For the questions regarding the difference HAs have made to their ability to hear speech (Q13) and their ability to hear environmental sounds (Q14), the Moderate+ subgroup gave higher mean ratings for both questions (Q13 Mild: M = 79.6, SD 11.5, n = 49; Moderate+: M = 87.8, SD = 12.2, n = 44; Q14 Mild: M = 80.7, SD = 14.4, n = 50; Moderate+: M = 86.9, S = 13.8, n = 46). The Moderate+ subgroup also gave higher mean ratings (M = 86.3, SD = 13.8, n = 46) for Q15 (overall quality of life) than the Mild subgroup (M = 74.4, SD = 15.6, n = 50). Independent samples t-tests showed the differences between the subgroups to be statistically significant for questions 13 ($p = 0.001$), 14 ($p = 0.031$) and 15 ($p < 0.001$).

Table 7 also provides the results for 'amount of time spent listening to music' and 'music listening enjoyment' for the subgroups of the HA-NCI group. In regards to the amount of time spent listening to music 'pre-hearing loss' (Q16a) and 'now with HAs' (Q16b), both subgroups shared similar mean ratings (Q16a Mild: M = 74.4, SD = 22.3, n = 50; Moderate+: M = 73.9, SD = 22.9, n = 47; Q16b Mild: M = 71.3, SD = 23.1, n =50; Moderate+: M = 73.6, SD = 23, n = 46). An independent samples t-test found no significant difference between the Mild and Moderate+ subgroups for Q16a or Q16b. Similarly, in regards to music listening enjoyment the mean ratings for the subgroups pre-hearing loss (Q17a) (Mild: M = 79.9; SD = 16.6, n = 49; Moderate+: M = 78.3, SD = 24.8, n = 47) and now with HAs (Q17b) (Mild: 81.3, SD = 19.8, n = 47) were similar and no significant difference found between the subgroups for Q17a and Q17b.

In regards to how much have HAs impacted on their overall enjoyment to music (Q23) the mean ratings were higher for the Moderate+ subgroup (76.4, SD = 25, n = 45) than the Mild subgroup (M = 66.9, SD = 20.3, n = 50). An independent samples t-test indicated a statistically significant difference between the subgroups ($p = 0.044$).

When asked to rate how tunes (or melodies) sound with HAs (Q30), the mean ratings given by the subgroups were: Mild: M = 73.3, SD = 20.4, n = 50; Moderate+: M = 79.3, SD = 27.9, n = 41. An independent samples t-test showed that there was no significant between these mean ratings.

3.3 Section 3: Sound Quality of Instruments, Instrumental Families and Singers

Respondents rated the sound quality of instruments, instrumental families and singers on the visual analogue rating scales of:

- very unpleasant–very pleasant
- very unnatural–very natural
- emptier–fuller
- duller–sharper
- more noisy–less noisy
- tinnier–richer
- rougher–smoother

The scales of pleasantness and naturalness were combined for analysis; a higher rating on both of these scales indicated a more favourable response. For the other five scales of specific timbral qualities, respondents were required to give ratings based on how they expect these instruments, instrumental families and singers to sound compared to how they expect them to sound to a person with normal hearing. A mid-point rating of 50 (i.e. 'As Expected') indicates the best possible result. For this reason, these scales were analysed separately and were not combined with the pleasant and natural scales. In this section, the term 'Instrument' (i.e. with a capital 'I') will be used to collectively refer to the various instruments, instrumental families and singers that were incorporated into the section.

3.3.1 Overall Sound Quality of Instruments

The overall mean ratings for the Pleasant/Natural combined scale for each Instrument are:

- drum kit (M = 56, SD = 14.5, n = 83)
- brass (M = 64.5, SD = 16.4, n = 84)
- strings (M = 65.5, SD = 20, n = 92)
- female singer (M = 65.7, SD = 15.9, n = 102)
- woodwind (M = 68.1, SD = 17.1, n = 82)
- guitar (M = 68.6, SD = 15.1, n = 92)
- male singer (M = 70.5, SD = 14.6, n = 104)
- piano (M = 71.8, SD = 16.1, n = 105)

A one-way Analysis of Variance (ANOVA) was conducted for the combined pleasant/natural scale to see if there were differences between the ratings for each instrument. Results of the one-way ANOVA indicated a significant difference between Instruments ($p < 0.001$), with post-hoc analyses using Bonferroni corrections showing the differences to be between the lowest-rated instrument (the drum kit) and each of the other Instruments:

- brass ($p = 0.023$)
- strings ($p = 0.004$)
- female singer ($p = 0.002$)
- woodwind ($p < 0.001$)
- guitar ($p < 0.001$)
- male singer ($p < 0.001$)
- piano ($p < 0.001$)

For the five scales related to specific timbral qualities a one-sample t-test was performed to determine whether respondents rated the sound quality of instruments to be significantly different to what they would expect them to sound to a person with normal hearing (i.e. to see if their ratings were significantly different to the ‘as expected’ value of 50). A significant p-value would suggest that the instrument digressed from how the respondent expected it to sound for a person with normal hearing for that particular scale being rated. The results for the one-sample t-test are presented below in Table 8 where the shaded cells indicate a significant difference, and p-values, mean, standard deviations are provided across participants.

Table 8: Results of one-sample t-test tests for the timbre-based scales

	Fuller	Sharper	Noisier	Richer	Smoother
Piano	**p = 0.811** M = 50.38 SD = 15.70 n = 97	**p = 0.001** M = 56.69 SD = 20.18 n = 98	**p = 0.216** M = 47.46 SD = 20.05 n = 97	**p = 0.368** M = 51.75 SD = 19.07 n = 97	**p = 0.002** M = 55.17 SD = 16.01 n = 93
Strings	**p = 0.017** M = 54.79, SD = 18.35 n = 87	**p = 0.002** M = 56.70 SD = 19.75 n = 86	**p = 0.869** M = 49.72 SD = 15.76 n = 85	**p = 0.082** M = 53.67 SD = 19.02 n = 83	**p = 0.001** M = 55.36 SD = 14.77 n = 85
Woodwind	**p = 0.012** M = 54.19 SD = 14.34 n = 77	**p = 0.021** M = 54.56 SD = 16.96 n = 77	**p = 0.504** M = 48.72 SD = 16.52 n = 75	**p = 0.027** M = 54.13 SD = 16.02 n = 76	**p = 0.004** M = 55.49 SD = 15.95 n = 75
Brass	**p = 0.003** M = 54.05 SD = 12.02 n = 80	**p = 0.002** M = 55.47 SD = 14.93 n = 80	**p = 0.691** M = 48.72 SD = 16.52 n = 75	**p = 0.332** M = 54.13 SD = 16.02 n =76	**p = 0.069** M = 55.49 SD = 15.95 n = 75
Drum kit	**p = 0.026** M = 54.06 SD = 15.98 n = 80	**p = 0.188** M = 56.62 SD = 17.70 n = 80	**p = 0.006** M = 43.46 SD =12.44 n = 85	**p = 0.510** M = 48.93 SD = 14.28 n = 79	**p = 0.117** M = 47.23 SD = 15.41 n = 78
Guitar	**p = 0.287** M = 51.63 SD = 14.22 n = 87	**p = 0.003** M = 55.12 SD = 15.56 n = 85	**p = 0.717** M = 50.57 SD = 14.41 n = 84	**p = 0.903** M = 50.21 SD = 15.31 n =82	**p= 0.040** M = 53.21 SD = 13.74 n = 80
Male singer	**p = 0.040** M = 55.13 SD =13.97 n = 98	**p = 0.036** M = 53.40 SD = 15.61 n = 95	**p = 0.121** M = 52.26 SD = 14.11 n = 95	**p = 0.002** M = 54.39 SD = 13.52 n = 92	**p = 0.016** M = 53.39 SD = 13.21 n = 92
Female singer	**p = 0.139** M = 52.10 SD =13.82 n = 96	**p = 0.010** M = 53.66 SD = 13.25 n = 91	**p = 0.470** M = 51.14 SD = 15.28 n = 95	**p = 0.120** M = 52.50 SD = 15.40 n = 93	**p = 0.010** M = 57.32 SD = 16.31 n = 95

As shown in Table 8 respondents rated that:

- most Instruments except the piano, guitar and female singer were fuller than expected;

- all Instruments (except the drum kit) were sharper than expected;
- the drum kit was the only Instrument noisier than expected;
- the woodwind family and male singer were the only Instruments that were richer than expected; and
- all Instruments, except the brass family and drum kit, were smoother than expected.

Precisely, for each Instrument:

- the piano and guitar were significantly smoother and sharper than expected;
- the strings family was significantly fuller, smoother and sharper than expected;
- the woodwind family was significantly fuller, sharper, richer and smoother than expected;
- the brass family was significant fuller and sharper than expected;
- the drum kit was significantly fuller and noisier than expected;
- the male singer was significantly fuller, sharper, smoother and richer than expected; and
- the female singer was significantly sharper and smoother than expected.

3.3.2 Sound Quality of Instruments: HA-CI vs. HA-NCI Group Comparisons

The sound quality of the Instruments were also analysed separately for each group and subgroup. For the pleasant and natural combined scale, the HA-NCI group rated all Instruments, as more pleasant and natural than the HA-CI group Figure 15.

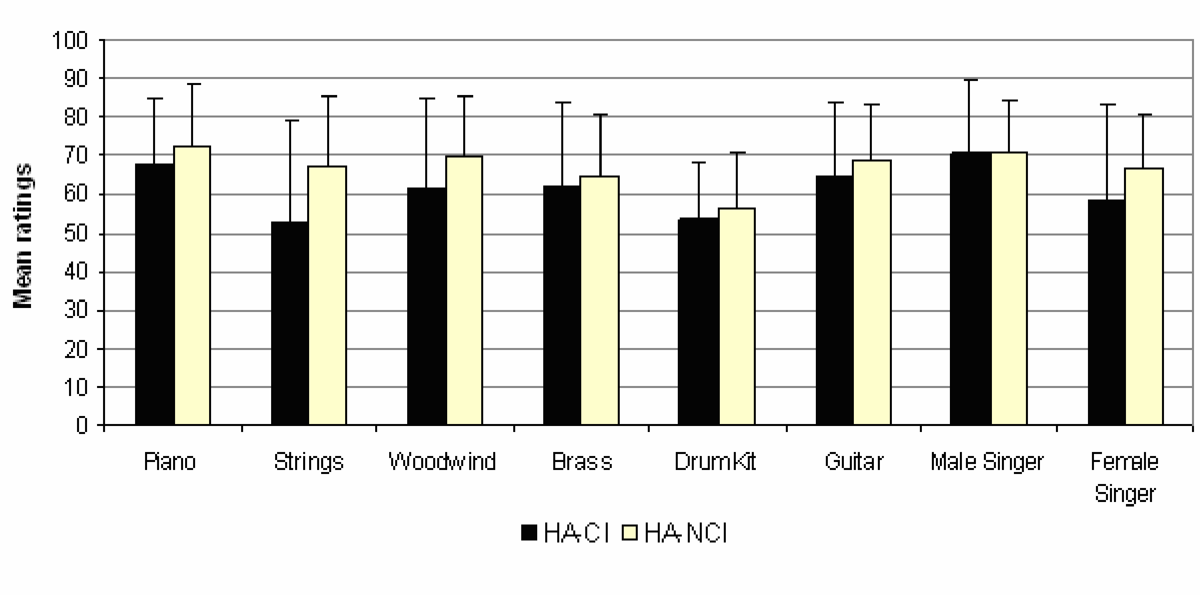


Figure 15: Mean ratings (groups and overall) for the combined pleasant/natural scales
(Error Bars = 1 SD)

Due to the small number of HA-CI subjects, non-parametric Mann-Whitney-U tests were performed to determine whether there was a significant difference between the HA-CI and HA-NCI groups for each of the sound quality rating scales across all Instruments. The results showed a significant difference between the groups for all of the rating scales, except the more noisy–less noisy scale, as shown below:

- combined pleasant /natural scale ($p = 0.007$)
- emptier–fuller ($p < 0.001$)
- duller–sharper ($p < 0.001$)
- more noisy–less noisy ($p = 0.524$)
- tinnier–richer ($p < 0.001$)
- rougher–smoother ($p = 0.012$)

In view of this, separate one-way ANOVAs were also conducted for the HA-CI and HA-NCI groups for each scale (except the more noisy–less noisy scale) to see if there were significant differences between the ratings for each Instrument. Results of these one-way ANOVAs showed that there were no significant differences between the Instruments for the HA-CI group for any of the scales. For the HA-NCI group, the only significant difference between the Instruments was for the combined pleasant/natural scale ($p < 0.001$) (Figure 5). Post-hoc analysis with Bonferroni corrections showed the differences to be between the lowest-rated Instrument (the drum kit) and the:

- piano ($p < 0.001$)
- strings ($p = 0.001$)
- woodwind ($p < 0.001$)
- brass ($p = 0.032$)
- guitar ($p < 0.001$)
- male singer ($p < 0.001$)
- female singer ($p = 0.001$)

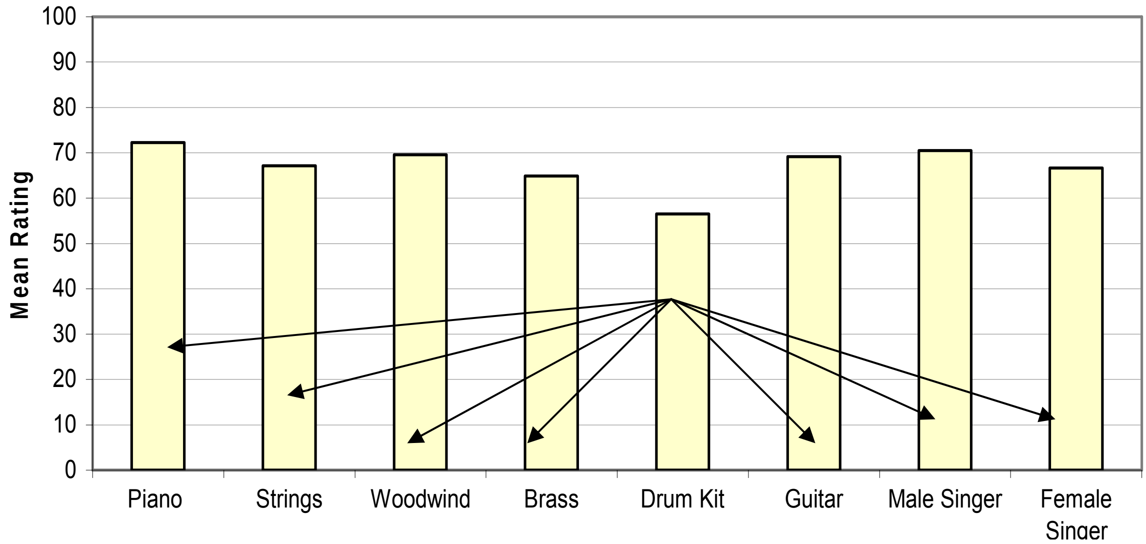


Figure 16: Mean ratings for the combined pleasant/natural scales for each Instrument for the HA-NCI group

(Arrows indicate significant differences between instruments (p < 0.050)).

For the more noisy–less noisy scale, the data for the two groups HA-CI and HA-NCI, were combined for the one-way ANOVA (as there was no significant difference between the groups). There was a significant difference across Instruments (p = 0.030), with post-hoc analysis with Bonferroni corrections showing the drum kit was rated to be significantly noisier than the male singer (p= 0.016).

3.3.3 Sound Quality of Instruments: Mild and Moderate+ Subgroup Comparisons

For the HA-NCI group, statistical analyses were performed to see if there were any differences between the Mild and Moderate+ subgroups. The Moderate+ subgroup were observed to rate all Instruments as slightly more pleasant and more natural than the Mild subgroup (Figure 17).

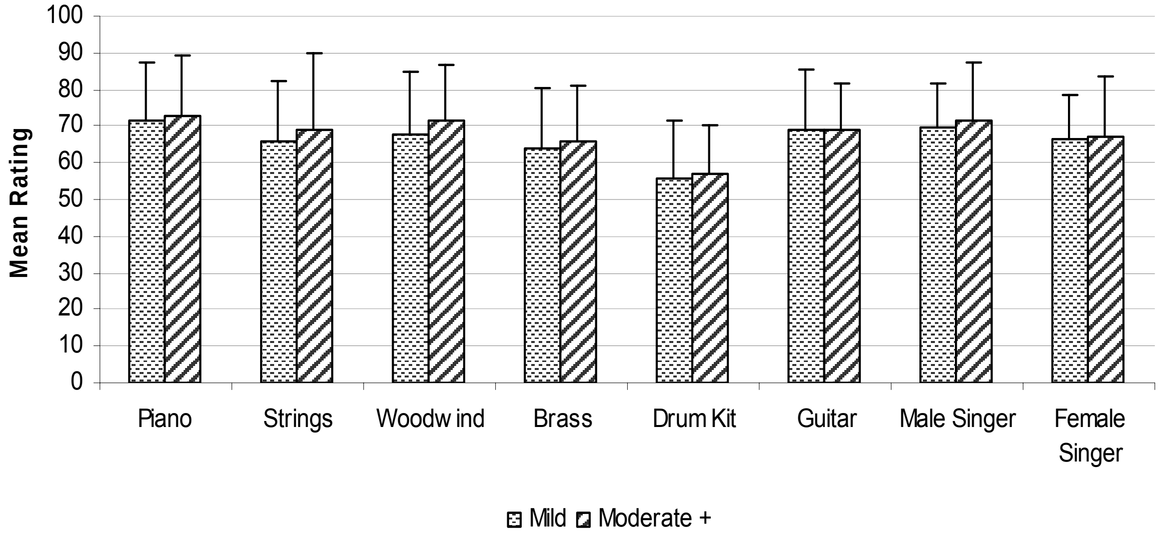


Figure 17: Mean ratings for the pleasant/natural combined scales for the Mild and Moderate+ subgroups.
(Error bars = 1 SD)

Two-way repeated measures (RM) ANOVAs were conducted for each of the scales, including the combined pleasant/natural scale, to see if there was a significant difference between the two subgroups, and for the eight instruments. The results are shown below in Table 9. The only scales that showed a significant difference for the between-subject factor of subgroup were 'duller–sharper' ($p < 0.001$) and 'more noisy–less noisy' ($p < 0.001$), where the Moderate+ subgroup rated the Instruments to sound sharper and noisier than the Mild subgroup. The individual differences between the subgroups at the level of instrument will not be discussed here as they have been covered in the previous section (Section 3.2.2 – i.e. as a whole group– HA-NCI).

Table 9: Results of Two-Way Repeated Measures ANOVAs on Instrument Sound Quality Ratings of Subgroups Mild vs. Moderate+

Ratings	Group Effect	Instrument Effect	Group by Instrument Interaction Effect	n	
				Mild	Moderate+
Pleasant/Natural[a]	p = 0.993	p < 0.001**	p = 0.805	37	30
Empty–Full	p = 0.699	p =0.793	p = 0.588	25	24
Dull–Sharp	p < 0.001*	p = 0.34	p = 0.102	25	29
Tinny–Rich	p = 0.564	p = 0.158	p = 0.402	23	25
More Noisy–Less Noisy	p < 0.001*	p = 0.071	p = 0.005*	25	27
Rough–Smooth	p = 0.53	p = 0.85	p = 0.765	24	25

Note: Significance *p<0.05, ** p<0.005
[a]Combined Rating

In view of the significant interaction for the more noisy–less noisy scale (p = 0.005), separate one-way ANOVAs were conducted for the two subgroups. A significant difference between the Instruments was found for the Mild group only (p = 0.005). Post-hoc analysis with Bonferroni corrections showed that the lowest-rated Instrument (the drum kit) was rated to be significantly noisier than the string family (p = 0.040), guitar (p = 0.003), and male singer (p = 0.014).

3.4 Section 4: Musical Styles

In this section, respondents rated various musical styles using the scales of:

- very unpleasant–very pleasant
- can never–can always follow the melody-line
- can never–can always identify the style
- simple–complex
- sounds nothing like–sounds exactly like it would sound to a person with normal hearing

The latter scale will be referred to as 'doesn't sound like–sounds like normal'. The data were analysed for each individual scale. In addition to analysing each scale individually, a combined rating scale score was calculated for each style. This combined score was the mean of all the rating scales except the simple–complex scale. For the former scales, a higher rating suggests a more favourable response, however a higher rating on the simple–complex scale does not necessarily indicate a better response.

3.4.1 Musical Styles: HA-CI and HA-NCI Group Comparisons

Similar to the previous section, non-parametric Mann-Whitney-U tests were performed to determine whether there was a difference between HA–CI and HA–NCI groups' ratings across all musical styles. Significant differences between the groups were found for all of the rating scales, as shown below:

- very unpleasant–very pleasant ($p < 0.001$)
- simple–complex ($p = 0.015$)
- can never–can always follow melody-line ($p < 0.001$)
- can never–can always identify style ($p < 0.001$)
- doesn't sound like–sounds like normal ($p < 0.001$)

Separate one-way ANOVAs were conducted for the two groups for each scale to see where these significant differences lay. For the HA-CI group, the only significant difference was for the very unpleasant–very pleasant scale ($p = 0.040$). Post-hoc analysis with Bonferroni corrections for this scale showed the difference to be between pop/rock and lowest-rated musical style (jazz) ($p = 0.045$).

For the HA-NCI group, significant differences were found for the following rating scales:

- very unpleasant–very pleasant ($p < 0.001$)
- simple–complex ($p = 0.002$)
- combined rating ($p = 0.013$)

Post-hoc analysis with Bonferroni corrections were performed for each of the three scales. Results showed that:

- all musical styles were significantly more pleasant than pop/rock;
- classical-orchestra, classical-small group and jazz were significantly more complex than country & western

- Country & western and jazz had significantly higher mean ratings than pop/rock when the scales were combined for overall analysis (Table 10).

Table 10: Post-hoc Analysis for the Pleasant, Complex, and Combined Rating Scales for the HA-NCI Group

Rating Scale	Significant differences between styles	
Very unpleasant–Very pleasant	Pop/Rock and	Classical – orchestra (p = 0.001)
		Classical – small group (p = 0.001)
		Classical – choir (p = 0.002)
		Country and Western (p = 0.001)
		Jazz (p < 0.001)
Simple–Complex	Country & Western and	Classical – orchestra (p = 0.044)
		Classical – small group (p = 0.033)
		Jazz (p = 0.005)
Combined (except complex)	Pop/Rock and	Country & Western (p = 0.009)
		Jazz (p = 0.040)

As mentioned earlier the descriptive statistics for these questions including means and standard deviations are provided in Appendix 3.

3.4.2 Musical Styles: Mild and Moderate+ Subgroup Comparisons

For the HA-NCI group, two-way RM ANOVAs were conducted for each of the individual scales as well as for the combined ratings scale to see if there was a significant difference between the Mild and Moderate+ subgroups; and across all instruments. The results are shown below in Table 11. As can be seen, none of the scales showed a significant difference for the between-subjects factor of subgroup and no significant interaction between subgroup and style. There were significant differences were found for the within-subject factor of musical style for the following scales: combined ratings scale (an average of all ratings except the complexity rating), can never–can always follow melody-line, can never–can always identify style and doesn’t sound like–sounds like normal.

Table 11: Results of Two-Way Repeated Measures ANOVAs on Musical Style Ratings of Subgroups Mild and Moderate

Ratings	Group Effect	Style Effect	Group by Style Interaction Effect	n	
				Mild	Moderate+
Combined Ratings[a]	$p = 0.670$	$p < 0.001$**	$p = 0.997$	17	19
Very Unpleasant—Very Pleasant	$p = 0.905$	$p = 0.21$	$p = 0.636$	17	17
Simple—Complex	$p = 0.876$	$p = 0.103$	$p = 0.342$	14	16
Can Never—Can Always Follow Melody-line	$p = 0.832$	$p < 0.001$**	$p = 0.928$	14	18
Can Never—Can Always Identify Style	$p = 0.476$	$p < 0.001$**	$p = 0.559$	14	17
Doesn't Sound like—Sounds like Normal	$p = 0.432$	$p = 0.015$*	$p = 0.981$	14	17

[a] An average of all the rating scales except the complexity ratings
Significance: *$p < 0.05$, ** $p < 0.005$

3.5 Section 5: Music Preferences

This section examined the musical preferences of the respondents. As in Section 3.3, the term 'Instrument' will be used to collectively refer to the instruments, instrumental families and singers.

For Q35 respondents were asked to rank Instruments where 1 = sounds most natural and 8 = sounds least natural. They were able to give equal rankings if they wished. The results are presented below in Table 12.

Table 12: Preference for Type of Instruments
1 = sounds most natural, 8 = sounds least natural

Instrument	Median	Mode
Piano	2	1
Strings	3	1
Woodwind	4	1
Brass	4	1
Drum kit	6	8
Guitar	3	1
Female Singer	3	2
Male Singer	2	1
		n = 84*

*Included respondents that ranked ALL types of Instruments only.

Overall, based on median rankings, the piano and male singer were ranked as sounding the most natural, with the drum kit sounding the least natural. A Friedman test on Ranks showed a significant difference in the rankings ($\chi^2 = 89.4$, $n = 84$, $p < 0.001$).

Shown in Table 13 are the median rankings and mode for the question on preferred number of performers (Q35). Overall ‘one performer’ and ‘larger group of performers’ yielded a median ranking of two and a mode of one suggesting that these musical ‘group’ sizes were most preferred. A Friedman test on Ranks revealed a significant difference between the rankings ($\chi^2(4, N = 86) = 11.8$, $p < 0.019$).

Table 13: Preferred Number of Performers
1 = most preferred and 5 = least preferred

Number of Performers	Median	Mode
One performer (instrument or singer)	2	1
Two performers (instruments and/or singers)	3	4
Three performers (instruments or singers)	3	3
Small group of performers (e.g. 4 to 5)	3	2
Larger group of performers (e.g. an orchestra, choir or band)	2	1
n	73*	

* Included respondents that ranked ALL types of performers, only.

In regards to the preferred gender of singer, 35% preferred a male singer over a female singer (9.7%) as shown below in

Table 14. A Binomial test revealed this difference to be significant ($p < 0.001$), although a large proportion had no preference for gender of singer (53.3%). For the preferred pitch on instruments, 47.6% preferred low-pitch to high-pitch instruments (5.8%), and 46.6% had no preference. A Binomial test revealed that the low-pitched instruments were preferred significantly more than the high-pitched instruments ($p < 0.001$).

Table 14: Preferences for singer gender, pitch of instrument and instrumentation

				HA-CI		HA-NCI					
		Overall		Overall		Overall		Mild		Moderate+	
			%		%		%		%		%
Gender (Q36a)	Male Singer	36	35.0	9	69.2	27	30.0	13	27.7	14	32.6
	Female Singer	10	9.7	1	7.7	9	10.0	4	8.5	5	11.6
	No preference	57	55.3	3	23.1	54	60.0	30	63.8	24	55.8
	n	*103*		*13*		*90*		*47*		*43*	
Instrumental pitch (Q36b)	Low pitched instrument	49	47.6	9	69.2	40	44.4	21	44.7	19	44.2
	High-pitched instrument	6	5.8	0	0	6	6.7	3	6.4	3	7.0
	No preference	48	46.6	4	30.8	44	48.9	23	48.9	21	48.8
	n	*103*		*13*		*90*		*47*		*43*	
Instrumentation (Q36c)	Instrumental- only Music	25	24.0	3	23.1	22	24.2	13	26.5	9	21.4
	Voice Only music	3	2.9	0	0	3	3.3	0	0	3	7.1
	Voice with instrument	37	35.6	8	61.5	29	31.9	16	32.7	13	31.0
	No preference	39	35.1	2	15.4	37	40.7	20	40.8	17	40.5
	n	*104*		*13*		*91*		*49*		*42*	

For the music instrumentation question (Q36c), 35.6% preferred voice with instrument music and 24% preferred instrumental-only music. A small proportion preferred voice-only music (2.9 %) and 31.5 % indicated no preference. A Chi-square test revealed a significant difference ($\chi^2 = 27.46$, n = 65, $p < 0.001$) between the proportions of individuals who preferred instrumental-only, voice-only, and voice with instrument preferences.

3.5.1 Music Preferences: HA-CI and HA-NCI Group Comparisons

For the HA-CI respondents that indicated their preference for type of singer (n = 13), a greater proportion preferred a male singer (69.2%) to a female singer (7.7%), and 23.1% indicated no preference. A Binomial test revealed the difference between the male and female preference to be significant (p = 0.021). For the preferred pitch of instruments (n = 13), significantly more preferred low-pitched instruments (69.2%) to high-pitched instruments (0%) (Binomial test: p = 0.004), with 30.8% indicating no preference. In regards to preferred instrumentation (n = 13), 61.5% of HA-CI respondents preferred 'voice with instrument music', 23% preferred 'instrumental-only music' and no respondents 'preferred voice with instrument music' (0%); 15.4% indicated no preference. A Chi-square test showed no significant difference between preferences of instrumental-only, voice-only, and voice with instrument music ($\chi^2 = 2.273$, n = 11, p = 0.132)

Within the HA-NCI group (n = 90), 30% preferred a male singer and 10% preferred a female singer whilst the largest proportion of respondents had no preference (60%). A Binominal test revealed the difference between the preference for a male singer versus a female singer to be significant (p = 0.004). For the HA-NCI respondents who rate their preferred pitch of instruments (n = 90), 44.4% preferred low-pitched instruments; 6.7% preferred high-pitched instruments, and 48.9% specified no preference. A Binomial test showed a significant difference (p < 0.001) between the preference for low- versus high-pitched instruments.

In regards to the preferred type of music, 24.2% preferred instrumental-only music, 31.9 % preferred voice with instrumental music, 3.3% preferred voice-only music, and 40.7% had no preference. A Chi-square test revealed a significant difference between preferences for instrumental-only, voice-only, and voice with instrument music ($\chi^2 = 20.12$, n = 54, p < 0.001).

3.5.2 Music Preferences: Mild and Moderate+ Subgroup Comparisons

A Binomial test showed that significantly more respondents in the Mild subgroup preferred a male singer over a female singer ($p = 0.049$). No significant difference was found for the Moderate+ subgroup. In regards to preferred pitch of instruments, a Binomial test revealed a significant difference between low-pitched and high-pitched instruments within both the Mild ($p < 0.001$) and Moderate+ ($p = 0.001$) subgroups, with low-pitched instruments being preferred by both groups. With regards to instrumentation preference, no significant difference was found between preferences for the Mild subgroup (Chi-square test: $\chi^2 = 0.310$, $n = 29$, $p = 0.577$). However there was a significant difference between preferences for these three instrumentations instrumental-only, voice-only, and voice with instrument music, for the Moderate+ subgroup (Chi-square test: $\chi^2 = 6.080$, $n = 25$, $p = 0.048$).

3.6 Section 6: Music Recognition

Shown below in

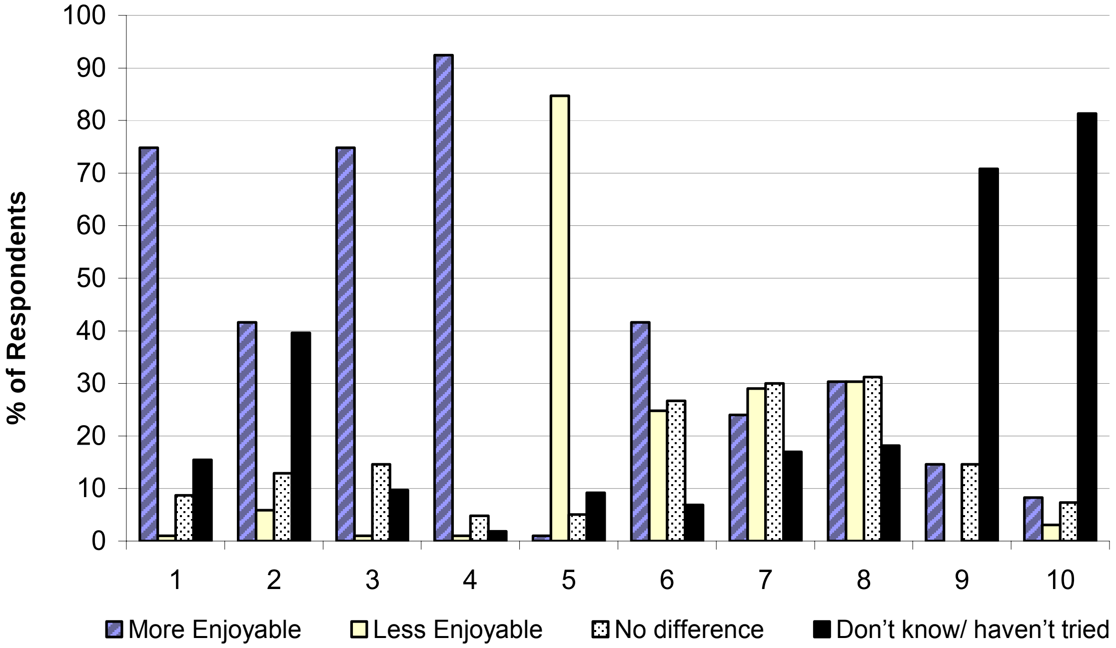
Table 15 are the descriptive statistics for the music recognition section. A large proportion of respondents in both groups indicated that there were tunes which they could always recognise with their HAs (Q38) (HA-CI: 84.6%; HA-NCI: 91.2%). Similarly, a large proportion of the HA-CI group (69.2%) reported that there were tunes that they could not recognise but would like to be able to recognise (Q39). However, 93.3% of respondents in the HA-NCI group reported that there were no tunes that they could not recognise but would like to be able to recognise. 69.2% of the HA-CI and 84.6% of the HA-NCI groups reported that listening alone there were some instruments that they could always recognise (Q40). Qualitative comments for including the names of the specific tunes and instrument provided by the respondents for these questions are shown in Appendix #4.

