PERCEPTION OF MUSIC FOR ADULT COCHLEAR IMPLANT USERS: A QUESTIONNAIRE

A thesis submitted in partial fulfilment of the requirements for the

Degree of Master of Audiology

in the University of Canterbury

by Jenny H. K. She

University of Canterbury

2008

Contents

List of Abbreviations

ACE: Advanced Combination Encoders

ANOVA: Analysis of Variance

BPF: Bandpass Filters

CI: Cochlear implant

NH: Normal hearing

CI+HA: Cochlear implant and hearing aid

CNC: Consonant-Nucleus-Consonant

CUNY: City University of New York

dB HL: Decibel Hearing Level

dB SPL: Decibel Sound Pressure Level

MTP: Music Training Program

QOL: Quality of Life

SD: Standard deviation

RM ANOVA: Repeated Measures Analysis of Variance

UCMLQ: University of Canterbury Music Listening Questionnaire

List of Figures

List of Tables

Acknowledgements

I would firstly like to thank my supervisor, Dr Valerie Looi, for her invaluable input and guidance throughout this thesis. Her efficiency and friendliness was also greatly valued.

Thank you, also, to Dr Peter Busby and Dr Pam Dawson from Cochlear Ltd. for their support, advice and assistance, and Ms Prue Humber for her administrative assistance.

I would also like to thank all the participants, especially the interviewees and pilot-test participants. Meeting them and listening to their views and experiences was definitely the highlight of this thesis!

Thank you, also, to Dr Emily Lin for so willingly sharing her expertise in statistical analyses.

I would also like to thank Co-operative Research Centre for Cochlear Implant & Hearing Aid Innovation, Melbourne, Australia, for providing funding and for managing the distribution and collection of the questionnaires.

Lastly, a heartfelt thank you to my boyfriend, family, my dear classmates and friends for all their encouragement, support and friendships.

Abstract

Existing music questionnaires have shown that postlingually deafened adult cochlear implant (CI) users generally find music to be less enjoyable following implantation. However, they did not investigate, in detail, which factors influence CI users' music listening enjoyment, nor did they examine the approach a music training program should take. In order to obtain such information, a questionnaire, the University of Canterbury Music Listening Questionnaire (UCMLQ), was developed. The UCMLQ investigated: (i) the effect of implantation on CI users' music listening enjoyment (determined by comparing the levels of enjoyment experienced post-implantation to pre-hearing loss, and just before implantation); (ii) the effect of a hearing aid in the unimplanted ear on CI users' music perception and appreciation; (iii) the effect of timbre on music listening enjoyment whereby respondents will be asked to rate the pleasantness and naturalness of common instruments and voices, and also, give ratings on the instruments' sound quality based on what they *expect* these instruments to sound to a person with normal hearing; (iv) whether respondents have a preference for a particular musical style (e.g. Country and Western, Jazz, Classical, etc); (v) whether respondents' have a preference for, firstly, low-pitched versus high-pitched instruments/voices; secondly, music with instruments-only, voice-only, or both instruments and voice; and lastly, music with smaller number of performers versus greater number of performers; (vi) practical methods or 'tips' for enhancing everyday music listening enjoyment were collated; and finally, (vii) respondents were asked for their views and opinions on the content and logistics of a 'take-home' MTP for improving their music listening enjoyment. One-hundred postlingually deafened adult CI users, ranging in age from 18 to 88 years (mean = 62.1, SD = 17.1), completed the UCMLQ. All respondents used a Nucleus CI24 implant and the ACE speech processing strategy. Results showed that following implantation, respondents generally found music to be less enjoyable but they also preferred certain types of instruments and music: (i) low-frequency instruments over high-frequency instruments; (ii) certain instruments (e.g. the guitar) over others (e.g. brass instruments); (iii) smaller numbers of performers as opposed to larger numbers; (iv) Country and Western music as opposed to Pop/Rock, Jazz, Classical-small group, and Classical-orchestra; and (v) music with a slow rhythm/beat, and words. A comparison of the ratings given by CI and Hearing Aid (CI+HA) users and CI-only users also revealed that CI+HA users felt that they were significantly more able to follow the melody-line of musical styles, identify these styles, and they also rated musical styles to sound significantly 'more normal' than the CI-only users did. However, no statistically significant

difference was found between the two groups' (CI+HA users versus CI-only users) ratings for common instrumental sounds. In regards to respondents' interest in partaking in a 'take-home' music training program (MTP), 54% of respondents stated that they would be interested in undertaking one. Respondents also indicated that the MTP should focus on improving their ability to recognise tunes, in particular, tunes known before implantation, and commonly-known tunes, and the MTP should offer a wide range of musical styles. In addition, training sessions should be of 30-minutes duration, 2 times per week, and the MTP should come in the form of a DVD with subtitles. Overall, this study collected information which not only helps us to better understand CI users' appreciation of music but also could be used in the shaping and development of a future MTP.

1 Introduction

1.1 Cochlear Implants

In normal hearing, sound travels from the outer ear through the middle ear to the cochlea, where it is converted into electrical impulses that are sent to the brain. In a normal cochlea, there are outer and inner hair cells, and attached to each of the inner hair cells are auditory nerves. In a deafened ear, the inner hair cells are usually severely damaged or missing altogether (Moore, 2003). A cochlear implant (CI) bypasses these damaged hair cells by directly stimulating the auditory nerve with electrical pulses. To date, the CI is the most successful neural prosthesis, restoring partial hearing to severe-to-profoundly deaf people (Wilson, 2004).

As shown in Figure 1, current-day CIs consist of a microphone that picks up the sound, a speech or sound processor that converts the acoustic sound into electrical signals, a transmission system that transmits the electrical signals to the implanted electrodes, and an electrode array (consisting of multiple electrodes) that is inserted into the cochlea. The use of multiple electrodes aims to stimulate different neural populations relatively independently in order to exploit the tonotopicity of the cochlea. In other words, auditory nerves that are 'tuned' for high frequencies are stimulated whenever the electrodes near the base are stimulated, while auditory nerves that are 'tuned' for low frequencies are stimulated whenever the electrodes near the apex are stimulated. Different electrodes are stimulated according to the frequency components of the input signal.

One of the main speech processing strategies used today, and the one relevant for this thesis, is ACE (Advanced Combination Encoders). Shown in Figure 2 is a block diagram of an ACE speech processor for a Nucleus implant. In ACE, a relatively large number of bandpass filters (BPF), typically 20 to 22, are used to estimate the short-term spectrum of the input signal. The envelope of the signal at the output of each filter is estimated and compared so that only the subset containing the highest levels (maxima) are passed to the following stages of processing. For example, if the subset is set to identify the ten highest levels then only the ten corresponding electrodes in the CI are activated. The resulting stimulation pattern comprises a series of interleaved pulses delivered at a fixed stimulation rate (McDermott, 2004). The parameters of the speech processing strategy (e.g. the number of maxima and the stimulation rate) have a major impact on the sound perceived by the CI user.

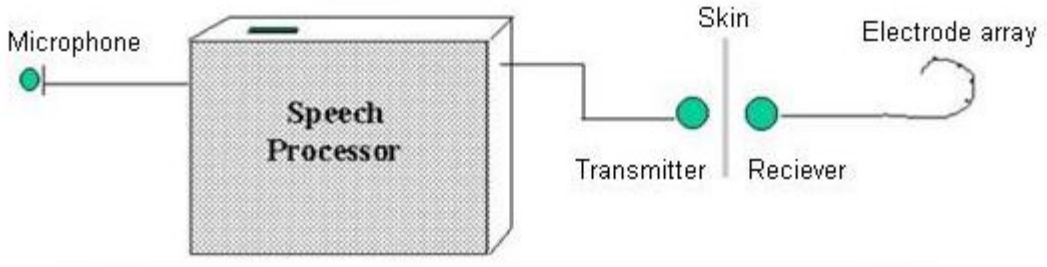


Figure 1: Major components of a CI (Loizou, 1998).

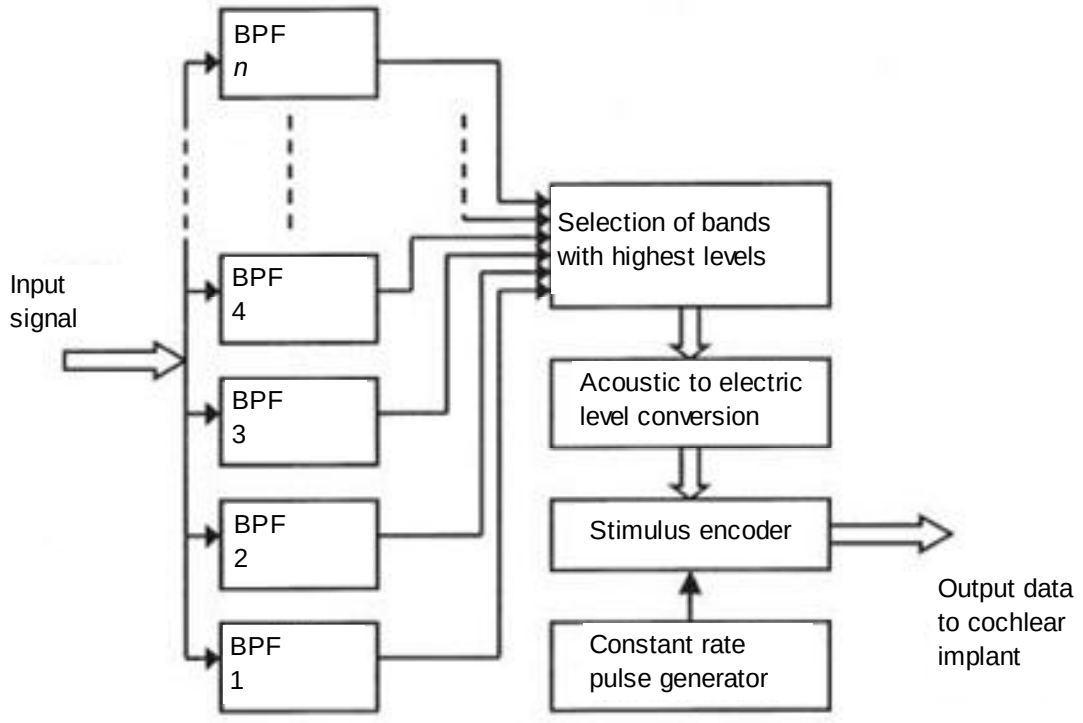


Figure 2: Block diagram of a typical ACE processor (McDermott, 2004).

1.2 Music Perception with a CI

Technological advances in CI hardware and speech processing strategies have resulted in vast improvements in the functional hearing of adults with postlingual hearing losses. The first CIs provided patients with little more than an awareness of environmental sounds and some cues to assist visual speech-reading (McDermott, 2004). In contrast, nowadays, the majority of postlingually deafened adult CI users demonstrate excellent open-set speech discrimination in quiet (Fetterman & Domico, 2002). However, speech perception in noise, and the perception of tonal languages and

music remains a challenge for many CI users (Fetterman & Domico, 2002; Galvin III, Fu, & Nogaki, 2007; Gfeller, Knutson, Woodworth, Witt, & DeBus, 1998; Gfeller et al., 2007; Grasmeder & Lutman, 2006; Kong, Cruz, Jones, & Zeng, 2004; Sucher & McDermott, 2007; Turner, Gantz, Vidal, Behrens, & Henry, 2004).

The ability to perceive more-complex acoustic stimuli (e.g. speech perception in noise and the perception of tonal languages and music) predominantly requires accurate pitch[1] perception. Pitch perception is an important underlying component of music perception because melodies[2] and harmonies[3] are made up of sequential pitch patterns and several concurrently presented pitches, respectively. The poor transmission of pitch therefore, has negative implications for the recognition of melodies with or without harmony. Research indicates that CI users as a group are significantly less accurate than normal-hearing non-musicians in the recognition of melodies, especially when lyrics or rhythmic cues are unavailable. (Gfeller et al., 2000b; Gfeller et al., 2007; Kong et al., 2004). Moreover, Gfeller et al. (2007) found that the open-set recognition of familiar melodies required as many as 32 bands in a no-rhythm condition. In contrast, all current-day CIs and speech processing strategies utilise fewer bands. One of the main types used, the Nucleus implant and ACE speech processing strategy, gives access to a maximum of 22 channels, and of these, usually only 10 are utilized at any given time.

Similarly, research by Arnoldner et al. (2007), Fu, Shannon, & Wang (1998) and Galvin III, Fu & Nogaki, G. (2007) suggests that current-day speech processing strategies omit the fine spectral and temporal cues that are necessary for accurate pitch and timbre perception. Limited temporal information reduces the CI user's ability to perceive the fundamental frequency of musical notes. For example, while an individual with NH would hear an ascending C major scale as an orderly progression of pitches from low to high, an implant recipient may not hear the same orderly progression for pitch (Gfeller, Mehr, & Witt, 2001). In fact, Sucher & McDermott (2007) reported

[1] Pitch (which is sometimes used synonymously with 'tone' or frequency') is the highness or lowness of a musical note in relation to other musical notes. In a non-musical context, for example, female voices are higher-pitched than male voices, or the sound of a motorbike running is a low-pitched compared to the high-pitched whistle from a boiling kettle.

[2] A melody is a rhythmically organized sequence of single pitches, where the pitches are grouped together sequentially so as to make up a particular musical phrase or 'idea'. For example, for a song, such as "Twinkle Twinkle Little Star", the music that the words are sung along to is the melody.

[3] Harmony is a combination of two or more (different) musical notes sounding at the same time. For example, in the case of a person singing with a guitar, the strumming of the guitar provides the harmony to the singing (or melody).

that some CI users consistently rank acoustic signals with a lower fundamental frequency as higher in pitch, a phenomenon known as 'pitch reversals'. Limited spectral resolution in CIs, on the other hand, precludes the resolving of harmonics which means that the pitch of complex sounds is less salient than for normal-hearing listeners. This is because in a CI, as sounds are analysed in channels or frequency bands, the discrete frequencies in an acoustic signal may not be transmitted. That is, CI users would only be able to determine which band the signal fell into via the electrode that was activated but they would not be able to determine the exact frequency of the signal. Timbre percepts may also be quite distorted relative to normal (Galvin III, Fu & Nogaki, 2007).

Timbre, as described by Grasmeder & Lutman (2006, p.148) is the feature of music that "gives quality to musical sounds and enables the listener to perceive differences between [musical] notes that have the same frequency, duration and intensity but are produced in a different way, such as on different musical instruments." The unique timbre of various instruments is an important aspect of music's aesthetic quality (Gfeller et al., 2002a). Therefore, the extent to which the implant transmits timbral cues may not only affect CI user's perception of timbre but also their appreciation of music.

A study on timbre appraisal, or 'liking', by Gfeller et al. (2002b) compared timbre appraisal between 51 postlingually deafened adult CI users and 20 NH adult listeners. The stimuli consisted of eight different musical instruments (the trumpet, trombone, flute, clarinet, saxophone, piano, violin and cello) playing a standardised seven-note melodic sequence. The instruments selected covered three different fundamental frequency ranges (low: 131 to 262 Hz; medium: 262 to 534 Hz; high: 534 to 1068 Hz), and represented four different instrumental families (brass, woodwind, pitched percussion, and strings). The participants were required to rate each instrument for its overall pleasantness, as well as for various timbral qualities of the instrument. For the overall pleasantness of an instrument, participants were required to give ratings of liking on a 100 mm scale with the bipolar anchors of "dislike very much" (=0) to "like very much" (=100). For the timbral qualities of an instrument, participants were required to give ratings for three perceptual dimensions: dull-brilliant, compact-scattered, and full-empty.[4] The study revealed, firstly, that CI users gave ratings of liking that were on average about 17 points lower than the NH listeners, and secondly, CI users

[4] Factorial investigations on verbal descriptors of timbre indicated that 88% of variance can be accounted for with the three scales, dull-brilliant (or sharp), compact-scattered, and full-empty (Bismarck, 1974). Bismarck (1974), reported that NH listeners judged sounds with more low-frequency energy as more dull, sounds with more high-frequency energy as more brilliant or sharp, sounds with more noise as sounding more scattered (on a continuum of compact to scattered), and sounds more rich in harmonics were more full (on a continuum of empty to full).

gave significantly lower ratings for strings compared to the other instrumental families (piano, $p < 0.0001$; woodwinds, $p < 0.001$ and brass, $p < 0.03$).

In rating the instruments on the three perceptual dimensions mentioned above, CI users rated string instruments to sound more scattered ($p < 0.0014$), less full ($p < 0.0001$), and duller ($p < 0.0001$) compared to the NH listeners. In addition, CI users rated the higher-pitched instruments to sound significantly more scattered ($p < 0.003$) and less brilliant ($p < 0.0001$) than NH listeners. Thus, musical instruments generally sound less pleasant to CI users, with the sound quality of strings and higher-pitched instruments being particularly unpleasant.

Another study by Gfeller, Christ, Knutson, Witt, & Mehr (2003) compared ratings of 'liking' and 'complexity' between CI users and NH listeners for 'real-world' excerpts of music. The study also investigated the effect of complexity on 'liking'. Sixty-six postlingually deafened adult CI users and a comparison group of 36 NH adults participated in the study. The test stimuli were representative of three musical styles - Classical, Country and Western, and Pop music. Measures of liking and complexity were obtained for 36 items (12 of each style). A comparison of the two groups showed that CI users rated Country and Western, and Pop music to be significantly more complex than NH listeners. In addition, compared to NH listeners, CI users gave significantly lower ratings of 'liking' for Classical music.

In summary, CI users' perception of pitch and timbre, and therefore, their perception of music is significantly poorer than NH listeners due to the limitations of implant technology. This in turn, has a negative influence on CI users' appreciation of music.