Table 15: Descriptive Statistics for Music Recognition

		HA-CI		HA-NCI					
		Overall		Overall		Mild		Moderate+	
			%		%		%		%
Q38	Yes	11	84.6	83	91.2	42	89.4	41	93.2
	No	2	15.4	8	8.8	5	10.6	3	6.8
	n	*13*		*91*		*47*		*44*	
Q39	Yes	6	69.2	6	6.7	3	6.7	3	6.7
	No	8	30.8	84	93.3	42	93.3	42	93.3
	n	*13*		*90*		*45*		*45*	
Q40	Yes	9	69.2	77	84.6	40	87.0	37	82.2
	No	4	30.8	14	15.4	6	13.0	8	17.8
	n	*13*		*91*		*46*		*45*	

3.7 Section 7: Factors Affecting Music Listening Enjoyment

Shown in Figures 18 to 21 are the respondents views how various factors affect their music listening experiences. The HA-CI and HA-NCI groups are combined in these analyses. Figure 18 illustrates factors that are related to music environment, Figure 19 contains factors related to respondents' past listening experiences and contextual cues, and 20 contains factors related to features of music such as volume, rhythm and beat.

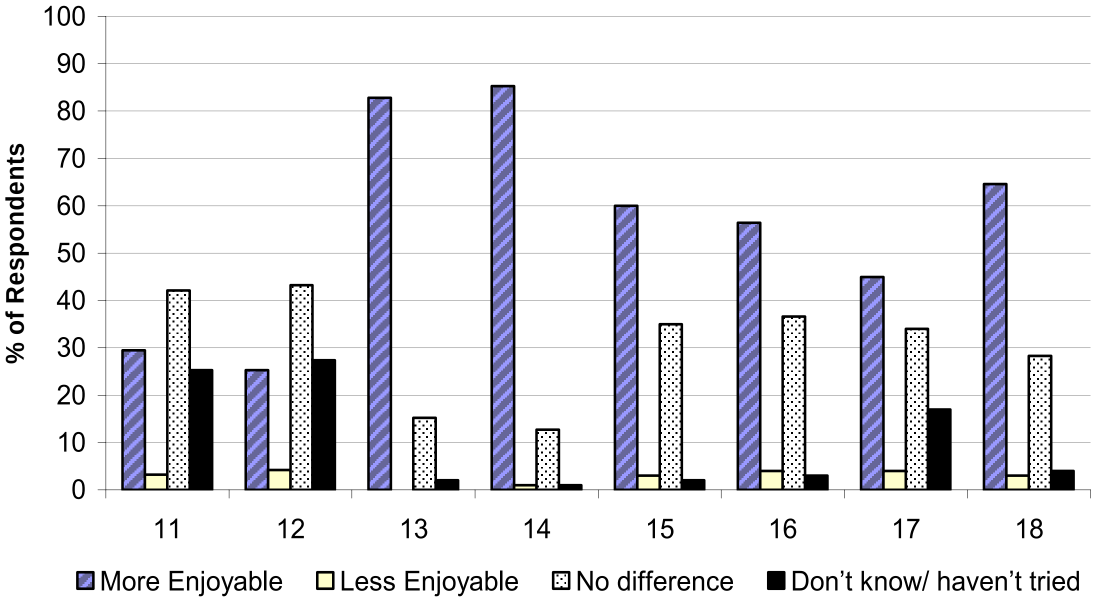


Key:

1	High quality speakers	6	Live concert indoors
2	High quality headphones	7	Live concert outdoors
3	High quality recordings	8	Sitting at the front of the hall/theatre
4	Quiet environment	9	Using a special music programme on your HAs
5	Echoey (reverberant) room	10	Direct Audio Input

Figure 18: Factors related to the listening environment and equipment which impact on music listening enjoyment

The factors related to the listening environment and equipment which were rated most frequently to improve listening enjoyment were: a quiet environment (92.8%), high quality speakers (74.8%), high quality recordings (74.8%), and high quality headphones (41.6%) (Figure 18). The factor most commonly reported to hinder musical enjoyment was an echoey (reverberant) room (84.6%). A large proportion 'didn't know/ hadn't tried' using a special music programme (70.8%) or Direct Audio Input (DAI) (81.3%), which corresponds to results reported in Section 1 of the UCMLQ_HA.

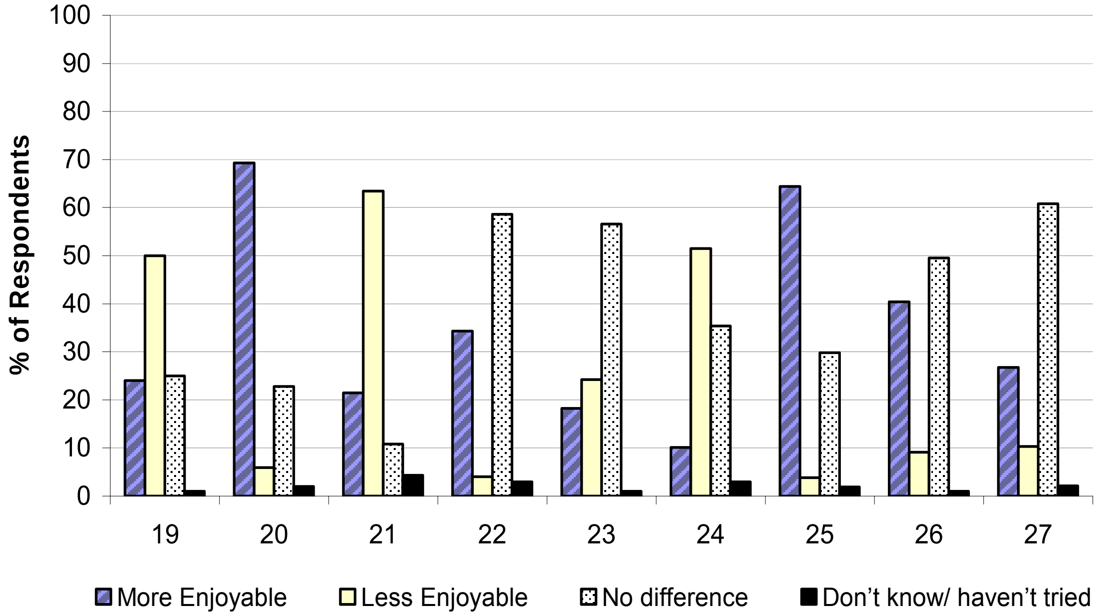


Key:

11	Increased length of time with HAs	15	Knowing the song title
12	Practice listening to music	16	Knowing the context
13	Familiar lyrics and words	17	Following musical score or words
14	Familiar tunes	18	Watching the performers

Figure 19: Factors related to past listening experiences and contextual cues which impact on music listening enjoyment

As Figure 19 illustrates, factors related to past listening experiences and contextual cues which were most frequently reported to improve listening enjoyment were: familiar tunes (85.3%), familiar lyrics and words (82.8%), knowing the song title (60%), watching the performers (64.6%), and knowing the context (56.4%). A similar proportion of respondents indicated that increased time with HAs (42.1%) and practice listening to music (43.2%) made no difference to listening enjoyment.



Key:

19	Soft volume	24	Tune with no harmony
20	Medium volume	25	Tune with harmony
21	Loud volume	26	With words
22	Slow rhythm or beat	27	Without words
23	Fast rhythm or beat		

Figure 20: Features of music which impact on music listening enjoyment

As shown in Figure 20 features of the music which were most frequently reported to improve listening enjoyment were medium volume (69.3%) and a tune without harmony (64.4%). A large proportion indicated that a loud volume (63.4%) and soft volume (50%) hindered their listening experience. The speed of the music had little impact on enjoyment for many respondents with 56.6% and 58.6% indicating that a fast or slow rhythm/beat, respectively, made no difference to their music listening experience. The presence or absence of words also had little impact on enjoyment for many respondents (with words: 47.7%; without words 60.8%).

In summary, a large proportion of HA users in this study reported factors related to listening environment that made listening more enjoyable were:

- quiet environment (92.8%)
- high quality recordings (77%)

- high quality speakers (74.8%)
- high quality headphones (41.6%)

Factors related to past listening experiences and contextual cues that made listening more enjoyable were:

- familiar tunes (85.3%)
- familiar lyrics and words (82.8%)
- watching the performers (64.6%)
- knowing the song title (60%)
- knowing the context (56.4%)

Features of music that made listening more enjoyable were:

- medium volume (69.3%)
- tune without harmony (64.4%)

Conversely, a large proportion of respondents also reported factors that made music listening less enjoyable were:

- echoey (reverberant) room (84.6%)
- loud volume (63.4%)
- soft volume (50%)

3.8 Music Training Programme (MTP)

When asked if they would interested in a MTP if one became available (Q43), 71.3% of respondents (including both HA-CI and HA-NCI respondents) reported ‘no’ and 28.6 % reported ‘yes’ as shown on Table 16. A Binomial test revealed this difference to be significant ($p < 0.001$). Although a large proportion of respondents were not interested in a MTP, many of them provided answers and comments to the subsequent questions have been included in the following analyses.

Table 16: Interest in a MTP (Q43)

	Overall		HA-CI		HA-NCI					
			Overall		Overall		Mild		Moderate+	
		%		%		%		%		%
Yes	29	28.7	8	61.5	21	23.6	11	22.9	10	24.4
No	72	71.3	4	33.3	68	76.4	37	72.5	31	75.6
n		101		12		89		48		41

Respondents were asked to rank eights skills in terms of how important they are to their music listening enjoyment (where 1 = most important and 8 = least important). Shown below in Table 17 are the median rankings and modes for this question (Q44). The music listening skills that were most frequently ranked to be most important were the ability to: recognise commonly-known musical instruments, recognise commonly-known tunes, hear changes in pitch, hear more-complex rhythms and pick out the tune when presented with harmony. A Friedman test on Ranks revealed a significant difference between rankings ($\chi^2 = 82.155$, n = 71, $p < 0.001$).

Table 17: Music Listening Skills Important to Listening Enjoyment
1 = most important, 8 = least important

Music Listening Skills	Median	Mode
Ability to recognise commonly-known musical instruments	2	1
Ability to recognise commonly-known tunes	1	1
Ability to recognise previously-know tunes (known before HAs)	2	1
Ability to recognise musical styles	4	2
Learning new tunes	5	3
Ability to hear changes in pitch	3	1
Ability to hear more complex rhythms	4	1
Ability to “pick out” the tune when it is presented with harmony	3	1
*n**	71	

* Included respondent that ranked ALL music listening skills only.

When asked if there are any instruments, instrumental families, musical styles, or songs that they would like to be able to hear better (Q45), significantly more respondents reported ‘no’ (Binomial test: $p< 0.001$, n = 89). A significantly greater proportion of respondents reported that would like the MTP to focus a wide range of musical styles (69.9%) as opposed to a preferred style only (30.2%) (Binomial test p = 0.002, n = 63).

With regard to the duration of each training session (Q47), frequency (Q48), the most-common responses were 30 minutes (M = 32.6, SD = 14.2, range = 5-60, n = 58) and two times per week (M = 2.2, SD = 1.1, range = 1-6, n = 59). No significant associations were found between the subject factors of age, PTA or experience with their HAs, and the preferred length and frequency of the MTP, using Pearson's R correlation analysis.

Shown in Figure 21 is the preferred mode of delivery for the MTP. As can be seen, almost half the respondents preferred a DVD (43%). 76.5% of the respondents also said that they would find a written manual helpful (n = 62).

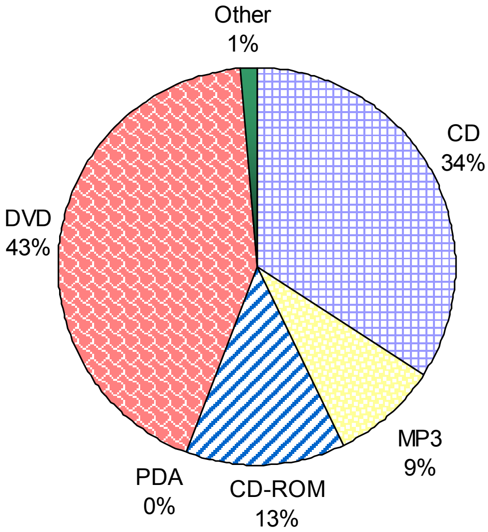


Figure 21: The preferred mode of delivery for the MTP (n = 58)

4. Discussion

The aim of the current study was to assess ratings of music by postlingually deafened adults hearing aid (HA) users, using a questionnaire (UCLMQ_HA). To date, very few studies have been conducted focusing on the music listening habits and music perception of HA users. Although speech perception through HAs is well researched (Blamey et al., 2006; Ching et al., 1998; Moore, 2003b; Turner & Cummings, 1999; Vinay & Moore, 2007; Yund & Buckles, 1995), as is the music perception of CI users (for a review see Looi (2008) and McDermott (2004)), music appreciation and enjoyment levels through HAs is significantly less reported (Chasin & Russo, 2004; Looi et al., 2007; Looi et al., 2008). Given the limited research thus far, the overall aim of this study was to collect more detailed and descriptive information on music listening and the ratings of musical sounds from postlingually deafened adults who use HAs via the UCMLQ_HA. This study also sought to investigate whether there are any differences in ratings of musical sounds in HA users with a mild versus a moderate or worse hearing loss, as well as between those HA users that have been assessed for a CI and those who have not been assessed for a CI. Specifically, the following hypotheses were posed:

1. Ratings for music from HA users who have been assessed for a CI (HA-CI group) will be worse than for those who have not been assessed for CI (HA-NCI group).
2. HA users with a moderate or worse hearing loss (Moderate+ subgroup) will provide lower ratings than those HA users with a mild hearing loss (Mild subgroup).

In order to test these hypotheses, a modified version of the UCMLQ was administered to two groups of participants (HA-CI and HA-NCI), of which the latter group was divided into two subgroups (Mild and Moderate+). The findings supported the assumptions in Hypothesis 1, however Hypothesis 2, which was related to the level of hearing loss of the subgroups, was only partially supported.

Firstly, the findings pertinent to hypothesis 1 will be discussed, which will involve the differences between the HA-CI and HA-NCI groups (Section 4.1). This will be followed by a discussion of overall HA users (Section 4.1.1) – i.e. results where there were no significant differences between the two groups. After this, the findings regarding Hypothesis 2 will be discussed which will involve the differences between the Mild and Moderate+ subgroups (Section 4.2), followed by a discussion of these subgroups as a whole (Section 4.2.1), where no differences occurred (i.e. HA-NCI group, who would be considered as satisfied HA users who have not been assessed for a CI). Although unrelated to the hypothesis, there were additional factors and ratings that may not have contributed to the music listening experience of the respondents. Differences and similarities between groups and subgroups will also be discussed (Sections 4.3.2 and 4.3.3). Lastly, the general discussion (Section 4.4) will address other additional findings from this study, where the participants were analysed as a whole group, as well as potential clinical implications, limitations of the study, and directions for future research.

4.1 Hypothesis 1

Overall the results supported the hypothesis that ratings on the UCMLQ who have been assessed for a CI will be worse than those not assessed for a CI. The discrepancy in the groups was expected because of the different levels of audibility. There were differences in the ratings of ‘Instruments’ (i.e. instruments, instrumental families, singers) and musical styles between the HA-CI and HA-NCI groups. The HA-CI group provided lower ratings in terms of ‘pleasantness’ and ‘naturalness’ for Instruments and music styles than the HA-NCI group.

Although there was considerable variance in respondents’ ratings for the sound quality ratings of Instruments, in general the HA-CI group gave similar ratings for all Instruments, whereas the HA-NCI group provided significantly different ratings for various Instruments. The HA-NCI group rated Instruments to sound significantly more ‘pleasant’ and ‘natural’ (combined scale) ($p = 0.07$), significantly ‘fuller’ ($p < 0.001$), significantly ‘richer’ ($p < 0.001$), and significantly ‘smoother’ ($p = 0.012$) than the HA-CI group. Similarly, the HA-NCI group also rated all musical styles to sound significantly more ‘pleasant’ than the HA-CI group ($p < 0.001$).

The lower ‘pleasantness’ ratings given by the HA-CI group in Sections 2 and 3 of the UCMLQ_HA were similar with pre-implant CI users in Looi et al.’s (2007) study. In their study respondents were required to give quality ratings where 1 = ‘very unpleasant’ and 10 = ‘very pleasant’ for three sets of musical stimuli: single instruments; solo instruments with background accompaniment; and musical ensembles. The HA users who were on the waiting list for a CI gave significantly higher ‘pleasant’ ratings across musical stimuli ($p = 0.026$) post-implantation with a CI than pre-implantation with a HA. The respondents commented that with their HAs they could only hear the beat or bass sounds, and "got more" of the sound with their CI, once they had been implanted.

In addition to the higher 'pleasantness' ratings of musical styles Section provided by the HA-NCI group, they also felt they were significantly more able to follow melody lines ($p < 0.001$), identify the style ($p < 0.001$), and they rated musical styles, in general, to sound significantly more normal (i.e. closer to how they would it expect it to sound to a person with normal hearing) ($p < 0.001$) than the HA-CI group. It was also found in this study that the HA-NCI group rated tunes to sound significantly more 'melodic' than the HA-CI group ($p = 0.007$). In considering the differences between the two groups, the differences of their level of hearing loss must be accounted for. The mean PTA (average of unaided thresholds at 500, 1000, 2000 and 4000 Hz) for the HA-CI group was 75.2 dB HL ($SD = 23.3$, $n = 13$), which was significantly higher (worse) ($p = 0.015$) than the mean PTA thresholds of the HA-NCI group ($M = 39.3$ dB HL; $SD = 15.2$, $n = 98$). As hearing loss becomes more severe, elements of pitch, melody, harmony, rhythm and timbre become more difficult to perceive due to issues related to audibility factors and signal distortions that may be introduced to a hearing impaired ear (Gfeller & Knutson, 2003). Accurate music perception may contribute to higher levels of music enjoyment and appreciation.

In essence, there is difference in some of ratings for musical Instruments and music styles by the two groups. These findings are in agreement with the first hypothesis, that HA users that have been assessed for a CI (HA-CI) will provide lower music ratings than those that have not been assessed for a CI (HA-NCI). Although significant differences were found between the two groups the results should be interpreted with caution due to the small sample size of the HA-CI group ($n = 13$) compared to the HA-NCI group ($n = 98$).

4.1.1 Overall HA users: similarities between the HA-CI and HA-NCI groups

Although there were distinct differences between the groups, for some factors there was no significant difference between the groups. In some cases both groups provided similar responses for the questions related to ratings of common Instrumental sounds.

There were similarities in the ratings of common Instrumental sounds. Although the HA-NCI group rated Instruments to be significantly more pleasant and natural than HA-CI group, the piano and male singer were rated the highest by both groups to be the most pleasant and natural sounding Instruments. In regards to the least pleasant and natural sounding instruments, the drum kit was rated the lowest by the HA-NCI group and the second lowest (after the strings family) by the HA-CI as seen in Figure 15 (Chapter 3). In fact all Instruments were rated as sounding significantly more pleasant and natural than the drum kit (lowest rated instrument) ($p < 0.001$, one-way ANOVA). It is possible that drums are typically perceived as being a 'loud' and 'noisy' instrument and are often associated with pop/rock music. Since, music spectra are highly variable, and typically yield a much higher output than speech (Chasin & Russo, 2004), the high volume levels may initiate the activation of automatic noise reduction features. In the current study five respondents commented that the drums are loud and noisy and can cause their HAs to 'drop out'. The effects of noise reduction and feedback cancelation systems will be explained later in the general discussion. Further in the 'factors affecting music listening enjoyment' section (Section 3.7), loud volume was reported by a large proportion of respondents (64.3%) to make music listening less enjoyable. This is consistent with research by Leek et al. (2008) and Feldmann & Kumpf (1988) where 47% and 40% of respondents, respectively, reported that music at a loud volume was a problems associated with music. The lower enjoyment levels of the drum kit and pop/rock music may be supported by Chasin & Russo (2004) who found that the settings for speech in HAs are not necessarily adequate for music. The authors reported that their subjects, preferred higher peak input-limiting levels of at least 105 dB SPL, which is considerably higher than the typical settings of 85-90 dB SPL. This was supported anecdotally, where respondents commented that music sounded notably more natural at higher peak input levels. Chasin & Russo (2004) also noted secondary factors that could impact the optimal reproduction of music through HAs: the number of channels, knee-point of input compression, and use of compression systems. They recommend that an optimal HA for musicians and those with hearing losses who like to listen to music should include WDRC with a higher threshold knee point than prescribed for speech, and a HA with one channel or multichannel system with similar compression specifications.

In terms of the specific sound qualities of instrumental sounds, such as their fullness, sharpness, noisiness, richness and smoothness, respondents' ratings indicated that all Instruments sounded significantly different to how they would expect them to sound to a person with normal hearing. Although they were asked to rate according to their expectations for these Instruments to sound to a person with normal hearing, some may have tried compare back to their memory of when they had normal hearing. For example, HA users who have had a hearing loss for a long period of time may find it hard to make comparisons to what they perceive as normal hearing, as several respondents commented they could not recall or did not know what music sounds like to a person with normal hearing. Further, it may be that expectations of 'normal hearing' may differ among the HA user population, as some commented that that did not know what normal hearing is. However when asked "if it was possible would you like music to sound as (with HAs), like you think it would sound to a normally hearing person?" (Q34), 97.1% said 'yes' ($p < 0.001$). This may infer that how music sounds like to a normally hearing person may be considered as the 'gold standard' for perceptual judgements. This is similar with She (2008) who reported that 98% of CI users they would like music to sound like it would to normal hearing listeners. Compounding this, HAs may provide an inaccurate representation of the sound of musical instruments, due to limitations related to their sound processing parameters, which will be explained further in the general discussion.

Although there were similarities between the groups for ratings of music, these results generally support the hypothesis, that those that had been assessed for a CI (HA-CI group), would provide significantly lower ratings than those HA users not assessed for a CI (HA_NCI group). These similarities give important insights of HA users in general, which may be beneficial for counselling and fitting of HAs, which will be addressed in the general discussion.

4.2 Hypothesis 2

In relation to the second hypothesis that the Moderate+ subgroup would provide lower ratings of music than the Mild subgroup; results were inconsistent. In most areas of self-rating there were no significant differences between the subgroups.

The Mild subgroup gave higher levels in the ratings of Instrumental sounds than the Moderate+ subgroup. Overall the former subgroup found Instruments to sound significantly less noisy ($p < 0.001$) and less sharp ($p < 0.001$) than the latter subgroup. The Mild subgroup also rated the drum kit (lowest rated Instrument) to be significantly noisier than the string family ($p = 0.040$), guitar ($p = 0.03$) and male singer ($p = 0.014$). However there were no significant differences between instruments for the Moderate+ group. A possibility for this finding may be that respondents in the Mild subgroup were more able to differentiate between

Instruments than the Moderate+ subgroup. It is important to note that a large proportion (74.8%) of HA users in this study had sloping hearing losses. It may be that for those with a greater high frequency hearing loss would be less used to hearing higher frequency sounds; several respondents commented that some higher pitched notes in music were unpleasant. Similarly the Mild subgroup had significantly lower (better) PTA thresholds (for the better-hearing ear) than the Moderate+ subgroup ($p < 0.001$). Therefore there would have been a significant difference in the audibility of sounds. For example, those with a mild loss can hear speech sounds and may miss certain sounds such an unvoiced consonant sounds, whereas a person with a severe hearing loss may not be able to hear speech at normal conversational levels (Table 18). Just as audibility of speech sounds differs with degree of hearing loss, music enjoyment may also be different for HA users with different levels of hearing loss.

Table 18: Effects of hearing loss

(Adapted from (*Hearing loss association California*, 2008; Northern & Downs, 2002)

Average Hearing Level (500 – 2000 HZ)	Description	What can be heard without amplification
0 - 20 dB	Normal range	All speech sounds
21 - 40 dB	Mild hearing loss	Vowels sounds and louder voice sounds of speech; may miss unvoiced consonant sounds. Faint or distant speech may be difficult.
41 – 55 dB	Moderate hearing loss	Conversational speech may be understood at a distance of a metre Almost no speech sounds at normal conversational level
56 – 70 dB	Moderately severe	Speech must be loud in order to be understood, group discussions hard to follow
71 – 90 dB	Severe hearing loss	No speech sounds at normal conversational level, but some voices may be able to be heard at a distance of 30 cm from the ear
>90 dB	Profound hearing loss	No speech sounds, loud sounds may be heard, but vibrations will be felt more than tones heard.

4.2.1 Satisfied HA users: similarities between subgroups for music ratings

Although there were some sections where a significant difference was found between the subgroups as listed above, the majority of the comparisons showed no difference between these two subgroups. This section will discuss these areas, combining the results of the two subgroups (i.e. HA-NCI group). This group are those that have not been assessed for a CI and could therefore be assumed to be benefiting and/or are reasonably satisfied with their HAs as opposed to the HA-CI group who have sought an alternative option (i.e. assessment for a CI).

In relation to sound quality ratings for Section 2 of the UCMLQ_HA, the only significant difference between Instruments was for the pleasant/natural scale ($p < 0.001$). More specifically the HA-NCI group reported the drum kit (the lowest rated Instrument) to be significantly less pleasant and less natural than all other Instruments. It was also found that all musical styles were significantly more pleasant than pop/rock. Country and western had significantly higher mean ratings than pop/rock when the scales (except complex) were combined for overall analysis. A possible explanation that pop/rock was regarded as the least pleasant musical style may be that it commonly features drums, and/or that drums are often linked or associated with pop/rock music. As mentioned earlier the drum kit was only instrument that was rated to be 'noisier' than expected and it was also rated as the least pleasant sounding Instrument.

In the current study, classical (orchestra and small group) and jazz were rated to sound significantly more complex than country and western. This is similar to a study by Gfeller et al. (2003) where CI recipients perceived classical music as significantly more complex than country and western ($p < 0.001$). In their study they compared the appraisal ratings (liking) of complex songs by adults who use CIs ($n = 66$) with a comparison group of adults with normal hearing ($n = 36$). Respondents rated the complexity and likeability of these styles on 100 mm bipolar visual analogue scales, where 0 = 'simple' or 'dislike' and 10 = 'complex' or 'like'. The normal hearing listeners gave significantly higher 'liking' ratings than the CI users for classical music ($p < 0.001$). For the CI users there was a strong negative correlation ($r = -0.72$) between liking and complexity, which infers that the CI recipients preferred simpler music. The normal hearing listeners preferred music they rated to be more complex. In the current study, although classical music was rated to sound 'complex', it was the musical style that sounded the best and listened to more often with HAs. This is consistent with other research where classical was rated at the most popular style of music by HA users (Davies-Venn et al., 2007; Leek et al., 2008). It may be that HA users enjoy listening to complex music, akin to the normal hearing listeners in the aforementioned study (Gfeller et al., 2003). An alternative explanation is that respondents in the current study may have mistakenly assumed that for the complex scale higher ratings were equivalent to more-positive ratings. As mentioned above, the HA-NCI group preferred instrumentations comprising of small groups (e.g. four to five) or larger groups of performers, with duets being the least preferred instrumentations. This is consistent with the pleasant ratings given in the musical styles section whereby small group classical had the highest mean rating. Also as mentioned earlier, classical music was ranked as the style of music 'that sounds best with HAs' (Q27) and listened to most often with HAs (Q28).

In summary, the second hypothesis was only partially supported by the findings of this study. For instrumental ratings, the Mild subgroup rated Instruments to sound less noisy and less sharp that the Moderate+ subgroup. However most commonly there were many similarities between in the groups including the amount of time spent listening to music, preferences for classical music, and preferences for classical music.

4.3 Additional Factors Related to Music Listening in the UCMLQ_HA

Although not directly related to the main hypothesis, additional information collected from the UCMLQ_HA related to music listening experience of HA users, was analysed. These factors may or may not impact the music ratings, however they provide information regarding music listening habits, and music preferences of HA users. Demographic factors that may contribute to music listening experiences of HA users were also included. Similarities and differences between the groups and subgroups in relation to these findings are discussed.

4.3.1 Additional Factors and Ratings of the HA-CI and HA-NCI Groups

Additional sections from the UCMLQ_HA revealed significant differences between the groups for the questions of music listening background and music enjoyment, as well as speech perception scores and level of hearing loss. These findings provided additional information about the two groups.

It was found that the HA-CI group listen to music less now with their HAs, than before they were diagnosed with a hearing loss. This in contrast to the HA-NCI group whose listening habits have remained fairly constant. Additionally the HA-CI group reported significantly lower levels of music listening (Q16b; $p = 0.001$) and current music enjoyment (Q17b; $p = 0.021$) than the HA-NCI group. These findings are consistent with Kochkin (2000) who found musical satisfaction with HAs varied with level of hearing loss. Items were rated on a 5-point Likert scale using the values 'very dissatisfied', 'dissatisfied', 'neutral', 'satisfied' and 'very satisfied'. In the study, 64% of HA users with a Mild hearing loss; 66% with a severe hearing loss; and 62% with a severe hearing loss, were satisfied either 'most of the time' or 'always' with listening to music with their HAs, whilst only 45% with a profound hearing loss were satisfied either 'most of the time' or 'always' listening to music with their HAs. This difference in hearing levels of the groups would likely explain these findings.

Differences in speech perception scores may also contribute to different levels of musical enjoyment, with the HA-NCI group having significantly higher speech perception scores ($p = 0.007$) than the HA-CI group. It might be that better speech perception skills could contribute to a better ability to perceive music, which may potentially lead to higher music enjoyment levels. In particular, better speech perception may contribute to the ability to understand lyrics. For this reason, it is a possibly that the HA-CI group may experience increased difficulty understanding lyrics compared to the HA-NCI group. As one respondent in the HA-CI group (#A042) comments: "to understand the lyrics requires reading them or having someone tell me the lyrics when listening to the music so I can familiarise myself". Leek et al. (2008) and Feldmann & Kumpf (1988) also reported that understanding lyrics in music was a common complaint amongst HA users. Leek et al., (2008) suggests that this problem may reflect the difficulty of hearing speech sounds, and separating the lyrics from the background music. These findings are comparable to Gfeller et al.(2008), who found that improved speech perception scores for CI users were predictor for the recognition of real world music melodies that contained linguistic information only. They found that speech perception contributes better results in musical stimuli that include lyrics; however, it did not impact music perceptual accuracy or positive appraisal of music without lyrics.

In the current study, the HA-CI group most preferred a solo performer, and least preferred a larger group of performers (e.g. an orchestra, choir or band). This differed to the HA-NCI group who most preferred either small (e.g. four to five performers) or larger group of performers, and least preferred duets (i.e. two instruments and/or singers). This may be related to the complexity of the music; smaller number of performers will usually result in less complex sounding music. Existing research that has shown that both HA and CI users with a severe to profound hearing loss preferred listening to single instrument stimuli as opposed to multiple instrument stimuli (Looi et al., 2007; Looi et al., 2008), with Gfeller, Christ et al. (2003) also reporting that CI recipients prefer music they judge to be simpler. Although these do not relate directly to music ratings they are important contributing factors that affect the music listening experience of HA users.

4.3.2 Overall HA users: Similarities Between the Groups for Additional factors and Ratings

There were instances where no significant differences occurred between the groups, therefore HA users are considered as whole in this section. For the questions regarding ability to hear speech and environmental sounds with their HAs, as well the impact HA has had on their overall quality of life (QOL), there were no significant differences between the groups. Further both groups provided similar responses for the questions related to which device that provides the best sound quality for listening to music, preferred styles of music, ratings of common instrumental sounds, and preferences of singer and pitch of instrument. Therefore in this section the two groups were considered collectively as HA users in general.

Overall, the results of this study indicate that HA users (i.e. both the HA-CI and HA-NCI groups) found that with HAs their ability to hear speech and environmental sounds has improved. The overall mean rating for the overall difference HAs have made on their ability to hear speech was 83.9 (SD =12.7, n = 106) and for the ability environmental sounds was 83.6 (SD = 14.6, n = 109), where 0 = 'greatly worsened' and 100 = 'greatly improved'. These findings are consistent with research suggesting HAs improve speech perception (Chang et al., 2008; Gatehouse, Naylor, & Elberling, 2006; Horwitz & Turner, 1997; Ricketts & Henry, 2002; Turner & Cummings, 1999; Wood & Lutman, 2004). A study by Chang et al. (2008) evaluated speech performance for older individuals (aged 65 years and over) with a bilateral sensorineural hearing loss. There were two groups of participants. Participants in Group A were aged between 65 and 80 years, with the mean PTA of 70.7 dB HL (n = 32). Participants in Group B were over 80 years old and had a mean PTA of 67.2 dB HL (n = 27). Speech reception threshold (SRT) tests were performed prior to (unaided) and following the fitting of HAs (aided), four months later. Although there was no significant difference in improvement between the groups they reported that overall, there was a substantial improvement in SRT scores following the fitting of HAs, four months later. As well as improvements of speech recognition, respondents in the current study also reported that with HAs their overall quality of life has improved. The overall mean rating of 80.7 (SD = 15.8, n = 108), where 0 = 'greatly worsened' and 100 = 'greatly improved'. This finding is in agreement with Cohen, Labadie, Dietrich & Haynes (2004), who reported that HAs bring a better QOL for those with milder as opposed to a more severe level of hearing loss as do cochlear implants for those with a profound hearing loss. These findings suggest that the primary aim of HA fitting to improve communication and overall QOL is being achieved for most of the HAs users in this study.

In the UCMLQ_HA, both music enjoyment with HAs and time spent listening to music with HAs were unrelated to the subject factors of age, PTA, and HA experience. Existing studies addressing music perception of CI recipients also showed that post implant music enjoyment was unrelated to length of implant use (Gfeller, Christ et al., 2000; Lassaletta et al., 2007; She, 2008). There were mixed findings for the association between age, or music enjoyment with CIs and time spent listening to music. For example Lassletta et al (Lassaletta et al., 2007) found a positive correlation with age. This is in contrast to She (2008), Mirza et al., (2003) and Gfeller et al. (2000a), who found a strong negative correlation between age and post-implant music listening enjoyment.

Another interesting factor, in terms of music listening habits, is the device option that was reported to provide the best sound quality for listening to music. Significantly more respondents in this study (n = 70) used their normal everyday listening programme (ELP) for listening to music (Chi-square test, $p < 0.001$), compared to other options, including no HAs (n=17); HAs with a music listening programme (n = 11), HAs with DAI (n = 1), or ‘other’ (n = 2). Twenty-one respondents who used their ELP to listen to music commented that they found this programme enriched or enhanced their music listening experience. Interestingly, only a small proportion of overall respondents had a programme specifically set up for music (n = 25), with mean ratings (where 0 = never, 50 = sometimes, 100 = always) indicating that they only used it ‘sometimes’ when listening to music (M = 47.7; SD = 33.6; n =24).

There are many possible explanations for the results regarding preferred device option. Respondents may not have had HAs that enabled a music program, or they may not be aware of HAs having a music programme (or the option to have one). Further, respondents may not have had an opportunity to try a programme specifically set up for music when they were fitted with their HAs, or since. Further possibilities may be that respondents may have had HAs with automatic settings only, and did not have the ability to manually switch to a specific programme. Alternatively, respondents may be content with their current ELP and have no need for an additional programme specifically set up for music. Qualitative comments supported these explanations (Appendix 4). Of those who used their everyday listening programme for listening to music, 10 respondents commented that they did not have access to, or an opportunity to try a music programme, or that their ELP was the only option they had. Of the 25 participants with a music listening programme six respondents who commented that the programme set up for music enhanced their music listening experience, and three other respondents commented that they had tried using a specific programme for listening to music but could not distinguish much difference between programmes. This may suggest that manufacturer default settings for music programmes were used and may not have been customised to the users' needs. Overall, the majority of HA users wear their HAs for listening to music, with only 16.8% reporting that no HAs provides them with the best sound quality for listening to music. These findings are consistent with Leek et al.(2008) and Feldmann & Kumpf (1988) who found that less than 20 % (19% and 13 % respectively) of respondents did not wear HAs when listening to music.

In the questions regarding music preferences, Section 3.4 of the UCMLQ_HA, respondents were asked to rank Instruments from 1 to 10 were 1 = 'sounds most natural' and 10 = 'sounds least natural'. It was found that the piano and male singer, were rated to sound the most natural, with the drum kit sounding the least natural of the eight Instruments. This is consistent with the sound quality results (Section 3.3) for the pleasant/natural combined scale in which the piano and the drum kit had the highest and lowest rankings respectively; and where the male singer was ranked higher than the female singer in terms of sound quality. Further for Q36a, the male singer was significantly preferred over female singer ($p < 0.001$), and low-pitched instruments were significantly preferred over high-pitched instruments. It is possible that the preference for the male singer is related to their lower fundamental frequencies. This is consistent with music perception studies with CI recipients who also preferred low pitched to high pitched instruments and male to female singers (K. Gfeller et al., 2002; Looi et al., 2008; She, 2008). Looi et al. (2008) found that CI users were significantly less accurate in the pitch ranking ($p < 0.001$) and melody tests ($p < 0.001$) than HA users with a similar level of hearing loss. In that same study HA users provided significantly better scores for the female-sung vowels than the male-sung vowels ($p = 0.001$), in contrast to the CI users who provided higher scores for male-sung vowels. Although the HA users performed better than the CI users in these tasks, their performance was significantly poorer than that achieved by listeners with normal hearing. Consequently the authors concluded that despite the aforementioned differences between the groups, both subject groups were largely unable to achieve accurate music perception. The ability to accurately perceive pitch may in part help to improve music appreciation, as good melody recognition would require accurate pitch perception.

The configuration of hearing loss for the participants in this study may have influenced the preference for low pitched instruments. For example, the mean PTA score in the current study indicate that participants typically had better low frequency hearing thresholds than high frequencies thresholds, which may have enabled them to better perceive lower frequency stimuli. Some respondents, particularly in the Mild subgroup, had normal hearing at the low frequencies, with sloping thresholds in the higher frequencies. Sloping thresholds would also alter the sound quality of both music and speech since a sloping hearing loss implies that different frequencies are affected differently (i.e. it not just the overall audibility that it affected). Certain elements will be better heard and these may potentially mask other sounds. Therefore differing levels of loss of different frequencies may affect the relative levels for different elements of music.

4.3.3 Additional Factors and Ratings of the Mild and Moderate+ Subgroups

In addition to music ratings, respondents were also asked about the music listening background and general HA use. Firstly the significant differences between the Mild and Moderate+ subgroups, followed by the similarities for these areas.

For the area of music listening background although both subgroups reported improvements in terms of hearing speech and environmental sounds with their HAs, a larger improvement was found for the Moderate+ subgroup ($p = 0.001$ for speech Q13, and $p = 0.031$ for environmental sounds Q14). A similar result was also found in regards to overall QOL, where the Moderate+ subgroup reported significantly larger improvement in QOL than the Mild subgroup ($p < 0.001$). This is consistent with Kochkin (2000) who reported that those with a mild loss (37%) rated their HAs to have lower impact on QOL than those with moderate (61%) and severe hearing losses (76%). Although both subgroups also reported that their overall enjoyment of listening to music had increased with their HAs, the Moderate+ subgroup reported that their overall enjoyment of listening to music had greatly increased with HAs, significantly more than that for the Mild subgroup ($p = 0.044$). Collectively, these findings may suggest that the Moderate+ subgroup may be receiving more benefit from their HAs than the Mild subgroup, which would be a reasonable assumption considering their greater levels of hearing loss and the likelihood of the hearing loss having a greater impact on their life. The Moderate+ subgroup may be more reliant on their HAs and may not be able to function or listen effectively without them whereas some of those in the Mild subgroup have low frequency thresholds within the normal range (i.e. ≤ 20dB HL), thus may still be able to function/listen without HAs. These findings are again consistent with Kochkin (2000) who also found that those with moderate (58%) and severe (60%) hearing loss rated HAs more satisfactory than those with a mild hearing loss (48%).

The amount of time spent listening to music ‘pre hearing loss’ (Q16a) and ‘now with HAs’ (Q16b) was similar for the two subgroups, with no significant difference found between the subgroups at either point in time. The mean scores indicate that satisfied HA users listen to music ‘fairly often’. In addition, the amount of time spent listening to music did not change since being fitted with HAs (Q16c). Results indicate that both subgroups listened to music for similar amounts of time both ‘pre hearing loss’ and ‘with HAs’. For example the mean ratings for amount of time spent listening to music ‘pre hearing loss’ was 74.4 for the Mild subgroup (SD = 22.3, n = 50) and 73.9 for the Moderate+ subgroup (SD = 22.9, n = 47), and ‘with HAs’ was 71.3 (SD = 23.1, n = 50) for the Mild subgroup and 73.6 (SD = 23, n = 46) for the Moderate+ subgroup, where 0 = never, 50 = sometimes, 100 = very often. Both subgroups also enjoyed music both ‘pre hearing loss’ (Q17a) and now with HAs (Q17b), indicating that music enjoyment has not changed after developing a hearing loss.

Although these findings were additional to the hypothesis they provide useful information in regards to music preferences and music listening habits of HA users. This information may have clinical significance; these possibilities will be discussed in the clinical implications sector of the general discussion (Section.4.5)

4.4 General Discussion

There were also several areas of the questionnaire which the findings were analysed as a whole (i.e. HA-CI and HA-NCI groups), as factors between the groups are less clinically significant than if the results are considered as a combined ‘HA users’ group. These include factors affect music enjoyment, music training and the music training programme (MTP). Following this, factors such as psychoacoustic impact of cochlear hearing loss and parameters of HA processing will be discussed, as well as additional factors that may potential contribute towards the variance in the respondent’s preferences and ratings.

4.4.1 Factors Affecting Music Enjoyment

The highest rated factor that made listening to music more enjoyable was a quiet environment (92.8%). Other factors that were commonly rated to have a positive effect on music enjoyment were: familiarity with tunes (85.3%), familiarity of lyrics and words (82.8%), high quality recordings (74.8%), high quality speakers (74.8%), listening to music at a medium volume (69.3%), watching the performers (64.6%), tune without harmony (60.4%), knowing the song title (60%) and the context in which the music is being played (56.4%). Conversely, the highest rated factor that makes music listening less enjoyable was an echoey (reverberant) room (84.7%). Listening to music at either a loud volume (63.4%) or at a soft volume (50%) were also commonly rated to hinder music enjoyment and is consistent with other research (Feldmann & Kumpf, 1988; Leek et al., 2008). The factors that enhance and detracted music listening in the current study were similar to existing studies (Gfeller, Christ et al., 2000; Looi & She, 2008). For example She (2008) reported that CI users also found that the following factors: a quiet environment, high quality recordings, high quality speakers, listening to music at a medium volume, familiarity with tunes and lyrics, and knowing the context in which the music is being played, were commonly rated to have a positive effect on music enjoyment. Similarly, listening to music at a loud volume and in an echoey (reverberant) room, also hindered musical enjoyment. This suggests that both CI users and HA users share similar views in regards to factors that enhance and hinder their musical enjoyment. In essence, HA users may be able to enhance their music enjoyment to some degree by controlling their listening environment, such as using high quality equipment, controlling the volume, and by listening to familiar music. These issues may be important to address with counselling HA users.

4.4.2 Music Training and the MTP

Overall, the majority of HA users indicated they had not had formal music training before they were fitted with HAs (Q18, 62.2%), and most do not have formal training now with their HAs (95.5%). Only three respondents commented that their music training had reached a professional level, for most training occurred during childhood (e.g. piano lessons), or they were part of a school or church choir (refer to Appendix 4 for more detail). Although 44.1% of respondents reported that they took part in musical activities before they were fitted with HAs (Q20), only 22.5% of respondents take part in musical activities now with their HAs (Q21). Only a small proportion indicated that such training and involvement in musical activities prior to receiving HAs have impacted on current music listening enjoyment (Q22, 21.7%). This is consistent with other research where respondents had little or no professional music training (Davies-Venn et al., 2007; Gfeller, Christ et al., 2000; Gfeller, Stordahl, Mehr, & Woodworth, 2000). Given the number of participants who receive formal music training now (5.5%), the low preference for a MTP is unsurprising. A large proportion of all respondents (71.3%) indicated they would not be interested in a MTP. However, significantly more interest was indicated by respondents in the HA-CI group (61.5%) than for the in HA-NCI group (23.6%, $p = 0.002$). The findings of the HA-CI group are in agreement with She (2008) who found that 54% of CI respondents were interested in a MTP. Age and length of HA use may have contributed to the difference in interest in the development of a MTP. The HA-CI group were significantly younger than ($p = 0.001$) (Figure 22) and had HAs for a significantly longer time, than the HA-NCI group ($p < 0.001$).

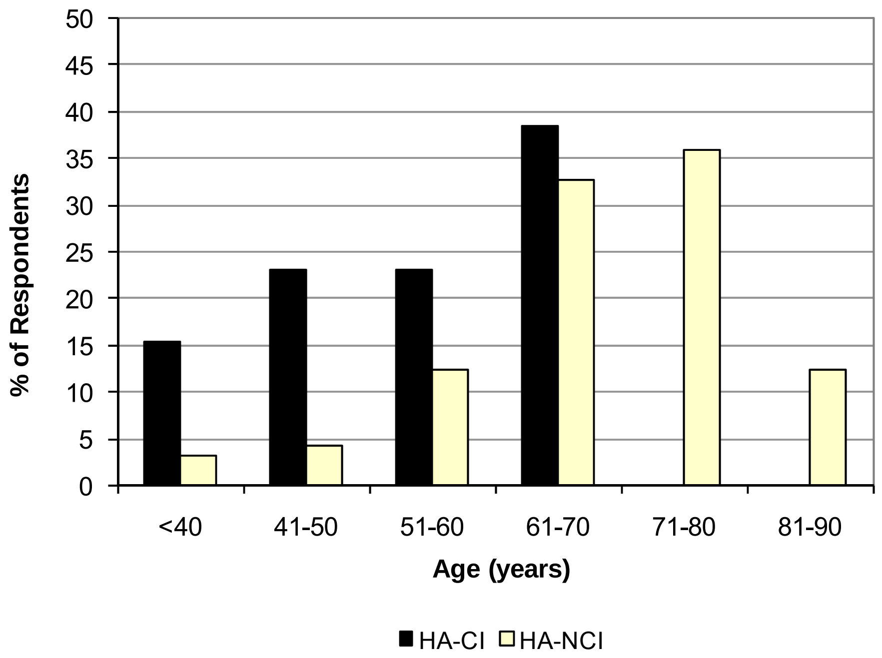


Figure 22: Percentage of respondents in each age group for HA-CI and HA-NCI respondents

This idea is supported by respondents' comments where nine respondents commented that there were "too old" for a MTP and felt such a programme would not help at their age. Also it may be that the HA-CI group may feel they 'need' MTP more than the HA-NC group who are reasonably satisfied their music listening and enjoyment and do need to partake in a MTP to improve it. In regards to the implementation of the MTP, a DVD was the preferred mode of delivery (42.9%) and respondents indicated that they would like the MTP to focus on a wide range of music styles. DVD may be preferred the option as it enables the viewer to watch the performers as well as listen to the music, hence providing visual cues. This is consistent with a finding in the previous section, in which 64.6% respondents indicated that watching performers makes their music listening experience more enjoyable. The preferred duration of each session was 30 minutes, twice a week. One respondent suggested the MTP could be "free and online", so it could be completed in their own time. Two respondents commented the MTP would have been useful when they first got their HAs. Existing research by Gfeller, Christ et al (2000), Gfeller, Stordahl, et al., (2000) and Galvin, Fu & Nogaki (2007), has shown that some aspects of music listening can be improved with training in CI recipients, however further research is need to investigate the effectiveness of a MTP for HA users. There are various rehabilitation programmes designed to improve speech perception and communication (Stecker et al., 2006; Sweetow & Sabes, 2007; Woods & Yund, 2007), but none to date, that are aimed at improving music perception of HA users. Speech perception studies suggest that training can significantly improve phoneme discrimination abilities of HA users with a mild to moderate hearing loss (Burk, Humes, Amos, & Strauser, 2006; Stecker et al., 2006). It may be interesting to incorporate a music perception component into an existing rehabilitation perceptual programme. It could be aimed at new, motivated HA users, as well as experienced HA users who are interested in improving their music perception.

4.4.4 Psychoacoustic Impact of Cochlear Hearing Loss and Sound Processing Parameters of HAs

Overall, a salient finding was that music sounds significantly different to what participants would expect it sound to a person normally hearing person. This may be in part due to the psychoacoustic effects of cochlear hearing loss and for the limitations of HA technology. Gfeller & Knuston (2003) stipulate that people with a mild hearing loss particularly those who receive adequate amplification, can hear pitch, melody, harmony, rhythm and timbre quite effectively. However these elements become more difficult to perceive as the hearing loss becomes more severe due to psychoacoustic implications of a hearing impaired cochlea such as reduced audibility, reduced frequency selectivity, dead regions and a reduced dynamic range. These psychoacoustic effects of a cochlear hearing loss worsen as hearing loss increases and may partially explain why the HA-CI group has provided lower ratings of music than the HA-NCI group.

Results were more variable between the Mild and Moderate+ subgroups. It should be kept in mind that individual responses may have been affected by different fitting considerations of their HAs. For example, some respondents had different listening programmes for various environments such as music, whereas some had an automatic setting. Information regarding the type, style and model of HA was not analysed in this study. It may be possible that different levels of technology may have provided different levels of sound quality for the users in the current study.

As previously mentioned, HAs are designed to optimise speech. The frequencies that are essential for speech intelligibility are between 500 and 4000 Hz (Dudley, 1939; Dunn & White, 1940; Fletcher & Galt, 1950; French & Steinberg, 1947; Mueller & Killion, 1992). However the frequencies important for music enjoyment cover a much greater range than required for speech. Additionally the fundamental frequencies and intensity levels for music are much larger than for speech. For example, the fundamental frequency of speech is typically between 120 and 130 Hz for male speakers and 180 to 220 Hz for women speakers (Chasin & Russo, 2004). Music which can range from less than 20 Hz for low piano tones to above 20,000 Hz for the upper partials of a violin (Russo, 2006). With regards to intensity, typical outputs for normal conversational speech can range from 53 dB SPL to approximately 77 dB SPL, reaching 83 dB SPL for shouted speech. Conversely, louder components of music can exceed an output of 100 dB SPL, and can reach peaks of 118 dB SPL (Chasin & Russo, 2004). Therefore, in regards to parameters such as the peak input limiting level of a HA which is typically 85 dB SPL, Chasin & Russo (2004) suggest that the settings for speech are not adequate for music listening. There are various HA features and settings that may impact on music listening enjoyment, with the main ones being filter bandwidths, compression, and active noise reduction systems.

Existing research highlights the preference towards wider bandwidths for listening to music (Moore & Tan, 2003; Ricketts, Dittberner, & Johnson, 2008). In Moore & Tan's (2003) study, which was described in the introduction, they found that highest ratings for the perceived naturalness of music was attained for the signal with the largest bandwidth (55 – 16 854 Hz) which was significantly wider than the bandwidth preference for speech (123 - 10 869 Hz) ($p < 0.001$). However current HAs do not provide a great deal of useable gain below 500Hz or above 6000 Hz (Ricketts et al., 2008). Thus frequencies that are essential for the perceived naturalness of music exceed the frequency limits of HAs. The frequency bandwidth of current HAs may not be a problem for HA users with a mild loss, and/or who may have normal hearing in the low frequencies, however it would affect those with low and high frequency hearing losses. This is supported by several respondents who commented that their HAs need "more bass", whilst other respondents comment they were missing the "higher pitched" sounds of music when listening with their HAs. It is important to consider how sounds are processed in HAs. The incoming sound, picked up by the microphone(s) is divided up into a number of available channels in a multichannel HA, with the sound is processed in each channel independently. In contrast, a normal hearing cochlea has overlapping auditory filter bandwidths covering the entire frequency range, therefore theoretically the sound is processed through almost an infinite number of filters (Moore, 1987, 2003a). However in the case of cochlear hearing loss, the broadening of auditory filters, leads to reduced frequency selectivity (Glasberg & Moore, 1986; Moore, 1996, 2007a). Moore (1996) reports that auditory bandwidths are twice as wide for those with cochlear hearing losses greater than 40 dB HL than for those with normal hearing. Consequently this would impact on the listeners' ability to accurately resolve the individual frequency components of a complex sound and this may have a deleterious effect of both pitch and timbre perception. Their perception of the spectral shape would be altered, which could then affect music enjoyment. Moore's (1996) findings infer that for those with cochlear hearing losses in the Moderate+ subgroup and HA-CI group, may potentially have auditory bandwidths at least twice as wide as those in the Mild subgroup. The Mild subgroup may have been better at differentiating between Instruments (i.e. instruments, instrumental families and singers) than the Moderate+ subgroup, in which the Mild subgroups provided significantly different ratings for the factor of Instruments whereas the no significant difference was found between musical styles for the Moderate+ subgroup.

Gfeller & Knutson (2003) state that with amplification those with a mild loss can perceive pitch, rhythm, melody and timbre reasonably effectively. However for people who have greater than a mild loss, these elements are harder to perceive and distortions in auditory processing by a hearing impaired ear may result in not only a loss of audibility but also the inability to appreciate some of the salient features of music.

Another issue for music is that it encompasses a wide range of volumes and can reach peaks of up to 118 dB SPL (Chasin & Russo, 2004); this can drive the HA into saturation causing maximum compression and/or output limiting. This may cause distortion and further affect the sound quality of the signal. Further, the varying acoustic features of musical stimuli may activate noise reduction and feedback cancellation/management systems. In current HAs, digital noise reduction (DNR) systems endeavour to differentiate the noise from the speech signal in each frequency channel by considering noise as a constant input, and speech as a modulating signal. Consequently the gain is reduced in the channels which contain the noise, the low-frequency areas, whilst maintaining the gain for the frequencies of the speech signal (Bentler & Chiou, 2006; Kim & Barrs, 2006). The gain may reduce the low frequency components of music and/or some of the lower frequency instruments, which may cause them to sound ‘tinny’. Similarly in feedback management or cancellation systems, digital signal processing in the HA can enable the phase of the feedback to be inverted, which nullifies the feedback (Kim & Barrs, 2006; Parsa, 2006). This feature may potentially remove certain components from the input signal such as pitch, which may have a deleterious effect on the sound quality of the signal when listening to music (Parsa, 2006). Although these features may potentially be useful in certain environments such as listening to speech in noise, there are disadvantages for other signals such as music. For example in the current study several respondents comment that their HA “drops out” when listening to music; this may occur if the HA treats the music stimuli as noise or feedback. Two additional respondents commented that feedback occurs when listening to instruments in the string and woodwind families. These factors may give reason to as why some instruments may not sound as ‘complete’ or ‘full’ and why some instruments sound better than others. A prominent challenge of noise reduction and feedback cancellation systems is the ability for the algorithm to recognise desirable signals other than speech, and leave the desired signal unaltered (Chung, 2004b). Hence, it is recommended that both feedback and noise reduction algorithms are turned off or reduced for music enjoyment (Chasin & Russo, 2004; Chung, 2004b). This can be achieved in a programme specifically set up for listening to music but may be harder to achieve in automatically adapting HAs with only one programme. This may be a factor in the current study where the majority of respondents (69.3%) indicated that their ELP gave them the best sound quality for listening to music.

4.4.5 Additional Factors Impacting Music Listening and Music Ratings

For the sound quality and music style ratings, the UCMLQ_HA did not specify the listening environment. For instance, the respondent may predominantly listen to music on the radio, via a CD in a stereo system, attending a live concert, or watching a musical performance on television. Different listening environments could have an impact on how the sound is processed by the HA, and could explain the variance in the respondents’ ratings. In contrast, in Leek et al.’s (2008) study the respondents reported that they predominantly listened to music on the radio (82%), recorded media (72%), live music (43%), and television (41%). The most common place to listen to music was the car (72%), and at church (24%). These different listening situations introduce a range of variables. For example, additional noise sources in a car, such as the motor running, road noise, and conversation with other passengers. Background noise may be an issue at an outdoor concert, as can high volume levels, as several respondents in the current study comment, as well as listening to music in a social situation where people may be conversing whilst listening to music. A number of factors that can impact music listening may arise from this situations. In addition to having to separate a melody and/or lyrics from an accompaniment, the listener would have to separate the background noise from the music itself. The competing 'noise' sources may activate automatic features such as feedback management and noise cancellation, and/or add to the overall input level of the sound.

Other factors may have contributed to the considerable variance in respondent's ratings, such as individual preferences, as well as factors related to the questionnaire itself. Respondents were asked to rate instrumental families as opposed to individual instruments (e.g. woodwind family rather than the clarinet or flute) and as pointed out by several respondents, there is a wide variability of musical instruments in these instrumental families, with instrumental families typically comprising of both low and high frequency instruments. Similarly respondents commented that instrumental families are not usually listened to in isolation in general music listening. In a study by Gfeller, Stordahl et al. (2000), CI recipients were asked to give ratings for low and high pitch instruments within the same family (e.g. low pitch woodwinds vs. high pitch woodwinds). Further, respondents were asked to give subjective judgements, and therefore one needs to consider their prior music knowledge and experience. As respondents were not asked to listen to a piece of music, the ratings were subjective. In some existing research on the music perception of CI users (Gfeller et al., 2008; Gfeller, Stordahl et al., 2000) questionnaires in addition to excerpts of real-world music stimuli were used to assess respondents. In the latter study (Gfeller, Stordahl et al., 2000) information regarding music listening background and training was obtained via questionnaire. Subjects were also required to undertake a series of music perception tests; one included listening to a brief excerpt of music, and to plot their responses on a bipolar 100 mm rating scales e.g. 'like – dislike', 'simple – complex'. On another test subjects were required to listen to an excerpt of music and selecting whether the melody line was familiar or not. There are limitations and advantages to both methods. For example the ratings may be dependant on several factors such as the piece of music chosen, the listeners' familiarity with and 'liking' of the piece chosen, and the listening environment and equipment used. Further, music preferences are extremely variable and it would be difficult to generalise ‘real-world’ stimuli to a wide range of HA users.

In the current study the respondents were asked to rate various attributes of music sounds (e.g. sharp, pleasant, full), however a higher rating does not necessarily mean that they ‘enjoy’ music. Although there were several questions of the enjoyment of music, it was assumed that if music more ‘pleasant’ and ‘natural’ it may potentially be more enjoyable to the listener.

4.5 Clinical Implications

This research may provide audiologists with information to assist with developing appropriate strategies for improving music listening for HA users. Although the main focus of the questionnaire was to investigate ratings of music, an additional focus was to gather detailed and specific information to assist in determining the most-appropriate settings for music listening programs on HAs, as well as information that could potentially contribute to the development of a MTP. Although there was mixed interest in the MTP, as mentioned earlier it may be beneficial to incorporate the MTP into an advanced aural rehabilitation programme. This could assist new or interested HA users to get the most from their HAs for different listening situations, and to maximise their listening experiences as well as their potential with their HAs and its features. However in regards to the MTP, it may be beneficial to incorporate preferred instruments and styles of music as indicated in this study. For example in the current study it was found that respondents preferred low-pitched to high-pitched instruments, male to female singers, and both small and large groups of performers. Music styles that were generally preferred were country & western and jazz as opposed to pop/rock, and in terms of Instruments, the piano was preferred as opposed to the drum kit. Also classical music was also selected as the style that sounded the best with their HAs and listened to the most often. Respondents also indicated that familiar tunes and songs with familiar lyrics and words would enhance their listening enjoyment and they would like the MTP to cover a wide range or styles. Hence it would be beneficial to incorporate a wide range of music from each decade as well as popular classical music to ensure that wide range of ages and music preferences were catered for. Alternatively for those who may not want to take part in a MTP, it may be beneficial to introduce HA users to these preferred styles of music when they first receive their HAs.

Factors which were commonly rated to impact music listening experience may be important for counselling patients on improving their music listening experience wearing HAs. For example audiologists could recommend listening conditions and environments which enhance music listening such as listening to music a quiet room and using good quality speakers. Similarly, patients could also be counselled on the factors that typically music listening less enjoyable for instance listening to music in a reverberant room, listening to music at a soft or loud volume. Counselling patients on these factors may be particularly useful to new HA users who are not acclimatised to amplification.

For those patients interested in improving their music listening experience, a specific music programme with optimised settings may also be helpful. This would involve this setting up a programme specifically for music, individualised to the patient's needs. Their preferred music styles and genres, their usual listening situations (e.g. CD, radio, live music), should be considered in addition to their hearing loss. It may entail allowing the patient to listen to extracts of their preferred music in the clinic and tune the HA accordingly. It would be recommended that the patient to trial the setting in their usual music listening conditions, outside of the clinic in a real world situation, and provide feedback at the next appointment. It may also involve several trials to get the programme sufficiently optimised In terms of HA settings, it has been widely recommended that automatic features such as DNR and feedback management be reduced or turned off when listening to music (Chasin, 2003; Chasin & Russo, 2004; Chung, 2004a; Parsa, 2006). Chasin & Russo (2004) recommended that one channel or a multi channel device where gain is set at a similar level in each channel, may be optimal for listening to music through HAs, and the peak input limiting level should be set to at least 105 dB SPL, in order to get a broader input spectrum that is required for music.

It would also be worthwhile counselling patients about the physiologic changes in the cochlea due to hearing loss that cannot be reversed (i.e. for a sensorineural hearing loss) and could impact music perception, as well as speech perception for the more severe levels of hearing loss. In simpler terms, if the hearing loss is greater, music enjoyment may be affected depending on the level and configuration of loss it may be useful to suggest particular instrumental sounds that are harder to hear. For example for those with a high frequency loss may experience more difficulty hearing female singers and high pitched symbols.

Most importantly, as music enjoyment varies between users it is important to optimise settings to their individual preferences and needs. A manufacturer-derived default music listening programme may not provide the best outcome.

4.6 Limitations of the Study and Directions for Future Research

In regards to rating the sound quality of Instruments and musical styles, it was assumed that all respondents were wearing HAs, as specified in the information sheet and introductory letter. However this may not have always been the case as some commented that no HAs provided them with best sound quality, thus they listen to music without their HAs. Also it was assumed the participants were full time HA wearers, as stated in the information sheet. However this was not confirmed as there was not a question explicitly asking them "how many hours a day do you wear your HAs?" As is the nature of mailed-out questionnaire research, responses from respondents cannot be verified or tested. For example if respondents said they could recognise an instrument or melody, it was not tested if they could actually do so.

Further this questionnaire consisted of 51 questions, not including sub-questions. Many respondents expressed it was a long questionnaire and was "very hard to do". The length of the questionnaire may have contributed to the low response rate of successfully completed questionnaires (23.6%). The response rate of the telephone survey by Leek et al. (2008) obtained a response rate of 40%, and involved 37 questions which comprised of a variety of open-ended and closed-set questions. However the aim of the UCMLQ_HA was to gather more specific detailed information rather than general like/dislike, yes/no questions that have been asked on some QOL questionnaires, as well as post HA fitting verification questionnaires. In order to be able to find out how to improve music listening and how to potentially programme HAs for music, solely recording like/dislike preferences would not give sufficient detail. It was necessary to gather information such as sound quality ratings of specific attributes of Instruments and music styles, as well as music preferences, music listening background and musical training as there is a small amount of research in this area (Leek et al., 2008; Feldmann & Kumpf, 1988). There is a trade-off between the response rate and the amount of detail a questionnaire can obtain. In the consideration of the low response rate and long questionnaire, it is possible that the respondents could have been slightly biased, and not an accurate sample of the general population of HA users. For example, as the questionnaire was optional, the participant group may have included a disproportionate number of HA users who potentially liked or disliked music (i.e. had more extreme views and had something to comment on) and/or had more spare time to complete the questionnaire. However, this kind of bias is inherent to most mail-out questionnaire studies where the questionnaire is optional.

There was a large difference between the sample size of the two experimental groups HA-CI (n = 13) and HA-NCI (n = 98); this needs to be considered for the group comparisons. For those who had been assessed for a CI (HA-CI group) were separated from the rest of the respondents; since they have had an assessment for a CI, it may be assumed that they did not feel like they were receiving adequate benefit from their HAs.