1.3 Music Training

Although current-day speech processors are less than optimal in transmitting information to assist with pitch and timbre perception, a study by Gfeller et al. (2000b) confirms anecdotal reports which suggests that some aspects of music listening can be improved with practice and training. Their study examined the effect of structured music training on the recognition of simple melodies and complex songs, and the liking of complex songs. The training involved multiple exposures to: (a) simple melodies presented in two forms - melody, and melody plus harmony; and (b) complex songs representing three styles of music - Classical, Country and Western, and Pop. Twenty-four

postlingually deafened adult CI users participated in this study. They were divided into a control group and a training group, whereby only the latter completed the 12-week music training program. Statistical analyses on mean %-correct scores for simple melody recognition revealed that there was no significant difference in pre- and post-training test scores for either group. However, post hoc analyses on mean %-correct scores for complex song recognition revealed that there was a significant difference ($p < 0.0001$) between the post-training test scores for the control and training groups, with the training group also recording a significant increase in pre- to post-training test scores ($p < 0.0001$). Thus, it appears that the implant transmits enough salient cues from complex songs to permit an improvement in complex song recognition after a period of focused listening and training (Gfeller et al., 2000b). As the training did not result in an improvement in simple melody recognition, the authors hypothesised that the improvement in complex song recognition was due to subjects developing compensatory strategies, such as recognising cues available in complex songs (e.g. timbre cues) that were not available from simple melodies. The study also showed that the training group gave significantly more positive ratings for 'liking' than did the control group on second test administration ($p < 0.0001$). Furthermore, the training group showed an increase in appraisal ratings post training ($p < 0.0001$). On these findings, Gfeller et al. (2000b) commented that it was encouraging to see a significant improvement in both the recognition and liking of complex songs following training, particularly because complex songs (as opposed to simple melodies) are most representative of the kinds of musical sounds a CI user is likely to encounter in everyday life.

Thus, the study by Gfeller et al. (2000b) indicates that some aspects of music listening can be improved with training, even with current-day speech processors which are less than optimal in transmitting music. However, as some CI users are highly disappointed by the initial sound quality of music post-implantation, they actively avoid listening to music and consequently, miss out on the potential for improvement that might have resulted with more listening practice (Gfeller et al., 2000a). A music training program (MTP) may therefore encourage some CI users to persist with music listening. Such a training program could assist CI users in better-appreciating music by targeting music listening tasks that are more amenable to rehabilitation, and by helping CI users to set more realistic expectations and goals for music listening.

1.4 Music Questionnaires

In order to develop a MTP that optimises the use of current-day CIs for music, detailed and descriptive information from adult CI users' is required, such as their opinions and views on music listening. To date, there have been three main studies that have gathered and analysed self-reported information from adult CI users on music listening. These studies were carried out by Gfeller et al. (2000a) in the United States of America; by Mirza, Douglas, Lindsey, Hildreth, & Hawthorne (2003) in the United Kingdom; and by Lassaletta et al. (2007) in Spain. All three studies surveyed postlingually deafened adult CI users. These individuals have a memory of music as heard through normal acoustic hearing channels, and can compare their music listening experiences, post-implantation, to this memory.

In the study by Gfeller et al. (2000a) on the listening habits and musical enjoyment of 65 adult CI users (29 Clarion, 17 Nucleus, 11 Med-El and 8 Ineraid users), participants were required to rate their overall satisfaction with how music sounds post-implantation compared to their recollection of how music sounds prior to having a hearing loss. Twenty-three percent of participants reported little satisfaction with music listening prior to or after implantation. Forty-three percent reported that the sound of music was improving over time or was better than no music at all (although less pleasant than before hearing loss), and 23% noted that music now sounded as pleasant as before having a hearing loss, or more so. In Mirza et al.'s (2003) study, 35 participants were asked to grade how much they enjoyed listening to music before becoming deaf and now after implantation, on a scale from 0 to 10 (where 0='not at all', 10='very much'). Enjoyment of music was graded a mean score of 8.7 out of 10 before deafness but only a mean score of 2.6 out of 10 after implantation. In addition, 24 patients (69%) reported that they were disappointed with how music sounded after implantation, and only 16 patients (46%) reported that they listened to music after implantation.

In the study by Lassaletta et al. (2007) which investigated the impact of music perception on quality of life (QOL) following implantation, 52 postlingually deafened adult CI users completed two questionnaires, a music questionnaire and a QOL questionnaire (the Glasgow Benefit Inventory). In this study, twenty-eight participants had a Med-El device (eighteen Combi40+, ten Pulsar CI100), twenty-one had a Cochlear Ltd. device (nine Nucleus CI22 and twelve Nucleus CI24), two had an Ineraid device updated to a Med-El processor, and one participant had a Clarion device. In the music questionnaire (Lassaletta et al., 2007), participants indicated the amount of time they spent listening to music per week (0 – 2 hours, 3 – 5 hrs, 6 – 8 hrs, ≥ 9hrs) prior to deafness and post-implantation.

In addition, they were asked to rate on a 4-point Lickert-type scale, the extent to which they would describe themselves as persons who enjoyed music prior to deafness and post-implantation. Similar to the findings by Gfeller et al. (2000a) and Mirza et al. (2003), Lassaletta et al.(2007) found that music enjoyment significantly decreased post-implantation compared to pre-deafness ($p < 0.007$). In addition, it was found that the time spent listening to music per week was significantly less after implantation than before deafness ($p < 0.01$). Participants were also required to rate the overall sound quality of music on four 100 mm visual analog scales, anchored with the bipolar adjectives: 'dislike—like', 'doesn't sound like music—sounds like music', 'mechanical—natural' and 'difficult to follow—easy to follow'. For each bipolar adjective, a result of 0 - 49 was evaluated as a negative response while a result of 50 - 100 was evaluated as a positive response. It was found that CI users who rated positive scores for all four scales had significantly higher QOL scores than those who rated negative scores (dislike—like, $p = 0.001$; 'doesn't sound like music—sounds like music', $p = 0.04$; 'mechanical—natural', $p = 0.002$; and 'difficult to follow—easy to follow', $p = 0.002$). Mean QOL scores were also higher for users who spent more time listening to music post-implantation, with the results approaching significance. It was also found that Med-El users gave a significantly higher rating on the bipolar visual analog scale, 'doesn't sound like music – sounds like music' than Nucleus users (Chi-square test, $p=0.01$). However, no differences were found for the other rating scales ('dislike—like', 'mechanical—natural' and 'difficult to follow—easy to follow') between both CI types. Furthermore, no association was found between QOL scores and demographic variables, musical background, duration of deafness, length of implant use, or CI-type.

In the previous studies, music listening enjoyment scores were correlated with a range of subject factors: age, musical background, time spent listening to music pre- and post- implant, length of profound deafness, length of implant use, and speech perception measures. Gfeller et al. (2000a) found significant correlations ($p < 0.01$) between post-implant music enjoyment and both age ($r = -0.42$) and the time spent listening to music post-implantation ($r = 0.73$). That is, younger patients and patients who spent more time listening to music post-implantation tended to enjoy music more. Similarly, Mirza et al. (2003) found that for the 16 patients who listened to music after implantation, there was a strong negative correlation between age and how much they enjoyed listening to music with an implant ($r = -0.65$, $p = 0.007$). Lassaletta et al. (2007) also found that CI users who listened to music for more than 2 hours per week 'agreed' or 'strongly agreed' to enjoying music following implantation (chi-square test, $p=0.009$). Enjoyment of music post-implantation was not found to be related to other subject factors, including length of profound deafness (Gfeller et al., 2000a; Mirza et

al., 2003), speech perception measures (Gfeller et al., 2000a; Mirza et al., 2003), length of implant use, musical background, pre-implant listening habits (Gfeller et al., 2000a) or CI-type (Gfeller et al., 2000a; Lassaletta et al., 2007).

In summary, CI users have reported a decline in music listening enjoyment post-implantation compared to pre-hearing loss or pre-deafness. Lassaletta et al. (2007) found that for postlingually deafened adult CI users, increased music listening enjoyment was linked to an improvement in the perceived quality of life. This emphasises the importance and value of a MTP for postlingually deafened adult CI users.

1.5 Rationale for the Current Study

In order to design a MTP that aims to enhance CI users music listening enjoyment, it is important to determine the effect that different features of music (e.g. pitch, melody and timbre) have on music enjoyment. In the study by Gfeller et al. (2000a), participants were required to rate the sound quality of music on 100mm visual analog scales anchored with bipolar adjectives. For example, the first scale was anchored with 'doesn't sound like music' (=0) to 'sounds like music' (=100). Participants were required to mark a point along the scale that represents their opinion. The other scales were 'dislike–like', 'unpleasant–pleasant', 'mechanical–natural', 'fuzzy–clear', 'complex–simple' and 'hard to follow–easy to follow'. In the study by Lassaletta et al. (2007), the visual analog scales were 'like–dislike', 'sounds like music–doesn't sound like music', 'natural–mechanical', and 'easy to follow–difficult to follow'. Although these scales convey how music may sound to CI users, they do so only in general terms, more clarification is needed; for example, what makes music hard to follow? What is simple or complex music? Are there styles of music that are easier or harder to follow than others? In what ways does music sound mechanical? Does it sound empty, noisy or tinny? Thus, existing questionnaire studies lack the level of detail that is required to develop an effective and focused music training program for enhancing CI users' music listening enjoyment. Therefore, the purpose of this study was to develop and administer a questionnaire to collect information which not only helps us to better understand CI users' appreciation of music but also could be used in the shaping and development of a future MTP. In particular, the key areas that the questionnaire will include (and this thesis will focus on) are:

1. The effect of implantation on music listening enjoyment determined by comparing the levels of enjoyment experienced post-implantation to pre-hearing loss, and just before implantation

(with a severe-to-profound hearing loss). It is hypothesised that the participants in this study will report a decreased level of enjoyment post-implantation compared to pre-hearing loss, as previous studies by Gfeller et al. (2000a), Mirza et al. (2003) and Lassaletta et al.(2007) have shown this to be the case.

2. The effect of a hearing aid in the unimplanted ear on CI users' music perception and appreciation. As the candidacy criteria for CIs expands to include patients with greater levels of residual hearing, more CI users will be able to hear low-frequency sounds postoperatively, particularly with the simultaneous use of a hearing aid. With research by Gfeller et al. (2006), Turner et al. (2004) and Kong et al. (2004), showing that low-frequency hearing greatly assists with pitch perception, it is hypothesised that respondents using both a CI and hearing aid will report a greater level of music appreciation than those using a CI only.
3. The effect of timbre on music listening enjoyment whereby respondents will be asked to rate the pleasantness and naturalness of common instruments and voices, and also, give ratings on the instruments' sound quality based on what they *expect* these instruments to sound to a person with normal hearing. (This type of rating will be covered in more detail in Section 2.1). It is hypothesised that respondents will rate instruments and voices to sound poorer than they would expect them to sound to a person with normal hearing, as research by Gfeller et al. (2002b) showed that CI users gave lower ratings of liking for common musical instruments than NH listeners.
4. Whether respondents have a preference for a particular musical style (e.g. Country and Western, Jazz, Pop/Rock, Classical, etc). It is hypothesised that respondents would prefer musical styles that they perceive are simpler, as Gfeller et al.'s (2003) study revealed that there was a strong negative correlation ($r = -0.72$) between liking and complexity. That is CI users preferred music that they perceived to be simpler.
5. Whether respondents' have a preference for, firstly, low-pitched versus high-pitched instruments/voices; secondly, music with instruments-only, voice-only, or both instruments and voice; and lastly, music with smaller number of performers versus greater number of performers. This will provide further insights on the effects of pitch, timbre and complexity, respectively, on music listening enjoyment.
6. Practical methods for enhancing everyday music listening enjoyment, as this will provide relevant information which could be included in a MTP aimed at improving music listening enjoyment. Insofar, CI users have reported the following factors to improve their music listening enjoyment: quiet listening environment, good quality recordings, watching the

performer, having the musical score or words to follow along with, familiar music, knowing the song title, and music listening practice (Gfeller, 1998; Gfeller et al., 2000a). It is expected that the respondents for the UCMLQ will report the same. The UCMLQ will also list additional factors that may have a positive (or negative influence) on respondents' music listening enjoyment, which respondents will be asked to give their opinion on.

7. Finally, as this questionnaire served to collect information that would assist in the development of a music training program, respondents will be asked for their views and opinions on the content and logistics of a 'take-home' MTP for improving their music listening enjoyment.

2 Method

Ethical clearance for this study was obtained from the Human Research Ethics Committee at the Royal Victorian Eye and Ear Hospital in Melbourne, Australia. All procedures were in accordance with these requirements.

2.1 Materials – The UCMLQ

In order to collect detailed, unique and comprehensive information that would assist in the development of a music training program, a questionnaire, the University of Canterbury Music Listening Questionnaire (UCMLQ) was designed. It differed from existing questionnaires in a number of ways. Firstly, CI users were required to give ratings on how instruments and musical styles sound with a CI compared to how they *expect* them to sound a person with NH. Existing questionnaires ask CI users to compare back to how they remember music to sound with normal or 'pre-deafness' hearing, where 'pre-deafness' could refer to a number of points in time, such as, when the CI user had NH or a mild hearing loss. The onset and progression of hearing loss, and the length of profound hearing loss, affect CI users' recollection of musical sounds. Moreover, as the long-term goal was to develop a training program that targets music listening enjoyment, it was felt that asking participants to make comparisons to how they 'expect' music to sound as opposed to how they 'remember' music to sound was more appropriate. Furthermore, subjects were asked to clarify if how they *expect* music to sound is how they would *like* music to sound, and if not, to describe the difference between the two judgements.

Secondly, some of the rating scales used in this study were different to those used in existing studies. Most of the rating scales were similar to the 100 mm visual analog scales used by Gfeller et al. (2000b) and Lassaletta et al. (2007), and are anchored with bipolar adjectives only. However, some scales had bipolar adjectives as well as a descriptor 'as expected' at the centre of the scale. These scales were designed so that respondents could rate the sound quality of instrumental sounds based on how they expect them to sound to a person with NH. (An example of this type of scale is illustrated in Section 2.1.2.) It is also worth noting that all of the scales used in this study were marked with 100 subdivisions. These marks enabled participants' ratings to be easily converted into a number between 1 and 10 for data analysis.

Thirdly, unlike existing studies on timbre appraisal where CI users were asked to provide ratings for individual musical instruments (Gfeller et al., 2000a; Gfeller et al., 1998; Gfeller et al., 2002b), this questionnaire asked respondents to give ratings for instrumental families, as well as individual instruments and voices. The inclusion of instrumental families is unique and was included for a number of reasons. Firstly, it is possible that respondents may be unfamiliar with individual instruments, such as the trombone, clarinet or oboe, and may be more familiar with different instrumental families, such as 'brass' or 'woodwind'. The inclusion of instrumental families also reduced the number of instrumental sounds that respondents were required to rate.

Fourthly, as previously mentioned, the UCMLQ will assess what proportion of CI users wear a contralateral hearing aid for music, and what difference this made to the sound quality of, and their appreciation of music.

Finally, as the UCMLQ served to collect information that would assist in the development of a music training program, a separate section containing questions on the content and logistics for a 'take-home' MTP was incorporated.

2.1.1 Pilot Version

A pilot version of the UCMLQ was developed and tested. To assist us in the initial development of the pilot version, in-person interviews were conducted with three postlingually deafened adult CI users from Christchurch, New Zealand. (The transcriptions and notes for these interviews can be found in Appendix 1.) The unstructured interviews gave the researchers an opportunity to hear CI users describe in their own words, how music sounds with a CI. They thus, provided insight on topics that should be included in a questionnaire and the terminology that is appropriate for the questionnaire. For example, musical terms, such as timbre, may not be meaningful to a CI user with little or no music experience. The adjectives, "full", "rich" (Interviewee 2) and "tinny" (Interviewees 2 and 3) were used to describe how music sounded post-implantation. As such, 'tinnier' and 'richer' were used to formulate one of the scales in the section on 'Sound Quality', where respondents were asked to rate the sound quality of common instrumental sounds.

All three interviewees also expressed that with an implant, they had difficulty hearing melodies or pitches. Interviewee 1 described it as,

> "[…] in terms of tone, it's like when I'm watching, say, 'Australian Idol', they'll come on and they'll sing, and I'll have to ask "were they good or were they not good?" because I can't tell because of the tone. I mean you can hear music and you hear the singing. But it all kinda sounds the same. If someone was singing really badly, I probably wouldn't even notice." (Appendix 1, p. 72).

Interviewee 2 said,

> "[…] I wanted to do more with singing because I was a singer and I just can't sing now. Well, I can but it's dreadfully out of tune and I can't pitch myself. You can hear it but you can't quite pinpoint the pitch. You're either slightly high or slightly low but you just can't quite get it and it's very frustrating […]"(Appendix 1, p. 80).

Interviewee 2 also said,

> "[…] sometimes there is too subtle a difference to hear the difference [in pitch] until you've maybe gone up half an octave [on the piano] and then, it might sound a wee bit different. You know, so if you played C and you played G, you could hear the difference but C, C-sharp, or D, D-sharp, chromatically, there's not a lot [of difference] in it." (Appendix 1, p. 82).

Interviewee 3 said,

> "Personally, I believe the biggest hurdle to overcome, regarding music appreciation is pitch discrimination […] as without pitch, music doesn't really exist. To correctly understand and hear a diatonic scale is imperative to truly appreciating Western music. Music equals ordered pitch and rhythm. CI technology is great with rhythm, I still wait for pitch." (Appendix 1, p. 90).

Hence, as all three interviewees shared the same difficulty with perceiving pitch, Question 26 was developed. Here, respondents were required to mark their opinions on how melodies sound with a CI on a bipolar visual analog scale (as shown in Figure 3).

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)

Figure 3: The rating scale for how melodies sound with a CI.