In regards to future research it would be beneficial to have more participants at each level of hearing loss (i.e. mild, moderate, moderately-severe, severe and profound) so music ratings may be examined as a function of hearing loss rather than broad groups (i.e. HA-CI vs. HA-NCI, and mild vs. Moderate+). It may also be beneficial to consider the configuration of hearing loss and how this impacts music ratings. Although this information and data was gathered it was beyond the scope of this thesis. Further as mentioned previously, although studies involving CI recipients have found mixed correlations with age and time spent listening to music and music enjoyment levels (Gfeller, Christ et al., 2000; Lassaletta et al., 2007; Mirza et al., 2003; She, 2008), very few (if any) HA studies have looked at correlations between level of loss and music enjoyment. There were no significant correlations were found in this study for between the subject factors of age, PTA, or experience with HAs with amount of time spent listening to music, music enjoyment or mean ‘pleasant’ rating scale across all Instruments in the current study. However, having more subjects and more equally distribution of subjects across the different levels of hearing loss and age range may provide more accurate information.

The data from this study indicates that musical enjoyment varies from one respondent to the next regardless of their hearing threshold level. Individual differences that occur may be dependent on factors such as the listening situation (e.g. a quiet room, good quality sound equipment), and/or structural features of the music (rhythm or beat). Additional factors may include the HA itself, and its sound processing features. Although there are many music perception studies with CI users, there are few studies (if any) which focus solely on HA users. In regards to future research studies could address listening to musical stimuli in a test situation, testing elements essential for music perception such as pitch and timbre perception, and melody recognition. Music appreciation of HA users could also be assessed via participants listening to music stimuli and rating their responses after excerpts of music. Another interesting area would be to look at the effectiveness of music programmes in HAs, and different HA settings among manufacturers and verify whether these algorithms effectively preserve the dynamic characteristics of music. It would also be interesting to look at data logging information of the various environments that HA users are in when listening to music.

Despite some limitations to the study, it has not only provided interesting, new and detailed information on how HA users rate music to sound, but additionally highlighted the need for more research in the areas of music listening, music enjoyment and music perception of HA users.

5. Summary and Conclusions

Existing studies have shown that different sound processing parameters on hearing aids (HAs) can impact on music listening, which can be compounding by the issues related to the physiological changes of the of the cochlear associated with hearing loss. However these studies did not investigate, in detail, HA users rate how specific instruments, instrumental families, or a wide range of musical styles to sound with HAs. In order to obtain such information the University of Canterbury Music Listening Questionnaire for Cochlear Implant users (UCMLQ_CI) developed by She (2008) was modified for HA users modified for HA users and was named the University of Canterbury Music Listening Questionnaire for Hearing Aid Users (UCMLQ_HA).

This study aimed to collect more detailed and descriptive information on music listening and the ratings of musical sounds from postlingually deafened adults who use HAs. This study also sought to investigate whether there were any differences in subjective music ratings from HA users that have been assessed for a cochlear implant (CI) compared to HA users who have not been assessed for a CI as well as HA users with a mild hearing loss compared to those with a moderate or worse hearing loss. Specifically it was hypothesised that, (i) ratings for music from HA users who have been assess for a CI (HA-NCI group) will be worse than those who have not been assessed for a CI; and (ii)HA users with a moderate or worse hearing loss (Moderate+ subgroup) will provide lower ratings than those with a mild hearing loss (Mild subgroup). Factors that may and may not have contributed to music listening habits and enjoyment were discussed.

One hundred and thirteen postlingually deafened HA users, ranging in age from 23 to 89 years (M = 67, SD = 12.6), completed the UCMLQ_HA. There were 13 respondents in the HA-CI group and 98 respondents in the HA-NCI group. For the latter group which was divided into two subgroups; there were 51 respondents in the Mild subgroup, and 47 in the Moderate+ subgroup.

5.1 Summary of Group Comparisons: HA-CI vs. HA-NCI

Essentially, the findings of the UCMLQ_HA supported the first Hypothesis, that the HA-CI group will provide lower ratings for music than the HA-NCI group. This was indicated the HA-CI group provided lower ‘pleasant and natural’ ratings for instruments, instrumental families and singers than the HA-NCI group. The HA-NCI group also rated Instruments to sound significantly more ‘pleasant and natural’, ‘fuller’, ‘richer’, and ‘smoother’ than the HA-CI group. Despite the differences in the ratings the piano and male singer were given the highest pleasant and natural ratings by both groups, and the drum kit was among the lowest rated instruments by both groups.

In terms of musical styles the HA-CI group preferred solo performers whereas the HA-NCI group preferred small (e.g. 4 to 5 performers) and large groups of performers (e.g. orchestra, choir or band). The HA-NCI group also rated all musical styles to sound significantly more ‘pleasant’ than the HA-CI group. The former group also indicated that they were significantly more able to follow melody lines and identify the style, and they also rated musical styles, in general, to sound significantly more normal (i.e. closer to how they would it expect it to sound to a person with normal hearing) than the latter group. The HA-CI group rated pop/rock as most pleasant sounding musical style, and jazz as the least pleasant style, in contrast to the HA-NCI group gave classical (small group) the highest pleasant rating and pop/ rock the lowest rating. It was also found in this study that the HA-NCI users rated tunes (melodies) to sound significantly more ‘melodic’ than the HA-CI group.

Additional differences between the groups were also found for music listening habits and music enjoyment.The HA-CI group tended to listen to music less with their HAs, than before they were diagnosed with a hearing loss, whereas as for those in the HA-NCI group who tended to listen to music ‘often’ before their hearing loss and now with HAs. Some of the differences in music listening enjoyment are likely to be related to physiologic and psychoacoustic effects of cochlear hearing loss. Research suggests that as hearing loss becomes more severe, elements of pitch, melody, harmony, rhythm and timbre become more difficult to perceive due to issues related to audibility and signal distortions that may be introduced to a hearing impaired ear (Gfeller & Knutson, 2003).

5.2 Summary of subgroup comparisons: Mild vs. Moderate+

The second hypothesis was only partially confirmed; there were only a few cases in which the Mild subgroup provided higher rating of music than the Moderate+ subgroup. The Mild subgroup found Instruments to sound significantly less noisy and less sharp than the Moderate+ subgroup. Additionally the Mild subgroup also rated the drum kit (lowest rated

Instrument) to be significantly noisier than the string family, guitar and male singer, whereas the Moderate+ subgroup indicated no significant differences between Instruments.
Contrary to the hypothesis there were several instances where the Moderate+ subgroup provided higher ratings for music than the Mild subgroup. It was found that for the Moderate+ subgroup, the overall enjoyment of listening to music had greatly increased with HAs, more than for that of the Mild subgroup. That is the Moderate+ subgroup rated that HAs had a positive impact on their music listening experience than the Mild subgroup. For the reported impact their HAs have had on their ability to hear speech and environmental sounds, as well as on their quality of life (QOL), significantly higher ratings were provided for these factors by the Moderate+ subgroup than the Mild subgroup. Collectively, these findings may suggest that the Moderate+ subgroup maybe receiving significantly more benefit from their HAs than the Mild subgroup.

There were also instances when there were no significant differences between the subgroups, such as ‘pleasant and natural’ ratings for Instruments. Both groups rated the piano and the drum kit as the Instruments to sound the most and the least ‘pleasant and natural, respectively. In regards to music listening. Both subgroups rated the drum kit to be significantly less pleasant and less natural than all other Instruments and that all musical styles were significantly more pleasant than the pop/rock musical style.

5.3 Summary of Overall HA users

When considered as a collective group, the majority of HAs users indicated that their easy listening programme (ELP) provided them with the best sound quality for listening to music. The most preferred style of music was classical. It was also the style of music that was listened to most often with HAs, and rated to sound the best with HAs. Additionally the piano was rated as the Instrument to sound the most natural and pleasant, with drum kit rated to sound the least natural. In terms of preferences of singer and pitch of instrument, the male singer was significantly preferred over female singers and low-pitched instruments were significantly preferred over high-pitched instruments. It is also important to note that almost all of the respondents indicated that they would like music in general to sound it would to those with normal hearing (97.1%). Therefore, how music sound to a person with normal hearing could be considered as the benchmark for the perceptual judgements in the study.

In regards to factors affecting music enjoyment, the highest rated factor that made listening to music more enjoyable was a quiet environment. Other environment related factors that made listening more enjoyable were high quality recordings, high quality speakers, and high quality headphones. Factors related to past listening experiences and contextual cues that made listening more enjoyable were familiar tunes, familiar lyrics and words, watching the performers, knowing the song title, and knowing the context. Features of music that were commonly rated to make listening more enjoyable were listening to music at a medium volume, and tunes without harmony. Conversely, factors reported hinder music enjoyment were an echoey (reverberant) room, listening to music at either a loud volume or soft volume. These factors may be useful in counselling patients about improving their music listening environment which could improve their music listening experience.

In terms of music training the majority of HA users indicated they had not had formal music training before they were fitted with HAs, and most do not have formal training now with their HAs. Results indicate that the involvement in music activities has decreased since respondents were fitted with HAs, with only a small proportion indicating that such training and involvement in musical activities prior to receiving HAs having as impact on current music listening enjoyment. Furthermore, a large proportion of all respondents indicated they would not be interested in a MTP if one became available. However, it was found that significantly more respondents in the HA-CI group showed interest than in the HA-NCI group. Respondents indicated they would like the MTP to focus on a wide range of music styles and feature commonly known tunes. In addition training sessions should be 30 minutes, twice a week, and the preferred mode of delivery of the MTP was DVD.

5.4 Conclusions and Recommendations

Overall respondents' generally preferred certain music styles (country & western and classical), and certain Instruments (e.g. piano) over others (e.g. pop/rock style and drum kit). Respondents also indicated a preference for low-pitched to high-pitched instruments, and male to female singers. Therefore it may be beneficial to introduce HA users to these Instruments and types of music when they initially fitted with HAs. Further it may be worthwhile to integrate these styles and types of music in a MTP if one was to be developed. Respondents also indicated that familiar tunes, and songs with familiar lyrics and words would enhance their listening enjoyment, and they would like the MTP to cover a wide range of styles. Hence it may be beneficial to incorporate well-known music from each decade, as well commonly-heard music covering a range of different styles and genres. This would cater for a wide range of ages and preferences and allow the respondents to choose from a range of musical styles.

In regards to fine-tuning the settings of HAs, it is recommended that digital noise reduction (DNR) and feedback cancellation algorithms are reduced or turned off, and that HA sound processing parameters should use the widest possible frequency response. Further Chasin and Russo (2004) provide the following recommendations:

- Have a wide dynamic range with a higher threshold knee point threshold than prescribed for speech;
- Have a higher peak input level for music (e.g 105 dB SPL) than for speech;
- A HA with one channel or for a multichannel system all compression ratios should be the same in each channel.

Overall, this study gathered detailed and specific information regarding music listening habits and music background, sound quality ratings for Instruments, musical styles, and music preferences and factors which enhance and hinder music listening enjoyment for postlingually deafened adults. Information was also collected to assist in determining appropriate settings for music listening programs on HAs, as well as information that could potentially contribute to the development of a MTP. Although there were both similarities and differences to music enjoyment ratings compared to CI users in She's (2008) study, as well as considerable variance in respondent's ratings in the current study, the general consensus was the same: that music did not sound as they would expect it to sound to a person with normal hearing, and that respondents would like to enjoy listening to music more. Although HAs provide benefit for most respondents in regards to improvement in QOL, and the ability to hear speech and environmental sounds, there was considerable difference in music enjoyment ratings. Although music listening is satisfactory for some users, it is largely unsatisfactory for others, as the following respondents comment:

- "whilst the 'higher frequencies' are not as good as before HAs, nevertheless enjoy listening to musical programmes on TV and our CDs" (#E003),
- "I really miss the enjoyment of music" (#F003)
- "I would just like to hear music without distortion, regardless of vocal instrument content" (#F005)

- “Cannot listen to (loud) pop with hearing aids, dislike has something to do with it” (#E093)

These findings may lead us to question the use and effectiveness of music programmes on HAs. There does not appear to be any specific justification for the way music programmes are set up, other than providing a wider frequency range and turning off noise suppression characteristics. Due to the high levels of inter-subject variability, the benefit of a manufacturer-derived default music listening programme for all HA users could be questioned. Instead, individualised programmes related to the wearer’ specific needs, preferences and hearing loss my better enhance their music listening experience.

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Appendices

Appendix 1

Modifications of the original questionnaire (UCMLQ_CI)

The questionnaire was adapted so it was applicable to hearing aid (HA) users. For example, throughout the questionnaire cochlear implant (CI) was replaced with HA, 'implantation' was replaced with 'receiving HAs'. Also the visual analogue rating scales were adjusted to reduce the number of major subdivisions from ten to five, with labels at two or more divisions on each scale, to further improve the questionnaire. The visual analogue rating scales were adjusted to reduce the number of major subdivisions from ten to five, with labels at two or more divisions on each scale. Specific changes are listed below.

Section 1: Music listening and Music Background

Questions added to the UCMLQ		**Explanation**
Question 5	Do you wear you HA in: both ears, right ear or left ear?	To ensure if they were unilateral or bilateral HA users.
Question 7	What style of HAs do you currently have	This information was obtained from their audiological files, however was not analysed
Question 8	What type of HAs do you have?	
Question 9	What level of hearing loss do you have in your right ear?	To obtain severity level of hearing loss, however this information was obtained from their audiological files.
Question 10	What level of hearing loss do you have in your left ear?	
Question 11	Have you ever been assessed for a cochlear implant?	To divide into groups HA-CI and HA-NCI.

The following questions from the original questionnaire were removed, as they were not applicable to HA wearers.

Question from Original (UCMLQ_CI)	
16	Which of the following do you use for listening to *live* music? *Please circle your response(s). You may choose more than one response.* a) Cochlear Implant (CI) AND Hearing Aid b) CI only c) Hearing Aid only
17	Which of the following do you use for listening to *recorded* music? *Please circle your response(s). You may choose more than one response.* a) CI AND Hearing Aid b) CI only c) Hearing Aid only d) CI with Direct Audio Input e) Hearing Aid with Direct Audio Input
18.	Do you notice a difference in the sound quality (for listening to music) for the following? a. "CI only" compared to "CI AND Hearing Aid". YES / NO / NEVER TRIED *If 'Yes', which is better and why* ______________________________ b. "CI only" compared to "Hearing Aid only". YES / NO / NEVER TRIED *If 'Yes', which is better and why*

____

c. “Hearing Aid only” compared to “CI AND Hearing Aid”. YES / NO / NEVER TRIED

If ‘Yes’, which is better and why

____

d. “‘With Direct Audio Input” compared to “Without Direct Audio Input”. YES / NO / HAVE NOT TRIED

If ‘Yes’, which is better and why

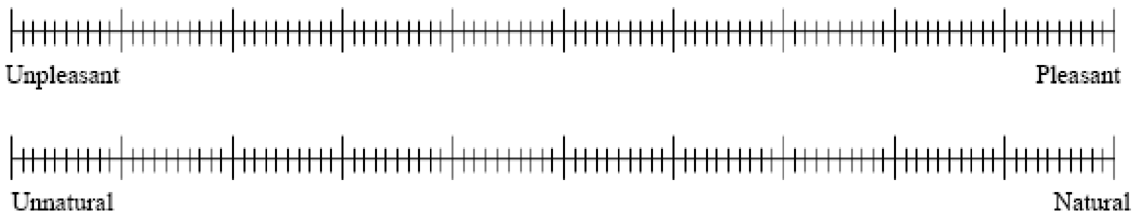
____

Original Questionnaire	**Current Questionnaire**
19. Post-implantation, which of the following provides the *best* sound quality for recorded music? *Please circle <u>one</u> response.* a) CI AND Hearing Aid b) CI only c) Hearing Aid only d) CI with Direct Audio Input e) Hearing Aid with Direct Audio Input f) Other ______________________	25. Which provides you with the best sound quality for listening to music? *Please circle <u>one</u> response.* a) No HAs b) HAs with regular everyday listening programme c) HAs with music listening programme d) HAs with Direct Audio Input e) Other ______________________

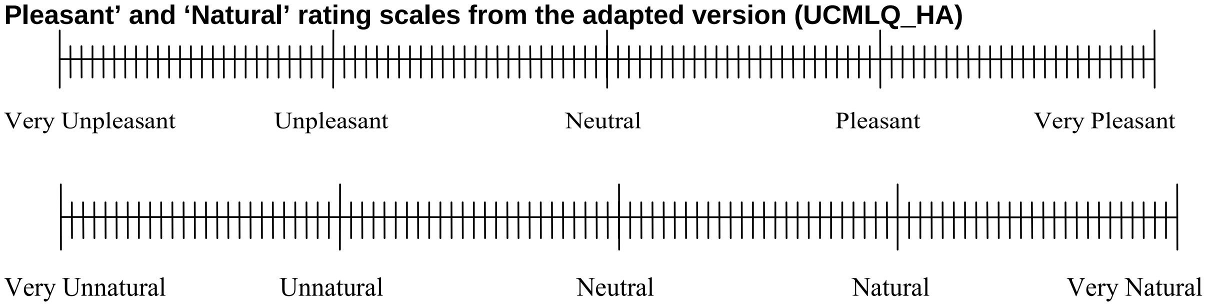
Section 2: Sound Quality

As mentioned earlier, the visual analogue rating scales were adjusted to reduce the number of major subdivisions from ten to five, with labels at two or more divisions on each scale. For the ‘pleasant’ and ‘natural’ scale, additional labels were added, to make the rating more specific.

‘Pleasant’ and ‘Natural’ rating scales from the original version (UCMLQ_CI)



Pleasant’ and ‘Natural’ rating scales from the adapted version (UCMLQ_HA)



There were no further changes to questions in the additional sections.

Appendix 2
The University of Canterbury of Music Listening Questionnaire[1]

UCMLQ_HA

LISTENING TO MUSIC WITH A HEARING AID QUESTIONNAIRE

If there is not enough space for you to write your answers or comments, please feel free to write on the blank pages attached to the end of this questionnaire. Please label these answers with the corresponding question number. It would help us if you could answer all of the questions.

Note that some questions may require you to mark your opinion on a scale. Please mark your opinion with ×. There is no right or wrong answer. Please give your most honest opinion.

Abbreviations used:
HA(s)= Hearing Aid(s)
NA = Not Applicable

Music Listening & Music Background

1. What is your age? ________ years
2. At what age were you first diagnosed with a hearing loss? ________ years
3. At what age were you when you were first considered for a HA(s)? _______ years
4. How long have you had HA(s)? __________________
5. When were you fitted with your current HA(s)? ____________________
6. Do you wear a HA in: ____ Both ears ___ Right ear only ___ Left ear only
7. What style hearing aids do you currently have ?
   a. Behind the Ear (BTE)
   b. In the ear (ITE) or In the canal (ITC)
   c. Completely in the canal (CIC)
   d. Other ________________________
   e. Unsure
8. What type of hearing aids do you have? (If you are not sure, leave this blank).

____

9. What level of hearing loss do you have in your RIGHT ear?
   ___ Mild ___ Moderate ___ Moderately-severe ___ Severe ___ Profound
10. What level of hearing loss do you have in your LEFT ear?
   ___ Mild ___ Moderate ___ Moderately-severe ___ Severe ___ Profound
11. Have you ever been considered for a Cochlear implant? YES / NO
   i) if YES, what was the outcome?

[1] Please note that the layout of the actual UCMLQ is different to as shown here – these pages have been reduced.

12. Does your HA(s) have a music programme or a separate listening programme specifically set up for music? YES / NO

    i) If YES, how often do you use it?

Never | Sometimes when listening to music | Every time when listening to music

13. What difference has the HA(s) made to your ability to hear speech?

Greatly worsened | No difference | Greatly improved

14. What difference has the HA(s) made to your ability to hear environmental sounds (e.g. running water, traffic noise, etc)?

Greatly worsened | No difference | Greatly improved

15. What difference has the HA(s) made on your overall quality of life?

Greatly worsened | No difference | Greatly improved

16. How often did you listen to music:

    a. Prior to having a hearing loss OR prior to being diagnosed with a hearing loss?

Never | Sometimes | Very Often

    b. How often do you listen to music, now, with your HA(s)?

Never | Sometimes | Very Often

    c. Has the amount of time spent listening to music changed since you were first fitted with HA(s)?

Greatly decreased | No difference | Greatly increased

How much did you enjoy listening to music:

a. Prior to have a hearing loss OR prior to being diagnosed with a hearing loss?

Did not enjoy at all | Neutral | Greatly enjoyed

b. How much do enjoy listening to music, now, with your HA(s)?

Do not enjoy at all | Neutral | Greatly enjoy

17. Did you have formal music training (e.g. music lessons) before you were fitted with HA(s)? YES / NO

18. Do you have formal music training now, with your HA(s)? YES / NO

19. Did you take part in musical activities (e.g. choirs, orchestras, musicals or bands, or play an instrument, sing or dance), prior to getting your HA(s)? YES / NO

20. Do you take part in musical activities now, with your HA(s)? YES / NO

IF YOU HAVE ANSWERED 'Yes' TO ANY OF THE ABOVE 4 QUESTIONS (i.e. Q 17-20), PLEASE PROVIDE DETAILS (e.g. length of time, activity or instrument, level attained etc.)

21. Does your music training and/or involvement in musical activities *prior* to receiving HA(s) impact on your current music listening enjoyment with your HA(s)? YES / NO / NA

Comments:

22. How much have your HA(s) impacted on your overall enjoyment of listening to music?

Greatly decreased enjoyment with a HA(s) | No effect | Greatly increased enjoyment with a HA(s)

23. Do you use Direct Audio Input* (DAI) for listening to music (e.g. TV, iPod, stereo). YES / NO

** Direct Audio Input usually connects via an audio boot attached to your hearing aid and allows you to connect to a music player.*

i) If yes, do you notice a difference in the sound quality 'with' vs.'without' DAI? YES / NO

If 'Yes', which is better and why ____

____

24. Which provides you the *best* sound quality for listening to music?
Please circle one response.

a. No HA(s)
b. HA(s) with regular, everyday listening program
c. HA(s) with music listening program
d. HA(s) with Direct Audio Input
e. Other ____________________

Please describe why this provides the best sound quality for you, in the space below.

25. Have you tried to improve your music listening or enjoyment since getting HA(s)? YES / NO
If 'Yes', please describe what you have tried and whether you had success (or otherwise) with this.

26. Which style of music sounds *best* with your HA(s)? *Please tick one response only.*

____ Classical	____ Country & Western	____ Modern Pop (1980s to now)
____ Jazz	____ Opera	____ Older-style Pop (prior to 1980s)
____ Rock 'n' Roll	____ Easy Listening	____ Musicals
____ Folk	____ Religious (e.g. hymns)	____ Hip Hop
____ Heavy Metal	____ Rap	____ Other (*Please specify*) __________

27. Which style of music do you listen to most often with your HA(s)? *Please tick one response only.*

____ Classical	____ Country & Western	____ Modern Pop (1980s to now)
____ Jazz	____ Opera	____ Older-style Pop (prior to 1980s)
____ Rock 'n' Roll	____ Easy Listening	____ Musicals
____ Folk	____ Religious (e.g. hymns)	____ Hip Hop
____ Heavy Metal	____ Rap	____ Other (*Please specify*) __________

28. Which style of music sounded best *before* your hearing loss (or before you were diagnosed with a hearing loss)? *Please tick one response only.*

____ Classical	____ Country & Western	____ Modern Pop (1980s to now)
____ Jazz	____ Opera	____ Older-style Pop (prior to 1980s)
____ Rock 'n' Roll	____ Easy Listening	____ Musicals
____ Folk	____ Religious (e.g. hymns)	____ Hip Hop
____ Heavy Metal	____ Rap	____ Other (*Please specify*) ____________

29. How do tunes (or melodies) sound with a HA(s)?

Monotonic (i.e. little or no variation between the pitches of each musical note)

Melodic (i.e. variations between the pitches of each musical note are "spot on" or accurate)

30. Do you have any additional comments on how tunes (or melodies) sound with your HA(s)?

Sound Quality

31. Instruments, Instrumental Families, and Singers

For the following instruments, instrumental families and singers, please mark your opinion with × on the scales provided. There is no right or wrong answer. Please give your most honest opinion.

Some of the scales require you to give your opinion of how an instrument/instrumental family/singer sounds compared to how you would <u>*expect*</u> *it to sound to a person with normal hearing. For instance, in Example 1, the position of the × means that the instrument sounds much emptier to you, than you would expect it to sound to a person with normal hearing. In Example 2, the instrument sounds slightly emptier to you and almost sounds like how you would expect it to sound to a person with normal hearing.*
If you are unfamiliar with a particular instrument or instrumental family, please write × in the box beside the instrument/instrumental family and skip to the next one.

Example 1:

Emptier — As Expected — Fuller

Example 2:

Emptier — As Expected — Fuller

a. Piano ☐

Overall sound quality

Very Unpleasant	Unpleasant	Neutral	Pleasant	Very Pleasant

Very Unnatural	Unnatural	Neutral	Natural	Very Natural

How does this instrument sound compared to how you would expect it to sound to a person with normal hearing?

Emptier	As Expected	Fuller

Duller	As Expected	Sharper

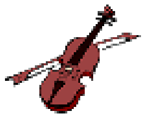
More Noisy	As Expected	Less Noisy

Tinnier	As Expected	Richer

Rougher	As Expected	Smoother

If you have any additional comments on this instrument, please use the space below:

b. Strings (e.g. Violin, Cello) ☐



Overall sound quality

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Very Unnatural | Unnatural | Neutral | Natural | Very Natural

How does this instrument sound compared to how you would <u>expect</u> it to sound to a person with normal hearing?

Emptier | As Expected | Fuller

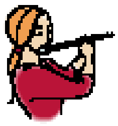
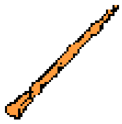
Duller | As Expected | Sharper

More Noisy | As Expected | Less Noisy

Tinnier | As Expected | Richer

Rougher | As Expected | Smoother

If you have any additional comments on this instrumental family, or any specific instrument in this family, please use the space below:

c. Woodwind (e.g. Flute, Oboe, Clarinet) ☐   

Overall sound quality

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Very Unnatural | Unnatural | Neutral | Natural | Very Natural

How does this instrument sound compared to how you would ***expect*** *it to sound to a person with normal hearing?*

Emptier | As Expected | Fuller

Duller | As Expected | Sharper

More Noisy | As Expected | Less Noisy

Tinnier | As Expected | Richer

Rougher | As Expected | Smoother

If you have any additional comments on this instrumental family, or any specific instrument in this family, please use the space below:

d. Brass (e.g. Trumpet, Trombone) ☐

Overall sound quality

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Very Unnatural | Unnatural | Neutral | Natural | Very Natural

How does this instrument sound compared to how you would <u>expect</u> it to sound to a person with normal hearing?

Emptier | As Expected | Fuller

Duller | As Expected | Sharper

More Noisy | As Expected | Less Noisy

Tinnier | As Expected | Richer

Rougher | As Expected | Smoother

If you have any additional comments on this instrumental family, or any specific instrument in this family, please use the space below:

e. Drum Kit ☐ 

Overall sound quality

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Very Unnatural | Unnatural | Neutral | Natural | Very Natural

How does this instrument sound compared to how you would expect it to sound to a person with normal hearing?

Emptier | As Expected | Fuller

Duller | As Expected | Sharper

More Noisy | As Expected | Less Noisy

Tinnier | As Expected | Richer

Rougher | As Expected | Smoother

If you have any additional comments on this instrument, please use the space below:

f. Guitar ☐

Overall sound quality

Very Unpleasant	Unpleasant	Neutral	Pleasant	Very Pleasant

Very Unnatural	Unnatural	Neutral	Natural	Very Natural

How does this instrument sound compared to how you would ***expect*** *it to sound to a person with normal hearing?*

Emptier	As Expected	Fuller

Duller	As Expected	Sharper

More Noisy	As Expected	Less Noisy

Tinnier	As Expected	Richer

Rougher	As Expected	Smoother

If you have any additional comments on this instrument, please use the space below:

g. Male Singer ☐

Overall sound quality

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Very Unnatural | Unnatural | Neutral | Natural | Very Natural

How does this instrument sound compared to how you would ***expect*** *it to sound to a person with normal hearing?*

Emptier | As Expected | Fuller

Duller | As Expected | Sharper

More Noisy | As Expected | Less Noisy

Tinnier | As Expected | Richer

Rougher | As Expected | Smoother

If you have any additional comments, please use the space below:

h. Female Singer ☐

Overall sound quality

Very Unpleasant	Unpleasant	Neutral	Pleasant	Very Pleasant

Very Unnatural	Unnatural	Neutral	Natural	Very Natural

How does this instrument sound compared to how you would ***expect*** *it to sound to a person with normal hearing?*

Emptier	As Expected	Fuller

Duller	As Expected	Sharper

More Noisy	As Expected	Less Noisy

Tinnier	As Expected	Richer

Rougher	As Expected	Smoother

If you have any additional comments, please use the space below:

33. **Musical Styles**

For the following musical styles, please mark your opinion with ✕ on the scales provided. For instance, in Example 1, the position of the ✕ means that the musical style sounds very unpleasant to you, and in Example 2, the position of the ✕ means that the musical style is still unpleasant but more pleasant than for Example 1. There is no right or wrong answer. Please give your most honest opinion.

If you have not listened to a musical style with your HA(s), please write ✕ in the box beside the musical style and skip to the next one.

Example 1:

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Example 2:

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

a. Classical – (orchestra) ☐

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style by *listening-alone* | Can *always* identify this *style* by *listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

b. Classical – small group (e.g. 2 to 5 instruments) ☐

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style *by listening-alone* | Can *always* identify this *style by listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

c. Classical – choir ☐

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style *by listening-alone* | Can *always* identify this *style by listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

d. Pop/Rock (please specify the style/time of music e.g. '1960's' or 'now') ☐ ___________

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style *by listening-alone* | Can *always* identify this *style* *by listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

e. Country and Western ☐

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style *by listening-alone* | Can *always* identify this *style* *by listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

f. Jazz ☐

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style *by listening-alone* | Can *always* identify this *style by listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

g. Other (*please specify*) ______________________

Very Unpleasant | Unpleasant | Neutral | Pleasant | Very Pleasant

Simple | Complex

Can *never* follow melody-line | Can *always* follow melody-line

Can *never* identify this style *by listening-alone* | Can *always* identify this *style by listening-alone*

Sounds *nothing* like I would expect it to sound to a person with normal hearing | Sounds *exactly* as I would expect it to sound to a person with normal hearing

If you would like to add any comments on these, or any other styles, please use the space below.

34. If it was possible, would you like music to sound (with the HA(s)) like you think it would sound to a normally hearing person? YES / NO

    If no, please provide more information.

Music Preferences

35. Please rank the following from 1 to 8, where '1' means this instrument/instrumental family/singer sounds *most* natural to you, and '8' means, this instrument/instrumental family/singer sounds *least* natural to you. You may give equal rankings. For equal rankings, please write an equal sign beside the number. For example, if you find that both woodwind and brass are the most natural-sounding instrumental families, please write '1=' beside woodwind and brass.

____ Piano
____ Strings (e.g. violin, cello)
____ Woodwind (e.g. flute, clarinet, oboe)
____ Brass (e.g. trumpet)
____ Drum kit
____ Guitar
____ Female singer
____ Male singer

If you would like to make any comments, please use this space below.

____

____

____

____

36. Which do you prefer (*please circle your response*):

    a. Male singer / Female singer / No preference

    b. Low-pitched instrument / High-pitched instrument / No preference

    c. Instrumental-only music / Voice-only music / Voice with instrument / No preference

37. Please rank the following from 1 to 5, where:
    1 = most preferred; 5 = least preferred. *(Please use each number once only.)*

____ one performer (instrument or singer)
____ two performers (instruments and/or singers)
____ three performers (instruments or singers)
____ small group of performers (e.g. 4 to 5)
____ large group of performers (e.g. an orchestra, choir or band)

Music Recognition

38. With your HA(s) are there any tunes that you can *always* recognise? YES / NO

If 'Yes', please describe as best as you can how you recognise the tunes (e.g. from the words, the rhythm/beat, or the melody line).

39. Are there tunes that you cannot recognise but would like to be able to recognise? YES / NO

If 'Yes' please write down the names or descriptions of these tunes.

40. Are there any instruments that you can *always* recognise, by listening-alone? YES / NO

If 'Yes' please write down the names of these instruments.

41. Are there instruments that you cannot recognise by listening-alone but would like to be able to recognise? YES / NO

If 'Yes' please write down the names of these instruments.

Factors affecting Music Listening Enjoyment

42. The following is a list of factors that may affect your listening experience. Beside each factor, write a:

+ if the factor makes music listening *more* enjoyable
- if the factor makes music listening *less* enjoyable
o if the factor makes no difference to your music listening experience
NA if you don't know or have not tried it

____ High quality speakers
____ High quality headphones
____ High quality recordings
____ Soft volume
____ Medium volume
____ Loud volume

____ Quiet environment
____ Echoey (or reverberant) room
____ Live concert, indoors
____ Live concert, outdoors
____ Sitting at the front of a hall/theatre

____ Using a special music programme on your HA(s)
____ Direct Audio Input (DAI)
____ Increased length of time or experience with the HA(s)
____ Practice listening to music

____ Familiar lyrics/words
____ Familiar music (e.g. tunes you knew prior to getting your HA)
____ Knowing the song title
____ Knowing the context (e.g. knowing the performer(s), at a social situation, or background music for a movie)
____ Having the musical score or words to follow along with
____ Watching the performer(s)

____ Slow rhythm or beat
____ Fast rhythm or beat
____ Tune with no harmony (or accompaniment)
____ Tune with harmony (or accompaniment)
____ With words (to any style of music)
____ Without words (for any style of music)

Are there any other factors that improve, or detract from, your music listening experience?

Music Training Program

The results of this questionnaire maybe used to help us to design a Music Training Program for improving music listening enjoyment for HA users. Therefore your responses to these questions, along with any additional detail that you feel may be appropriate, will be of great assistance. Thank you.

43. Do you think you would be interested in a Music Training Program aimed at improving your music appreciation and music listening experiences? YES / NO

44. Please order the following skills in terms of importance, from 1 (most important) to 9 (least important), to help your music listening enjoyment. You may give equal rankings. For equal rankings, please write an equal sign beside the number. For example, if you find that 'learning new tunes' and 'being able to hear changes in pitch' are equally the most important, please write '1=' beside these skills.

____ Being able to recognise commonly-known musical instruments
____ Being able to recognise commonly-known tunes
____ Being able to recognise tunes that you knew prior to fitting of HAs
____ Being able to recognise musical styles (e.g. pop, rock, jazz, etc)
____ Learning new tunes
____ Being able to hear changes in pitch
____ Being able to hear more-complex rhythms
____ Being able to hear or "pick out" the tune when it is presented with harmony (accompaniment)
____ Other (please specify) ______________________________

45. Are there any instruments, instrumental families, musical styles, or songs that you would like to be able to hear better? YES / NO

If 'Yes', please provide more detail.

46. Would you like the Training Program to focus on your preferred musical style OR introduce you to a wide range of musical styles? PREFERRED STYLE ONLY / WIDE RANGE

The Music Training Program will be designed so that it can be carried out 'at home', in your own time. Please take this into consideration when answering Questions 44 to 47.

47. How long do you think each training session should last for?

____ minutes

48. How many times a week do you think the sessions should be?

____ times a week.

49. In what form would you like the Music Training Program to come in? *Please tick one response.*

____ CD (e.g. to play in a CD walkman or stereo)
____ MP3 (e.g. to play on an iPod or a portable music player)
____ CD-ROM (e.g. to play on a computer or laptop)
____ PDA (i.e. a Personal Digital Assistant – a hand-held, palm-size mini computer, similar to a personal organiser)
____ DVD
____ Other (please specify) ____________________

50. Would you find a written manual with information and exercises, to accompany the Music Training Program, helpful? YES / NO

51. If you have any comments or suggestions that you would like to make about the Music Training Program, please use the space below.

THE END

Thank you for completing this questionnaire. Your time and effort is much appreciated.

If not enough space has been provided for you to write your answers or comments in, in the questionnaire above, please feel free to attach additional pages.

Appendix 3
Summary of Results I

Response Rate

	Overall	**%**
Sufficiently Completed	111	23.566 (111/471) overall 60% (111/185) replies
Insufficiently Completed	12	6.486 (12/185)
Excluded	4	2.162 (6/185)
Unable to participate	22 (1 deceased)	11.189 (22/185)
Returned blank	36	19.459 (36/185)
Overall replies	185	39.278 (185/471)

In total, 471 questionnaires were sent.
Fully Completed: 111; 13 HA-CI (HA-CI), 98 HA-NCI (HA-NCI)

Participant Audiological Data

PTA of 500, 1000, 2000, and 4000 Hz better hearing ear

	Overall	**HA-CI**	**HA-NCI**		
		Overall	**Overall**	**Mild**	**Moderate+**
M	42.3	75.2	3901	30.8	48
SD	16.5	17.8	10.7	5.7	7
n	111	13	98	51	47

An independent samples t-test showed:
- HA-NCI had significantly better PTA thresholds (average of 500, 1000, 2000 and 4000 Hz) than the HA-CI group ($p < 0.001$).
- a significant difference in PTA thresholds between the Mild and Moderate+ subgroups ($p < 0.001$).

Configuration of Hearing loss

			HA-CI		**HA-NCI**					
	Overall		**Overall**		**Overall**		**Mild**		**Moderate +**	
		%		%		%		%		%
Flat	25	22.5	6	46.2	19	9.4	8	15.7	11	23.4
Sloping	83	74.8	7	53.8	76	77.6	42	82.4	34	72.3
Trough	3	2.7	0	0	3	3.1	1	2.0	2	4.3
n	111		13		98		51		47	

Site of Lesion (better hearing ear)

			HA-CI		**HA-NCI**					
	Overall		**Overall**		**Overall**		**Mild**		**Moderate +**	
		%		%		%		%		%
Sensorineural	93	83.8	7	53.8	86	87.8	47	92.2	39	83.0
conductive	9	8.1	2	15.4	7	7.1	3	5.9	4	8.5
mixed	9	8.1	4	30.8	5	5.1	1	2.0	4	8.5
n	111		13		98		51		47	

Severity Level of better hearing ear

			HA-CI		HA-NCI					
	Overall		**Overall**		**Overall**		**Mild**		**Moderate +**	
		%		%		%		%		%
Mild	51	45.9	0	0	51	52.0	51	100	0	0
Moderate	42	37.8	2	15.4	40	40.8	0	0	40	85.1
Moderately-Severe	10	9.0	3	23.1	7	7.1	0	0	7	14.9
Severe	6	5.4	6	46.2	0	0	0	0	0	0
Profound	2	1.8	2	15.4	0	0	0	0	0	0
n	111		13		98		51		47	

Progression of Hearing loss

			HA-CI		HA-NCI					
	Overall		**Overall**		**Overall**		**Mild**		**Moderate +**	
		%		%		%		%		%
Sudden	9	10.0	1	11.1	8	9.9	5	11.4	3	8.1
Gradual	81	90.0	8	88.9	73	90.1	39	88.6	34	91.9
n	90		9		81		44		37	

Speech Perception Scores

		HA-CI	HA-NCI		
	Overall	**Overall**	**Overall**	**Mild**	**Moderate +**
M	92.38	72.00	95.0	96.02	94.02
SD	15.09	24.31	11.2	13.33	8.313
n	104	12	92	47	45
Independent samples t-test		p = 0.007		p = 0.393	

Note: Monosyllabic words presented at a range of levels. Best available score recorded of better hearing ear. Not all patients had their speech perception scores in their files.

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Participant information		**Overall**		**HA-CI**		**HA-NCI**					
				Overall		**Overall**		**Mild**		**Moderate +**	
			%		**%**		**%**		**%**		**%**
Sex	Male	67	60.4	4	30.8	63	64.3	38	74.5	25	53.2
	Female	44	39.6	9	69.2	35	35.7	13	25.5	22	46.8
	n	111		13		98		51		47	
Severity level of better hearing ear	Mild	51	45.9	0	0	51	52.0	51	100	0	0
	Moderate	42	37.8	2	15.4	40	40.8	0	0	40	85.1
	Moderately-Severe	10	9.0	3	23.1	7	7.1	0	0	7	14.9
	Severe	6	5.4	6	46.2	0	0	0	0	0	0
	Profound	2	1.8	2	15.4	0	0	0	0	0	0
	n	111		13		98		51		47	
Symmetry of hearing loss	Symmetrical	86	77.5	7	53.8	79	80.6	40	78.4	39	83.0
	Asymmetrical	25	22.5	6	46.2	49	19.4	11	21.6	8	17.0
	n	111		13		98		51		47	
Configuration of HL	Flat	25	22.5	6	46.2	19	19.4	8	15.7	11	23.4
	Sloping	83	74.8	7	53.8	76	77.6	42	82.4	34	72.3
	Trough	3	2.7	0	0	3	3.1	1	2.0	2	4.3
	n	111		13		98		51		47	
Site of lesion	SNHL	93	83.8	7	53.8	86	87.8	47	92.2	39	83.0
	Conductive	9	8.1	2	15.4	7	7.1	3	5.9	4	8.5
	Mixed	9	8.1	4	30.8	5	5.1	1	2.0	4	8.5
	n	111		13		98		51		47	
Progression of HL	Sudden	9	10.0	1	11.1	8	9.9	5	11.4	3	8.1
	Gradual	81	90.0	8	88.9	73	90.1	39	88.6	34	91.9
	n	90		9		81		44		37	
Aetiology	From a young age	9	18.0	3	75.0	6	13.0	4	12.1	2	15.4
	NIHL	35	70.0	0	0	35	76.1	24	72.7	11	84.6
	Aging	3	6.0	0	0	3	6.5	3	9.1	0	0
	Other	3	6.0	1	25.0	2	4.3	2	6.1	0	0
	n	50		4		46		33		13	0

Aetiology and participant data – was recorded if in the patients file, if mentioned in report letters. NIHL – easily identified as ACC clients.
Note: Severity_level calculated using pure-tone average of 500, 1000, 2000 and 4000 Hz in each ear. Severity levels based on Goodman (1968) classification levels.

Section 1: Music Listening and Music Background

Note: All units are in years. Years calculated as a whole number – e.g. 0.5 years = 6 months

Question			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
1.	What is your age?	M	66.93	53.61	68.69	65.47	72.20
		SD	12.58	13.07	11.46	11.08	10.93
		n	111	13	98	51	47
		Range	23-89	23-68	30-89	30-82	37-89
	Independent Samples t-test				p < 0.001**		p = 0.003**
2	At what age were you first diagnosed with hearing loss?	M	52.54	25.61	56.11	55.41	56.87
		SD	19.95	16.70	17.51	16.29	18.89
		n	111	13	98	51	47
		Range	2-85	2-51	6-85	6-79	7-85
2a.	Length of time with hearing loss.	M	14.39	28.00	12.58	10.05	15.32
		SD	14.08	11.44	13.43	10.65	15.57
		n	111	13	98	51	47
		Range	0.5-72	15-51	0.5-72	1-48	0.5-72
3	At what age were you first considered for HAs?	M	59.41	33.2	62.88	61.86	64.00
		SD	16.49	18.9	12.65	11.36	13.96
		n	111	13	98	51	47
		Range	2-86	2-59	27-86	29-79	27-86
4	How long have you had HAs?	M	6.98	19.94	5.27	3.33	7.36
		SD	9.13	14.34	6.61	4.61	7.77
		n	111	13	98	51	47
		Range	0.5-48	1.25-48	0.5-29	0.5-23	0.5-29
	Independent Samples t-test				p < 0.001**		p = 0.002
5	How long have you been fitted with your current HAs?	M	2.12	4.05	1.87	1.53	2.23
		SD	2.21	5.20	1.28	0.93	1.51
		n	111	13	98	98	47
		Range	0.5-20	1-20	0.5-9	0.5-5	0.5-9

Independent samples t-tests showed:

- 1. HA-CI were significantly younger in age (years) than HA-NCI ($t = -4.385$, $p < 0.001$) and for the subgroups; the Mild group were significantly younger in age than the moderate + group ($t = -3.023$, $p = 0.003$).
- 2. HA-CI were diagnosed with a hearing loss at a significantly younger age than HA-NCI ($t = -5.928$, $p < 0.001$).
- 2a) Length of time with hearing loss: the length of hearing loss for HA-CI is significantly longer than for HA-NCI ($t = 3.946$, $p < 0.001$).
- 4. HA-NCI have had HAs for a significantly longer period of time than HA-NCI ($t = 6.333$, $p < 0.001$). The moderate + subgroup have had HAs for a significantly longer period of time than the Mild subgroup ($t = -3.150$, $p = 0.002$).

Question			**Overall**		**HA-CI**		**HA-NCI**					
					Overall		**Overall**		**Mild**		**Moderate+**	
				%		**%**		**%**		**%**		**%**
6	Do you wear a HA in:	Both	105	94.6	7	53.8	98	100	51	100	47	100
		Right	5	4.5	5	38.5	0	0	0	0	0	0
		Left	1	0.9	1	7.7	0	0	0	0	0	0
		n	111		13		98		51		47	
7	What style of HAs do you currently have?	BTE	75	70.1	10	76.9	65	66.3	40	78.4	25	56.8
		ITE/ITC	27	25.2	3	23.1	24	24.5	7	13.7	17	38.6
		CIC	2	1.9	0	0	2	2.0	0	0	2	4.5
		Unsure	3	2.8	0	0	3	3.1	3	6	0	0
		n	107		13		94		50		44	
11	Have you ever been considered for a CI?	Yes	13	11.7	13	100	0	0	0	0	0	0
		No	98	88.3	0	0	98	100	51	100	47	0
		n	111		13		98		51		47	
	Meet CI criteria?	Yes	5	45.5	5	45.5	0	0	0	0	0	0
		No	6	54.5	6	54.5	0	0	0	0	0	0
		n	11		11		0		0		0	

Question			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
				%		%		%		%		%
12	Do your HAs have a music programme or a separate listening programme specifically set up for music.	Yes	25	23.14	2	15.38	23	24.21	13	26.53	10	21.74
		No	83	76.85	11	84.61	72	75.79	36	73.47	36	78.26
		n		108	13		95		49		46	
Test: Chi-Square test χ^2 (1, *N* = 108) = 31.45, *p* <.001**												

Question			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
12i)	If YES, how often is it used (0=never, 50= sometimes when listening to music, 100= every time when listening to music).	M	47.66	47.00	47.72	48.53	46.55
		SD	33.64	41.01	34.04	32.59	38.03
		n	24	2	22	13	9

Q 13-15 Difference HAs have made:
(0=greatly worsened, 50= no difference, 100= Greatly improved)

Question			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
13.	What difference has the HA(s) made to your ability to *hear speech*?	M	83.9434	87.3077	83.4731	79.6122	87.7727
		SD	12.69933	14.38972	12.45914	11.46701	12.22438
		n	106	13	93	49	44
	Independent samples t-Test			p=0.310		p=0.001**	
14.	What difference has the HA(s) made to your ability to *hear environmental sounds?*	M	83.6055	83.0000	83.6875	80.6600	86.9783
		SD	14.57993	16.49747	14.39540	14.41882	13.77839
		n	109	13	96	50	46
	Independent samples t-Test			p=0.874		p=0.031*	
15.	What difference has the HA(s) made on your overall *quality of life?*	M	80.6574	85.0000	80.1146	74.4000	86.3261
		SD	15.83334	16.56393	15.74525	15.58126	13.77839
		n	108	12	96	50	46
	Independent samples t-Test			p=0.316		p<0.001	

Q16a-c: Listening to music
(0=greatly worsened, 50= no difference, 100= Greatly improved)

Question **How often do you listen to music?**			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
16a.	Prior to having or being diagnosed with a hearing loss (0=never, 50= sometimes, 100= very often)	M	74.1545	74.0769	74.0769	74.4400	73.8723
		SD	22.68904	25.46390	22.43773	22.26937	22.85266
		n	110	13	97	50	47
	Independent samples t-Test			p=0.990		p=0.902	
16b.	How often do you listen to music now, with your HAs? (0=never, 50= sometimes, 100= very often)	M	69.5505	48.3846	72.4167	71.3400	73.5870
		SD	24.61800	26.93677	22.97214	23.10898	23.01939
		n	110	13	96	50	46
	Independent samples t-Test			p=0.001		p=0.635	
16c.	Has the amount of time spent listening to music changed since you were first fitted with HAs? (0=greatly decreased, 50= no difference, 100= Greatly increased)	M	52.2636	41.7692	53.6701	50.9412	56.6957
		SD	18.94448	23.72114	17.89537	14.97252	20.40356
		n	110	13	97	51	46
	Independent samples t-Test			p=0.103		p=0.120	

Q17 a,b. Enjoyment of music
(0=did/do not enjoy at all, 50= neutral 100= greatly enjoy(ed))

Question			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
17a.	Prior to having or being diagnosed with a hearing loss	M	79.2477	80.2308	79.1146	79.8980	78.2979
		SD	20.78512	20.66460	20.90574	16.56961	24.79474
		n	109	13	96	49	47
	Independent samples t-Test			p=0.857		p=0.712	
17b.	Now, with your HAs?	M	76.9364	63.1667	78.6224	76.1765	81.2766
		SD	20.78512	30.21088	20.40897	20.88225	19.76130
		n	110	12	98	51	47
	Independent samples t-Test			p=0.021		p=0.218	

Correlation Matrix for age, time spent listening to music, music listening enjoyment, and PTA scores of better hearing ear

		Age	Best PTA	Experience with HAs	Time spent listening to music now with HAs (Q16a)	Current Music enjoyment with HAs (Q16b)	Pleasantness across Instruments	Pleasantness across musical styles
Age	r	1.000	.056	.001	.110	.091	.166	-.019
	p	.	.562	.993	.254	.349	.084	.846
	n	111	111	111	110	109	109	106
Best PTA	r	.056	1.000	**.522(**)**	.043	.052	-.107	-.108
	p	.562	.	.000	.658	.592	.267	.269
	n	111	111	111	110	109	109	106
Experience with HAs	r	.001	**.522(**)**	1.000	.033	.062	-.097	**-.200(*)**
	p	.993	.000	.	.736	.525	.316	.040
	n	111	111	111	110	109	109	106
Time spent listening to music now with HAs (Q16a)	r	.110	.043	.033	1.000	**.474(**)**	**.195(*)**	.047
	p	.254	.658	.736	.	.000	.043	.634
	n	110	110	110	110	108	108	105
Current Music enjoyment with HAs (Q16b)	r	.091	.052	.062	**.474(**)**	1.000	.258(**)	.191
	p	.349	.592	.525	.000	.	.007	.052
	n	109	109	109	108	109	107	104
Pleasantness across Instruments	r	.166	-.107	-.097	**.195(*)**	**.258(**)**	1.000	.111
	p	.084	.267	.316	.043	.007	.	.259
	n	109	109	109	108	107	109	105
Pleasantness across musical styles	r	-.019	-.108	**-.200(*)**	.047	.191	.111	1.000
	p	.846	.269	.040	.634	.052	.259	.
	n	106	106	106	105	104	105	106

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
r = correlation, p = p-valuer, n = number of participants responding

Q 18-22. Music Training and Activities

Question			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
18	Did you have formal music training (e.g.) music lessons) before you were fitted with HAs			%		%		%		%		%
		Yes	42	37.8	7	53.8	35	35.7	17	33.3	18	38.3
		No	69	62.2	6	46.2	63	64.3	34	66.7	29	61.7
		n		n=111		n=13		n=98		n=51		n=47
	Independent samples t-Test					p=0.209				p=0.613		
19	Do you have formal music training now with your HAs?	Yes	5	4.5	1	7.7	4	4.1	0	0	4	8.5
		No	106	95.5	12	92.3	94	95.9	51	100.0	43	91.5
		n		n=111	n=13			n=98		n=51		n=47
	Independent samples t-Test							p=0.560				p=0.044
20	Do you take part in musical activities (e.g. choirs, orchestras, musicals or bands, or play an instrument, sing or dance) prior to getting HAs?	Yes	48	44.1	6	46.2	43	43.9	22	43.1	21	44.7
		No	62	55.9	7	53.8	55	56.1	29	56.9	26	55.3
		n		n=111	n=13			n=98	n=51			n=47
	Independent samples t-Test							p=0.878				p=0.879
21	Do you take part in musical activities now with your HAs?	Yes	25	22.5	6	46.2	43	43.9	11	21.6	9	19.1
		No	86	77.5	7	53.8	55	56.1	40	78.4	38	80.9
		n		n=111		n=13		n=98		n=51		n=47
	Independent samples t-Test					p=0.237				p=0.769		
22	Does your music training involvement and/involvement in musical activities prior to receiving HAs impact on your current music listening enjoyment with your HAs?	Yes	20	21.7	2	16.7	48	22.5	7	15.6	11	31.4
		No	33	35.9	7	58.3	26	32.5	18	40.0	8	22.9
		NA	39	42.4	3	25.0	36	45.0	20	44.4	16	45.7
		n		n=111		n=12		n=80		n=45		n=35
	Independent samples t-Test					p=0.514				p=0.419		

Q 23. HAs and enjoyment of music

Question			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
23	How much have your HAs impacted your overall enjoyment of music? (0= greatly decreased enjoyment with HAs, 50=no effect, 100greatly increased enjoyment with HAs)	M	69.1308	51.4167	71.3684	66.8600	76.3778
		SD	24.31712	27.87785	23.03792	20.32492	25.00117
		n	n=107	n=12	n=95	n=50	n=45
	Independent samples t-Test			p=0.007		p=0.044	

Note: For questions 13-23 an independent samples test was used and a significant difference between the M ratings is illustrated by the highlighted values above.

Question			Overall		HA-CI		HA-NCI					
					Overall		**Overall**		**Mild**		**Moderate+**	
24	Do you use Direct Audio Input (DAI) for listening to music (e.g. TV, iPod, stereo)			%		%		%		%		%
		Yes	5	4.6	1	7.7	4	4.2	1	2	3	6.7
		No	103	95.4	12	92.3	91	95.8	49	98	42	93.3
		n	n=108		n=13		n=95		n=50		n=45	
24i	If yes do you notice a difference in the sound quality 'with' vs. 'without' DAI?	Yes	4	3.6	1	7.7	3	3.1		0	3	6.4
		No	0									
		n	n=4		n=1		n=3		n=0		n=3	
25	Which provides you the best sound quality for listening to music: a) No HAs, b) HAs with regular, everyday listening programme, c) HAs with music listening programme, d) HAs with DAI, e) Other	A	17	16.8	3	23.1	14	15.9	7	15.2	7	16
		B	70	69.3	8	61.5	62	70.5	31	67.4	31	66
		C	11	10.9	1	0	11	12.5	7	15.3	4	8.5
		D	1	1.0	1	7.7	0	0	0	0	0	0
		E	2	2.0	0	7.7	1	1.1	1	2.2	0	0
		n	n=101		n=13		n=88		n=46		n=42	
	Test: Chi-Square test χ	$\chi^2(4, N = 101) = 162.12, p < 0.001$										
26	Have you tried to improve your music listening or enjoyment since getting your HAs?	Yes	23	22.5	5	41.7	18	20	6	12.2	12	29.3
		No	79	77.5	7	58.3	72	80	43	87.8	29	70.7
		n	n=102		n=12		n=90		n=49		n=41	
	Test: Chi-Square test	$\chi^2(1, N = 102) = 30.74, p < 0.001$										

Question			Overall		HA-CI		HA-NCI					
					Overall		**Overall**		**Mild**		**Moderate+**	
				%		%		%		%		%
27.	Which style of music *sounds best with your HAs?*	Classical	38	35.8	3	23.1	35	37.6	22	46.8	13	28.3
		Jazz	4	3.8	0	0	4	4.3	3	6.4	1	2.2
		Folk	1	.9	0	0	1	1.1	0	0	1	2.2
		Rock 'n' Roll	0	0	0	0	0	0	0	0	0	0
		Heavy Metal	2	1.9	0	0	2	2.2	1	2.1	1	2.2
		Country & Western	12	11.3	1	7.7	11	11.8	5	10.6	6	13
		Opera	2	1.9	0	0	2	2.2	1	2.1	1	2.2
		Easy Listening	22	20.8	5	38.5	17	18.3	7	14.9	10	21.7
		Religious (e.g. hymns)	3	2.8	0	0	3	3.2	1	2.1	2	4.3
		Rap	0	0	0	0	0	0	0	0	0	0
		Modern Pop (1980s to now)	1	0.9	0	0	1	1.1	1	2.1	0	0
		Older-style Pop	7	6.6	2	15.4	5	5.4	0	0	5	10.9
		Musicals	9	8.5	0	0	9	9.7	3	6.4	6	13
		Other	5	4.7	2	15.4	3	3.2	3	6.4	0	0
		n=	n=106		13		93		47		46	

	Test: Chi-square	$\chi^2(11, N = 106) = 150.07, p < 0.001$										
Question					**HA-CI**		**HA-NCI**					
			Overall		**Overall**		**Overall**		**Mild**		**Moderate+**	
28	Which style of music do you listen to most often with your HA(s)?			%		%		%		%		%
		Classical	36	34.6	3	23.1	33	36.3	22	45.8	11	25.6
		Jazz	5	4.8	0	0	5	5.5	3	6.3	2	4.7
		Folk	0	0	0	0	0	0	0	0	0	0
		Rock 'n' Roll	1	1.0	0	0	1	1.1	1	2.1	0	0
		Heavy Metal	1	1.0	0	0	1	1.1	0	0	0	0
		Country & Western	9	8.7	1	7.7	8	8.8	3	22.9	5	11.6
		Opera	1	1.0	2	15.4	1	1.1	0	0	1	2.3
		Easy Listening	27	26.0	0	0	25	27.5	11	22.9	14	32.6
		Religious (e.g. hymns)	2	1.9	1	7.7	1	1.1	0	0	1	2.3
		Rap	0	0	0	0	0	0	0	0	0	0
		Modern Pop (1980s to now)	2	1.9	1	7.7	1	1.1	1	2.1	0	0
		Older-style Pop	9	8.7	2	15.4	7	7.7	3	6.3	4	9.3
		Musicals	4	3.8	0	0	4	4.4	0	0	4	9.3
		Other	7	6.7	3	23.1	4	4.4	3	6.3	1	2.3
			n=104		13		91		47		43	
	Test: Chi-square	$\chi^2(11, N = 104) = 160.000, p < 0.001$										
29	Which style of music sounded best *before your hearing loss* (or before you were diagnosed with a hearing loss)?					%				%		%
		Classical	37	35.6	2	15.4	35	37.6	24	49	11	25
		Jazz	6	5.8	0	0	6	6.5	3	6.1	3	6.8
		Rock 'n' Roll	2	1.9	0	0	2	2.2	2	4.1	0	0
		Folk	0	0	0	0	0	0	0	0	0	0
		Heavy Metal	1	1	0	0	1	1.1	1	2.0	0	0
		Country & Western	8	7.7	0	0	8	8.6	4	8.2	4	9.1
		Opera	3	2.9	0	0	3	3.2	0	0	3	6.8
		Easy Listening	22	21.2	4	30.8	18	19.4	7	14.3	11	25.0
		Religious (e.g. hymns)	3	2.9	0	0	3	3.2	1	2.0	2	4.5
		Rap	0	0	0	0	0	0	0	0	0	0
		Modern Pop (1980s to now)	2	1.9	0	0	2	2.2	2	4.1	0	0
		Older-style Pop	8	7.7	3	23.1	5	5.4	1	2.0	4	9.1
		Musicals	8	7.7	1	7.7	7	7.5	2	4.1	5	11.4
		Other	4	3.8	1	7.7	3	3.2	2	4.1	1	2.1
		n	n=104		11		93		49		44	
	Test: Chi-square	$\chi^2(11, N = 104) = 141.07, p < 0.001$										

Note: For questions 25,26,27,28 and 29 a Chi-Square test showed a significant difference. More people found that classical and easy listening were more significant than other styles

Question			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
30	**How do tunes (melodies) sound with HAs (0= Monotonic, 100=Melodic)**	M	73.47	54.2500	76.0110	73.3400	79.2683
		SD	26.46	35.83580	24.09725	20.40969	27.86487
		n	103	12	91	50	41
	Independent samples t-test			p = 0.007		p = 0.245	

Section 2: Sound Quality (Instruments, Instrumental families and Singers)

Question 32 a. Piano			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32a.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	72.21	68.50	72.70	72.57	72.86
		SD	17.29	19.15	17.09	17.44	16.88
		n	103	12	91	49	42
32a.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	71.65	67.00	72.34	71.67	73.07
		SD	17.29	16.73	16.84	17.06	16.78
		n	94	12	82	43	39
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32a.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	50.38	37.25	52.23	51.70	52.89
		SD	15.69	23.39	13.49	14.59	12.13
		n	97	12	85	47	38
32a.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	56.69	45.42	58.27	58.06	58.48
		SD	20.18	29.21	18.27	18.98	17.72
		n	98	12	86	44	42
32a.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	47.46	49.18	47.24	49.24	45.05
		SD	20.05	31.17	18.42	17.14	19.71
		n	97	11	86	45	41
32a.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	51.75	38.91	53.56	52.28	55.07
		SD	19.07	30.45	16.35	16.71	16.00
		n	97	12	85	46	39
32a.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	55.17	52.75	55.53	53.72	57.67
		SD	16.01	24.97	14.42	14.04	14.746
		n	93	12	81	44	37
32a.	Pleasant and Natural Combined Rating	M	71.76	67.50	72.28	71.81	72.80
		SD	16.05	17.14	15.93	15.68	16.35
		n	105	12	93	49	44

Question 32 b. Strings (e.g. Violin, Cello)			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32b.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	65.74	50.70	67.62	65.65	70.02
		SD	21.48	26.27	20.23	18.83	21.83
		n	90	10	80	44	36
32b.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	65.15	54.30	66.64	66.62	66.67
		SD	20.14	27.63	18.65	16.29	21.43
		n	83	10	73	40	33
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32b.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	54.79	41.60	56.51	56.75	56.22
		SD	18.34	24.34	16.88	14.45	19.48
		n	87	10	77	41	36
32b.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	56.69	44	58.36	57.32	59.53
		SD	19.75	27.40	17.72	16.01	19.62
		n	86	10	76	40	36
32b.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	49.71	54.50	49.08	49.85	48.20
		SD	15.76	29.94	14.24	8.63	18.82
		n	85	10	75	40	35
32b.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	53.67	36.20	56.07	53.71	58.76
		SD	19.02	30.59	15.71	13.52	17.72
		n	83	10	73	39	34
32b.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	55.36	59.73	54.72	54.15	55.38
		SD	14.77	22.72	13.30	11.41	15.38
		n	85	11	74	40	34
32b.	Pleasant and Natural Combined Rating	M	65.53	52.50	67.13	65.51	69.00
		SD	20.04	26.72	18.66	16.92	20.56
		n	92	10	82	44	38

Question 32 c. Woodwind (e.g. Flute, Oboe, Clarinet)			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32c.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	69.08	59.89	70.24	68.84	71.9
		SD	18.95	27.84	17.12	17.82	16.39
		n	81	9	72	38	34
32c.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	69.21	64.50	69.76	66.75	73.15
		SD	16.84	22.59	16.16	17.36	14.20
		n	76	8	68	36	32
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32c.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	54.19	52	54.48	54.91	55.44
		SD	14.34	22.59	13.11	15.32	12.21
		n	77	9	68	34	34
32c.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	54.55	36.78	56.91	58.38	50.09
		SD	16.93	21.60	14.92	17.27	16.35
		n	77	9	68	34	32
32c.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	48.72	44.89	49.24	48.44	50.09
		SD	16.52	27.77	14.61	12.97	16.35
		n	75	9	66	34	32
32c.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	54.13	46.78	55.12	55.48	54.72
		SD	16.01	22.66	14.86	13.98	15.99
		n	76	9	67	35	32
32c.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	55.49	49.89	56.26	53.73	59.94
		SD	15.95	21.97	15.01	14.59	15.64
		n	75	9	66	34	32
32c.	Pleasant and Natural Combined Rating	M	68.07	61.39	69.60	67.69	71.67
		SD	17.14	23.84	16.12	17.00	15.08
		n	82	9	66	38	35

Question 32 d. Brass (e.g. Trumpet, Trombone)			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32d.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	64.19	59.50	64.83	63.28	66.62
		SD	19.29	28.30	17.90	19.11	16.52
		n	83	10	73	39	34
32d.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	65.55	63.90	65.81	65.51	66.12
		SD	15.71	19.04	15.31	16.33	14.35
		n	77	10	67	35	32
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32d.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	54.05	48.70	54.81	53.91	55.76
		SD	12.01	12.14	11.89	10.81	13.03
		n	80	10	70	36	34
32d.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	55.47	48.20	56.51	56.91	56.06
		SD	14.93	18.85	14.16	13.85	14.68
		n	80	10	70	36	34
32d.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	49.23	43.30	50.08	49.77	50.41
		SD	17.07	27.39	15.16	14.13	16.39
		n	80	10	70	36	34
32d.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	51.84	43.90	53.03	52.80	53.29
		SD	16359	24.41	14.99	16.74	12.93
		n	77	10	67	36	31
32d.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	52.92	45.30	54.04	53.27	54.90
		SD	14.02	23.33	11.95	10.71	13.33
		n	78	10	68	36	32
32d.	Pleasant and Natural Combined Rating	M	64.51	61.70	64.89	64.19	65.67
		SD	16.38	22.43	15.55	16.01	15.10
		n	84	10	74	39	35