Following the interviews, a draft of the questionnaire was developed. This was then pilot-tested on 9 postlingually deafened adult CI users from Christchurch. The purpose of the pilot-test was to determine where the questionnaire was unclear or lacking. The draft questionnaires were sent to the pilot-test participants who completed the questionnaires in their own time, and were later interviewed in-person. Based on the pilot-test, changes were made to the draft questionnaire as shown in Table 1. The changes made were to improve the accuracy of responses, to make the questionnaire more appropriate (e.g. use more-appropriate terminology), and to improve the clarity of questions and instructions. Pilot-testing revealed that respondents took about an hour to complete the questionnaire.

2.1.2 Final Version

The final version of the UCMLQ consisted of 48 questions divided into the following 7 sections:

1. Music Listening and Music Background
2. Sound Quality
3. Musical Styles
4. Music Preferences
5. Music Recognition
6. Factors affecting Music Listening Enjoyment, and the
7. Music Training Program.

Below, is an overview on the structure and contents of the UCMLQ. A copy of the UCMLQ is in Appendix 2.

Table 1: Changes made to the Draft Questionnaire.

Question Number*	Change/Modification	Explanation for the Change/ Modification
32 and 41	Participants were instructed that they could give equal rankings i.e. they can use the same 'rank' (number) more than once.	As some pilot-test participants gave equal rankings, the researchers wanted to make it clear to all participants that they had the option of giving equal rankings.
28, 29, 30 and 31.	An explanation[5] was given in the information sheet (that accompanied each final version of the questionnaire) as to why participants were required to *compare* how music sounds with a CI to how it sounds to a *person with normal hearing (NH).*	Some pilot-test participants struggled to make this comparison. One said that he considers himself to have "normal" hearing with an implant. Another said that "I have always assumed that a hearing person hears a different sound but I am not unhappy with my CI sound. The unhappiness begins if you compare – and you really can't do that". However, one pilot-test participant felt that it was necessary to make this comparison - in this way, technology could progress until eventually CI users could hear as normally as possible.
28	Changed one of the sound quality scales from 'compact-to-scattered' to 'less noisy-to-more noisy'.	Some participants found the terms, 'compact' and 'scattered' hard to relate to. As the study by (Bismarck, 1974) showed that NH listeners rated sounds with more noise as sounding more scattered (on a continuum of compact to scattered), we replaced the terms, 'compact' and 'scattered' with 'less noisy' and 'more noisy'.
28 and 30	Participants were instructed that if they were unfamiliar with an instrument or family, they could put a 'cross' in the box beside the name of the instrument/musical style and skip to the next one.	This was done to avoid participants giving invalid ratings that they might otherwise have given if they were not given the option to skip unfamiliar instruments/musical styles.
23 to 35	The musical style 'Rock' was changed to "Rock 'n' Roll"; the styles 'Modern Pop' and 'Older-style Pop' were changed to 'Modern Pop/Rock' and 'Older-style Pop/Rock'; and 'Heavy Metal' was added to replace 'Rock'.	There was some confusion over the 'Rock' and 'Rock 'n' Roll'.

*Refers to questions in the final version of the questionnaire (Appendix 2).

In the section, 'Music Listening and Musical Background', respondents were asked to rate their music listening enjoyment across three points in time: (i) pre-hearing loss, (ii) pre-implantation and

[5] The explanation that was given is as follows: "We realise that this may be a difficult comparison for you to make, particularly if you have had a hearing impairment for a long time. However, we would like you to consider how YOU think a normal hearing person MAY hear that particular instrument or music style, and make your judgements based on that reference. There is no right or wrong answer."

(iii) post-implantation. Respondents were also asked if they had formal music training lessons or partook in musical activities, pre- and post-implantation, and if they used a HA in the unimplanted ear, and if so whether this had an impact on their enjoyment of music.

In the section on 'Sound Quality', respondents were asked to rate the following instrumental sounds: the piano, string family, woodwind family, brass family, drum kit, guitar, male singer and female singer. As respondents may have trouble identifying the different instruments and instrumental families, pictures of instruments and people playing instruments were included in the questionnaire. For each instrumental sound, respondents were asked to rate the overall sound quality on the bipolar visual analog scales, 'Unpleasant—Pleasant' and 'Unnatural—Natural'. An example of the scale, 'Unpleasant—Pleasant' is shown by the top illustration in Figure 4. In addition to these scales (as mentioned in Section 1.5), respondents were asked to rate specific sound qualities of instrumental sounds based on how they *expect* these instruments to sound to a person with NH. For these particular ratings, visual analog scales with a descriptor "As Expected" at the centre were used. If the respondent made a mark to the left of "As Expected" (as shown by the bottom illustration in Figure 4), this means that the respondent has rated the instrument to sound "emptier" than they would have expected it to sound to a person with NH. Other specific sound qualities that participants were asked to rate on were:

- Duller-to-Sharper,
- More Noisy-to-Less Noisy,
- Tinnier-to-Richer, and
- Rougher-to-Smoother.

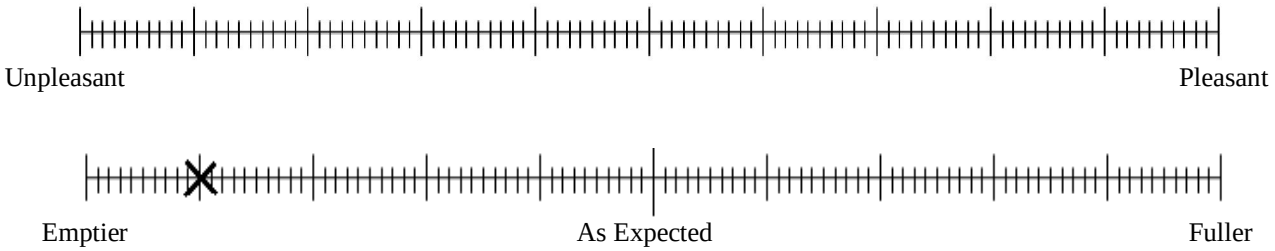


Figure 4: Two types of ratings scales for the sound quality of instrumental sounds.

Respondents were also asked to rate the musical styles of Classical-orchestra, Classical-small group, Classical-choir, Pop/rock, Country and Western, and Jazz, using the following bipolar visual analog scales:

- Unpleasant—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, and
- Sounds *nothing* like I would expect it to sound to a person with NH—Sounds *exactly* as I would expect it to sound to a person with NH.

In the section, 'Music Preferences', respondents were required to rank musical instruments in terms of their 'naturalness'; to circle their preferred types of singers (male or female), instruments (low-pitched or high-pitched) and styles of music (instrumental-only, voice-only, or voice with instrument); and to rank the number of performers from 'most preferred' to 'least preferred'. For these questions, the options to give equal rankings or circle 'no preference' were provided. This section was included as it will not only provide further insights into the type of music CI users prefer, but also, the effects of pitch, timbre and complexity on their choice of music i.e. their music listening enjoyment.

In the section, 'Music Recognition', respondents were asked if there were tunes and instruments that they could and could not recognise, and if so, to provide detail. These results may be useful to developers of a MTP in deciding which tunes and instruments should be included.

The section, 'Factors affecting Music Listening Enjoyment', contains a list of factors that existing studies and anecdotal reports (Gfeller, 1998; Gfeller et al., 2000a; the interviews conducted for this thesis (2007; Appendix 1)) have shown affects music listening enjoyment. Here, respondents were required to state whether the factors improve, impede or make no difference to their music listening enjoyment. Some factors were related to the properties of music itself (e.g. soft/loud volume, slow/fast rhythm); other factors were related to past listening experiences and contextual cues (e.g. length of implant use, practise listening to music, and watching the performer). Still other factors were related to the acoustic properties of the listening environment, whether it was ambient sound or

through headphones (e.g. quiet environment, quality of recordings or speakers). In response to each item, the respondent was to mark a '+' if that factor enhanced music listening enjoyment, a '-' if that factor detracted from music listening enjoyment, a '0' next to factors that had no perceptible influence, and 'na' if they did not know or had not tried it. As mentioned in Section 1.5, practical methods or 'tips' for CI users on how to optimise their music listening experience would be useful to include in a MTP aimed at improving their music listening enjoyment.

Finally, the 'Music Training Program' section served to obtain information about the practicalities of implementing such a program. The questions in this section included whether respondents would be interested in undertaking one, the skills they feel are important for music listening enjoyment, and the logistics for a training program, for example, how long and how frequent they think the training sessions should be.

Throughout the questionnaire, respondents were given many opportunities to provide additional comments and detail.

2.2 Procedure

The final version of the questionnaire was sent to the Cooperative Research Centre for Cochlear Implants and Hearing Aid Innovation (CRC) in Melbourne at the start of August 2007. The CRC posted out the questionnaires in early-August. Each questionnaire was accompanied by an information sheet, containing instructions, and a consent form. Recipients were asked to complete the questionnaire and return both the consent form and questionnaire to CRC in the reply-paid envelope provided, by the end of August. A reminder/follow-up letter was then sent to the recipients who did not return their questionnaires and/or consent forms or who returned blank or incomplete questionnaires. The final date for receiving returned questionnaires was the end of September 2007.

The anonymity of the respondents from the researchers was ensured, with CRC managing the distribution and tracking of the questionnaires. A numerical coding system was used by CRC to assist them with tracking responses and issuing the follow-up letters. The coding system also enabled the collation of respondents' demographic data from the patient database. Demographic information was not obtained from respondents themselves, as firstly, the CRC had access to the patient database in Melbourne. Secondly, it would save respondents time as they would not have to

provide this information in the questionnaire. Lastly, it ensured better accuracy of the information; for example, respondents may not know the specific speech processing strategy that they use. The information that was required by the researchers included their age, the types of implant and speech processing strategies used, length of implant use, the duration of severe to profound hearing loss prior to implantation, and respondents' speech perception scores post-implantation. Information that may potentially identify the respondents was removed before the questionnaires were sent to the researchers in Christchurch, New Zealand.

2.3 Participants

Participants were recruited from a large CI clinic in Melbourne. Participants were required to be current CI users, at least 18 years of age, and have a postlingually-acquired hearing loss. Potential participants were excluded if they were implanted for less than six months, were poor CI performers or 'non-users', had English as their second language, had other major intellectual or physical impairment (e.g. dementia), had bilateral CIs, were unilateral hybrid users (i.e. had a CI and hearing aid on the same ear), or if they used now-obsolete speech processing strategies (e.g. MULTIPEAK or SPEAK).

2.3.1 Speech Measures

The open-set speech perception measures that were used by the clinic were the monosyllabic CNC (Consonant-Nucleus-Consonant) word lists (Peterson and Lehiste, 1962), in quiet, and the CUNY (City University of New York) sentence test (Boothroyd, Hanin & Hnath, 1985), in quiet and in noise (+10 signal-to-noise ratio). The CNC word list was scored as a percentage of phonemes correct, and the CUNY test was scored as a percentage of words correct. According to the clinic's protocols, stimuli were presented at 65 dB SPL, auditory-alone. This information was obtained from the patient database (i.e. it was not assessed or tested in this study).

3 Results

This chapter presents the results from this study. These are organised into the sections: 'Response Rate and Demographic Variables', 'Music Listening and Background', 'Sound Quality of Common Instrumental Sounds', 'Musical Styles', 'Music Preferences', 'Factors Affecting Music Listening Enjoyment', and 'Music Training Program'. Due to the quantity of data collected by the UCMLQ, only some of the results are presented here, namely, the results that would help us better understand CI users' appreciation of music and which could be used in the development of a MTP for improving music appreciation for CI users (as discussed in Section 1.5). The quantitative results for *all* parts of the questionnaire (including raw means, standard deviations, and the number of respondents for each question) are in Appendix 3, which you may wish to peruse for more detail. The qualitative responses and additional comments made by respondents are in Appendix 4.

It should be noted that the number of respondents for each question differed as some respondents did not answer all the questions. Hence, the degrees of freedom (df) and number of respondents for each question (n) are reported. Where applicable, two-tailed statistical tests with a significance value of $p < 0.05$ were used. For the correlations, the non-parametric Spearman's rho test was used as some of the subject-characteristic data failed the Kolmogrov-Smirnov test for normality. For the Analysis of Variance (ANOVA), only the respondents that gave ratings on ALL the scales were included, in order to fulfil the assumptions of an ANOVA. Thus, the means reported for the ANOVA may differ from the raw means, as many respondents did not give ratings on all the scales.

3.1 Response Rate and Demographic Variables

Based on the inclusion criteria discussed in the previous chapter, 221 possible CI users were identified. Of the 221 questionnaires that were sent, 133 (60%) replies were received. Of these, 100 (45%) questionnaires were fully or semi-completed, and were included in the study; twenty-eight (12.7%) recipients either returned incomplete questionnaires or replied to state that they were unable to participate due to poor health or because they did not listen to music; 5 questionnaires were returned unopened (2.3%).

The participants ranged in age from 18 to 88 years of age (mean = 62.1, SD = 17.1). The length of severe-to-profound deafness ranged from 0 to 60 years (mean = 13.4, SD = 12.8), and the length of implant use ranged from 1 to 19 years (mean = 4.11, SD = 3.07). (For more detail, please refer to Q1 - 4 of Appendix 3). All participants used the Nucleus CI24 implant and the ACE speech processing strategy.

3.2 Music Listening and Music Background

3.2.1 Audiologic Performance with the CI

Results from the speech perception tests measured at 12 months after implantation (obtained from the clinic database), are shown in Table 2. (For more detail, please also refer to Q1 - 4 of Appendix 3).

Table 2: Descriptive statistics for speech perception measures*

Speech Perception Measures	Mean	Range	n**
CNC words in quiet (% phonemes correct)	50.8	0 - 90	63
CUNY sentences in quiet (% words correct)	88.2	1.0 – 100	63
Sentences in noise (%)	66.3	0 – 100	58

*As measured 12 months after implantation.
**Not all patients had their 12-month speech perception scores recorded in the clinic database

The mean (M), standard deviation (SD) and range of scores for the 'amount of time spent listening to music' and 'music listening enjoyment' for three points in time: 'pre-hearing loss', 'in the time just prior to getting a CI' and 'now, with a CI', are shown in Table 3. (For more detail, please refer to Q8a-c and Q9 of Appendix 3).

Table 3: Descriptive statistics for the 'amount of time spent listening to music' and 'music listening enjoyment'

	Pre-hearing loss	In time just prior to getting a CI	Now, with a CI
Amount of time spent listening to music (0=never, 5=sometimes, to 10=very often)	M = 7.20 *(SD=2.93)*	M = 3.30 *(SD=3.12)*	M = 4.58 *(SD=3.34)*
Music listening enjoyment (0=did not enjoy at all, 5=neutral, to 10=greatly enjoyed)	M = 8.37 *(SD=2.17)*	M = 3.71 *(SD=3.28)*	M = 5.15 *(SD=3.61)*

Note that the range for all the scores is 0 - 10.

3.2.2 Correlations

To determine whether music listening habits and enjoyment are related to participants' demographic characteristics and/or their audiologic performance with their implant, the ratings for 'time spent listening to music' and 'music listening enjoyment' were correlated with the following measures: age, length of severe-to-profound deafness, length of implant use, and speech perception measures. (A correlation matrix for these measures can be seen in Appendix 3, 'Correlations'.)

Strong significant correlations ($rho > 0.5$, $p < 0.001$) were found between:

- music listening enjoyment & time spent listening to music ($rho = 0.853$, $p < 0.001$)
- all three speech perception measures ($rho \geq 0.675$, $p < 0.001$).

Weaker but significant correlations ($rho < 0.5$, $p < 0.05$) were found between:

- time spent listening to music & CUNY sentence score in noise (+10 dB SNR) ($rho = 0.375$, $p = 0.004$)
- music listening enjoyment & CUNY sentence score in noise ($rho = 0.359$, $p = 0.007$)
- age & time spent listening to music ($rho = -0.208$, $p = 0.039$)
- age & music listening enjoyment ($rho = -0.231$, $p = 0.023$)
- age & CNC word score in quiet ($rho = -0.301$, $p = 0.016$)
- age & CUNY sentence score in quiet ($rho = -0.340$, $p = 0.006$)
- length of severe-to-profound deafness & CNC word score in quiet ($rho = -0.370$, $p = 0.003$)
- length of severe-to-profound deafness & CUNY sentence score in quiet ($rho = -0.314$, $p = 0.012$).

3.2.3 CI+HA versus CI-only

The devices or combination of devices that respondents used to listen to recorded music and live music are shown in Table 4. From this table, it can be seen that a similar number of respondents either used the CI+HA or the CI-only to listen to music.

Table 4: The device or combination of devices that respondents used to listen to recorded and live music

Device	Recorded Music	Live Music
CI and Hearing Aid	41.5%	47.0%
CI-only	46.2%	45.0%
Hearing Aid-only	2.8%	1.0%
CI with DAI[a]	2.8%	-
HA with DAI[a]	0.0%	-
CI with T-coil	0.9%	-
CI and Hearing Aid (x2)	0.9%	-
Not applicable	4.7%	7.0%
Did not answer	9	5
n*	106	100

[a] DAI = Direct Audio Input
*Some respondents used more than one device or combination of devices to listen to music.

Respondents were also asked to compare the sound quality of music as heard through the different devices. 39.8% of respondents (n=93) noticed a difference in the sound quality of music between the CI+HA and the CI-only, 16.1% did not notice any difference and 44.1% said they had 'never tried it'. For the 32 respondents that *did* notice a difference in sound quality, 92.9% reported that the CI+HA gave a *better* sound quality. 7.1% (or 2 out of 37 respondents) reported that the CI-only gave a better sound quality. (For more detail, please refer to Q18a of Appendix 3).

For some of the statistical analyses in the following sections (e.g. analyses on the ratings given for instrumental sounds and musical styles), respondents were separated into two groups: CI+HA users and CI-only users. For these analyses, 45 respondents were in the CI+HA group (including the respondent who used a CI and two hearing aids), and 46 respondents were in the CI-only group (including the respondent that used a CI with Direct Audio Input). Nine respondents were excluded because they did not indicate which type of device or combination of devices they used to listen to music, or they did not listen to music.

When respondents were asked to rate how melodies sound with an implant on a visual analog scale from 0 to 10, where 0 = monotonic and 10 = melodic (as mentioned in Section 2.1.1), the mean rating was 5.02 (SD = 3.39, n = 80). The mean ratings given by the two groups, CI+HA users and the CI-only users, were very similar: 5.03 (SD = 3.48) and 5.01 (SD = 3.35), respectively. An independent samples t-test showed that there was no significant difference between these mean ratings ($p = 0.976$). (For more detail, please refer to Q26 of Appendix 3).

3.3 Sound Quality of Common Instrumental Sounds

Respondents rated the sound quality of common instrumental sounds on the rating scales: 'unpleasant—pleasant' and 'unnatural—natural'. They also gave ratings on the scales: 'empty—full', 'dull—sharp', 'more noisy—less noisy', 'tinny—rich' and 'rough—smooth'. For these particular scales, respondents were required to give ratings based on how they expect the instruments to sound to a person with NH. (For the descriptive statistics on respondents' ratings on these scales, please refer to Q28, Appendix 3.)

In order to determine which instruments were rated as significantly 'emptier' or 'fuller', 'duller' or 'sharper', etc. than expected, data pertaining to each scale were analysed separately. In addition, in order to obtain an overview of the responses, the ratings for 'pleasantness' and 'naturalness' were combined for analysis. These scales were combined as for both these scales, a higher rating denotes a more favourable response. For example, if the mean for the guitar was higher than the mean for brass, this suggests that the sound quality of the guitar was rated more favourably (i.e. more pleasant and more natural) than brass. A strong correlation was also found between these two scales ($r = 0.941$, $p < 0.001$). For the other rating scales (empty—full, dull—sharp, etc.), respondents were required to give ratings based on how they expect the instruments to sound to a person with NH. In addition, a higher rating did not necessarily denote a more favourable rating. Hence, the ratings for the sound qualities, empty—full, dull—sharp, etc., were not combined with the 'pleasant and natural' ratings.

Shown in Figure 5 are the mean ratings for the combined pleasant and natural scales. Although the CI+HA group were observed to have rated all of the instruments, except for the drum kit, as more pleasant and natural than the CI-only users, a two-way Repeated Measures ANOVA (RM ANOVA) did not reveal a significant difference between the two groups' ratings. The results of two-way RM ANOVAs for all of the ratings are shown in Table 5. As can be seen in Table 5, no significant group effects or group by instrument interaction effects were found for any of the rating scales. However, significant instrument effects were found for all scales except for the 'tinny—rich' scale. Significant instrument effects were followed up with post-hoc analyses using the Tukey test. The results of these post-hoc analyses are shown in Figures 6 to 10.

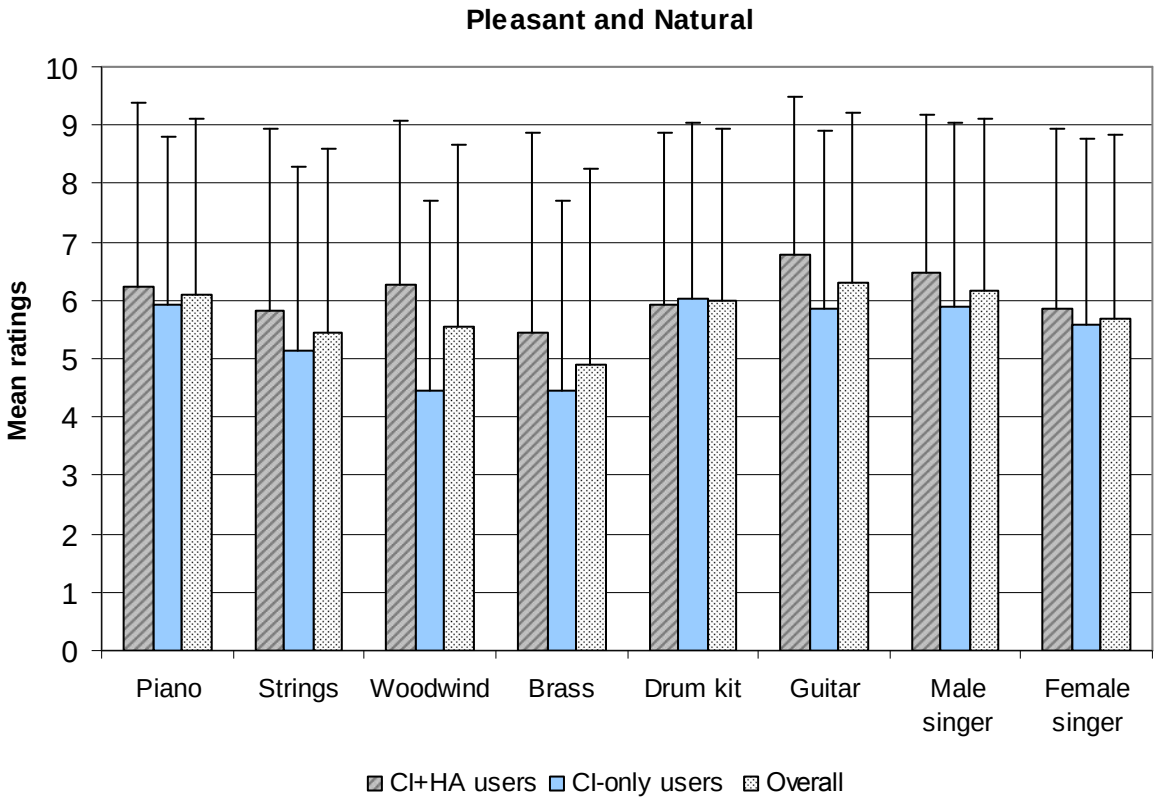


Figure 5: Mean ratings (groups and overall) for the combined 'pleasant' and 'natural' scales.
(Error bars = 1 standard deviation)

Table 5: Results of two-way repeated measures ANOVAs on instrument sound quality ratings.

Ratings	n[a]	Group Effect	Instrument Effect	Group by Instrument Interaction Effect
Pleasant and Natural	500	p = 0.406	p < 0.001**	p = 0.692
Empty—Full	537	p = 0.514	p < 0.001**	p = 0.949
Dull—Sharp	504	p = 0.128	p < 0.001**	p = 0.990
Tinny—Rich	502	p = 0.294	p = 0.052	p = 0.659
Less Noisy—More Noisy	510	p = 0.085	p = 0.007*	p = 0.280
Rough—Smooth	500	p = 0.525	p = 0.004**	p = 0.881

[a]These 'n' differ as only the respondents that provided ratings for ALL instruments were included.
Significance: *p<0.05, **p<0.005

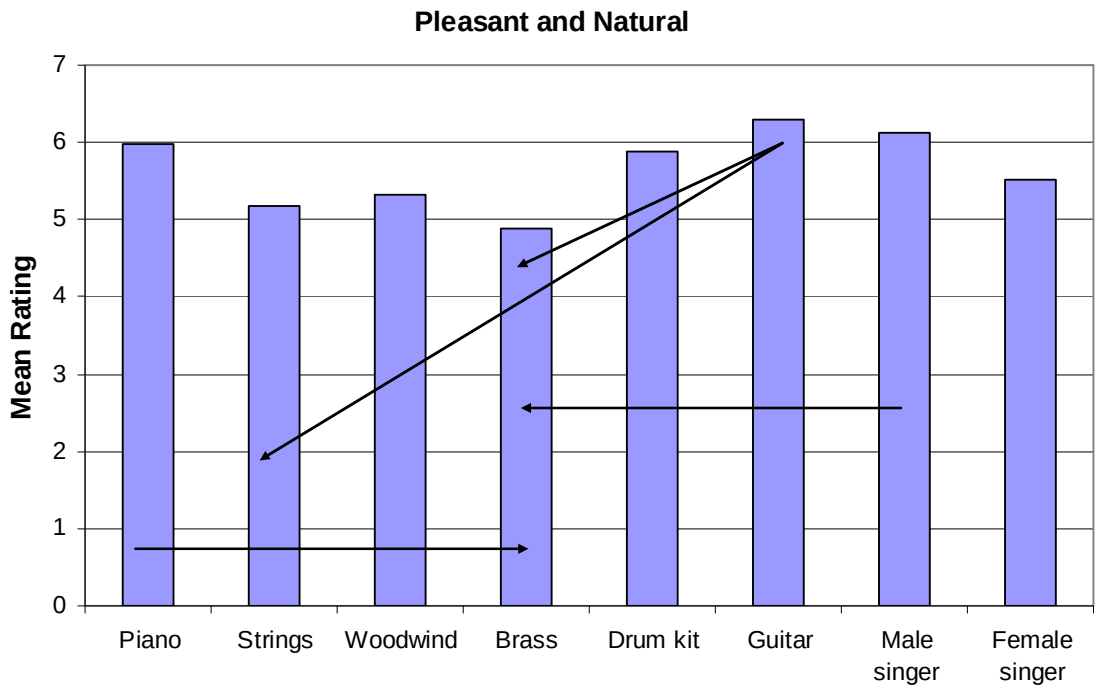


Figure 6: Mean ratings for the combined 'pleasant' and 'natural' scales for instruments.
(Arrows indicate significant differences between instruments ($p = 0.001$ for guitar versus brass, $p = 0.02$ for guitar versus strings, $p = 0.006$ for male singer versus brass, and $p = 0.028$ for piano versus brass)).

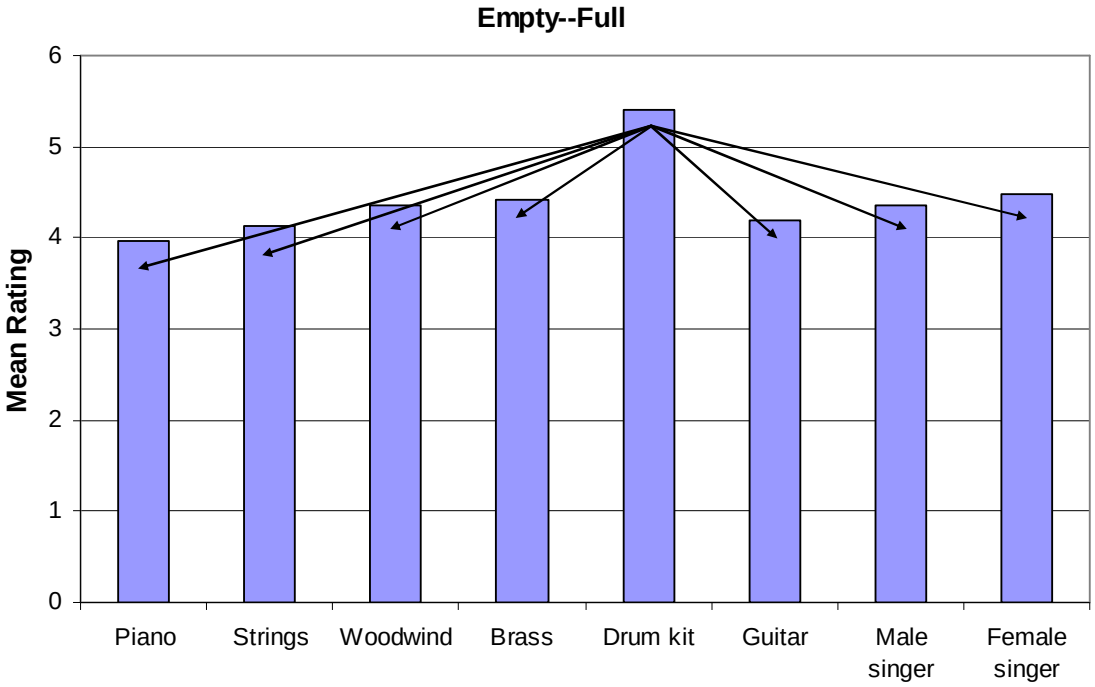


Figure 7: Mean ratings on the 'empty—full' scale for instruments.
(Arrows indicate significant differences between instruments ($p < 0.001$ for drum kit versus piano, drum kit versus strings, and drum kit versus guitar; $p = 0.002$ for drum kit versus male singer, $p = 0.006$ for drum kit versus woodwind, $p = 0.010$ for drum kit versus brass and drum kit versus female singer)).

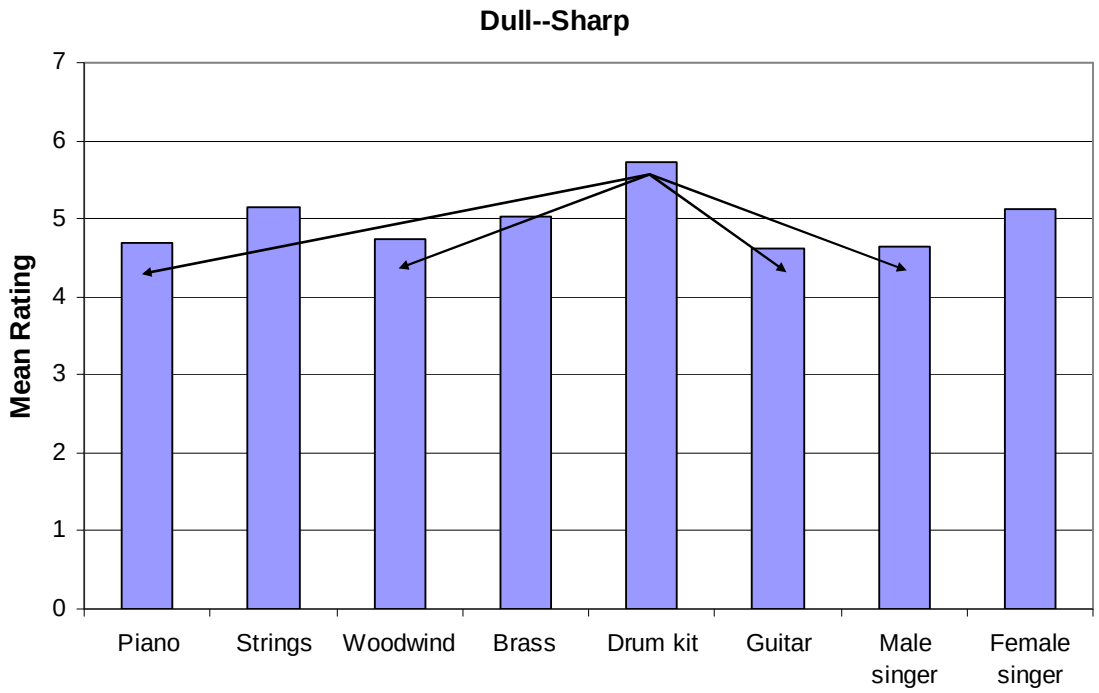


Figure 8: Mean ratings on the 'dull—sharp' scale for instruments.
(Arrows indicate significant differences between instruments ($p = 0.003$ for drum kit versus guitar, and drum kit versus male singer, $p = 0.005$ for drum kit versus piano and $p = 0.031$ drum kit versus woodwind)).

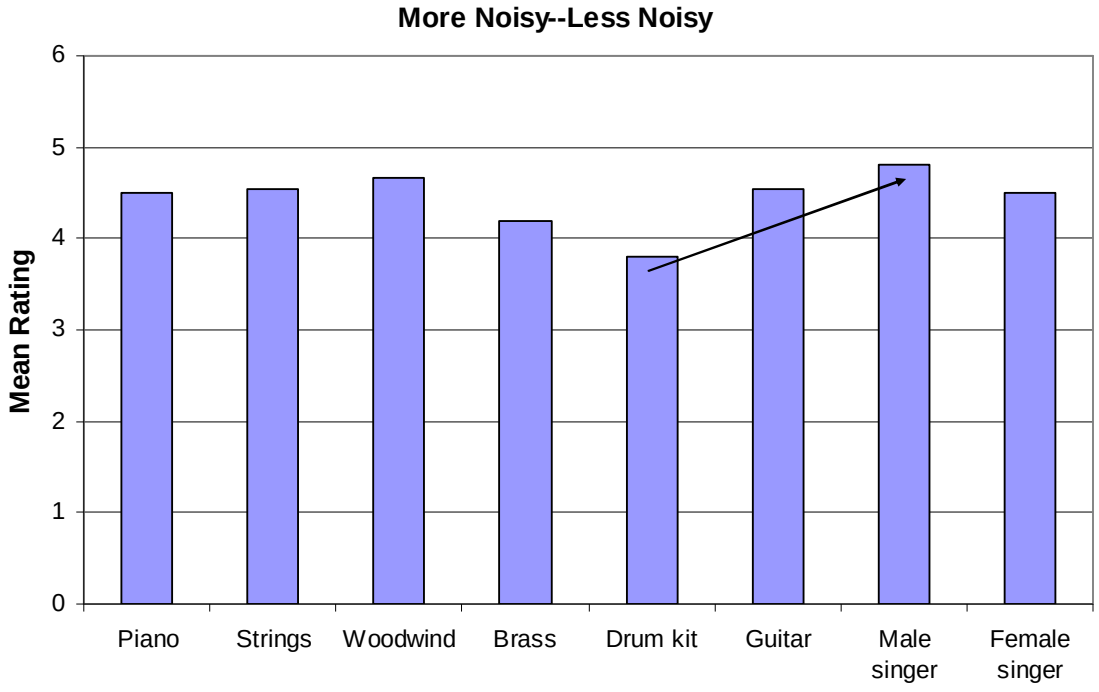


Figure 9: Mean ratings on the 'more noisy—less noisy' scale for instruments.
(Arrows indicate significant differences between instruments ($p = 0.003$ for male singer versus drum kit)).