Question 32 e. Drum Kit			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32e.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	52.12	50.17	52.44	51.46	53.54
		SD	21.08	25.93	20.38	19.85	21.19
		n	86	12	74	39	35
32e.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	58.83	60.92	58.45	57.75	59.34
		SD	17.84	16.36	18.19	19.05	17.31
		n	78	12	66	37	29
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32e.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	54.06	46	55.48	55.38	55.59
		SD	15.97	19.73	14.94	1606	13.83
		n	80	12	68	36	32
32e.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	52.62	42.75	54.37	53.10	55.87
		SD	17.69	19.73	17.04	16.80	17.46
		n	80	12	68	37	31
32e.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	43.54	34.67	44.90	39.84	50.40
		SD	21.43	27.96	20.04	17.43	21.45
		n	85	12	73	38	35
32e.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	48.93	42	50.18	49.47	51.00
		SD	14.28	10.99	14.51	13.95	15.32
		n	79	12	67	36	31
32e.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	47.23	29.83	50.39	47.94	53.52
		SD	15.41	20.74	11.94	9.386	14.14
		n	78	12	66	37	29
32e.	Pleasant and Natural Combined Rating	M	56.04	53.46	56.49	55.89	57.17
		SD	14.49	15.00	14.47	15.78	13.01
		n	83	12	71	38	33

Question 32 f. Guitar			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32f.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	69.02	66	69.48	68.92	70.11
		SD	16.95	19.61	16.70	18.79	14.19
		n	91	12	79	42	37
32f.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	68.41	6..67	69.19	69.71	68.63
		SD	15.56	19.61	14.81	16.34	13.17
		n	85	12	73	38	35
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32f.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	51.63	43.42	52.95	51.85	54.20
		SD	14.21	13.79	13.92	14.57	13.24
		n	87	12	75	40	35
32f.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	55.11	45.83	56.64	55.63	57.74
		SD	15.56	22.06	13.83	12.90	14.89
		n	85	12	73	38	35
32f.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	50.57	58.50	49.25	47.52	51.18
		SD	14.41	20.48	12.86	11.06	14.54
		n	84	12	72	38	34
32f.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	50.20	40.17	51.93	52.43	51.36
		SD	1.31	15.48	14.71	14.42	15.24
		n	82	12	70	37	33
32f.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	53.21	49.50	5..87	52.62	55.35
		SD	13.74	17.04	13.12	11.88	14.51
		n	80	12	68	37	31
32f.	Pleasant and Natural Combined Rating	M	68.59	64.83	69. 16	69.07	69.25
		SD	15.05	18.88	80	16.24	12.41
		n	92	12		42	38

Question 32 g. Male Singer			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32g.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	70.61	67.83	70.99	70.51	71.22
		SD	15.71	20.12	15.15	13.53	16.87
		n	101	12	89	47	42
32g.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	71.19	73.08	70.93	69.71	72.30
		SD	13.72	18.88	12.97	12.11	13.89
		n	97	12	85	45	40
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32g.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	55.13	49.08	55.97	55.73	56.24
		SD	13.97	18.63	13.11	12.06	14.32
		n	98	12	86	45	41
32g.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	53.40	45.67	54.52	54.14	54.92
		SD	15.61	21.76	14.35	12.97	15.85
		n	95	12	83	43	40
32g.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	52.26	56.92	51.59	50.67	52.57
		SD	14.11	18.72	13.33	11.62	15.04
		n	95	12	83	43	40
32g.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	54.39	49.33	55.15	53.19	57.31
		SD	13.21	16.19	13.02	12.21	13.69
		n	92	12	80	42	38
32g.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	53.39	48.33	54.15	53.90	4.43
		SD	13.21	19.92	11.89	11.07	12.91
		n	92	12	80	43	37
33g.	Pleasant and Natural Combined Rating	M	70.50	70.46	70.50	69.66	71.42
		SD	14.56	18.92	14.03	12.20	15.87
		n	104	12	92	48	44

Question 32 h. Female Singer			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
32h.	Pleasantness (0=Very Pleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant	M	65.96	57.75	67.07	66.61	67.62
		SD	16.33	27.88	13.98	14.45	16.71
		n	101	12	89	49	40
32h.	Naturalness (0=Very Unnatural, 25=Unnatural, 50=Neutral, 75= Natural, 100=Very Natural.	M	65.02	59.42	66.05	65.52	66.66
		SD	17.38	23.16	16.39	15.79	17.25
		n	94	12	82	44	38
	How does this instrument sound compared to how you expect it to sound to a person with normal hearing?						
32h.	Full (0=Emptier, 50=Neutral, 100=Fuller)	M	65.20	42.25	53.51	52.36	54.97
		SD	17.38	18.64	12.51	11.37	13.85
		n	94	12	84	47	37
32h.	Sharp (0=Duller, 50= Neutral, 100=Sharper)	M	57.32	55	57.66	57.48	57.87
		SD	16.31	21.87	15.49	14.42	16.87
		n	95	12	83	45	38
32h.	Noisy (0=More Noisy, 50=Neutral, 100=Less Noisy)	M	51.13	58.17	50.12	47.82	52.84
		SD	15.28	21.15	14.12	11.82	16.18
		n	95	12	83	45	38
32h.	Rich (0=Tinnier, 50=Neutral, 100=Richer)	M	52.50	40.75	54.25	52.72	56.05
		SD	15.40	22.31	13.43	11.44	15.44
		n	93	12	81	44	37
32h.	Smooth (0=Rougher, 50= Neutral, 100=Smoother)	M	53.66	47.83	54.54	53.59	55.74
		SD	13.24	16.65	12.14	9.72	14.69
		n	91	12	79	44	35
33h.	Pleasant and Natural Combined Rating	M	65.67	58.58	66.62	66.40	66.88
		SD	15.86	24.93	14.18	12.01	16.56
		n	102	12	90	49	41

A one sample t-test was performed on ratings for sound quality. The table below shows the significant values for the overall population

Question	**Instrument**	**p-value**	**Instrument significantly different than expected (test value=50)**
32A Sharp	Piano	p=0.001, (M= 56.69, SD = 20.18, n=98)	Piano Significantly sharper
32A Smooth	Piano	p=0.002, (M= 55.17, SD = 16.01, n=93)	Piano Significantly smoother
32BFuller	Strings	p=0.017, (M= 54.79, SD = 18.35 20.18, n=87)	Strings Significantly fuller
32BSharper	Strings	p=0.002, (M= 56.70, SD = 19.75, n=86)	Strings Significantly sharper
32BSmooth	Strings	p=0.001, (M= 55.36, SD = 14.77, n= 85)	Strings Significantly smoother
32CFull	Woodwind	p=0.012, (M= 54.19, SD = 14.34, n= 77)	Woodwind significantly fuller
32CSharp	woodwind	p=0.021, (M= 54.56, SD = 16.96, n= 77)	Woodwind Significantly sharper
32C Rich	Woodwind	p=0.027, (M= 54.13, SD = 16.02, n= 76)	Woodwind significantly richer
32CSmooth	Woodwind	p=0.004, (M= 55.49, SD = 15.95, n= 75)	Woodwind significant smoother
32DFull	Brass	p=0.003 (M= 54.05, SD = 12.02, n= 80)	Brass significantly fuller
32DSharp	Brass	p=0.002 (M=55.47, SD = 14.93, n=80)	Brass significantly sharper
32EFull	Drum Kit	p= 0.026 (M=54.06= , SD =15.98, n= 80)	Drum kit significantly fuller than expected
32ENoisy	Drum Kit	p= 0.006 M= 43.46, SD =12.44, n= 85)	Drum kit significantly more noisy than expected
32FSharp	Guitar	p= 0.003 (M= 55.12, SD = 15.56, n= 85)	Guitar significantly sharper than expected
32FSmooth	Guitar	p= 0.040 (M= 53.21, SD =13.74, n= 80)	Guitar significantly smoother than expected
32GFull	Male singer	p= 0.040 (M=55.13 SD=13.97, n=98)	Male singer significantly fuller than expected
32GSharp	Male singer	p= 0.036 (M=53.40, SD=15.61, n = 95	Male singer significantly more sharper than expected
32GRich	Male singer	p= 0.002 (M=54.39, SD=16.52, n=92)	Male singer significantly richer than expected
32GSmooth	Male singer	p= 0.016 (M=53.39, SD=13.21, n=92)	Male singer significantly smoother
32HSharp	Female Singer	p<0.001 (M=57.32, SD=16.31, n=95)	Female Singer significantly more sharper than expected
32HSmooth	Female Singer	p= 0.010 (M= 53.66, SD=13.25, n=91)	Female Singer significantly smoother than expected

Section 3: Musical Styles

Question – a. Classical Orchestra			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
33a	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant)	M	71.05	54.12	72.75	73.8605	71.46
		SD	21.16	23.51	20.30	21.17004	19.46
		n	88	8	80	43	37
33a	Simple (0=Simple, 100=Complex)	M	68.63	63.50	69.26	69.2778	69.23
		SD	19.27	17.83	19.47	19.06172	20.28
		n	74	8	66	36	30
33a	Melody Line (0=Can never follow a melody line, 100=Can always follow a melody line)	M	70.83	53.75	72.65	72.3158	73.00
		SD	21.87	28.74	20.42	19.43820	21.65
		n	83	8	75	38	37
33a	Identify style (0=Can never identify style, 100=can always identify listening style)	M	71.63	47.62	74.16	74.0513	74.27
		SD	22.57	29.87	20.31	20.69700	20.18
		n	84	8	76	39	37
33a	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	71.31	46.25	73.92	72.3250	75.65
		SD	22.63	31.56	20.03	20.47686	19.67
		n	85	8	77	40	37
33a	Average of all scales expect simple complex	M	70.50	50.44	72.48	71.28	73.83
		SD	20.74	25.92	17.67	20.67	17.67
		n	89	8	81	43	38

Question – b. Classical –small group (e.g. 2 to 5 instruments)			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
33b	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant)	M	72.02	59.87	73.45	74.3514	72.39
		SD	20.30	20.92	19.93	21.57701	18.05
		n	76	8	68	37	31
33b	Simple (0=Simple, 100=Complex)	M	69.00	62.50	69.85	70.9118	68.52
		SD	19.68	25.82	18.84	18.71212	19.27
		n	69	8	61	34	27
33b	Melody Line (0=Can never follow a melody line, 100=Can always follow a melody line)	M	73.45	57.28	75.20	73.9143	76.70
		SD	21.45	21.57	20.86	21.47005	20.38
		n	72	7	65	35	30
33b	Identify style (0=Can never identify style, 100=can always identify listening	M	72.30	51.75	74.92	74.3235	75.62
		SD	21.72	22.57	20.35	19.31983	21.81

	style)	n	71	8	63	34	29
33b	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	71.67	48.57	74.20	72.9118	75.67
		SD	20.19	17.28	18.94	19.48483	18.53
		n	71	7	64	34	30
	Average of all scales expect simple complex	M	71.81	54.66	73.80	72.34	75.45
		SD	20.05	17.39	19.48	20.83	17.98
		n	77	8	69	37	32

Question – c. Classical - choir			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
33c	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant)	M	71.17	58	72.64	71.1389	74.14
		SD	20.12	19.76	19.76	21.86341	17.5
		n	80	8	72	36	36
33c	Simple (0=Simple, 100=Complex)	M	66.24	51.50	68.14	66.3667	69.81
		SD	22.28	21.08	21.79	18.59085	24.60
		n	70	8	62	30	32
33c	Melody Line (0=Can never follow a melody line, 100=Can always follow a melody line)	M	68.34	49.12	70.54	69.3529	71.67
		SD	23.11	28.04	21.64	20.73919	22.70
		n	78	8	70	34	36
33c	Identify style (0=Can never identify style, 100=can always identify listening style)	M	71.46	50	73.96	73.6667	74.22
		SD	21.62	24.48	20.01	16.18384	23.20
		n	77	8	69	33	36
33c	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	71.76	43.37	74.92	70.9118	78.50
		SD	21.12	21.45	18.72	18.22148	11.66
		n	80	8	72	34	38
	Average of all scales expect simple complex	M	70.26	50.12	72.44	69.75	74.99
		SD	20.43	20.70	19.09	19.74	18.34
		n	82	8	74	36	38

Question – d. Pop/Rock			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
33d	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant)	M	62.34	66.00	61.66	64.32	58.04
		SD	21.05	20.10	21.32	21.52	20.92
		n	70	11	59	34	25
33d	Simple (0=Simple, 100=Complex)	M	18.92	59.27	59.96	61.71	57.61
		SD	59.84	20.31	18.83	19.09	18.63
		n	65	11	54	31	23
33d	Melody Line	M	61.87	61.36	61.97	66.33	56.42

	(0=Can never follow a melody line, 100=Can always follow a melody line)	SD	28.10	26.58	28.59	26.98	30.14
		n	70	11	59	33	26
33d	Identify style (0=Can never identify style, 100=can always identify listening style)	M	65.10	63.27	65.46	71.37	57.88
		SD	25.34	24.51	25.70	22.56	27.88
		n	68	11	57	32	25
33d	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	65.48	60.45	66.53	69.21	63.29
		SD	22.1	22.15	22.27	22.05	22.58
		n	64	11	53	29	24
	Average of all scales expect simple complex	M	63.98	62.77	64.21	67.19	60.30
		SD	22.633	21.23	23.04	22.44	23.67
		n	71	11	60	34	26

Question – e. Country & Western			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
33e	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant)	M	72.78	67.62	73.41	73.38	73.45
		SD	15.87	24.43	14.64	15.13	14.34
		n	73	8	65	34	31
33e	Simple (0=Simple, 100=Complex)	M	56.52	48.87	57.60	55.07	60.41
		SD	22.09	29.20	20.02	20.92	21.16
		n	65	8	57	30	27
33e	Melody Line (0=Can never follow a melody line, 100=Can always follow a melody line)	M	75.60	66.25	76.79	77.94	75.53
		SD	19.45	27.17	18.20	15.16	21.25
		n	71	8	63	33	30
33e	Identify style (0=Can never identify style, 100=can always identify listening style)	M	74.43	69.86	74.95	72.37	77.70
		SD	17.58	25.04	16.74	16.12	17.23
		n	69	7	62	32	30
33e	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	74.11	64.87	75.26	72.76	77.93
		SD	17.76	25.94	16.39	16.40	16.21
		n	72	8	64	33	31
	Average of all scales expect simple complex	M	74.69	66.62	75.66	74.97	76.40
		SD	14.52	24.39	12.82	11.97	13.85
		n	75	8	67	35	32
Question – f. Jazz			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate +**
33f	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very	M	67.73	34.37	71.91	71.03	73.03
		SD	22.10	21.51	18.45	20.60	15.54

	Pleasant)	n	72	8	64	36	28
33f	Simple (0=Simple, 100=Complex)	M	69.32	59.37	70.72	69.50	72.28
		SD	21.20	28.62	19.88	22.31	16.56
		n	65	8	57	32	25
33f	Melody Line (0=Can never follow a melody line, 100=Can always follow a melody line)	M	67.25	41.12	70.63	69.88	71.59
		SD	23.57	29.86	20.61	21.18	20.21
		n	70	8	62	35	27
33f	Identify style (0=Can never identify style, 100=can always identify listening style)	M	69.81	51.75	72.18	72.20	72.15
		SD	21.95	29.12	19.95	21.34	18.32
		n	69	8	61	35	26
33f	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	71.14	45.75	74.42	73.20	76.00
		SD	20.33	27.24	19.93	17.69	16.09
		n	70	8	62	35	27
	Average of all scales expect simple complex	M	68.86	43.25	71.97	70.64	73.65
		SD	20.27	25.78	17.31	19.05	14.95
		n	74	8	66	37	29

Question – g. Other			**Overall**	**HA-CI**	**HA-NCI**		
				Overall	**Overall**	**Mild**	**Moderate+**
33g	Pleasant (0=Very Unpleasant, 25=Unpleasant, 50=Neutral, 75=Pleasant, 100=Very Pleasant)	M	71.03	60.40	73.16	76.67	71.19
		SD	22.56	35.30	17.48	22.52	18.03
		n	30	5	25	9	16
33g	Simple (0=Simple, 100=Complex)	M	60.51	49.60	63.00	58.00	65.86
		SD	28.74	38.90	26.46	33.62	22.32
		n	27	5	22	8	14
33g	Melody Line (0=Can never follow a melody line, 100=Can always follow a melody line)	M	73.00	57.60	76.08	72.4	78.12
		SD	22.11	36.18	17.70	21.95	15.22
		n	30	5	25	9	16
33g	Identify style (0=Can never identify style, 100=can always identify listening style)	M	76.43	56.80	80.36	84.55	78.00
		SD	21.59	36.05	15.83	17.07	15.13
		n	30	5	25	9	16
33g	Expect (0=sounds nothing like I would expect it to, 100= Sounds exactly as I would expect it too)	M	75.13	75.00	75.16	81.50	72.18
		SD	20.10	18.14	20.82	17.22	22.16
		n	30	5	25	8	17
	Average of all scales expect simple complex	M	74.61	62.45	76.86	78.50	75.90
		SD	19.88	30.51	17.15	20.67	15.33
		n	32	5	27	10	17

Question			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
34	If it was possible, would you like music to sound (with the HAs) like you think it would sound to a normally hearing person?			%		%		%		%		%
		Yes	99	97.1	11	100	88	96.7	46	95.8	42	97.7
		No	3	2.9	0	0	3	3.3	2	4.2	1	2.0
		n		102		11		91		48		43

<u>**Section 4: Musical Preferences**</u>

Question 35			Overall		HA-CI	HA-NCI		
					Overall	Overall	Mild	Moderate +
35	Rank instruments from 1 to 8, where '1' Ms the instrument/ instrumental family/singer sounds *most* natural to you and '8' Ms this instrument/instrumental family/singer sounds least natural to you.		Median	Mode	Median	Median	Median	Median
		Piano	2	1	2.5	2	2	2
		Strings (e.g. violin, cello)	3	1	4	3	3	3
		Woodwind (e.g. flute, clarinet, oboe)	4	1	5	3	3	3
		Brass (e.g. trumpet)	4	1	2.5	4	4	4
		Drum kit	6	8	3.5	6	6	6
		Guitar	3	1	3	4	4	3
		Female Singer	3	2	4.5	3	3	3
		Male Singer	2	1	2	2	2	2
		n		84	12	72	39	33

Note: Included respondents that ranked ALL types of instruments and performers, only. A Friedman test on ranks $\chi^2(7, N = 84) = 89.37$, $p < 0.001$.

Question 36			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
				%		%		%		%		%
	Which do you most prefer (choose one response)	Male Singer	36	35.0	9	69.2	27	30.0	13	27.7	14	32.6
36a		Female Singer	10	9.7	1	7.7	9	10.0	4	8.5	5	11.6
		No preference	57	55.3	3	23.1	54	60.0	30	63.8	24	55.8
		n	103		13		90		47		43	
	Binomial test (Male vs. Female singer)				p = 0.021*		p = 0.004**		p = 0.049*		p = .064	
	Which do you most prefer (choose one response)	Low pitched instrument	49	47.6	9	69.2	40	44.4	21	44.7	19	44.2
36b		High-pitched instrument	6	5.8	0	0	6	6.7	3	6.4	3	7.0
		No preference	48	46.6	4	30.8	44	48.9	23	48.9	21	48.8
		n	103		13		90		47		43	
	Binomial Test (Low-pitched vs. High Pitched)				p = 0.004**		p < 0.001**		p < 0.001**		p = 0.001**	
	Which do you most prefer (choose one response)	Instrumental- only Music	25	24.0	3	23.1	22	24.2	13	26.5	9	21.4
36c		Voice Only music	3	2.9	0	0	3	3.3	0	0	3	7.1
		Voice with instrument	37	35.6	8	61.5	29	31.9	16	32.7	13	31.0
		No preference	39	35.1	2	15.4	37	40.7	20	40.8	17	40.5
		n	104		13		91		49		42	
			χ²(2, *N* =65) =27.446, p < 0.001*		χ²(1, *N* =11) =2.273, p = 0.132		χ²(2, *N* =54) =20.111, p < 0.001**		χ²(1, *N* =29) =0.310, p = 0.577		χ²(2, *N* =25) =6.080, p = 0.048*	

Question 37			Overall		HA-CI	HA-NCI		
					Overall	Overall	Mild	Moderate+
37	Rank the following from 1 to 5, where: 1=most preferred; 5=least preferred. (Please use each number once only).		Median	Mode	Median	Median	Median	Median
		One performer (instrument or singer)	2	1	1	3	3	3
		Two performers (instruments and/or singers)	3	4	2	4	3.5	4
		Three performers (instruments or singers)	3	3	3	3	3	4
		Small group of performers (e.g. 4 to 5)	3	2	4	2	2.5	2
		Larger group of performers (e.g. an orchestra, choir or band)	2	1	5	2	2	2
		n		73	10	63	36	27

Note: Included respondents that ranked ALL types of performers, only.

Section 5: Music Recognition

Question			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
				%		%		%		%		%
38	With your HAs are there any tunes that you can always recognise?	Yes	94	90.4	11	84.6	83	91.2	42	89.4	41	93.2
		No	10	9.6	2	15.4	8	8.8	5	10.6	3	6.8
		n	104		13		91		47		44	
39	Are there some tunes that you cannot recognise but would like to be able to recognise?	Yes	12	11.7	6	69.2	6	6.7	3	6.7	3	6.7
		No	91	88.3	8	30.8	84	93.3	42	93.3	42	93.3
		n	103		13		90		45		45	
40	Are there any instruments that you can always recognise, by listening alone?	Yes	86	82.7	9	69.2	77	84.6	40	87.0	37	82.2
		No	18	17.3	4	30.8	14	15.4	6	13.0	8	17.8
		n	104		13		91		46		45	
41	Are there instruments that you cannot recognise by listening -alone but would like to be able to recognise?	Yes	13	11.7	3	23.1	10	11.6	7	16.7	3	6.8
		No	86	77.5	10	76.9	76	88.4	5	83.3	41	93.2
		n	99		13		98		42		44	

Section 6: Factors affecting Music listening enjoyment

Q42. OVERALL										
Listening environment and Equipment		**More Enjoyable**		**Less Enjoyable**		**No difference**		**Don't know/ haven't tried**		**n**
			%		**%**		**%**		**%**	
A	High quality speakers	77	74.8	1	1.0	9	8.7	16	15.5	103
B	High quality headphones	42	41.6	6	5.9	13	12.9	40	39.6	101
C	High quality recordings	77	74.8	1	1.0	15	14.6	10	9.7	103
G	Quiet environment	97	92.4	1	1.0	5	4.8	2	1.9	105
H	Echoey (reverberant) room	1	1.0	83	84.7	5	5.1	9	9.2	98
I	Live concert indoors	42	41.6	25	24.8	27	26.7	7	6.9	101
J	Live concert outdoors	24	24.0	29	29.0	30	30.0	17	17.0	100
K	Sitting at the front of the hall/theatre	30	30.3	30	30.3	21	31.2	18	18.2	99
L	Using a special music programme on your HAs	14	14.6	0	0.0	14	14.6	68	70.8	96
M	Direct Audio Input	8	8.3	3	3.1	7	7.3	78	81.3	96
Listening Experience										
N	Increased length of time with HAs	28	29.5	3	3.2	40	42.1	24	25.3	95
O	Practice listening to music	24	25.3	4	4.2	41	43.2	26	27.4	95
P	Familiar lyrics and words	82	82.8	0	0	15	15.2	2	2.0	99
Q	Familiar tunes	57	85.3	1	1.0	13	12.7	1	1.0	102
R	Knowing the song title	60	60.0	3	3.0	35	35.0	2	2.0	100
S	Knowing the context	57	56.4	4	4.0	37	36.6	3	3.0	101
T	Having the musical score or words to follow along with	45	45.0	4	4.0	34	34.0	17	17.0	100
U	Watching the performers	64	64.6	3	3.0	28	28.3	4	4.0	99
Features of Music										
D	Soft volume	23	24.0	48	50.0	24	25.0	1	1.0	96
E	Medium volume	70	69.3	6	5.9	23	22.8	2	2.0	101
F	Loud volume	20	21.5	59	63.4	10	10.8	4	4.3	93
V	Slow rhythm or beat	34	34.3	4	4.0	58	58.6	3	3.0	99
W	Fast rhythm or beat	18	18.2	24	24.2	56	56.6	1	1.0	99
X	Tune with no harmony	10	10.1	51	51.5	35	35.4	3	3.0	99
Y	Tune with harmony	67	64.4	4	3.8	31	29.8	2	1.9	104
Z	With words	40	40.4	9	9.1	149	49.5	1	1.0	99
AA	Without words	26	26.8	10	10.3	59	60.8	2	2.1	97

Q42 HA-CI										
Listening environment and Equipment		**More Enjoyable**		**Less Enjoyable**		**No difference**		**Don't know/ haven't tried**		**n**
			%		**%**		**%**		**%**	
A	High quality speakers	9	69.2	0	0	3	23.1	1	7.7	13
B	High quality headphones	4	30.8	2	15.4	2	15.4	5	38.5	13
C	High quality recordings	8	61.5	0	0	5	38.5	0	0	13
G	Quiet environment	11	84.6	0	0	1	7.7	1	7.7	13
H	Echoey (reverberant) room	9	75.0	0	0	1	8.3	2	16.7	12
I	Live concert indoors	3	25	3	41.7	4	33.3	0	0	12
J	Live concert outdoors	3	23.1	7	53.8	3	23.1	0	0	13
K	Sitting at the front of the hall/theatre	5	38.5	4	30.8	2	15.4	2	15.4	13
L	Using a special music programme on your HAs	1	7.7	0	0	1	7.7	11	84.6	13
M	Direct Audio Input	1	7.7	2	15.4	0	0	10	76.9	13
Listening Experience										
N	Increased length of time with HAs	4	30.8	1	7.7	7	53.8	1	7.7	13
O	Practice listening to music	3	23.1	0	0	7	53.8	3	23.1	13
P	Familiar lyrics and words	10	76.9	0	0	3	23.1	0	0	13
Q	Familiar tunes	11	84.6	0	0	3	23.1	0	0	13
R	Knowing the song title	9	69.2	1	7.7	3	23.1	0	0	13
S	Knowing the context	8	61.5	1	7.7	3	23.1	1	7.7	13
T	Having the musical score or words to follow along with	7	53.8	0	0	4	30.8	2	15.4	13
U	Watching the performers	8	61.5	1	7.7	4	30.8	0	0	13
Features of Music										
D	Soft volume	0	0	11	84.6	2	15.4	0	0	13
E	Medium volume	8	61.5	2	14.4	3	23.1	0	0	13
F	Loud volume	5	38.5	7	53.8	1	7.7	0	0	13
V	Slow rhythm or beat	7	53.8	0	0	6	46.2	0	0	13
W	Fast rhythm or beat	0	0	8	61.5	5	38.5	0	0	13
X	Tune with no harmony	3	23.1	4	30.8	6	46.2	0	0	13
Y	Tune with harmony	5	38.5	3	23.1	5	38.5	0	0	13
Z	With words	4	30.8	1	7.7	8	61.5	0	0	13
AA	Without words	3	23.1	1	7.7	9	69.2	0	0	13

Q42 HA-NCI (overall)										
Listening environment and Equipment		**More Enjoyable**		**Less Enjoyable**		**No difference**		**Don't know/ haven't tried**		**n**
			%		**%**		**%**		**%**	
A	High quality speakers	68	75.6	1	1.1	6	6.7	15	16.7	90
B	High quality headphones	38	43.2	4	4.5	11	12.5	35	39.8	88
C	High quality recordings	69	76.7	1	1.1	10	11.1	10	11.1	90
G	Quiet environment	86	93.5	1	1.1	4	4.3	1	1.1	92
H	Echoey (reverberant) room	1	1.2	74	86	4	4.7	7	8.1	86
I	Live concert indoors	39	43.8	20	22.5	23	25.8	7	7.9	89
J	Live concert outdoors	21	24.1	22	25.3	27	31	17	19.5	87
K	Sitting at the front of the hall/theatre	25	29.1	26	30.2	19	22.1	16	18.6	86
L	Using a special music programme on your HAs	13	15.7	0	0	13	15.7	57	68.7	83
M	Direct Audio Input	7	8.4	1	1.2	7	8.4	68	81.9	83
Listening Experience										
N	Increased length of time with HAs	24	29.3	2	2.4	33	40.2	23	28	82
O	Practice listening to music	21	25.6	4	4.9	34	41.5	23	28	82
P	Familiar lyrics and words	72	83.7	0	0	12	14	2	2.3	86
Q	Familiar tunes	76	85.4	1	1.1	11	12.4	1	1.1	89
R	Knowing the song title	51	58.6	2	2.3	32	36.8	2	2.3	87
S	Knowing the context	49	55.7	3	3.4	34	38.6	2	2.3	88
T	Having the musical score or words to follow along with	38	43.7	4	4.6	30	34.5	15	17.2	87
U	Watching the performers	56	65.1	2	2.3	24	27.9	4	4.7	86
Features of Music										
D	Soft volume	23	27.7	37	44.6	22	26.5	1	1.2	83
E	Medium volume	62	70.5	4	4.5	20	22.7	2	2.3	88
F	Loud volume	15	18.8	52	65	9	11.3	4	5	80
V	Slow rhythm or beat	27	31.4	4	4.7	52	60.5	3	3.5	86
W	Fast rhythm or beat	18	20.9	16	18.6	51	59.3	1	1.2	86
X	Tune with no harmony	7	8.1	47	54.7	29	33.7	3	3.5	86
Y	Tune with harmony	62	68.1	1	1.1	26	28.6	2	2.2	91
Z	With words	36	41.9	8	9.3	41	47.7	1	1.2	86
AA	Without words	23	27.4	9	10.7	50	59.5	2	2.4	84

Q42. HA-NCI Subgroup: Mild										
Listening environment and Equipment		**More Enjoyable**		**Less Enjoyable**		**No difference**		**Don't know/ haven't tried**		**n**
			%		**%**		**%**		**%**	
A	High quality speakers	39	84.8	0	0.0	2	4.3	5	10.9	46
B	High quality headphones	23	48.9	1	2.1	65	10.6	18	38.3	47
C	High quality recordings	37	78.7	0	0	6	12.8	4	8.5	47
G	Quiet environment	46	93.9	21	2.0	2	4.1	0	0	49
H	Echoey (reverberant) room	1	2.2	37	82.2	2	4.4	5	11.1	45
I	Live concert indoors	19	40.4	11	23.4	14	29.8	3	6.4	47
J	Live concert outdoors	12	25.5	9	19.1	16	34.0	10	21.3	47
K	Sitting at the front of the hall/theatre	13	28.3	11	23.9	11	23.9	11	23.9	46
L	Using a special music programme on your HAs	8	17.4	0	0.0	6	13.0	32	69.6	46
M	Direct Audio Input	3	6.5	1	22	3	6.5	39	84.8	46
Listening Experience										
N	Increased length of time with HAs	15	31.9	1	2.1	21	44.7	10	21.3	47
O	Practice listening to music	10	22.7	3	6.8	19	43.2	12	27.3	44
P	Familiar lyrics and words	39	83.0	0	0.0	7	14.9	1	2.1	47
Q	Familiar tunes	40	85.1	0	0.0	7	13.7	0	0.0	47
R	Knowing the song title	26	56.5	0	0.0	19	41.3	1	2.2	46
S	Knowing the context	28	59.6	2	43	17	36.2	0	0.0	47
T	Having the musical score or words to follow along with	22	46.8	3	6.4	14	29.8	8	17.0	47
U	Watching the performers	34	73.9	0	0.0	10	21.7	2	4.3	46
Features of Music										
D	Soft volume	15	31.3	17	35.4	16	33.3	0	0.0	48
E	Medium volume	33	71.7	1	2.2	12	26.1	0	0.0	46
F	Loud volume	8	17.8	28	62.2	8	17.8	1	2.2	45
V	Slow rhythm or beat	14	29.8	3	6.4	28	59.6	2	4.3	47
W	Fast rhythm or beat	14	29.8	7	14.9	26	55.3	0	0.0	47
X	Tune with no harmony	5	10.6	23	48.9	19	40.4	0	0.0	47
Y	Tune with harmony	32	65.3	0	0.0	17	34.7	0	0.0	49
Z	With words	17	36.2	2	43	28	59.6	0	0.0	47
AA	Without words	9	19.6	5	10.9	31	67.4	1	2.2	46