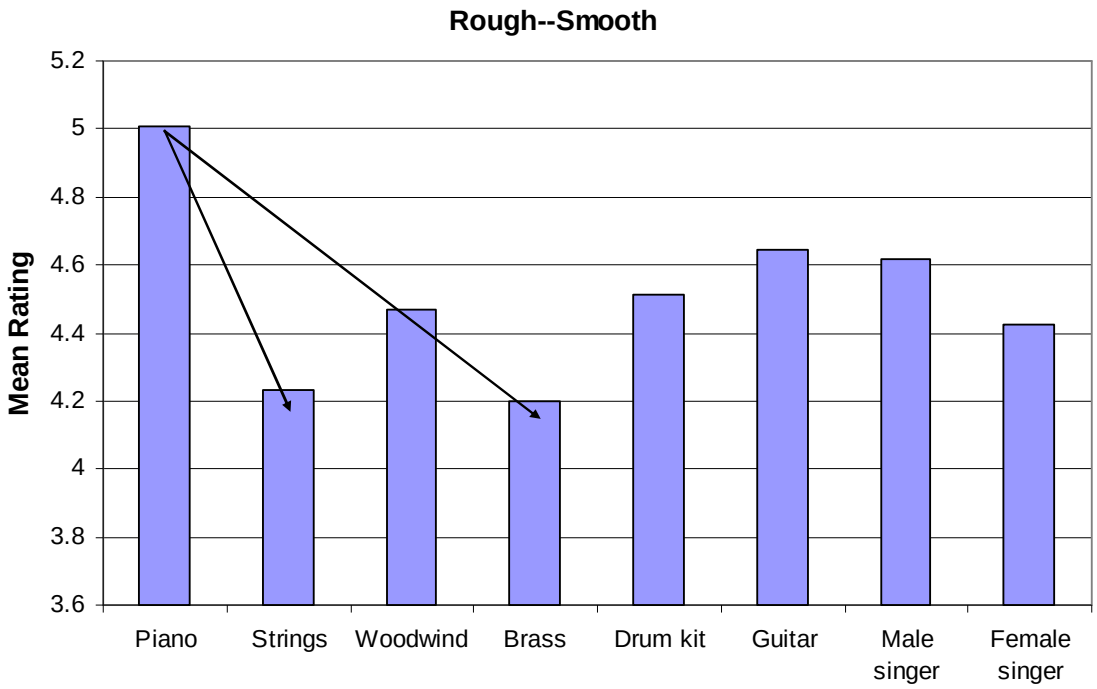


Figure 10: Mean ratings on the 'rough—smooth' scale for instruments.
(Arrows indicate significant differences between instruments ($p = 0.004$ for piano versus brass, and $p = 0.007$ for piano versus strings)).

As can be seen in Figure 6, respondents (CI+HA users *and* CI-only users) rated the:

- Guitar as significantly more pleasant and more natural than both brass and strings;
- The male singer as significantly more pleasant and more natural than brass; and the
- Piano as significantly more pleasant and more natural than brass.

As shown in Figures 7 and 8, respondents rated the:

- Drum kit as significantly fuller than all other instruments (Figure 7); and the
- Drum kit as significantly sharper than the guitar, male singer, piano and woodwind (Figure 8).

Finally, as shown in Figures 9 and 10, respondents rated the:

- Drum kit as significantly noisier than the male singer (Figure 9); and the
- Piano as significantly smoother than both brass and strings (Figure 10).

In summary, CI+HA users rated the sound quality of instrumental sounds similarly to CI-only users. In terms of respondents' (CI+HA *and* CI-only users) ratings on particular instrumental sounds, respondents rated:

- the guitar as significantly more pleasant and more natural than the brass and string families, and significantly ‘emptier’ and ‘duller’ than the drum kit;
- brass as significantly less pleasant and less natural than the guitar, male singer and piano, and significantly ‘emptier’ than the drum kit;
- the drum kit as significantly ‘fuller’ than all other instruments, significantly ‘sharper’ than the guitar, male singer, piano and woodwind, and significantly ‘noisier’ than the male singer;
- the piano as significantly ‘less rough’ than the brass and string families; and
- no instrument as significantly ‘tinnier’ or ‘richer’ than another instrument.

In order to determine whether respondents rated the sound quality of instruments as significantly different to what they would expect them to sound to a person with NH, 1-sample t-tests were carried out to see if their ratings were significantly different to the ‘as expected’ score of 5. That is, a significant p-value would suggest that the instrument deviated from how respondents expected it to sound to a person with NH, for the particular dimension being rated. The results of the 1-sample t-tests are shown in Table 6.

Table 6: Results of 1-sample t-tests (means and p-values) on instrument sound quality ratings

	Emptier	Noisier	Tinnier	Rougher	Duller/Sharper
Piano	4.03 p<0.001	4.43 p=0.025	4.17 p=0.005	4.95	4.67
Strings	4.19 p=0.009	4.47	4.03 p=0.005	4.13 p=0.002	5.00
Woodwind	4.28 p=0.050	4.53	4.28	4.43	4.67
Brass	4.06 p=0.001	4.06	4.17 p=0.012	4.19 p=0.006	5.14
Drum kit	5.59	3.74 p<0.001	4.77	4.48 p=0.049	5.72 p=0.010
Guitar	4.26 p=0.005	4.50, p=0.048	4.21 p=0.004	4.71	4.61
Male singer	4.30 p=0.013	4.76	4.46	4.46 p=0.017	4.59
Female singer	4.44 p=0.047	4.47 p=0.032	3.98 p<0.001	4.31 p=0.002	5.14

Note: unshaded cells indicate that the instruments sound ‘as expected’ for that particular sound quality (i.e. the mean scores were not significantly different to the ‘as expected’ score of 5).

As can be seen in Table 6, respondents rated the following as sounding significantly different to what they expected them to sound to a person with NH:

- all instruments, except the drum kit, as significantly ‘emptier’ than expected;
- half the instruments as significantly ‘noisier’ than expected;
- most instruments, except the piano, woodwind and guitar, as significantly ‘rougher’ than expected;
- more than half of the instruments as significantly ‘tinnier’ than expected (the exceptions were woodwind, drum kit and the male singer); and
- only one instrument (drum kit) as significantly sharper than expected.

Specifically, for each instrument/instrumental family:

- the female singer was significantly emptier, noisier, tinnier and rougher than expected;
- strings and brass was significantly emptier, tinnier and rougher than expected;
- the piano and guitar was significantly emptier, noisier and tinnier than expected;
- the drum kit was significantly noisier, rougher and sharper than expected;
- the male singer was emptier and rougher than expected; and
- the woodwind was significantly emptier than expected.

3.4 Musical Styles

Respondents rated various musical styles on the scales of unpleasant—pleasant, simple—complex, can never—can always follow melody-line, can never—can always identify style by listening-alone, and sounds nothing—sounds exactly like it would sound to a person with NH. (The latter scale will be referred to as ‘doesn’t sound like normal—sounds like normal’. Please also note that the descriptive statistics on respondents’ ratings on each scale, can be found in Appendix 3, Q30.). As well as analysing the data separately for each rating scale, the ratings for all of the scales, except for simple—complex, were combined to give an overview of the responses. These scales were combined as for each of the scales, a higher rating denotes a more favourable response. Furthermore, strong correlations were found between these scales (as described below). For the ‘complexity’ scale (where 0 = simple to 10 = complex), a higher rating is not equivalent to a more favourable rating. In fact, it was shown that a *simple* music structure enhanced music listening enjoyment for CI users (Gfeller et al., 2000a). Hence, the simple—complex ratings were not combined with the other ratings for the overall analysis.

As mentioned above, strong positive correlations (rho > 0.5, $p < 0.001$ for all of the comparisons) were found between the following rating scales:

- pleasantness & follow melody-line (rho =0.726)
- pleasantness & identify style (rho = 0.643)
- pleasantness & sounds normal (rho = 0.757)
- follow melody-line & identify style (rho = 0.823)
- follow melody-line & sounds normal (rho = 0.816)
- identify style & sounds normal (rho = 0.750)

In addition, a slight positive correlation was found between the pleasantness and complexity ratings (rho = 0.185; $p = 0.0015$).

Shown in Table 7 are the results of two-way RM ANOVAs on the combined ratings, as well as the ratings given on each of the individual scales. As can be seen, no significant group by style interaction effects were found. However, significant group effects were found for the combined ratings, as well as for the individual scales of can never—can always follow the melody-line, can never—can always identify the style, and doesn't sound like —sounds like normal. For these scales, CI+HA users gave significantly higher mean ratings than CI-only users. Significant style effects were also found for the combined ratings, as well as for the scales of unpleasant—pleasant, can never—can always follow the melody-line, and sounds like—doesn't sound like normal. The significant style effects were followed up with post-hoc analyses using the Tukey test. The results of these post-hoc analyses are shown in Figures 11 to 14.

Table 7: Results of two-way repeated measures ANOVAs on musical styles ratings.

Ratings	n[a]	Group Effect	Style Effect	Group by Style Interaction Effect
Combined Ratings[b]	308	p = 0.028*	p = 0.004**	p = 0.934
Unpleasant—Pleasant	332	p = 0.347	p = 0.042*	p = 0.732
Complexity	304	p = 0.156	p = 0.900	p = 0.068
Can Never—Can Always Follow Melody-line	334	p = 0.014*	p = 0.004**	p = 0.792
Can Never—Can Always Identify Style	325	p = 0.010*	p = 0.055	p = 0.599
Doesn't sound like—Sounds like normal	336	p = 0.009*	p = 0.008*	p = 0.915

[a]These 'n' differ as only the respondents that provided ratings for ALL instruments were included.

[b]An average of all the ratings except the complexity ratings.

Significance: *p<0.05, **p<0.005

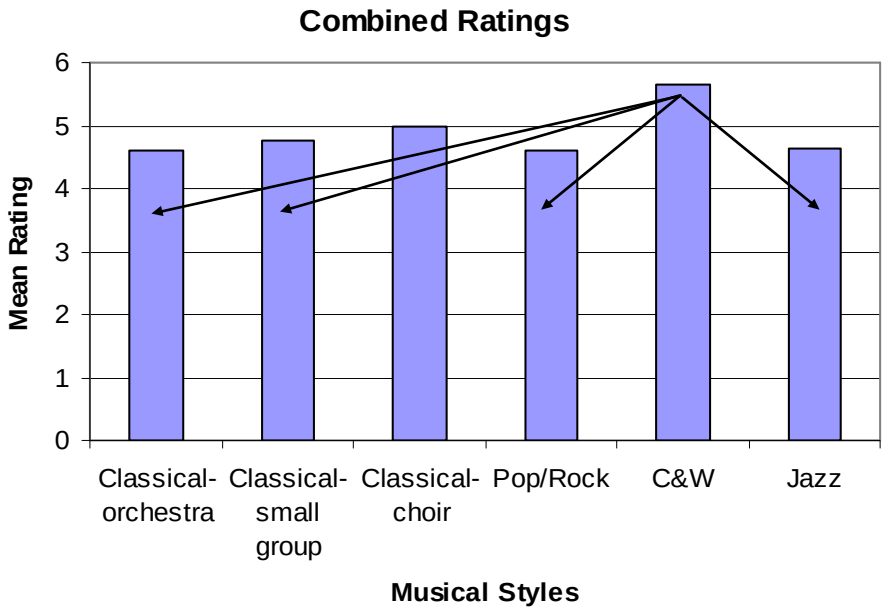


Figure 6: The combined ratings (average of all ratings except the complexity ratings) for musical styles. (Arrows indicate significant differences between musical styles (p = 0.007 for Country and Western (C&W) versus Classical-orchestra, p = 0.008 for C&W versus Pop/Rock, p = 0.016 for C&W versus Jazz, p = 0.047 for C&W versus Classical-small group)).

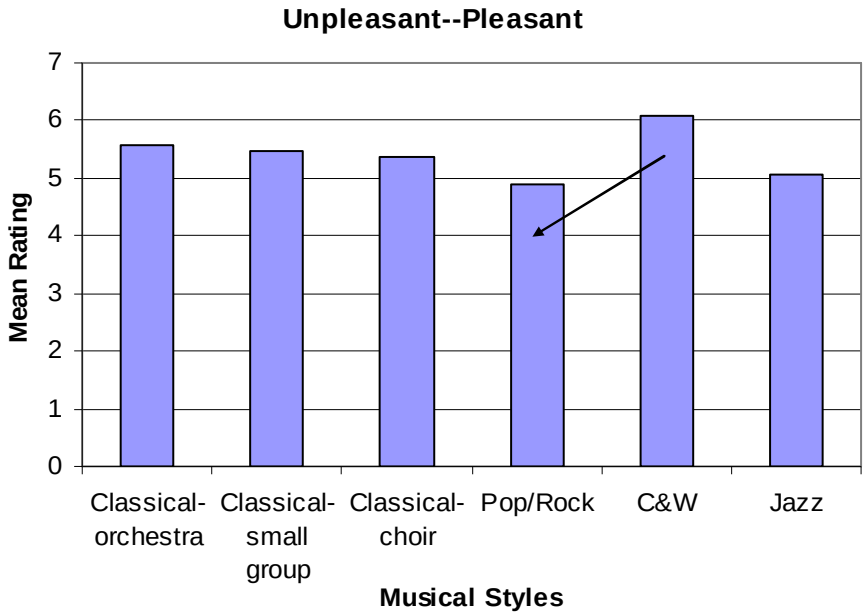


Figure 7: Mean ratings on the 'unpleasant—pleasant' scale for musical styles.
(Arrows indicate significant differences between musical styles (p = 0.022 for Country and Western (C&W) versus Pop/Rock)).

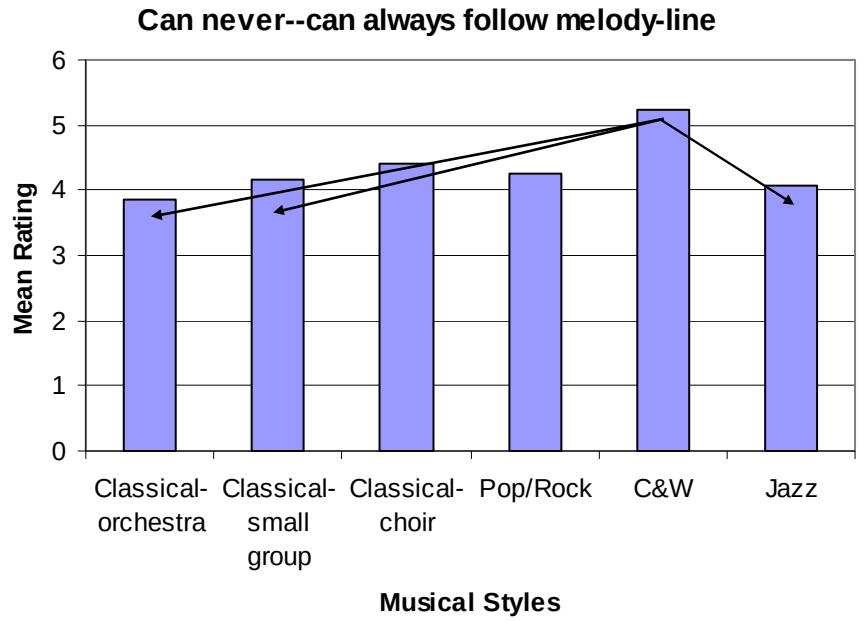


Figure 8: Mean ratings on the 'Can never—can always follow melody-line' scale for musical styles. (Arrows indicate significant differences between musical styles (p = 0.002 for Country and Western (C&W) versus Classical-orchestra, p = 0.025 for C&W versus Jazz)).

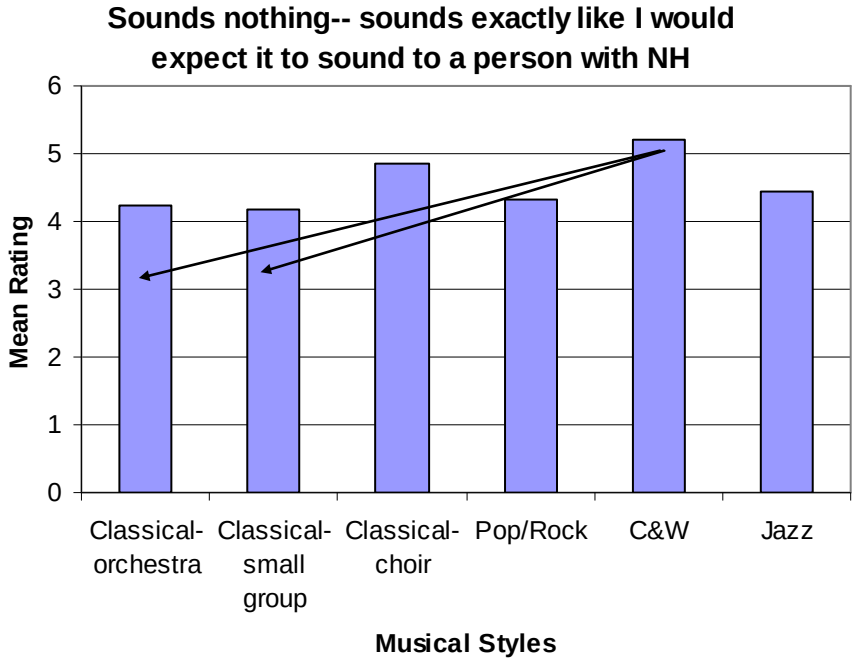


Figure 9: Mean ratings on the 'Sounds nothing—sounds exactly like I would expect it to sound to a person with NH' scale for musical styles. (Arrows indicate significant differences between musical styles ($p = 0.021$ for Country and Western (C&W) versus Classical-small group, and $p = 0.033$ for C&W versus Classical-orchestra)).

As can be seen in Figure 11 to 14, respondents (CI+HA users *and* CI users) rated:

- Country and Western significantly more favourably for the combined ratings than Classical-orchestra, Pop/Rock, Jazz, and Classical-small group ;
- Country and Western as significantly more pleasant than Pop/Rock;
- That they were significantly more able to follow Country and Western than Classical-orchestra , Jazz, and Classical-small group;
- Country and Western to sound significantly 'more normal' than Classical-small group and Classical-orchestra.

In summary, for all musical styles, CI+HA users felt that they were significantly more able to follow the melody-line and identify the style than CI-only users. In addition, all styles sounded significantly 'more normal' for CI+HA users than they did for CI-only users. Respondents (CI+HA users and CI-only users) also rated Country and Western significantly more favourably than all other styles except for Classical-choir. In other words, Country and Western was significantly more pleasant-sounding, respondents felt that they were more able to follow and identify this style, and this style

sounded more normal than all the other styles, except for Classical-choir. Lastly, in terms of complexity, no style was rated as significantly simpler or more complex than another style.

In response to ‘whether they would like musical instruments and singers to sound like they would to a normally hearing person’, 98% of 62 respondents said ‘yes’ and 2% said ‘no’. Similarly, in response to ‘whether they would like music to sound normal’, 98% of 92 respondents said ‘yes’ and 2% said ‘no’. For those that answered ‘no’ to either question, no comments or reasons were given. (For more detail, please refer to Q29 and Q31, respectively, in Appendix 3).

3.5 Music Preferences

For the respondents that indicated their preference for types of singer (n = 88), a greater proportion preferred male singers (38%) to female singers (11%), although 50% of respondents indicated no preference, and 1% of respondents ‘didn’t know’. For the preferred pitch for instruments (n = 88), a greater proportion preferred low-pitched instruments (53%) to high-pitched instruments (7%), 39% had no preference, and 1% ‘didn’t know’. In regards to their preferred type of music (n = 86), 30% preferred music with ‘instrument and voice’, 17% preferred ‘instrumental-only’ music and only 6% preferred ‘voice-only’ music, although a large proportion of respondents (46%) indicated that they had no ‘preferred type’ of music, and 1% ‘didn’t know’. (For more detail, please refer to Q33a-c of Appendix 3).

In regards to the preferred number of performers, a Friedman RM ANOVA on Ranks revealed that there was a significant difference in the rankings (chi square = 133.011, df = 4, $p < 0.001$). Shown in Table 8 are the median rankings. Post-hoc analyses using the Tukey test revealed that respondents significantly preferred:

- one, two and three performers over a ‘large group’;
- one and two performers over a ‘small group’;
- one performer over two and three performers; and
- two performers over three performers.

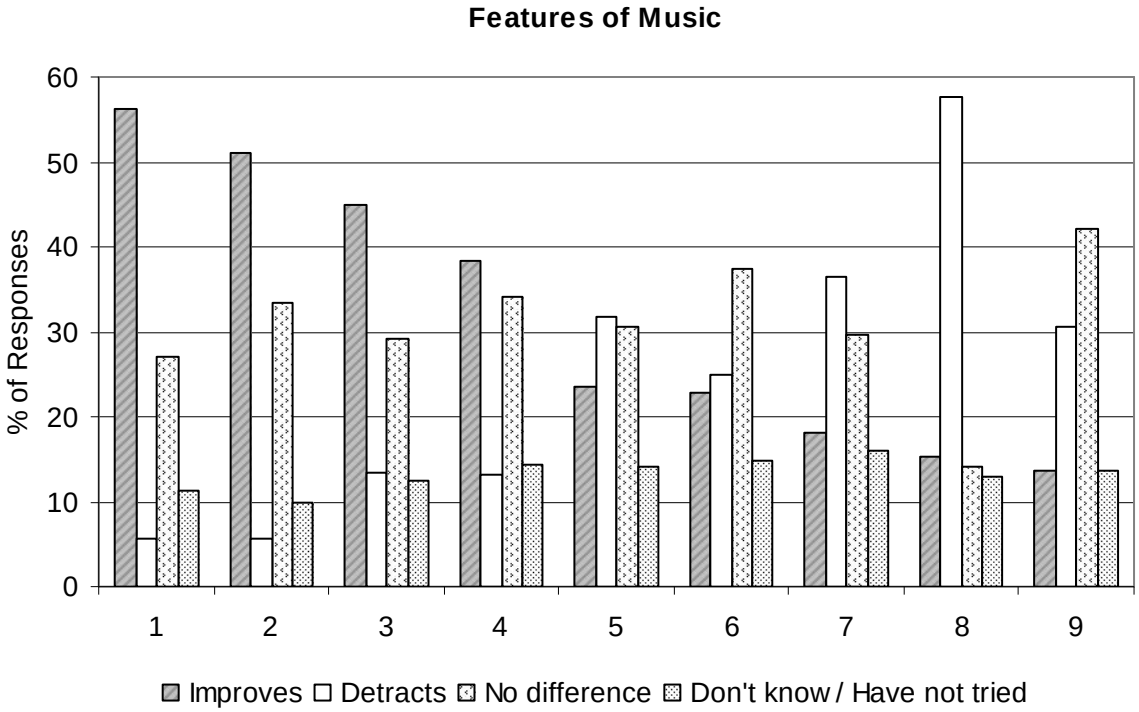
Table 8: 'Number of performers' ranked from 'most preferred' (=1) to 'least preferred' (=5).

Number of Performers	Median Ranking*
One performer	1
Two performers	2
Three performers	3
Small group (e.g. 4 to 5)	4
Large group of performers (e.g. orchestra)	5

* n=83 (respondents that ranked ALL types of performers).

3.6 Factors Affecting Music Listening Enjoyment

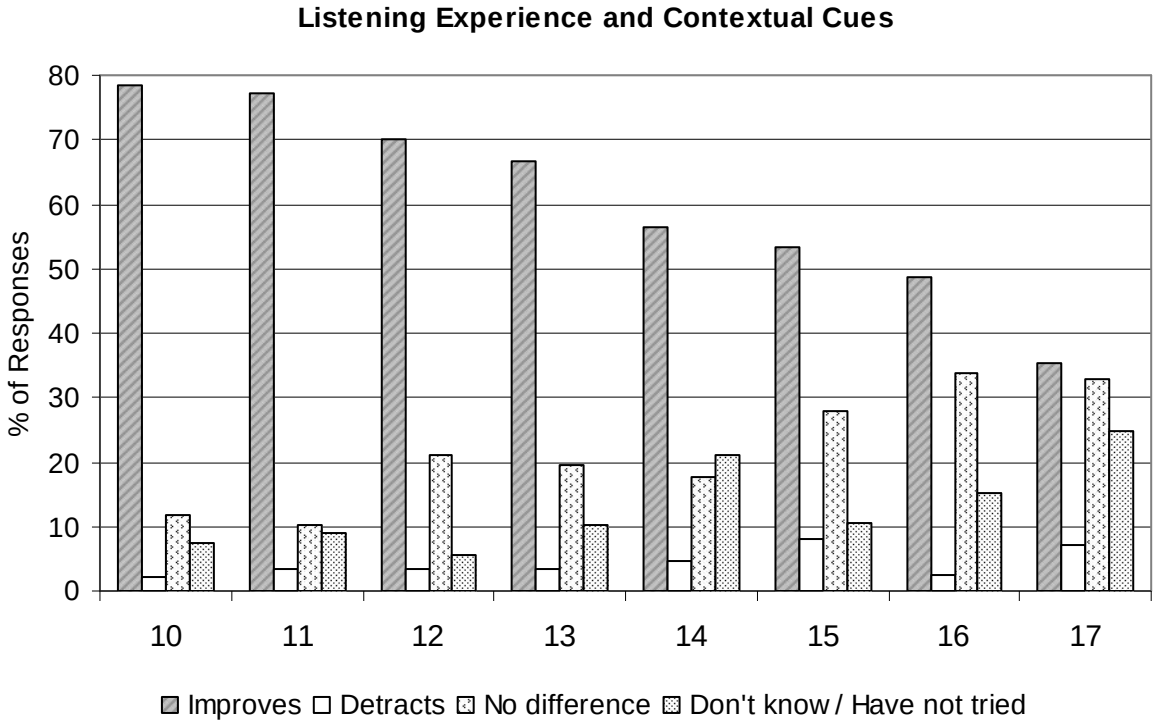
Shown in Figures 15 to 17 are respondents' views on how various factors affect their music listening experiences. Figure 15 contains factors that are related to features of music, Figure 16 contains factors that are related to past listening experiences and contextual cues, and Figure 17 contains factors that are related to the overall listening environment. (For more detail on the results presented in these figures, please refer to Q39 in Appendix 3).



Key:

1 Medium volume
2 Slow rhythm or beat
3 With words (to any style of music)
4 Tune with harmony/accompaniment
5 Soft volume
6 Without words (to any style of music)
7 Tune with no harmony (or accompaniment)
8 Loud volume
9 Fast rhythm or beat

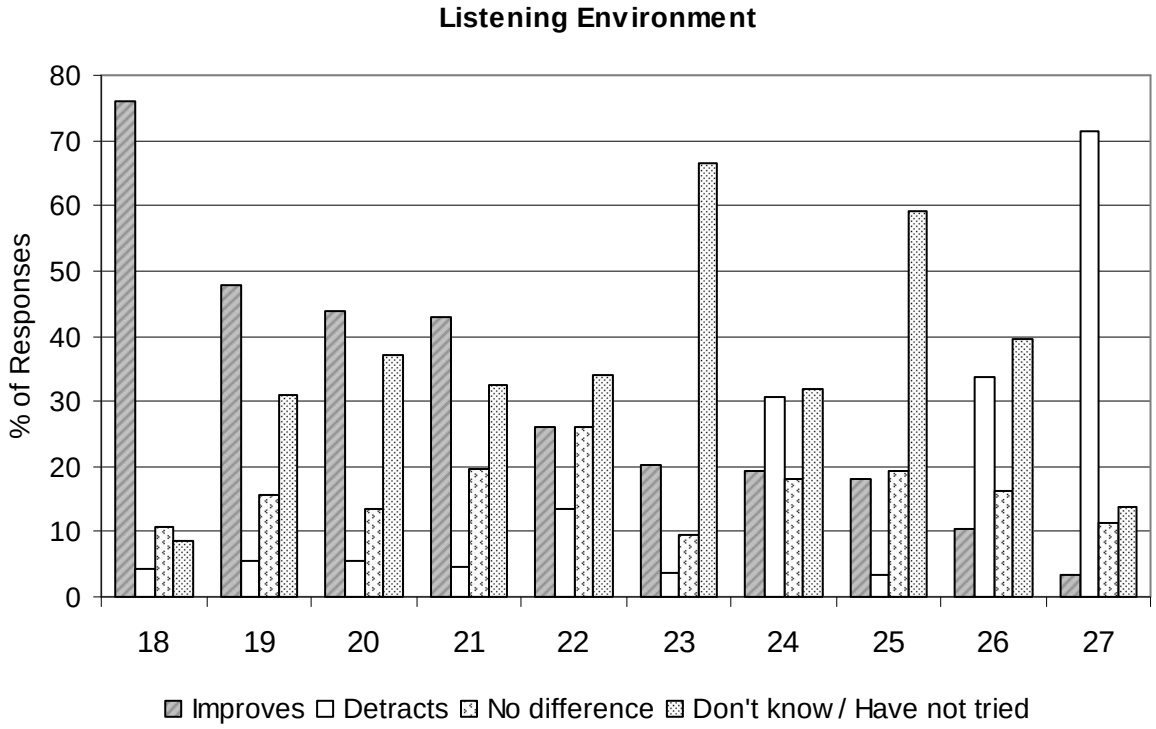
Figure 10: Features of music which enhance or detract from music listening enjoyment.



Key:

10	Familiarity with music	14	Following the musical score or words
11	Familiarity with lyrics/words	15	Knowing the context
12	Knowing the song title	16	Increased time/experience with CI
13	Watching the performer	17	Practise listening to music

Figure 11: Factors related to respondents' past listening experiences and contextual cues which enhance or detract from music listening enjoyment.



Key:

18	Quiet environment	23	Direct audio input (DAI)
19	High quality speakers	24	Live concert, indoors
20	Using a hearing aid with CI	25	High quality headphones
21	High quality recordings	26	Live concert, outdoors
22	Sitting at the front of a hall/theatre	27	Echoey room

Figure 12: Factors related to the listening environment which enhance or detract from music listening enjoyment.

As shown in Figure 15, features of music that were rated most frequently as factors that improve music listening enjoyment were: medium volume (56%), slow rhythm/beat (51%), and the presence of words (45%). The feature that was rated most frequently as hindering listening enjoyment was a loud volume (58%). A similar proportion of respondents indicated that a soft volume impeded (32%) or 'made no difference' (31%) to listening enjoyment.

As Figure 16 illustrates, factors related to past listening experiences and contextual cues which were rated most frequently as improving listening enjoyment were: familiarity with music (78%), familiarity with the lyrics (77%), knowing the song title (70%), watching the performer (67%), following the musical score or words (56%), knowing the context in which the music is being played (53%) and increased time/experience with the CI (49%). A similar proportion of respondents

indicated that practise listening to music (35%) improved or ‘made no difference’ (33%) to listening enjoyment.

As shown in Figure 17, factors related to the listening environment which were rated most frequently to improve listening enjoyment were: a quiet environment (76%), high quality speakers (48%), high quality recordings (43%), and using a hearing aid with the CI (44%). The factor that was rated most frequently to hinder listening enjoyment was an ‘echoey’ room (71%). A large proportion of respondents indicated that they did not know if the following factors improved or detracted from their listening enjoyment: direct audio input (67%) and high quality headphones (59%).

3.7 Music Training Program

For the 84 respondents that answered the question, ‘Would you be interested in a MTP if one becomes available?’, 54% said that they would be interested in one and 2% ‘didn’t know’. When asked to rank eight skills in terms of how important they are to their music listening enjoyment, a Friedman RM ANOVA on Ranks revealed that there was a significant difference in rankings (chi square = 72.659, df = 7, $p < 0.001$). Shown in Table 9 are the median rankings. Post-hoc analyses using the Tukey test revealed that:

- being able to recognise previously-known tunes (known before implantation), commonly-known tunes, and commonly-known instruments were significantly more important than being able to hear more-complex rhythms;
- being able to recognise previously-known tunes and commonly-known tunes were significantly more important than learning new tunes and being able to recognise musical styles; and
- being able to recognise previously-known tunes was significantly more important than being able to “pick out” the tune from the harmony.

Table 9: Eight music listening skills ranked from 'most important' (=1) to 'least important' (=8).

Music Listening Skills	Median*
Ability to recognise previously-known tunes (known before CI)	1
Ability to recognise commonly-known tunes	2
Ability to recognise commonly-known instruments	3
Ability to hear changes in pitch	3
Ability to recognise musical styles	4
Ability to "pick out" the tune when it is presented with harmony.	4
Learning new tunes	5
Ability to hear more complex rhythms	5.5

* n=64 (respondents that ranked ALL music listening skills).

A greater proportion of respondents (n = 61) would like the MTP to cover a wide range of styles (65%) as opposed to their preferred style (30%), and 5% 'didn't know'. (For more detail, please refer to Q43 of Appendix 3).

With regards to how long each training session should last for, and how many times per week, the most common responses were 30 minutes (mean = 35.6, SD = 14.5, range = 10 to 60 minutes, n = 60) and 2 times per week (mean = 2.66, SD = 1.58, range = 1 to 7, n = 61). Four respondents (#53, #75, #104 and #131) also commented on the need for flexibility regarding the length of training sessions, as will be discussed in the next chapter. (Their comments can be seen in Appendix 4, Question 48.)

Shown in Figure 18 are respondents' preferred modes of delivery for the MTP. (For more detail, please refer to Q46 of Appendix 3). As can be seen from this figure, almost half of the respondents preferred a DVD. In addition, five respondents commented that the DVD should have *subtitles*. (The comments can be seen in Appendix 4, Question 46 - #140 and #145 and Question 48 - #131, #134, #159.) 79% of 80 respondents also said that they would find an accompanying written manual helpful. (For more detail, please refer to Q47 of Appendix 3).

In summary, presented in this chapter are the major findings of this questionnaire. Other results from the questionnaire are in Appendix 3.

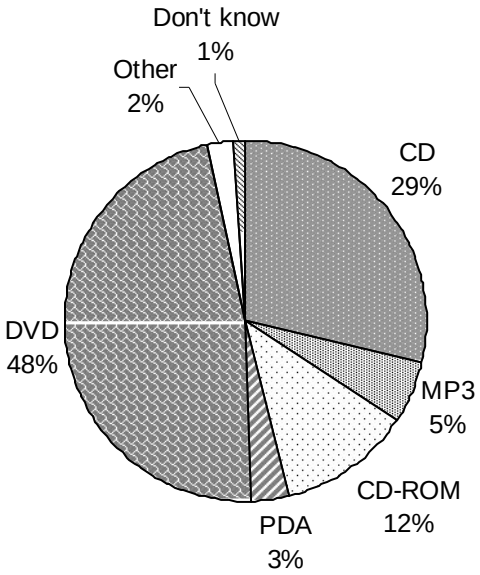


Figure 13: The preferred mode of delivery for the MTP.
(n=91)

4 Discussion

Existing studies and anecdotal reports have shown that postlingually deafened adult CI users generally find music to be less pleasant and less enjoyable post-implantation compared to pre-hearing loss or pre-deafness. They have also shown that music enjoyment levels can be improved via music training. However, they do not provide detailed information on the factors contributing to CI users' poorer ratings for music, nor do they investigate the approach a MTP should take. Thus, the purpose of this study was to develop and administer a questionnaire (the UCMLQ) to collect such information.