Q42. HA-NCI Subgroup: Moderate+										
Listening environment and Equipment		**More Enjoyable**		**Less Enjoyable**		**No difference**		**Don't know/ haven't tried**		**n**
			%		**%**		**%**		**%**	
A	High quality speakers	29	65.9	1	2.3	4	9.1	10	22.7	44
B	High quality headphones	15	36.6	3	7.3	6	14.6	17	41.5	41
C	High quality recordings	32	74.4	1	2.3	4	9.3	6	14	43
G	Quiet environment	40	93	0	0	2	4.7	1	2.3	43
H	Echoey (reverberant) room	0	0	37	90.2	2	4.9	2	4.9	41
I	Live concert indoors	20	47.6	9	21.4	9	21.4	4	8.5	42
J	Live concert outdoors	9	22.5	13	32.5	11	27.5	7	17.5	40
K	Sitting at the front of the hall/theatre	12	30	15	37.5	8	20	5	12.5	40
L	Using a special music programme on your HAs	5	13.5	0	0	7	18.9	25	67.6	37
M	Direct Audio Input	4	10.8	0	0	4	10.8	29	78.4	37
Listening Experience										
N	Increased length of time with HAs	9	25.7	1	2.9	12	34.3	13	37.1	35
O	Practice listening to music	11	28.9	1	2.6	15	39.5	11	28.9	38
P	Familiar lyrics and words	33	84.6	0	0	5	12.8	1	2.6	39
Q	Familiar tunes	36	85.7	1	2.4	4	9.5	1	2.4	42
R	Knowing the song title	25	60	2	4.9	13	31.7	1	2.4	41
S	Knowing the context	21	51.2	1	2.4	17	41.5	2	4.9	41
T	Having the musical score or words to follow along with	16	40	1	2.5	16	40	7	17.5	40
U	Watching the performers	22	55	2	5	14	65	2	5	40
Features of Music										
D	Soft volume	8	22.9	20	57.1	6	17.1	1	2.9	35
E	Medium volume	29	69	3	7.1	8	19	2	4.8	42
F	Loud volume	7	20	24	68.6	1	2.9	3	8.6	35
V	Slow rhythm or beat	13	33.3	1	2.6	24	61.5	1	2.6	39
W	Fast rhythm or beat	4	10.3	9	23.1	25	64.1	1	2.6	39
X	Tune with no harmony	2	5.1	24	61.5	10	25.6	3	7.7	39
Y	Tune with harmony	30	71.4	1	2.4	9	21.4	2	4.8	42
Z	With words	19	48.7	6	15.4	13	33.3	1	2.6	39
AA	Without words	14	36.8	4	10.5	19	50	1	2.6	38

Section 7: Music Training Programme

Question			Overall		HA-CI Overall		HA-NCI Overall		Mild		Moderate+	
43	Do you think you would be interested in a Music Training Programme (MTP) aimed at improving your music appreciation and music listening experiences?			%		%		%		%		%
		Yes	29	28.7	8	61.5	21	23.6	11	22.9	10	24.4
		No	72	71.3	4	33.3	68	76.4	37	72.5	31	75.6
		n		101		12		89		48		41
	Binomial test revealed a significant difference ($p < 0.001$)**											

Question 44. Please order the following in terms of importance, from 1 (most important) to 9 (least important), to help with your music listening enjoyment. You may give equal rankings.	Overall		HA-CI Overall	HA-NCI Overall	Mild	Moderate+
	Median	Mode	Median	Median	Median	Median
Being able to recognise commonly-known musical instruments	2	1	3.5	2	4	1
Being able to recognise commonly-known tunes	1	1	2	1	1	1
Being able to recognise tunes that you know prior to having your HAs fitted	2	1	1	2	3	1.5
Being able to recognise musical styles	4	2	3.5	4	4	3
Learning new tunes	5	3	4	5	6	3
Being able to hear changes in pitch	3	1	3	4	4	2
Being able to hear more complex rhythms	4	1	5.5	4	5	3.5
Being able to hear or “pick out” the tune when it is presented with harmony (accompaniment)	3	1	3.5	3	5	2
n	71		10	61	29	32
Other (please specify)	9 (n=20)		8.5 (n=2)	9 (n=18)	9 (n=11)	9 (n=7)
Friedman on ranks $\chi^2(7, N = 71) = 82.155$, $p < 0.001$**						

Note: Included respondents that ranked ALL skills only, except ‘Other (please specify). ‘Other’ responses were recorded if filled in, specified responses are in the comments section (see appendix)

Question			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
45	Are there any instruments, instrumental families, musical styles, or songs that you would like to be able to hear better?			%		%		%		%		%
		Yes	15	16.9	6	50	9	11.7	3	7.7	6	15.8
		No	74	83.1	6	50	68	88.3	36	92.3	32	84.2
		n		89		12		77		39		40
	Binomial test revealed a significant difference (p < 0.001)**											
46	Would you like the MTP to focus on your preferred musical style OR introduce a wide range if musical styles?	Preferred style	19	30.2	4	36.4	15	28.8	9	34.6	6	23.1
		Wide range	44	69.8	7	63.6	37	71.2	17	65.4	20	76.9
		n		63		11		52		26		26
	Binomial test revealed a significant difference (p = 0.002)**											

Question			Overall	HA-CI	HA-NCI		
				Overall	Overall	Mild	Moderate+
47.	How long do you think each training session should last for? (mins)	M	32.59	33.18	32.45	33.26	31.66
		SD	14.24	18.48	13.31	12.12	14.57
		Range	5-60	10-60	5-60	15-60	5-60
		n	58	11	47	23	24
48.	How many times a week do you think the sessions should be? (times per week)	M	2.22	2.18	2.23	2.26	2.20
		SD	1.14	0.75	1.22	1.10	1.35
		Range	1-6	1-3	1-6	1-5	1-6
		n	59	11	48	23	25

Correlation Matrix for age, PTA scores of better hearing ear, length of time with hearing loss and preferred length and frequency of sessions for MTP

		Age	Best PTA	Length of time with hearing loss	Preferred length of session (mins) (Q47)	Preferred no. of times per week (Q48)
Age	r	1.000	.056	.001	.075	.046
	p	.	.562	.993	.433	.632
	n	111	111	111	110	111
Best PTA	r	.056	1.000	**.522(**)**	-.108	-.028
	p	.562	.	.000	.261	.770
	n	111	111	111	110	111
Length of time with HAs	r	.001	**.522(**)**	1.000	-.072	-.010
	p	.993	.000	.	.452	.921
	n	111	111	111	110	111
Preferred length of session (mins) (Q47)	r	.075	-.108	-.072	1.000	**.805(**)**
	p	.433	.261	.452	.	.000
	n	110	110	110	110	110
Preferred no. of times per week (Q48)	r	.046	-.028	-.010	**.805(**)**	1.000
	p	.632	.770	.921	.000	.
	n	111	111	111	110	111

** Correlation is significant at the 0.01 level (2-tailed).
r = correlation, p = p-value, n = number of participants responding

Question			Overall		HA-CI		HA-NCI					
					Overall		Overall		Mild		Moderate+	
				%		%		%		%		%
49	In what form would you like the MTP to come in? (Please tick one response)	CD	24	34.3	2	16.7	22	37.9	9	32.1	13	43.3
		MP3	6	8.6	1	8.3	5	8.6	2	7.1	3	10
		CD-ROM	9	12.9	2	16.7	7	12.1	5	17.9	2	6.7
		PDA	0	0.0	0	0	0	0.0	0	0.0	0	0.0
		DVD	30	42.9	7	58.3	23	39.7	11	39.3	12	40
		Other	1	1.4	0	0	1	1.7	1	3.6	0	0.0
		n	70		12		58		28		30	
50	Would you find a written manual with information and exercises, to accompany the MTP helpful			%		%		%		%		%
		Yes	62	76.5	9	75	53	76.8	25	75.8	28	78.8
		No	19	23.5	3	25	16	23.2	8	24.2	8	22.2
		n		81		12		69		33		36

Appendix 4
Summary of Results II

Participants' (ptpt) comments, as well as their answers to all the qualitative questions are presented below.

Q.8 – Type of Hearing Aid

Ptpt #	Comment
A006	Industrial loss
A008	GN Resound
A015	First one a Starkey
A016	GN Resound
A019	Inteo elan IN-9e Widex
A020	Oticon
A026	Oticon
A032	Oticon
A036	ITC
A102	Resound Metrix MX70-0
A104	Plus 5RP 70-DV
A107	Delta Oticon
A110	Dot 30
E003	Phonak Savia 211 dsZ - in both ears
E007	Siemens Centra Active
E008	Siemens Acuris Life BTE hearing system
E017	Widex
E018	Resound (new), Widex Diva (older)
E019	Phonak
E020	Oticon Delta with fitted molds in ears.
E030	Siemens
E041	Siemens
E042	Siemens
E052	Atlas Plus ITE Direct
E057	Oticon
E058	Resound Pixel mini PL 60 Thin tube
E059	Pulse Resound
E076	Phonak Micro Savia Art CRT
E074	Oticon brand - top model.
E079	Phonak
E086	Siemens Acuris
E093	Oticon
E093	Phonak
E097	Siemens Intuis Life
E106	Oticon Epoq
E107	Siemens Centra Active
E113	Oticon
E122	Resound
E131	Widex
B009	Widex Akia ITE
B016	Senso Vita Elan
B049	Unitron (behind the ear)
B065	Phonak
B067	Siemens Activa
B074	Senso Diva Elan
B084	Phonak Micro Savia

B096	Widex Elan
B097	Widex Inteo
E010	Pulse ReSound
E039	Oticon Adpato
E054	Siemens
E094	Phonak Eleva Micro 100DAZ
C039	Phonak Micro Savia
C067	Widex
C072	Phonak
C088	Widex Flash
C089	Oticon
C109	Phonak
C019	Phonak
C028	Siemens Cielo 2 Active
C032	Siemens BTE Rechargeable battery
E118	Resound Air
F007	Digital
A042	Widex Senso Vita
F007	Bernafone Smile +115 DM - both ears
F012	Widex Senso
F014	ITC made by Starkey
F002	Bernafon Xtreme 121
F005	Oticon Synchro
F013	Oticon

Q4. How long have you had HAs

Ptpt#	Comment
E049	23 years for left and 3 years right aid. Had left aid for 4 years.
F003	All of my life (with no aids) then with 2 aids from mid 2003 until end 2004 (age 60) I listened to and enjoyed music frequently. Since losing my hearing in my left ear totally in 20004, I only listen to music if I am in a situation where I 'have' to. I wouldn't choose to listen to voluntarily, because it sounds quite unpleasant.
F005	Trialled aid in left ear for CI assessment

Q.11i) Outcome of CI assessment

E003	Nov 2005- Audiogram showed severe hearing loss in high frequencies, and a little over the level at which a bone-anchored hearing aid would provide benefit. So I continued with the conventional HAs.
E032	Recently tested. Not ready yet. Hearing with aids is too good.
B049	In England in 1988 - I decided against it at the time.
F007	The specialist decided I was not impaired enough, and could still manage with Hi-powered BTE
A042	Having one next month - July 08. Ideal candidate as not born deaf and worked well with my brother!
F015	I am having an implant done 20/11/08 in the left cochlea.
F001	Awaiting implant next month (July 08)
F007	Unable to have then due to excellent sound differentiation - although on paper I qualified.
F012	On wait list - undergoing assessment
F014	Not deaf enough. New hearings aids help.
F002	Still pending - have appointment with Cochlear ear specialist on July 21st 2008.
F005	First stage assessment indicated that speech perception (an artificial test environment) was too good to warrant a CI at this time.
F013	Still waiting for boards decision

Q12 Does your HA have a music or a separate listening programme specifically set up for music?

Ptpt#	Comment
E019	It is available but I did not find it any different from other settings so I stopped using it.
A042	Telecoil – have to use T when listening to Ipod

Q.17-21 – Music Training: length of time, activity or instrument, level attained etc)

Ptpt#	Comment
A013	Q18 - Piano at age 13 Q19- ambiguous question- I am not taking lessons, if that what you mean Q20- recorders, piano, dance 21-Play piano to myself, regularly square dance
A015	Q20 - John Ritchies University Orchestra - 1950, violin. Chamber music NZ in Wellington 1990-1993 and helped with Westpac competitions in Wellington (more admin). Q21- Violin Grade 8. No theory so couldn't go further, aged about 12 onwards
A016	Q18- 4 years- piano. Q20- From 1954-19992 in Various choirs: Royal Christchurch Musical Society, Adelaide Philharmonic & Harmony Choir, Oxford Terrace Baptist Church Choir, Cathedral of the Blessed Sacrament Choir, Travelling Chorus NZ Opera Co. 1964-65. Q21- A an auditor and at Orchestral and chorale concerts.
A019	I learned piano from childhood & still play. I am a professional musician- organist, choir director and teacher of piano and organ. I also sing in choirs (have done for 40+ years). I was secondary school music teacher for approximately 20 years.
A032	I play piano without my HAs. The HA rings when I play piano - and that is obnoxious. I generally do not use my HAs when listening to music.
A038	Choir aged 10-14 years. Singing aged 18 years.
A102	Played clarinet since aged 14. played professionally in symphony orchestras and chamber music groups until aged 55 years.
A107	Violin 8-20 years old, Grade 8. Adult education Celtic music short course (2006). Participate in congregational singing at church. Sing alto part in church singing.
A108	Many years ago, primary school piano, choir.
A110	Piano - Grade 2 (3 years). Guitar - casual playing (10 years). Church singing (20 years).
E003	Q18. For about 3 years, I had piano lessons - purely for my own enjoyment - and these finished some time before use of HAs.
E020	Piano lessons for 2 years (10-12 years old). Barbershop chorus, play piano in hospice.
E029	Choral interests for 18 months. Joined 2 choirs. Basic use of keyboard.
E041	Piano Grade 8 1958. Music teacher in school 1965-1971 and intermittently since regular choir member 1946 until preset. Regular member of operatic society production to the present.
E052	Army Pipe Band 4 years (war years). Brass band 6 years, Otahuhu Railway Band 6 years. Auckland Scottish Pipe Band 3 years. Putaruru Brass Band 5 years. Too old now for musical activities.
E058	1950 to 1970 - guitar. Semi professional - 15 years.
E059	Studied classical music followed by modern music for several years. The "Academy for Rhythmic Music" was passed on to me in 1988 & I have taught piano ever since and also entertain and functions, rest homes & hospitals.
E074	Learned piano early on from father, not to a high level. Took music in 1938 at A.U. as part of Arts degree (1st time offered outside Musical background). Joined father in music/record business. Retired after 59 or 60 years. Socialised in classical last 30 years or so
E079	I have a modern keyboard self taught, moderate skills.
E086	Professional dancer/singer during 50/60's in UK shows, pantomimes etc. NZ early 60's joined Wellington Operatic and performed in musicals.
E093	Learnt violin as a child.

E097	Child and Youth Choir.
E100	Played cornet and trumpet in a brass band in my early years. Played cornet and trumpet in a brass band in my early years.
E131	Only at school age, played in orchestra & sang in choir (compulsory), music lessons also.
E134	Choir 5 years. Piano/organ 10 years.
E135	Church Choir. Auckland Symphonia (listener only).
B007	Grade 8 Royal School of Music for piano.
B009	Most of life from secondary school age, includes one or other form of choir participation.
B016	Piano since infant, LTCL: Accompanied ballet classes & exams 30 years. Singing solo & choir work, conducted choirs up to 8 years ago when problems with voice. Play piano 2-3 days weekly for pre-school music classes. Deputy organist for church services.
B049	From 5 years old I have always been involved with music, my father taught me the beginnings of the piano & then I went to a teacher at 7 yrs old she told my father that although my playing was more than just good, I could not contain the theory that needed & therefore I did not attain any levels or certificates, but I have been playing.
B071	I have played violin for 60 years, achieved ATCL level. I have sung in choirs for about the same length of time.
B080	I had guitar lessons for about 6 months. We play and sing regularly with a friendship group of about 12. Instruments are harmonicas, organ, banjo & guitar. Sang for 27 years in the church choir. Also 9 years in an entertaining group of about 15 for the elderly.
B084	Studied piano aged 10-17 years. Continue to play regularly. Have accompanied other instruments, including cello, clarinet, violin and have played at time the clarinet, trumpet & organ. Classical preference.
B087	Piano lessons for 5 years as a child. School, church and a community choirs. Singing ever since.
E010	I learnt the violin when I was at school - grade 5. As a child I learnt ballet, ballroom etc. I go dancing 1-2 times a week.
E039	Sang solo and choir from age 7 to 35.
E054	I enjoy ballroom etc dancing but don’t have any particular awards.
E094	Piano as a child for 10 years. Choir from age 8-18 years
C052	Belonged to Operatic Society. Also played piano and sang. Husband died and all these things have gone by the board.
C072	I sang in church choirs for 10 years. I sang Barbershop for 10 years.
C089	As a child learnt piano to Grade 3. Sang in choirs from adolescence to age 50.
C109	I have always sang in choirs, has been a big improvement with my HAs, I enjoy it a lot more to.
C019	Q18- played piano/violin till 16 years old, started piano when 8. Q20 - Sang treble with school choir for about 5 years (9-13), played violin with school orchestra for 2 years.
C020	Go to concerts and choirs.
E123	Play piano for 40 odd years - play to about grade 6 level. Still play & have always played just for my own pleasure.
F007	I am a music teacher (piano, guitar) and a professional entertainer (singer) and have been both for 40 years.
A042	Intermediate and school musicals - singing and speech roles. Did 2 school productions at year 7 & 8. Both roles reasonably major involving speech and singing (not solo). 6th form year 12 stage challenge - dancing to music.
F006	I had singing lessons from age 40 to age 72. I sing in large choir perform in musical comedy productions as a lead character which requires singing solos as well as acting.
F004	Q18. Piano and singing Q20. Piano and choir
F015	I have guitar lessons. I find the effort I hear the sound helps and to a degree improves my hearing.
F007	Piano and recorder - both at school. Private lessons for piano. Participated in school

	plays, concerts and school choir.
F012	School choir until 1980 -many years ago.
F014	Learnt piano at 12 years of age for 6 years. Took part in church plays, with group singing.
F002	Piano lessons for 6 years - grade 4 (trinity college). Sang in Choir at high school (1998-1962).
F005	Only piano lessons for several years at primary school
F013	General Singing/dancing/musical lessons at school

Q.22 – Does Musical training and/or involvement in musical activities prior to receiving HAs impact on your current music listening enjoyment with your HAs?

Ptpt#	Comment
A013	Well, of course it impacts. Always has.
A019	HAs have enhanced my enjoyment of live music performances, especially orchestral concerts. My training and background are essential ingredients of my intelligent enjoyment of music.
A102	Wearing hearing aids means I can't play the clarinet. Playing without aids, I can't hear clearly what is going on around me, or what the conductor is saying. I love listening to music though, with my aids in.
E003	My interest is classical, jazz, and the 1900 to 1960's period, before the advent of most of 'modern music'. Whilst the 'higher frequencies' are not as good as before HA's. I nevertheless enjoy listening to musical programs on TV and our CDs.
E019	I have always enjoyed listening to music and still do. For me music is easier because I don’t have to interpret what is being said.
E059	If on my own I prefer to listen without HA's. With others present and for their sake the volume can be turned down if I wear HA's.
E079	Moderate improvement, the ability to turn up the volume compensated for hearing loss.
E093	No, not really
B009	Draws me to listen to what is familiar and loved in chroal music, chamber music, country & western, shows I have experienced or participated in - because I do not have to strain to pick up the lyrics
B016	All instruments sound more strident especially children playing maracas, castanets etc.
B071	Because of training and involvement with choirs and orchestras and theatre, the listening skills have always been intense. The HA have assisted this immensely.
B074	Approximately 3 years learning piano about 55 years ago - just a learner.
B084	Better able to hear individual instruments as in trio's etc. Similarly listening to full orchestra
B087	I'm not sure what you mean. My training was not highly technical.
B096	I am able now to hear various musical instruments more distinctly now.
E010	I never wear the aids when dancing as they make the music too loud.
E039	My audiologist has greatly enhanced my hearing but its still fairly 'plastic'. I have a sophisticated home theatre and fortunately live on my own with the sound up. When I have company I listen to TV with headphones.
C052	It does. I guess music appreciation will always be with me. Before my hearing loss and since.
C019	Unable to hear the higher notes, or a lot of the very quiet passages. A lot of singers, especially modern women, have become very nasal and unpleasant.
F006	Ability to hear other members of the cast is improved as well as to hear the orchestra. I still have problems at practice with the choir when numerous keyboards are simultaneously playing the notes for the different parts.
F015	I did not play any instruments before I had HAs.
F007	Depends on musical instruments e.g. HA's increases the sound of flute and violins - so much so it becomes unbearable.
F014	Enjoy musicals except when they have their music too loud.
F002	Piano music is still my favourite but have to face source of music to appreciate it.

Q.23 How much have HAs impacted overall enjoyment of listening to music?

Ptpt#	Comment
F006	Because I am a performer I rarely sit and listen to music as such unless I am learning a new composition. If in an audience, I rarely can catch all the dialogue or jokes.

Q.24i Difference in sound quality 'with' vs 'without' DAI.

Ptpt#	Comment
E017	Improved quality.
E019	If this is the same as a "hearing loop" the difference is very significant.
E055	Differentiation of instruments.
E122	Louder and clearer, especially speech.
F007	Tried once and I hated it - shallow tinny sound lacking warmth.
A042	With DAI and having HAs on T. Ipod only works when T option on.
F003	I don't believe that the aids have impacted at all. When I had no aids and then two aids, music was pleasant sounding. Only after totally losing hearing in the left ear, did music sound most unpleasant.

Q.25 – Which provided you the best sound quality for listening to music?

a) no HAs, b) HAs with regular everyday listening program, c) HAs with music listening program, d) HAs with DAI, e) Other

Ptpt#	Comment
A013	b. Greater clarity – HF more apparent
A015	b. Satisfied with my HA
A019	c. Being able to hear the wide spectrum of sound frequencies is marvellous.
A020	b. Able to hear sounds & noise, speech in a better quality.
A030	b. This setting is the 'normal speaking' setting. The other settings are for driving and face-to-face speech.
A036	b. I listen to everyday programs because I can hear better.
A038	b. Only HA option I have
A102	b. The music program is a bit "full on" and there is feedback in the higher frequencies which is annoying.
A107	b. Note - I don't know if my HA's have a music listening programme.
A107	b. The only option I have. Like the sound of music listening programme.
A110	b. Improved crispness in the treble range; especially noticeable in classical music.
E003	b. As it seems to have a better all-round result on most of my listening which also contains dialogue.
E008	b. Increases my ability to hear treble notes louder and clearer.
E019	b. I listen to music with my regular setting. I seldom sit down for the afternoon to "listen" to music. If and when we go to concerts I like to use the loop if the venue has it operating - which is seldom.
E020	b. I can hear the words clearly.
E022	b. Enjoy talkback music and I can hear any lyrics better.
E029	b. Clearer tone and lyrics.
E032	a. My low frequency hearing is good and high frequency very poor. I don't think there are many sounds in music that I hear but my transformational aids put mechanical noises in and turn up any background clatter noises.
E036	c. They are programmed for music/TV. They bring out some sound I don't get on the number 1 setting but I can hear it okay.
E041	a. Most consistent sound.
E042	b. I can listen to what pitch I like.
E052	a. The HAs are lacking bass sound
E055	c. Better sound of strings particularly
E058	c. Better appreciation.
E074	b. I listen to recordings or concert programme approximately 1 hour in the afternoon.
E079	b. HAs provide very clear sounds, without HA sound lacks highs, sounds very deep.

E086	a. HAs pick up too many background loud level noises.
E096	I do not have any music listening programme.
E097	b. Brings out higher frequencies
E122	b. Seems adequate for me
E100	c. It sounds much better
E106	c. Enhances/enriches - provides so much more to the whole sound.
E131	b. No music programme listening option.
B007	a. Setting for HA umpiring top level cricket. Too loud for classical music unless I can control the volume.
B009	b. The only one I know I have access to.
B016	a. I enjoy mellow sounds more than strident especially with orchestral music but I manage with HAs by turning volume down.
B048	b. Boosts the treble range and improves the richness of sound.
B049	b. This is all I have - have not had the opportunity to try the others.
B065	b. Better for recorded music, live music where can't adjust band volume means sometimes put in ear plugs instead of HAs.
B067	b. Compensates for high frequency sensorineural hearing loss. Do not have c or d facility.
B071	b. I think HAs can reduce surround sound, and help focus on specific sounds.
B074	c. I experience difficulty with the word in the songs
B084	c. As stated earlier, identifies the instruments contribution to the whole performance.
B086	a. Depending on how loud the music is.
B087	a.I enjoy the extra volume when wearing aids, but I hate the piercing notes that keep intruding.
B096	b. I tried a music listening program and there seemed to be a little difference. The present program I have now, I've forgotten what its called.
B045	b. It is more natural to listen to.
E010	a. I am only mildly deaf and will turn the radio or TV up a little rather than put the HAs on.
E049	e. I listen to radio, talk back/music via ear plugs both Ipod and walkman. The sound is volume controlled on headphones and ear plugs and is 'real' sound not the plastic variety.
E054	I enjoy ballroom etc dancing but don’t have any particular awards.
C039	c. My HAs self select for music
C052	b. Because with HAs I hear subtle notes and tones I might otherwise miss.
C072	b. Before I changed to my latest HAs, I preferred to sing in a chorus without HAs because of artificial sound. Now with a change of HAs regular listening programmes are good.
C086	b. Music is clearer.
C109	b.It allows me to hear instruments individually much better than I could in the past. Provides more detail when listening
C019	a. Stops the over emphasis of bass, but miss high notes and quiet passages.
C032	b. Clarity of vocals
C038	b. Because I have no other comparison
E118	b. I do not have c or d available
E123	b. Haven't tried HA with music listening programme so don't know whether this would change my view on quality or not.
F007	b. Clarity, warmth, but music listening program is just as good
A042	d. Ipod and special Y cord (DAI) to connect to HAs.
F015	b. For everyday music my number 1 setting (everyday listening) is ok. At a show I may use setting 2 or 3 which is loud noise setting.
F001	a. Sounds more natural!
F007	b. Cannot listen to plug ins e.g. iPods due to behind ear HAs. Can only used headphones that hear music but are restrictive - due to wiring or frequency range.
F012	b. I do not have any accessories for my HAs - cannot afford them.
F014	b. General TV Music where I can control the sound.
F002	b. I am more comfortable listening to music without normal sounds around me.
F003	Without aid I cannot hear at all. With Right aid music sounds unpleasant
F005	Find it hard to distinguish much difference between programmes

F013	a. Sounds very high pitched, needs more bass.

Q.26 – Have you tried to improve your music listening or enjoyment since getting HA(s)?

Ptpt#	Comment
A015	Make sure I sit nearer the stage
A038	Enquired about DAI but no response to date.
A102	I have had both regular and music programs tweaked to reduce feedback and I sometimes reduce volume but this tends to "dumb down" the overall effect.
A104	Just enjoy music - musical programmes, tapes, CDs.
A108	Have had to play around with tone, bass etc on stereos.
E003	Only by checks etc. to the music setting on my HA's at the hearing clinic
E029	When first using HAs a music program was tried. It proved ineffective and was eventually removed.
E041	Attending numerous concerts.
E055	Have bought Sennheiser earphones (2PRS).
E059	Good if on my own without other background noises. But the increase of other sounds can make me want the music without HA's.
E093	Yes, use the music programme. Better at home.
E106	Once I got the music channel, all is lovely.
B009	Apart from operating the off switch on occasions!
B016	By turning volume down
B049	Since receiving HA out 15 year old son starting playing in a band - HAs have helped sometimes and cannot be worn at other times.
E039	Installed surround sound home theatre with very good unit.
C109	Yes, I tried listening to music with and without my HAs and found a great difference when they were in.
E123	Certainly easier to pick up words to songs with HAs.
F007	I have trouble in some situations with speaker placement (professional entertainment). Aids will only cope with so much and DAIs & similar I've tried are not at all satisfying.
F001	Fitted with DAI but was too restricting.
F007	1. Headphones. 2. Visual enhancement eg lyrics of songs so as to understand the words in the song. 3. Visual through reading musical notes.
F002	Gone to the opera and musicals and requesting seats front on to the stage, but no the very front. Always select programmes with captions across the top of the screen.
F005	I use wireless head phones with or without my aid for listening to TV and have started to experiment with head phones for music.

Q.27 – Which style of music sounds best with your HAs

Ptpt#	Comment
A008	No Preference
A032	None
A038	light rock
E118	I have never compared the various options.
A042	Drum n Bass
F003	None

Q.28 – Which style of music do you listen to most often with your HAs

Ptpt#	Comment
A008	No Preference
A032	None
A036	Light Rock
A042	Drum n Bass
F015	Blues
F003	None
F005	CW -I find it easier to listen to simpler songs that I am familiar with e.g. Willie Nelson, Johnny Cash

Q.29 – Which additional style of music sounded best before your hearing loss (or before you were diagnosed with a hearing loss)?

Ptpt#	Comment
A008	Don’t know
A032	None
A032	Orchestras
A036	Light Rock
B009	I cannot recall!
E118	I have never compared the various options.
F015	Blues
F007	Not applicable as too young -songs were children’s songs.
C109	I cannot remember as my hearing decreased gradually over time.

Q.31– Additional Comments How tunes (or melodies) sound with HAs

Ptpt#	Comment
A013	Brighter
A015	Heard Jan Tawnoswewiczs, soft harmonics when he played Brahuns Sonata with violin and piano. Dminorop 102, last movement.
A020	Much more clearly.
A032	The melody is on top of a constant feedback ring - it makes everything like electronic bagpipes! Yuck!
A036	I do like orchestra music but find with hearing aids too loud or violins too high and make my hearing aids squeal.
A102	High flutes and high violins can produce feedback.
A107	Sound is "crisper". I probably hear more/ a greater range of sound….. Otherwise/ previously unaware.
E017	Improved top end response.
E019	I am aware that others hear music quite differently that I do because of comments they make about the music I was not aware of, i.e. perfect pitch, I don't know what this sounds like.
E032	Tunes are fine as long as they don't use very high frequencies.
E036	I find rock, heavy metal too bassy. Opera sounds good and Country & Western.
E041	Difficult question to answer. I have no difficultly hearing melodies without HA. Tone "brighter" with HA.
E042	Good.
E052	Need more bass.
E055	With IPod and ear phones - about 80%.
E057	Most music sounds much the same as it did before I had HAs except that it is sharper and clearer.
E059	Good to clearly hear the words of songs.
E063	Overall not a lot of noticeable difference.
E074	Upper frequencies restored. Orchestras no longer 'muddy'.
E079	Clear and realistic. All music sounds improved.
E100	Most vocals, the words are not clear, my right ear is muffled and requires left HA to sharpen words.
E106	Just fabulous!
B007	Clearer pin point sound depending on were the sound is being produced: CD, DVD, or live.
B016	I have more problems with instruments being played more than singing.
B049	With the HAs I now find that I lost some sounds before I had the HAs, & the ones I have now are even better than the old ones, I can actually pick out the instruments where before it was mainly all sound.
B071	Very much clearer and brighter.
B084	Overall increased appreciation of total sound.
B086	Sometimes muffled.
E010	The music is harsher.

E049	Unreal but could not manage without them.
C109	I can hear instruments a lot better, I enjoy it a lot more now with HAs
E123	No - other then words are easier to hear & don't need to have music up so loud.
A042	My HA are quite bassy and don't pick up much treble/detail, therefore pitch, variation etc is hard to pick up on.
F006	Everything sounds better with my digital aids and I sound much better to myself and this is very encouraging to a performer.
F015	Flat, muffled, and I miss subtleties.
F007	I don’t know - never heard clear accurate music, but it wasn't monotonic either. Just variations of noises.
F002	It is much more difficult to identify the piece of music.
F005	Songs that I know often sound 'empty' and distorted, especially on the car radio. I try to tune radio for best results but often give up. On the stereo I can appreciate some familiar songs but have difficulty getting a satisfactory result with new songs but have difficulty getting a satisfactory result with new songs. Overall distortion is reduced and clarity improved with head phones.