4.1 Music Listening and Music Background

A number of studies describe the music listening habits and enjoyment of postlingually deafened adults CI users (Mirza et al., 2003; Gfeller et al., 2000a; Lassaletta et al., 2007). These studies found that listening enjoyment following implantation was low, and at the same time, that there was a significant decline in the amount of time spent listening to music post-implantation compared to pre-hearing loss or pre-deafness. The findings from the UCMLQ were consistent with these results. As Respondent #192 wrote:

> "As I was always a keen music lover, my loss of natural hearing has seen my listening and appreciation of music greatly diminished. If there is any way possible that people with [a] hearing loss like mine could hear music like normal hearing people [it] would be a remarkable achievement and would make my quality of life even better."

It was also found in the UCMLQ that there was a significant increase in both the amount of time spent listening to music and music enjoyment levels, post-implantation, compared to 'just prior to getting a CI' (or when severely-to-profoundly deaf). The association between levels of music listening enjoyment and the amount of time spent listening to music is unsurprising, as the two factors are strongly related (this is discussed below in Chapter 4.1.1.).

In the study by Mirza et al. (2003), none of the 35 respondents listened to music after becoming profoundly deaf. In contrast, in the UCMLQ, only 21% of the 99 respondents never listened to

music ‘just prior to getting a CI’ or when severe-to-profoundly deaf. In fact, most respondents indicated that they listened to music, at least a little, during this period (see Table 3, Chapter 3.1.2). It is unsurprising that the majority of participants in the UCMLQ listened to music ‘just prior to getting a CI’ compared with none in Mirza et al.'s (2003) study. As the candidacy criteria for CIs have expanded to include patients with greater residual hearing, it is possible that current-day CI users are more likely to have residual hearing compared to those that were implanted sometime ago. As participants in the UCMLQ were implanted more recently[6], it is possible that the majority of these participants were able to listen to music ‘just prior to implantation’ because they had residual hearing, unlike the participants in Mirza et al.'s (2003) study.

4.1.1 Correlations

The UCMLQ, and studies by Gfeller et al. (2000a) and Lassaletta et al. (2007) have shown that there is a strong positive correlation between post-implant music listening enjoyment and the amount of time spent listening to music with an implant. This is unsurprising, for a couple of reasons. Firstly, CI users are more likely to spend more time listening to music if they enjoy it. Secondly, studies and anecdotal reports have shown that repeated music listening enhances listening enjoyment. For instance, as was mentioned in Section 1.3, following a period of focused music listening or training, ratings of ‘liking’ were significantly higher for complex songs (Gfeller et al., 2000b). Similarly, in this study, Interviewee 2 said:

> “The more you listen, the better it gets. An orchestra is an interesting one […] Initially, about a month after switch-on, […] my father-in-law was singing in a huge orchestral concert. And I went to that and it was just the most awful thing I’ve ever heard in my life. It was just, a big bad noise […] But I persevered because I knew that I had to, in order to appreciate music. I had to listen to it over and over and over again and eventually, over time, my brain was able to separate out the different instruments so now I can hear, like the violins and I can hear the flutes and I

[6] In this study, participants were implanted an average of 4.11 years ago (SD = 3.07, range 1 to 19 years) or around 2003. In Mirza et al.’s (2003) study, participants were implanted an average of 4.95 years ago (range 1 to 10 years) or around 1998 or earlier. The participants in Mirza et al.’s (2003) study also all used previous-generation CIs and now-obsolete speech processing strategies.

> can hear the various different instruments. I think my brain has been able to separate those out but that took a lot of time and a lot of listening to tune the brain into what it was hearing. So now, I do have an appreciation of music, where I can sit and listen and almost enjoy it. Well, pretty much enjoy it, not […] to the same level of enjoyment as before [implantation]."

In the UCMLQ, significant negative correlations were also found between age, and both the time spent listening to music, and music listening enjoyment levels. Similarly, Mirza et al. (2003) and Gfeller et al. (2000a) found a strong negative correlation between age and post-implant music listening enjoyment. This may be in-part due to the fact that ageing has natural degenerative effects on nerve survival and function at both cochlear and central locations, and may also affect general cognitive function (Blamey et al., 1996).

In regards to whether post-implant music enjoyment is related to speech perception measures, this study found significant positive correlations between the CUNY sentence scores in noise (+10 dB SNR) and both music listening enjoyment, and the time spent listening to music. In contrast, Gfeller et al. (2000a) and Mirza et al. (2003) found that there was no relation between these factors. In particular, Gfeller et al. (2000a) found that music listening enjoyment was unrelated to any of the speech perception measures that were used in their study, which included audition-only versions of the Consonant Test with and without noise, the Iowa Sentence Test (Tyler et al., 1986), the Vowel Recognition Test (Tyler et al., 1986), and the Northwestern University Auditory Test No. 6 (Tillman and Carhart, 1966). This difference in the correlation results may be due to the different 'speech perception in noise' test materials ('Consonant Test with noise' versus 'CUNY sentences in noise'). The associations between speech perception in noise, music listening enjoyment and the time spent listening to music, are plausible, as speech perception in noise and music listening both involve the perception of fine temporal and spectral cues. As mentioned in Chapter 1.2, current speech processing strategies remove such cues as only amplitude modulations of the signals envelopes are preserved. Although this does not appear to be a limitation for understanding speech in quiet (Turner et al., 2004; Fetterman & Domico, 2002), it has been shown to have a negative effect on speech perception in a multi-talker background (Fetterman & Domico, 2002; Turner et al., 2004; Kong et al., 2004). One of the effects of the elimination of such cues is that CI users are less able to perceive

the fundamental frequencies of talkers and therefore, are less able to 'separate' the target speech from a background of other talkers (Kong et al., 2004).

In the UCMLQ, both music enjoyment with a CI and the time spent listening to music with a CI were unrelated to the demographic variables of: length of severe-to-profound deafness, length of implant use, and speech perception in quiet. Similarly, existing questionnaires showed that post-implant music enjoyment was unrelated to:

- length of profound deafness (Gfeller et al., 2000a; Lassaletta et al., 2007),
- length of implant use (Gfeller et al., 2000a; Lassaletta et al., 2007),
- musical background (Gfeller et al., 2000a; Lassaletta et al., 2007),
- pre-implant listening habits and speech perception measures (Gfeller et al., 2000a), and the
- type of CI (Lassaletta et al., 2007).

4.1.2 CI+HA versus CI-only

Turner et al. (2004) and Kong et al. (2004) showed that low-frequency acoustic hearing combined with electric hearing provided by the CI improved speech perception in a multi-talker background and melody recognition. As such, it is possible that patients using both a CI and a contralateral hearing aid may experience greater music listening enjoyment than those using a CI only.

In the UCMLQ, nearly equal numbers of respondents used a CI+HA or a CI-only to listen to music. Of those who had tried both a CI+HA and a CI-only, the majority reported that the CI+HA gave a better sound quality for music. This was further evident in some of the comments made by respondents, as shown below.

> "[The] CI and HA evens up the sound." – Participant #220;
>
> "Both is better - organic hearing rounds out the sound and provides additional cues (particularly low frequencies)" – Participant #74;
>
> "[The] CI+HA [provides a] better balance of tone/sound. [The] CI [provides the] higher tone[s]." – Participant #203;

> "More added depth - not so tinny." – Participant #20;
>
> "Both is better: more natural sound, "warmer" with HA also." - Participant 79;
> "[It is] clearer, [provides] clarity [for] identify[ing] instruments." – Participant #81.

Thus, these comments demonstrate the benefit of combining low-frequency acoustic hearing with electric hearing on the sound quality of music for CI users. This is further demonstrated later, when the sound quality ratings for instruments and musical styles given by CI+HA users are compared to those given to CI-only users.

In the UCMLQ, respondents rated how melodies sound post-implantation on a visual analog scale from 0 to 10, where 0= 'monotonic (little or no variation between the pitches of each musical note)' and 10= 'melodic (variations between the pitches of each musical note are 'spot on' or accurate)'. There was considerable variance in respondents' ratings. However, as the overall mean was 5.02 out of 10 it seems that respondents, in general, were somewhat ambivalent about whether the CI accurately conveys pitches or melodies. In addition, there was no statistically significant difference between the mean ratings given by each group, CI+HA users and CI-only users. When asked to rate the sound quality of common instrumental sounds, again, there was no statistically significant difference between the mean ratings given by each group. In contrast, for the ratings on musical styles, there was a significant difference between the two groups', with the CI+HA users giving higher ratings for the combined scales for all six styles evaluated. Thus, according to the respondents in this study, it appears that low-frequency residual hearing improves the sound quality of musical styles but does not perceptibly improve the perception of pitch, melodies or the sound quality of common instrumental sounds. The ratings for musical instruments and musical styles are further discussed below.

4.2 Ratings on Common Instrumental Sounds

In examining respondents' ratings (i.e. CI+HA and CI-only users) on instrumental sounds, it was found that the guitar was rated as significantly more pleasant and more natural than the brass and string families, and both the male singer and the piano were rated as significantly more pleasant and more natural than brass. It is possible that the guitar was rated as significantly more pleasant and

more natural because its sound is better represented through implant processing than the brass and string instruments. Grasmeder & Lutman (2006) reported that the clear onset cue related to the plucking of the guitar was apparent in both the spectrogram and the electrodogram (the electrical equivalent of the acoustic spectrogram), as can be seen in Figure 19.[7] Similarly, an electrodogram of the piano (also shown in Figure 19) revealed marked onset cues followed by a gradual decay of the harmonics (Grasmeder & Lutman, 2006). That is, the characteristic percussive 'thud' of the piano appears to be maintained through implant processing. Thus, it was hypothesised that clear onset cues contribute to more pleasant and/or more natural ratings for instruments. In-keeping with this hypothesis, the drum kit was also rated as more pleasant and more natural after the guitar, male singer and the piano in the current study.

In terms of the specific sound qualities of instrumental sounds, such as, their fullness, sharpness, noisiness, etc., respondents rated all instruments, except the drum kit, as significantly 'emptier' than they would have expected them to sound to a person with normal hearing, and more than half the instruments as significantly 'tinnier' they would have expected them to sound to a person with NH (the exceptions being the woodwind, drum kit, and the male singer). Grasmeder & Lutman (2006) reported that for all of the 10 instruments that were included in their study, there was less low- and high- frequency energy in the electrodograms than in the spectrograms. This was noticeable by that fact that there was very little energy above 3 kHz, and at the low frequency end, for the pitched instruments, there was a reduction in the intensity of the fundamental frequency (Grasmeder & Lutman, 2006). As sounds with more harmonics tend to be judged as sounding fuller (on a continuum of empty to full) (Bismarck, 1974), it is thus unsurprising that respondents in this study judged instruments as sounding significantly emptier or tinnier than expected.

[7] In the study by Grasmeder & Lutman (2006), spectrograms and electrodograms were obtained for ten musical instruments. The computer software that was used to generate the electrodograms simulated the ACE sound-processing strategy.

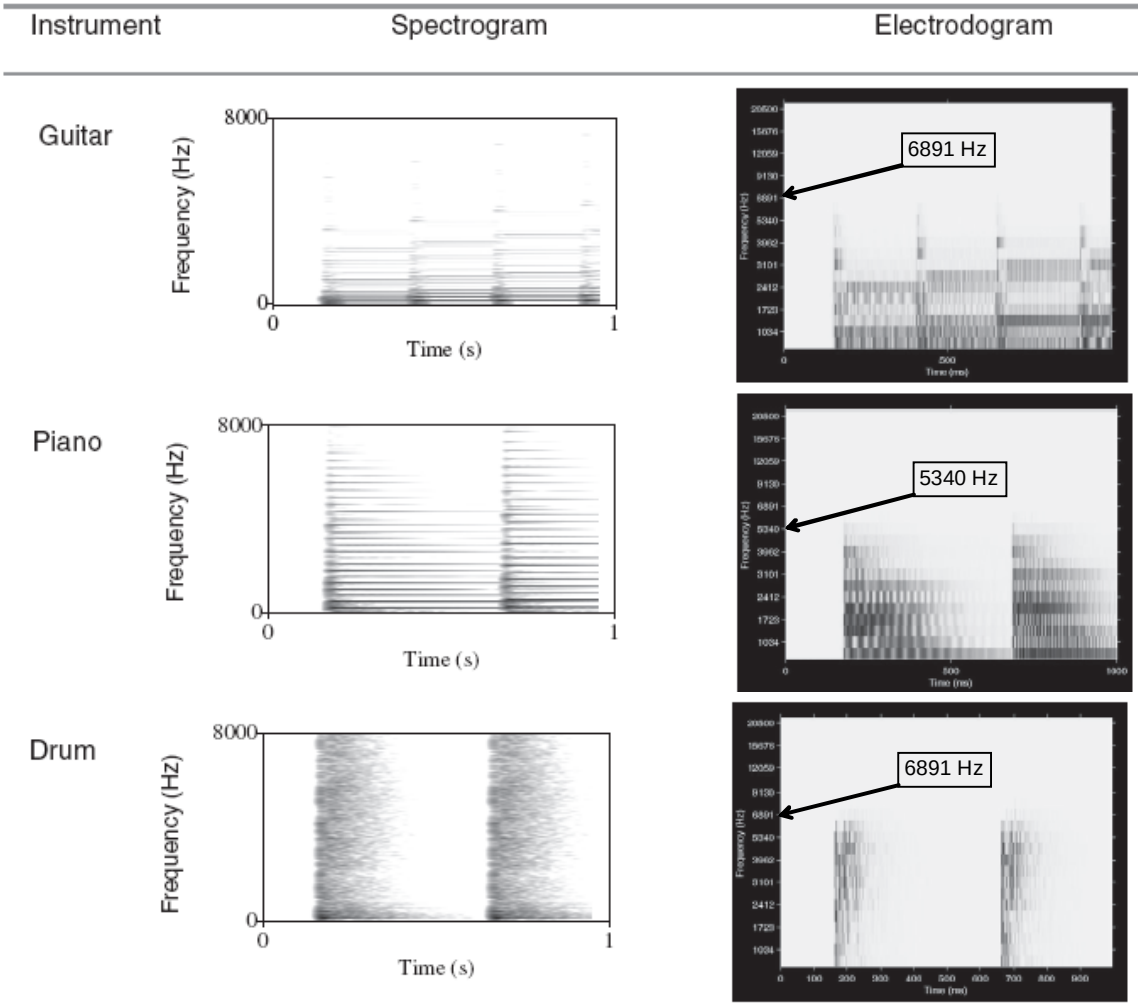


Figure 14: Spectrograms and electrodograms for various instruments.
(Adapted from Grasmeder & Lutman (2006).)

In the study by Gfeller et al.'s (2002b) on timbre appraisal, where CI users gave 'liking' and sound quality ratings for eight different musical instruments, ratings for each instrument were grouped into instrumental families for some of the analyses. The resultant groups were strings (violin and cello), brass (trumpet and trombone), woodwind (flute, clarinet and saxophone) and piano. It is interesting to compare the ratings from Gfeller et al.'s (2002b) study to those obtained from the UCMLQ. In making these comparisons, it should be noted that the participants in Gfeller et al.'s (2002b) study used a CI-only, whereas in the UCMLQ, both groups of participants (CI+HA users and CI-only users) were included. This was because statistical analyses on respondents' ratings revealed no significant difference between the two groups' ratings for the current study.

It can be seen in Figure 20 that the ratings of 'pleasantness' (from the UCMLQ) and 'liking' (from Gfeller et al.'s (2002b) study) follow a similar trend. Moreover, in the UCMLQ, respondents rated the piano to be significantly more pleasant and more natural than the brass family. This is consistent with Gfeller et al.'s (2002b) study, which showed that CI users gave a significantly lower 'likeability' rating for the brass family compared to the piano ($p < 0.0001$). It can also be seen in Figure 20 that there was considerable variance in respondents' ratings from the UCMLQ.

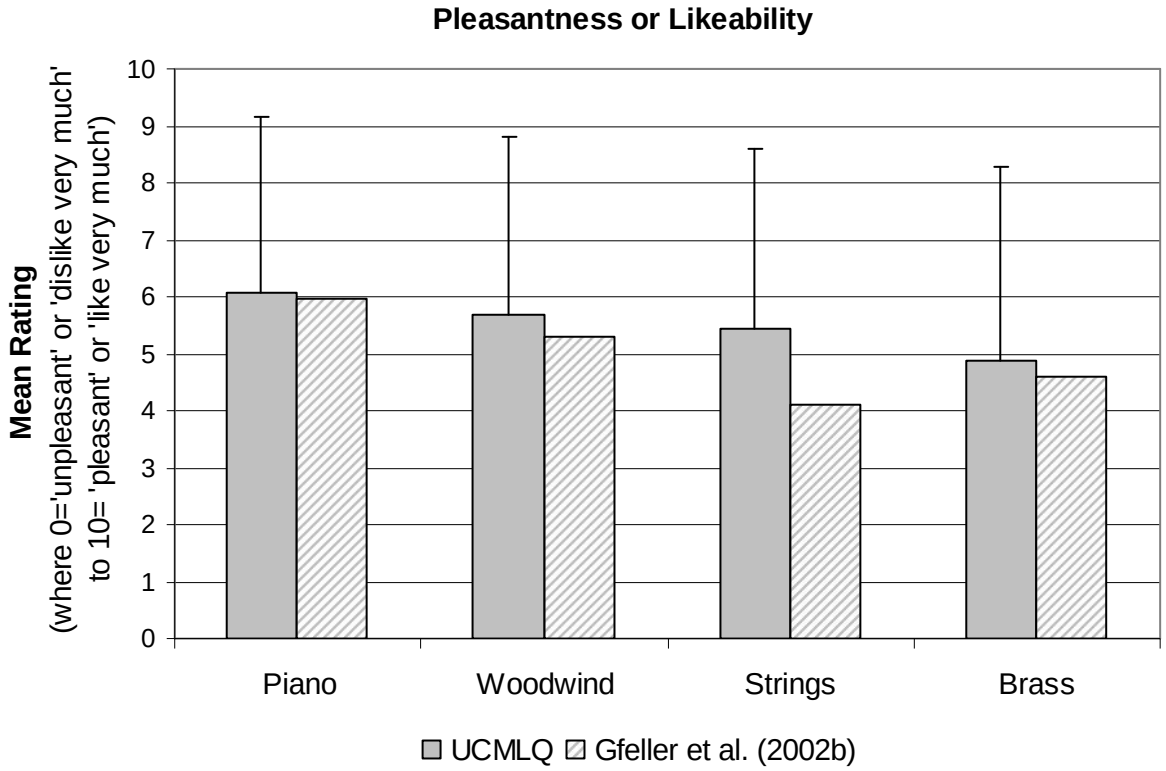


Figure 20: Comparison of mean ratings on the 'pleasantness' (UCMLQ) and 'likeablity' scales (Gfeller et al., 2002b) for instrumental sounds.[8] (Error bars = 1 standard deviation.)