Q32 Sound Quality

Q.32A Piano– Additional Comments

Ptpt#	Comment
A013	assuming without HA in
E032	I tend to turn my aids off at a concert or when really listening to music. My aids are behind ear so normal hearing in the lower frequencies with hearing aids.
E041	For all these questions, the HA, by making the sound sharper at times, gives a more strident quality that is not always as pleasant or when HA is no fitted.
E055	Piano the best instrument.
E059	How would I know how it sounds to someone with normal hearing?
E079	On first using HA adjustments to increase the higher frequencies made all instruments sound crystal clear.
B009	A piano played with full throttle is one of the most invasive sounds I have had to endure since wearing HAs. Comparable to extracting saucepans from the kitchen cupboard.
B084	There can initially be a degree of modulation but once the HA has settled into music mode, copes very well when at the keyboard.
E010	I put my HAs on and listened to some music.
E039	The piano is my favourite instrument. I no longer play but choose to listen without my HAs if in a room with a few people.
E054	The overall quality (timbre) is better with the HAs as the harmonics include higher frequencies.
C039	I enjoy piano.
C109	Very, very pleasant to listen to.
C020	Go to concerts and choirs.
F007	Impact sounds (talking about live piano not stereo etc). Tend to overload HAs.
A042	Variation in sound coming form piano is quite easy to pick up as it seems quite bassy (maybe you can feel the sound more).
F006	I listen to piano accompaniments when singing and they sound much better with hearing aids.
F015	The piano is a very clear instrument and without any interruption such as background noise it is easy to hear.
F014	Depends on the pianist and the type of piano as electric piano's sound different.
F005	Musical backing (treble and bass) tends to swamp vocals. Music and vocals are sharper than they should be. This applies to all instruments

Q.32B Strings (e.g. Violin, Cello)– Additional Comments

Ptpt#	Comment
A015	I do worry that my intonation is affected, but I don't think so. Can't always hear very soft high notes well above upper e, e.g. harmonics. Cellos ok.

A036	I cannot listen to a violin with my hearing aids in.
A102	High string sounds produce feedback.
A107	I played the violin previously. I know the rich sound possible, but haven't played since my HAs.
E072	The HA makes the sound louder.
E079	My HA with more higher frequency enhancement sounds natural.
B409	Higher pitches can grate.
B071	When playing my violin I always remove my left HA - it tends to be almost intolerable because it is beside the instrument!!
B084	HAs pick up notes in higher register which without (previously) were almost lost to hearing.
B087	Cello pleases me more than violin. Guitar is ok.
E039	My HAs bring out the high notes but two HAs have balanced things. Why did I wait as long for this second aid- my fault!!!
E054	I can hear higher frequency notes in a violin with the HAs that I cannot hear without, of course.
C039	I enjoy classical stringed instruments.
C020	Only like these in an orchestra.
F007	I can hear much higher notes.
A042	Very difficult to hear/distinguish as quite high pitched.
F015	The range of the instrument is too great so the very high or low notes are missed.
F007	Depends on type - I have chosen violin over cello. Cello is lower frequency and quite pleasant to listen to whereas violin hurts my ears with HAs and gives me a head ache.

Q.32C Woodwind (e.g. Flute, Oboe, Clarinet)– Additional Comments

Ptpt#	Comment
A015	Still notice poor flute intonation.
A036	Trumpet call get loud.
A102	High wind sounds produce feedback.
A107	Daughter plays Clarinet.
E079	Higher frequency enhancement - good results.
B049	I don't like wind instruments.
B087	I still love to hear the fluted. A saxophone I heard recently was less sharp. It may have been the style of playing, but I like it better.
E049	I listen a lot to trombone, sax and bass guitar.
E054	The woodwinds seem richer with HAs than without.
C020	Only like these in an orchestra.
F009	I can hear higher notes.
A042	Again, difficult to pick up as tends to be more high pitched, but variations can be picked up a bit better than string instruments.
F015	The clarinet is a clear sounding instrument that is easy to hear, the high notes can be missed.
F007	Depends on type I have chosen flute to answer this however I have different response for clarinet as they are a lower toned instrument. I do not listen to flute as I get head aches from intense sound.
F002	Find it very difficult to distinguish between these instruments - can usually recognise flute.
F005	Difficult for me to identify these instruments

Q.32D Brass (e.g. Trumpet, Trombone)– Additional Comments

Ptpt#	Comment
A036	Trumpet call gets loud.
E022	Had much more depth.
E072	Depends on how loud the music is that is being played. The music becomes distorted when played very loud. This applies to people with and without HA's.
B084	Haven't had the opportunity to make comparison.
B087	The intrusive bleeps have a great opportunity with brass.

E039	I belong to a men's club with choir orchestra and still enjoy it using my aids.
E054	I would expect that a person with normal hearing would find the brass tinnier than I would as the HAs, I believe, do not bring my high frequency reception up to normal young persons level of acuity.
C020	Only like these in an orchestra.
F007	Once again can hear higher notes.
A042	Brass is more deeper and therefore easier to pick up as opposed to strings or wood wind.
F002	As the instruments are loud, I feel that I may hear closer to normal than with others.
F005	Difficult for me to identify these instruments

Q.32E Drum kit - Additional Comments

Ptpt#	Comment
A016	Percussion: xylophone, marimba, glockenspiel, Tubular bells, wood block, Chinese block, gong, cymbals celesta.
A036	Always enjoyed the drums
E022	Too much noise, I needed to remove aids as I was getting too much input.
E032	Symbols sound terrible with aids on hence tend to turn them off for rock n roll concert.
E055	Best with piano and bass.
B016	Some drums - I need to turn HAs down as some sounds are like a thunder clap.
B087	I hate the deep pulsating beat of loud pop music.
E039	The bane of my life but drums are an integral part of music.
C039	I like drums in the background and some drum solo work.
F007	Live drums - impact sounds are too much for HAs to cope with.
A042	I love drums! It is deep and bassy and you can 'feel' the music!
F015	It is easy for me to hear drums but can cause the HA to drop out.
F002	Easy to identify this sound.
F005	Bass can swamp treble and vocals.

Q.32F Guitar - Additional Comments

Ptpt#	Comment
A019	Presume acoustic guitar.
E055	Do not like ANY except romantic and instrumental.
E074	As a plucked instrument the guitar is probably the easiest instrument to record.
B016	If guitar is played very fast, I have difficulty hearing separate tones.
B065	Higher pitches can irritate.
E039	Overall sound quality: neutral - if not too amplified
C088	I like listening to the guitar as there are a lot of good people who play it.
C020	Don't listen to guitar
F007	Guitar (live) is a lesser impact but I certainly notice the drop in quality since I've needed HAs (same top quality guitar).
F015	I play the guitar because it is a subtle instrument and can be very relaxing. It seems to sharpen the use of my HA.
F002	Don't listen to this instrument very much on its own. Have never really liked solo guitar.
F005	I can still appreciate some guitar music.

Q.32G Male Singer - Additional Comments

Ptpt#	Comment
A015	Prefer musical instruments-loathe poor pitch and too much vibration - can't get the actual note.
A019	In the graphic above the singer shouldn't be holding a microphone! - I presume.
A036	Singer can get loud.
E022	Able to hear lyrics above background instrumental.
E032	Can't determine lyrics as loss in high frequencies means consonants are clear to me.
E055	Prefer softer voices.

E059	More relaxing with HA's to be able to hear the words the singer sings.
B049	My husband has been singing in choirs for years, especially male voice, and has a rich Bass voice.
E039	If its through the loop I enjoy it. If not I can barley hear the lyrics. Most of us old deaf men have the same problems. Don't hear the words.
C088	A lot depends on the volume of the music but when it is at a comfortable volume I can hear male singers well.
C109	Male singers more pleasant to my hearing than female singers.
F007	I find it hard to distinguish words especially when mic is in mouth.
F015	Male voice is easier for me to understand.
F002	I have answered this question for listening to tapes at home in normal surroundings. When at the opera (e.g. Lyric Theatre Brisbane or Concert Hall) the sounds are very much better probably "as expected" because of acoustics.
F005	Obviously depends on the particular singer.
A042	Deeper voice easier to pick up.

Q.32H Female Singer - Additional Comments

Ptpt#	Comment
A015	Again loathe heavy vibration sign of a shot voice, love chorale music. Dame Janet Baker's voice, like boys unbroken voices. Many singers- are faintly flat.
A019	Again, the microphone may distort the natural sound of the voice.
A036	Female singers can get loud.
E022	I could differentiate the lyrics from the background music.
E032	As with male singer, can't determine lyric words. Sound is good.
E055	Prefer female negro singers singing soul.
B016	This question was difficult as the difference of alto and soprano for me is reasonably marked. As I have a marked trough in my hearing graph in the range of a high soprano.
E049	I find the female voice difficult as it can be good or squawky.
C109	I quite like good alto, but I always have a bit of trouble listening to soprano's unless they are highly trained. Otherwise the pitch is useless to me, quite tinny.
F007	Find it hard to distinguish words.
A042	Lighter voice than male, therefore bit harder to follow pitches etc.
F015	Female voice can be too high.
F007	Depends on pitch - I have chosen soprano/opera over pop group category.
F002	As for male singer - surroundings greatly affect appreciation. At "La Bohème" at Lyric Theatre, Mimi sounded wonderful, but at home she sounds hollow/ shrill.
F005	Female voices can be more difficult than male if too shrill. In conversation I prefer a sharper voice (often female) to a gravely voice (often male) I take each vocal situation as I find it.

Q32 – Additional Comments

Ptpt#	Comment
E079	My HA with some enhancement of the higher frequencies make just about all music & speech sound crystal clear, road noise and crowded malls need to be adjusted especially for this in a different way
E118	I cannot sing in key. I cannot tell a waltz from a fox trot and most music just sounds 'nice' to me, with perhaps only rap & heavy metal being unpleasant. I shall endeavour to answer your questions
F006	I can hear female voices much better with my hearing aids as I am more deficient with higher pitched sounds.
F003	I'm sorry I can't really answer these questions because I no longer go to concerts, opera, etc. or listen to music at home

Musical Styles

Q.33a – Classical – (orchestra)

Ptpt#	Comment
A036	I do not enjoy orchestras like I use to when I didn't have hearing aids.
E106	I just listen to music for enjoyment – not really anything else – re intense analysis
F005	Too annoying to listen to.

Q.33c – Classical – (choir)

Ptpt#	Comment
F007	Can't pick words at all
F005	Too annoying to listen to.

Q.33d – Pop/rock style

Ptpt#	Comment
A038	Light Rock
E007	Now
E008	1960's
E022	1960's/1970's.
E032	1950s-1970s
E041	1960's
E057	1960's
E058	1960's
E072	1960's
E074	1960's
E079	Now
E100	1960's
B016	1960's
B065	Now
B067	1960's
B070	1950-1970's
B084	1960's
B088	1960's
E010	1960's
C086	1960's
C089	1960's
C024	1960's
E118	1960's
E123	1960's/1970s
A042	1980/1990's
F015	1960-70's
F012	1970's
F002	1960's
F005	1960's

Q.33g – 'other' style

Ptpt#	Comment
A019	Pipe Organ
A020	Pipe Bands
A036	Group Singers

A038	Meditation Music
A102	Opera
A107	Heavy Metal
E019	I think that the answers to the last set of questions are too much dependant on "what" type of music is being listened to. The range & variety of all styles is huge.
E020	Singing quartets
E036	Religious Hymns Choir
E055	Love Hed Kandi (& Deep House)
E057	Pleasant
E096	Light Music
E100	Vocals & Easy listening
B007	Musicals G & S
B009	Musical Shows
B016	Easy Listening
B049	Organ (pipe)
B067	Selected examples of Greek, Russian, Latin American etc.
E039	Stage Sketches - comedy
C072	Barbershop
C089	Organ Music
C020	Easy Listening
F007	Easy Listening
A042	Drum & Bass
F015	Blues
F012	Techno/hip hop

Q33 – Additional Comments on Musical styles

Ptpt#	Comment
E022	Country & Western - I know most of the words and can hear them again as opposed to memory.
E029	Whereas Instrumental music does not appear to me to be greatly affected, vocals do suffer from lack of clarity.
E052	Would like HA slightly deeper in tone.
E055	Prefer popular classical only. Only enjoy playing of real musicians, i.e. virtuouses.
E059	I find your questions very hard to follow
E074	There are so many types of jazz from dixie to contemporary, my marks average from types 40's to 80's.
E131	Sometimes I do not hear lyrics as clearly as a person with normal hearing.
B049	Rock-n-roll of 60's okay but don't like nor or jazz, some country and western is okay too, I also enjoy pan pipes and the singing and whistling of Ronnie.
E039	If someone is telling a story its usually "what was the punch line?" I miss it too many times and hate it.
A042	To understand lyrics requires reading the or having someone tell me the lyrics when listening to the music so I can familiarise myself.
F002	Would have appreciated definition of "simple" and "complex". I have interpreted "simple" as not requiring a huge effort to follow, listen to.

Q34 – Would you like music to sound with HAs like you think it would sound to a normally hearing person?

Ptpt#	Comment
E057	Some distortion can be evident with HAs at times.

E106	Well I think the music programme must put the edge on listening to the average person's hearing - however I could be wrong!!

Musical Preferences

Q.35– Ranking Instrumental Families

Ptpt#	Comment
A019	With my HAs, I feel that I hear all the musical sounds as 100% natural.
A038	Unable to compare.
A107	No noticeable difference before/after HA's.
E022	Drums too much noise and very uncomfortable. Rock guitar a bit too loud. Classical guitar fine.
E041	For me the higher-pitched instruments (violin) do not sound as natural as the lower-pitched ones (e.g. cello).
E052	Not enough bass.
E055	For guitar and female singer - gentle and romantic.
E093	I really only listen to classical music and some male and female singers. Deep voices are more difficult.
E131	I'm not sure they all would sound equally natural sounding.
B049	They all have the ability to sound natural at times.
B067	Being able to hear higher frequency notes makes the difference to all these.
C089	Would have appreciated organ being included in survey.
E118	No real likes or dislikes.
A042	The more pitch/treble capable it is, the least natural t sounds. Simpler/less pitch= more natural.
F003	None of these sound natural to me.

Q.37– Ranking Preferred Performers

Ptpt#	Comment
A019	Impossible to rank, sorry!
A032	It's the music not the number of performers that matters.
	On what basis – sound quality? / hearing aid performance? / personal preference?
B084	Solo piano is vastly different to solo violin
E010	I like them all
E039	I love/enjoy all music and have good opportunities to listen and sometimes perform
F003	All of these were enjoyable prior to 2004 (hearing loss in LE)

Q.38– Tunes subject can always recognise (e.g. from the words, the rhythm/beat, or melody line) with HAs

Ptpt#	Comment
A013	Melody.
A015	Melody line. Rhythm.
A016	Symphony No. 3 'Eroica' (Beethoven), melody; Bolero (Ravel) rhythm/beat.
A019	All of these elements count; plus timbre, tempo, texture, etc.
A020	Melody line.
A026	Melody line.
A030	Rhythm, words.
A036	Normally the melody line.
A038	Words, beat, melody = all three.
A102	Melody line.
A104	Melody line.
A107	Combination of word, rhythm/beat, and melody line.
A108	Usually rhythm/beat.
A110	Recognise from the melody.
E003	Use of HAs has not affected my recognising a piece of music. I presume my memory

	is triggered by the melody and rhythm in the first instance, Not much help, but I assume it is usual and has been for me for as long as I can remember.
E007	Melody line.
E008	Melody line.
E017	Rhythm/beat, melody line and words.
E019	Music I know. I know all of the above.
E020	The words, melody line.
E022	Sometimes melody line and then words.
E029	Melody line.
E030	Rhythm/beat.
E032	Normal hearing in low frequencies means I think I hear music like normal hearing people but just can't make out the lyrics clearly and might miss some symbols or very high pitched noises.
E036	Musical beat, words.
E041	Melody line, rhythm, orchestration/harmonics.
E042	Melody line.
E052	Tune.
E057	Melody line.
E059	Melody line.
E072	Music in general.
E093	Melody line.
E096	Rhythm/beat.
E122	Melody line.
E100	All of the above - Rhythm/beat, melody line and words.
E106	The melody line more so.
E107	My hearing loss only moderate so I can hear ok.
E131	Rhythm/beat then melody, lastly words.
E134	Melody line/ from the words.
E135	Melody line.
B007	Rhythm/ beat. Melody line.
B009	A combination of these - plus a lively memory.
B016	Melody line
B048	As per all the examples stated above.
B049	Melody line.
B065	Usually from the melody line.
B067	All of these.
B074	Tunes with simple melody line.
B084	Melody/composition.
B086	Melody line.
B087	From the rhythm first, then melody. Words aren't so clear these days.
B088	Melody Line.
B112	Rhythm/ beat.
B006	From words.
B045	From the words. E.g. in the depths of the temple from the Pearl Fishers Jussi Bjorling & Robert Merrill.
B076	Words, rhythm/beat.
E010	Melody line
E039	I'm not so profoundly deaf. I miss diction mostly.
E054	Melody line
E094	The melody line
C039	From the melody line and the words
C052	Recognised by melody,
C067	1. From the melody. 2. From the words.
C072	Melody
C088	I can recognise tunes from the beat of the instruments when they start.
C089	I recognise most tunes from all 3.
C109	The melody line - can immediately pick it up by listening to the melody.
C019	Generally from melody line, but often some words.
C020	Melody line.

C028	Words, rhythm/beat, melody line. Only the new tunes, etc, that I don't know until I get used to them. A lot of tunes are only rubbish anyway.
C024	Rock & Roll and Country & Western. Usually words or beat.
C038	Rhythm beat
E118	From the words
E123	From the words and music.
F007	Melody line, often can't hear words.
F009	Old familiar tunes.
A042	If I am familiar with a song (i.e. someone has told me some of the lyrics or I have heard it many times) I may be able to identify it by the beats/rhythm. There must be no other background noise though (e.g. people talking etc). If someone says to me “you know this song” I’m more likely to pick it up.
F006	I have much better recognition of any music or vocalists with my hearing aids.
F004	All of the above
F015	The melody; I don't know why.
F001	Rhythm
F007	From words
F012	Memory - these are songs I know before hearing loss became more advanced.
F002	From the very distinctive melody line e.g. "Finlandia", "Hallelujah Chorus" - usually require loud pieces. Find soft, haunting pieces difficult.
F003	Unsure. Probably familiar tone/words.
F085	Chance recognition of tunes is rare. I really need to concentrate.

Q.39– Tunes subject cannot recognise but would like to be able to recognise.

Ptpt#	Comment
A030	Songs by female singers.
E042	No. Can recognise with HAs.
B074	Tunes with singing or spoken words are difficult to understand (i.e. the words are!).
E010	As I cannot recognise them I do not know their names. Any beautiful harmonious music whether it is classical, country, western or older style pop etc. As I don’t like jazz or modern music with its ugly tunes & discords I don’t listen to it.
C019	Old hymns, old popular songs of 1930's/40's/50's.
A042	Singing (words) over the music (instruments). Unfortunately HAs just pick up the most dominant background instrument noise.
F007	Hard rock/pop - need to have the words to understand tunes. If I don't then I don't listen hence I only listen to songs that I am familiar with before my hearing deteriorated.
F012	A lot from the 70's - it takes me sometimes up to 1 minute before I can decipher what the tune is.
F002	Chopin's nocturnes (piano).
F005	Music that I listening to 20 or 30 years ago, e.g. moody blues, pink floyd etc. Many of the subtleties are now lost to me.

Q.40– Instruments always recognised by listening alone

Ptpt#	Comment
A013	Piano, trumpet, Guitar, bagpipes, violin, flute, oboe, Cello, French horn, bassoon, harp
A015	Violin. Orchestral music e.g. Elgar. Chamber music groups: strings.
A019	All instruments (I wouldn't be much of a professional musician if I couldn't!).
A020	Drums, pipe, music, guitar, violin, piano.
A026	Guitar, violin, piano, organ, clarinet, bagpipe, flute, pan-pipes, cello.
A030	Saxophone, drums, piano.
A032	Any instrument.
A036	Piano.
A102	Piano, all orchestral instruments, guitar, drums.
A107	All orchestral instruments
A110	All instruments which I have learned to recognise.

E003	In general I can recognise most instruments of an orchestra, having been listening to them for over 40 years.
E008	Piano, trumpet, guitar, flute and violin.
E017	Piano. Violin, oboe, most other in orchestra.
E018	Drums
E019	I don’t have a problem identifying most instruments
E020	Bag-pipes, piano, trumpet, double bass, guitar, violin.
E029	Piano, violin, saxophone, trumpet.
E032	All or most.
E041	Virtually all.
E042	Ballroom dancing music (danced for years). Bands from before having HAs.
E052	Cornet, tenor, horn, EB bass.
E055	Piano, guitar, drums.
E057	Violin, guitar, saxophone, bagpipes etc.
E058	All stringed instruments, most wind and most percussion instruments.
E059	Piano, drums, violin, guitar, harp, flute.
E072	Most instruments.
E076	I would say most of them.
E074	Can from experience recognise most orchestra en Masse and all solo.
E079	I don't have problems with HA except in areas with road noise or crowded public areas (malls etc).
E086	Piano, strings.
E093	Piano, violin, cello, clarinet, flute.
E096	Piano, violin, trumpet.
E097	Piano, clarinet, guitar. Organ, trumpet, drum, bells.
E100	Trumpet, saxophone, guitar, piano etc.
E122	All instruments
E131	Never thought about it but sure I could recognise most orchestral instruments, string, wood wind, percussion.
E134	Piano, organ, cello, violin, flute, guitar, drums trumpet, bass.
B007	Trombone, piano, string instruments, woodwind, drums.
B009	Guitar, flute, oboe, violin.
B016	Piano, organ, flute, violin, double bass, tambourine, trumpet Saxophone, cymbals and drums.
B048	Trumpet, trombone, clarinet, saxophone, guitar, drums (most instruments).
B065	Guitar, drums, piano.
B067	All
B074	Trumpet, piano - generally solo instruments are easier to hear.
B084	Piano, violin, cello, woodwind, horn, flute, oboe. Saxophone, harp, drums, organ, harpsichord, guitar.
B087	Piano, violin, flute, double bass, saxophone, trumpet.
B088	Trumpet, clarinet, trombone.
B096	Piano, trumpet, violin, guitar, flute, saxophone, organ, harmonica, banjo.
B112	Brass, string, percussion.
B006	Piano, drums, guitar.
B045	Piano, flute, trumpet, cornet, bassoon, drums.
B076	Organ, guitar, piano.
E010	Piano, violin, cello, double bass, flute, clarinet, trumpet, drums, guitar, male and female singers.
E039	I recognise most instruments.
E054	Most instruments (orchestral)
C039	Violin, piano, flute, guitar.
C052	Piano, trumpet, clarinet.
C067	Drums, guitar, piano, violin.
C086	Piano, drums, tuba.
C088	Just about all really.
C089	Piano, guitar, violin, pipe organ.
C019	Piano, organ, violin.
C020	Piano, organ.

C028	Piano, guitar, banjo, drums, saxophone, trumpet, violin, organ-keyboard, piano accordion (bag-pipes would sound best underwater!).
C034	Drums, piano.
E118	Trumpet. Piano.
E123	Piano, strings, woodwind, drums.
F007	Many - I'm a musician.
A042	Bass (drums). Because you can feel it.
F004	All orchestral instruments and piano
F015	I can recognise most instruments but it will in some cases take a while.
F001	Piano, guitar, drums.
F007	Most instruments however I have trouble differentiating between trumpet/trombone, clarinet/Bassoon/bass recorders, cello/ viola, harp/piano.
F012	Drums, brass.
F002	Drum.
F003	Don't know, because I tend not to listen.
F005	Drums, piano, guitar.

Q.41– Instruments that are not recognised by listening alone, but would like to be able to recognise

Ptpt#	Comment
A013	violin, clarinet, triangle
E008	Some of the orchestra instruments, i.e. wind.
E022	Violin, brass instrument, piano, guitar, flutes etc.
E052	High pitched wind instrument. EB Cornet.
E134	Oboe.
B074	Usually bands or orchestra with numerous players.
E054	Double bassoon/ bass clarinet, cor anglais/oboe, mandolin/ mandola.
E094	Piano, double bass, cornet, violin, drums, sax, trombone.
C019	Some woodwind, flute.
C034	Violin
A042	Guitar/strings. Woodwind.
F002	Cello, viola, oboe.
F005	I would just like to be able to hear music without distortion, regardless of vocal instrument content.

Q.42– Additional factors that improve or detract from your listening experience

Ptpt#	Comment
A013	background noise, sharp noises (coughs)
A015	Coughing or talking audience. Performers with theatrical extravagant mannerisms.
A108	I find that most music in public places e.g. concerts or in bars/nightclubs are really loud and harsh. Can be really uncomfortable.
E020	Music that is too loud, with no melody, like rap or hip hop.
E041	Echoey reverberant room - some music (e.g. played in cathedrals, choral especially) needs this quality. Much does not.
E042	Not really.
E059	Being comfortable.
E072	Music that is played at too loud in volume.
E093	Cannot listen to loud pop with hearing aids. Dislike has something to do with it.
E131	Only volume - too loud makes it less enjoyable.
B084	Live concerts best situation to judge quality of hearing - recordings vary enormously with factors affecting the quality including CD, video tape, vinyl, amplifier, & speaker (quality & position).
B088	I have not been able to use my electrostatic headphones with my HAs which has detracted from my listening experience.
E039	Detract: people talking, breaking open chip packets, tapping feet during musical performances. Improve: enjoy the loop if its operating.
E094	I often find music, especially live bands extremely unpleasant because of the high

	amplification. I try to remember to take ear plugs and leave HAs at home.
C039	Wind out side, drums and organ - to loud.
F007	If there is clatter, chatter, etc, the HA's tend to pick that up first.
A042	Seeing other 'normal hearing' people enjoy the song.
F002	A physical factor is when I am very tired, everything becomes too difficult!

Q. 43 Interest in a MTP

Ptpt#	Comment
A042	If it was free, online and I could do it in my own free time
F003	I feel that I prefer to hear normal day to day speech and sound and have better quality of life in that respect, before embarking on a MTP. Having said that, I do really miss the enjoyment of music

Q.44 Skills which help music listening enjoyment – Other

Ptpt#	Comment
A107	To hear the words of songs clearly.
E107	Able to control volume.
B049	To be able to hear a new tune, before putting it into practice.
B067	Really they are all important
C032	Being able to understand/ hear lyrics
A042	Being able to see how much people around you enjoy/appreciate/dance to the music.
F003	It would be nice to be able to enjoy music as I did prior to 2004, however I know this is not possible.

Q.45– Instruments, instrumental families, musical styles or songs, subjects would like to be able to hear.

Ptpt#	Comment
A030	Jazz
A032	All of them.
A036	To be able to listen to high pitch music such as violins.
A102	High pitched instruments.
E019	Of course I would like to hear all the above better, my pleasure would increase if I could improve the mushy sounds I hear to crisp clear sounds.
E100	Music from the 60's: vocals & instrumental piano orchestral vocals the old style tunes.
E131	Only lyrics
B067	HAs enable high frequency tones to be heard and this improves the full experience.
B071	I can hear most music reasonably well.
B074	I would like to hear all music more clearly - in particular the words.
C038	Strings tell me the difference between violin, cello in an orchestra.
F007	Piano and guitar - impact sounds, important to soften the sound thump so HA doesn't overload.
F009	Orchestra, choirs, voices, words.
A042	The songs your friends/social groups enjoy the most so you can 'fit in' when the song is played, thus mainly the most popular classics.
F001	Lyrics.
F002	Orchestral pieces which feature soloists.
F005	Musical styles - rock & roll, country, moody blues/Eagles/ Billy Joel etc.

Q. 49 – Form subjects would like the MTP to come in

Ptpt#	Comment
A032	Any of the above.
A055	I am 90!

E039	DVD close 2nd equal
A042	DVD with detailed subtitles (e.g. pitch & intensity) so you can try and lip read what they say and see their facial expressions.
F002	As I am retired and have plenty of time 3x60 mins of practice per week is not a burden. But for a working person who is tired at night and may only have weekends this is far too much. If the music programme is for a wide range of users, then 2x30 min programmes a week is probably sufficient, or even just 1x60 min programme.

Q. 51 –Comments or Suggestions about Music Training Programme

Ptpt#	Comment
A006	I am not a musical person and found this questionnaire difficult to do
A013	Music needs a certain literacy - a deeper understanding, beyond mere familiarity with a style. It's to do with patterns. Anything that can help show the patterns – e.g. Chord progressions, key changes, mood - would be helpful
A015	Manual would be very helpful.
A019	I have been a music teacher (both secondary schools and private lessons) for many years.
A036	I am very happy with what I hear on my radio, TV & CDs. I go out to entertaining groups & find that is very good too.
A038	I am not really interested in a Music Training Program, but would like to try DAI, either via wire or wireless.
A104	I appreciate you want to try and design a training programme but:) 27, 28, 29 style of music too restrictive as you have asked for one response only. 2) I'm a general music listener, the survey is very detailed.
A107	Already a competent musician, so no need for a training programme for me.
E003	Questions 46 to 49 are more applicable to someone interested in taking a Music Training Program, and I've left these blank as any response from me would not be relevant, in view of my answer to Q43.
E020	Make it simpler, melodic, and in short doses.
E036	I am happy with my new ears. Maybe some fine organisation. I did find it hard to remember normal hearing sometimes as it was a long time back, tried by best.
E041	Q.43 - I have answered as if I wanted a MTP. However as indicated in Q.43 I don't think such a programme is appropriate for me. For me, the HAs are most effective when watching TV, or picking up quieter conversation.
E057	We have a vast number of CDs and DVD recording dating from the late 1950's to the present day.
E058	Seems ok, but possibly more suited to a younger person.
E074	As I am 97 sections 44 are only suggestions - they would not apply to me.
E079	Small classes with a teacher who does not assume you know it all/ I personally found my HAs to be very good almost anywhere expect malls, attention should be given to some adjustments to elimination of some of the lower frequency sounds.
E093	I find that with my hearing aids I am quite satisfied with what I can hear. I have learned to avoid situations where for example loud pop is superimposed on voices. I find the noise level in those circumstances quite stressful.
E113	I enjoyed music before HAs. I still enjoy with HA all music, particularly coast on radio, car & stereo etc. The only change with HAs is turning up or down the volume. My wife & I listen to DVD (musical) on TV, have DVD box, Donell O Donnell, Foster & Allen. I have bought or taped all the musical shows such as, showboat, 7 brides for 7 brothers, Annie get your gun.
E135	No comments - not at my age.
B009	I am too ancient to learn new tricks, especially when my current HAs give me sufficient satisfaction with the selection of music I can access now. A great feature of HAs (both ears) when it comes to unpleasant music is the ability to turn them into ear plugs with a couple of clicks!
B016	I have not answered questions 46-51 as I don't think the programme would be of help to me. I am sure a music training programme could be of help to a number of hearing impaired people.
B049	If my aids are not tuned for a music programme how will this be accomplished?
B071	This is an excellent possibility and could bring people together in many ways to make

	music or learn instruments or just extend knowledge.
B084	While realising the suggested MTP could be valuable, I personally can't become enthusiastic, largely as I prefer to play and secondly I'm happy to enjoy recorded or lice music in my own way, even though I admit there may be improved techniques for 'total' appreciation. For this reason I've left this section incomplete.
B006	Being 83 years of age I find having any type of training would be a waste of time.
E049	Would have been great years ago.
E054	Sounds like a good idea!
C109	I'm too old for a MTP. Enjoy music always have done, but don't feel a programme would help at my age.
C019	Thankyou for suggesting such a program. I can manage at this stage, still hear and enjoy music - choral/orchestra/church choir and radio (at times). At my age I will just carry on now.
C028	At my age I don't want to be tied down to learning. I enjoy listening to good music (easy listening, etc.) on radio. I do not like the FM sound of music. To my listening it is too high pitched. I much prefer the AM as the tone of notes is softer and smoother. Maybe I'm too old fashioned.
C024	Not really a music fan.
E123	I would like something like this for when you get your HAs. In my case I think I was borderline deaf since childhood and when I got HAs at 50 I didn't realise who "deaf" I had become. My voice control is still on the low side & I don't really know when I'm speaking loud or how loudly.
F007	I don't need music training but if you mean training to get the best out of the HAs, I'm all ears!!
F009	Prefer female voice.
A042	I like 2 kinds of music. 1. Drum and Bass – just because I can hear the defined beats well and it is a familiar/repetitive. 2. Music my friends/family like and have taught me while they are playing the music (songs on tape/CD). Even being taught the chorus make you appreciate the song when you become familiar with it (repetition & awareness of lyrics,/keywords/phrases). The music training programme may be most effective, at first, if it teaches people the name of the song, they type of music it is (e.g. soft rock, country) and key choruses. Once people identify choruses, they can join in (sing) and identify song/beats and have fun with their friends and family. You may not 'hear' everything but you can at least follow along, sing the chorus, and take part in the music to some extent.
F015	Like learning to play an instrument 15 to minute training daily is better than 2 hours every second day.