In Gfeller et al.'s (2002b) study, the sound quality of instruments were rated on the scales, 'empty-to-full' 'dull-to-brilliant or sharp' and 'compact-to-scattered', where empty, dull and compact equalled 0, and full, brilliant and scattered equalled 10. In the study by Bismarck (1974), sounds

[8] Note that the means and standard deviations reported by Gfeller et al.'s (2002b) study corresponded to 3 groups of instruments, where the instruments were grouped according to their frequency ranges (low, medium or high frequency ranges). Thus, in order to obtain the mean rating for the woodwind family, for example, as a whole, the ratings given for the low, medium and high-frequency woodwinds within the woodwind family were averaged. This was then compared to the mean value for the woodwind family from the UCMLQ. However, the standard deviations could not be accurately obtained this way and hence, are not displayed in this figure, and Figures 21 to 23.

with more high-frequency energy were judged as more brilliant or sharp in quality, and sounds with more noise were judged as sounding more scattered (on a continuum of compact to scattered). Therefore, in terms of timbre, brilliant and sharp can be used synonymously. Similarly, 'compact-to-scattered' could be considered equivalent to 'less noisy-to-more noisy'. Thus, the mean ratings on the scales, 'empty-to-full', 'dull-to-brilliant or sharp' and 'compact-to-scattered' (or 'less noisy—more noisy'), from both studies, are compared in Figures 21 to 23.

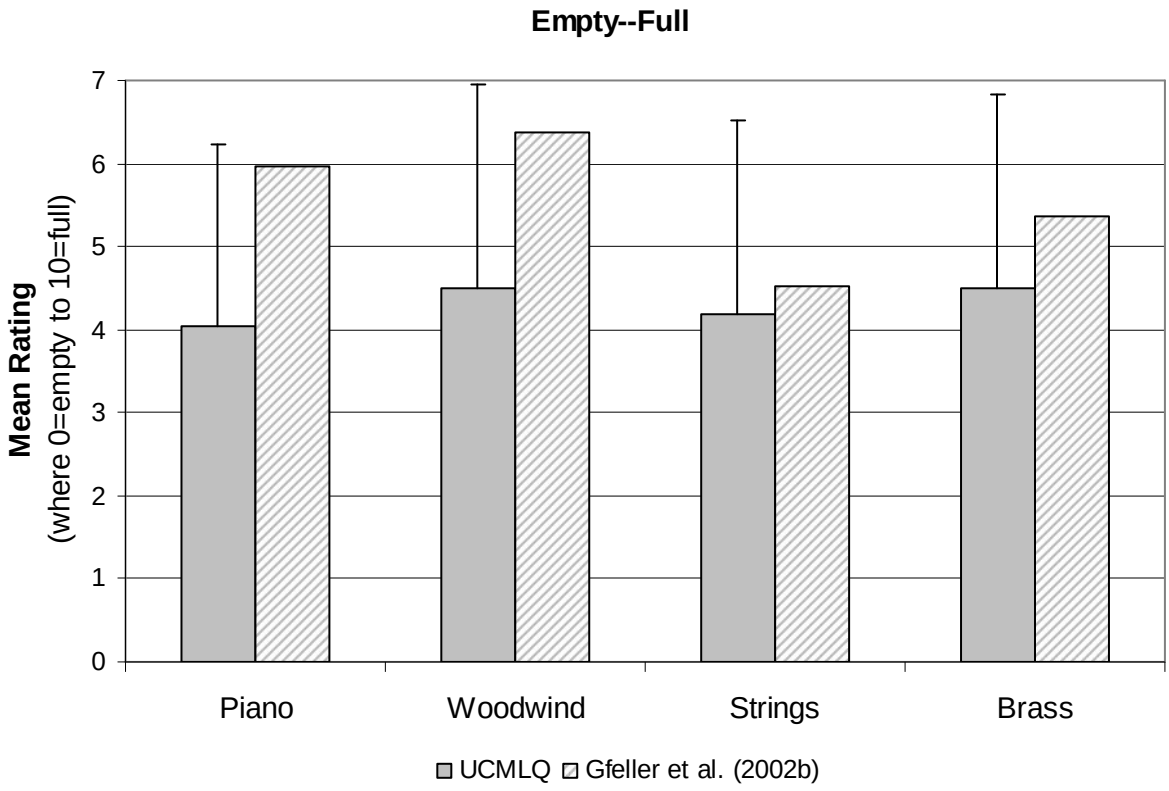


Figure 15: Mean ratings on the 'empty—full' scale for instrumental sounds from both studies.[9]
(Error bars = 1 standard deviation.)

[9] See footnote for Figure 20.

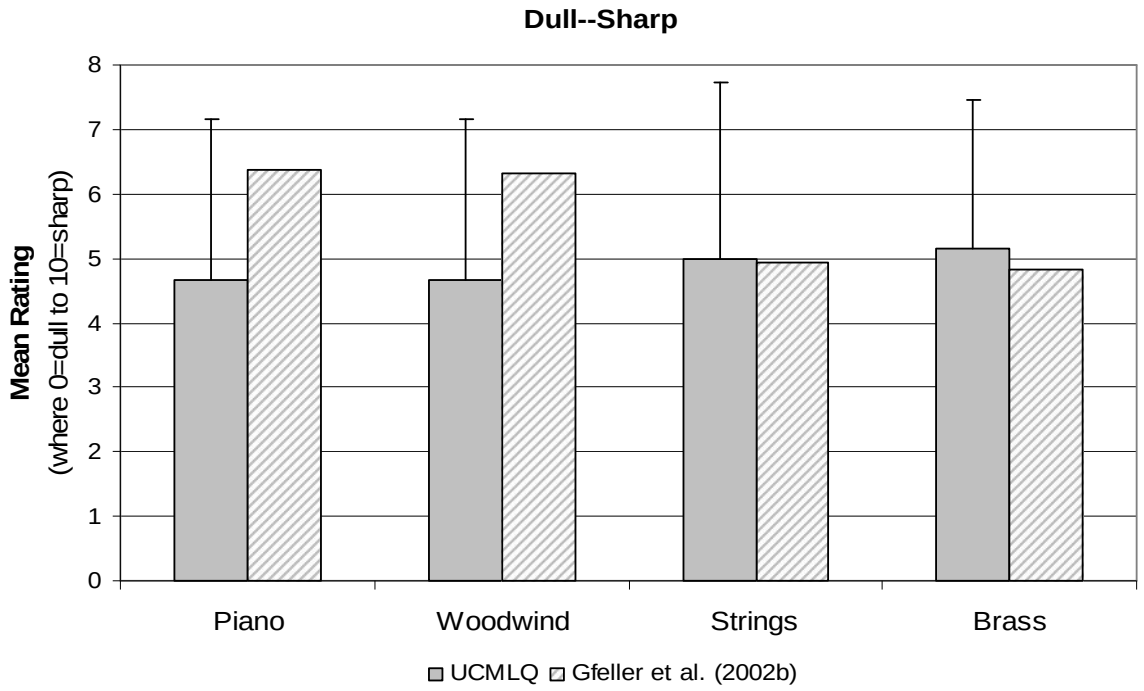


Figure 16: Mean ratings on the 'dull—sharp' scale for instrumental sounds from both studies.[10] (Error bars = 1 standard deviation.)

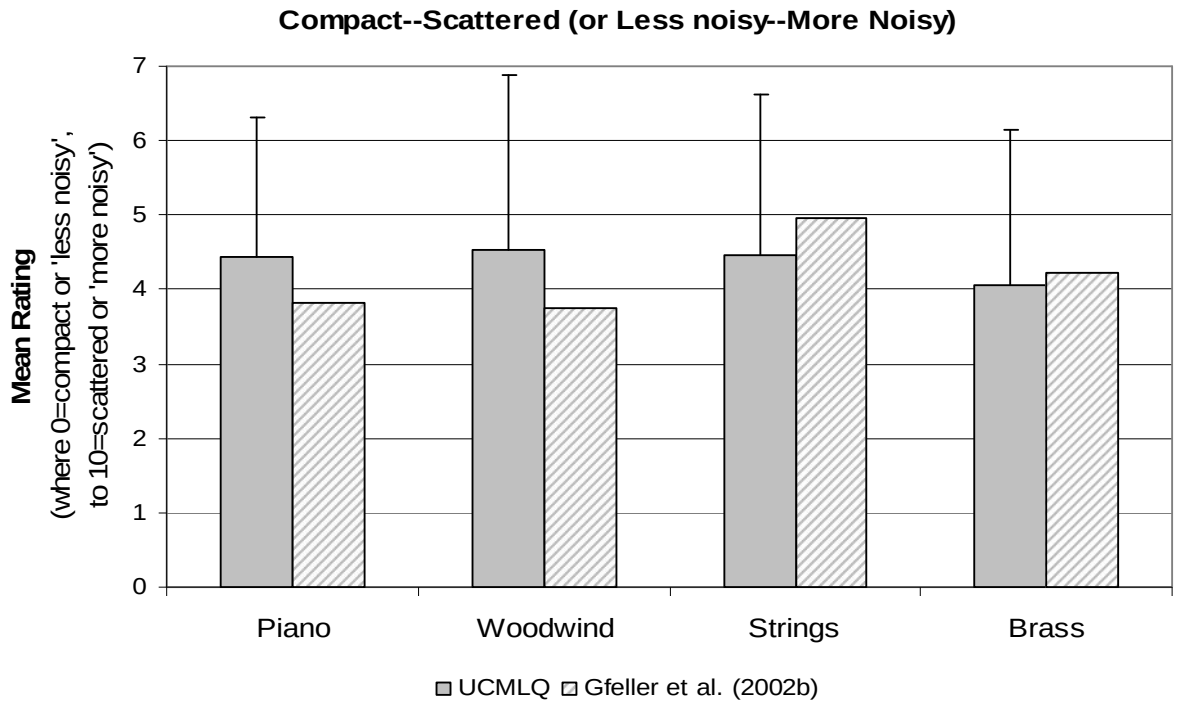


Figure 17: Mean ratings on the 'compact—scattered' (or 'less noisy—more noisy') scale for instrumental sounds from both studies.[10] (Error bars = 1 standard deviation.)

[10] See footnote for Figure 20.

As can be seen in Figures 20 to 23, there was considerable variability in respondents' ratings from the UCMLQ. This is to be expected as there would be individual differences in preferences for instrumental sounds, as well as in the perceived sound quality of different instruments. However, other factors may have contributed to the variability found. The study by Gfeller et al. (2002b) showed that the frequency range of an instrument had a great influence on the 'liking' rating given for it. Significantly higher ratings of liking were given for the lower-frequency instruments within the same instrument family (low woodwinds versus high woodwinds, $p<0.0001$; medium-low woodwinds versus high woodwinds, $p<0.03$; low strings versus high strings, $p<0.0001$). As instrumental families contain both low-frequency and high-frequency instruments, requesting respondents to rate instrumental families, as opposed to individual instruments, may have contributed to the large variance found in this study. In the 'Music Preferences' section of the UCMLQ, it was also found that many respondents preferred low-pitched instruments to high-pitched instruments (as will be discussed in Section 4.4 of this chapter).

There was considerable variance in respondent's ratings in the current study, which could account for the disparity between the ratings in both studies; for example, in the UCMLQ, the piano and woodwind family was rated to sound significantly emptier whereas in Gfeller et al.'s (2002b) study, they were rated to sound fuller. Similarly, in the UCMLQ, the piano and woodwind family was rated to sound duller whereas in Gfeller et al.'s (2002b) study, they were rated to sound sharper. The difference in ratings in both studies maybe due to the fact that different experimental designs were used. In Gfeller et al.'s (2002b) study, respondents rated the pleasantness and sound quality of individual instruments immediately after listening to a recording of the instrument being played by a professional musician.[11] That is, they listened to standardised recordings presented via good quality speakers in a quiet environment. In contrast, in this study, respondents had to rely on their memory and knowledge of the instruments within a family; they were not presented with musical stimuli immediately preceding making the rating. It is possible that in asking respondents to give ratings based on their memory alone, their ratings were not entirely accurate.

[11] Each professional musician played a standardised melodic pattern on their respective instruments. Recordings were carried out with a good quality microphone (Mackie 1402-VLZ mixer with phantom power) at the University of Iowa Electronic Studios. These recordings were then played in soundfield, via Yamaha speakers (model YST-M15), in a quiet room.

4.3 Musical Styles

In the UCMLQ, respondents rated various musical styles along five scales: unpleasant—pleasant, simple—complex, can *never*—can *always* follow melody-line, can *never*—can *always* identify this style by listening-alone, and sounds *nothing*—sounds *exactly* as I would expect it to sound to a person with NH. In the study by Lassaletta et al. (2007), respondents were asked to rate the quality of music, in general, on the scales of: 'dislike—like', 'mechanical—natural', 'difficult to follow—easy to follow', and 'doesn't sound like music—sounds like music'. Three of these scales are similar to those used in the UCMLQ ('dislike—like', 'difficult to follow—easy to follow', and 'doesn't sound like music—sounds like music'). In order to compare the findings of the two studies, the ratings given to each musical style by the CI-only users in the UCMLQ were averaged. (Note that the ratings given by CI+HA users were excluded from this comparison, as CI+HA and CI-only users gave significantly different ratings for musical styles, and Lassaletta et al.'s (2007) study included CI-only users.) The mean scores and standard deviations from both studies for the three similar rating scales are displayed in Figure 24.

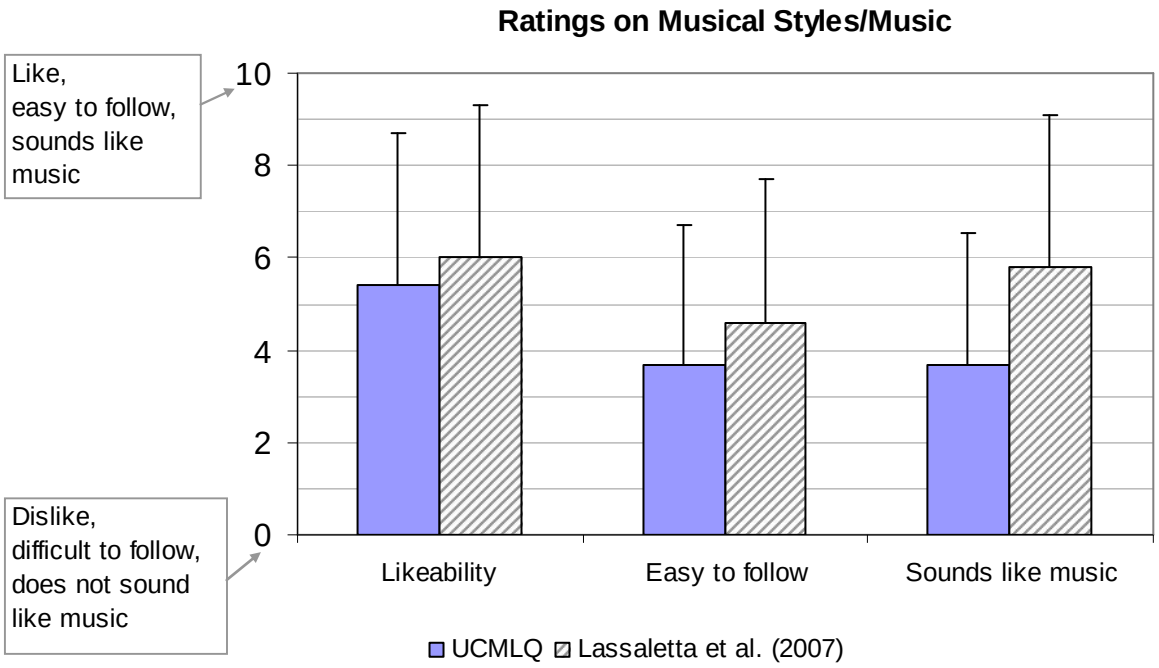


Figure 18: A comparison of the mean ratings on musical styles from the UCMLQ, and on music, from Lassaletta et al.'s (2007) study. (Error bars = 1 standard deviation.)

As can be seen in Figure 24, again, there is considerable variability in the ratings given for both studies. However, it can be seen that the mean ratings given by the respondents in Lassaletta et al.'s (2007) study are generally higher than those given by the respondents in this study. This could be accounted for by the fact that respondents in Lassaletta et al.'s (2007) study were asked to rate the sound quality of music in general, while in this study, respondents were asked to rate various musical styles. (As mentioned above, the ratings for each style from the current study were averaged in order to compare the ratings from both studies.) Asking CI users to rate the sound of music in a broad sense, may elicit different responses to asking them to rate musical styles individually. It can also be seen in Figure 23 that the CI users from this study generally rate music to be 'difficult to follow' and that it 'doesn't sound like music'. This is consistent with existing research which shows that pitch and timbre cues, which allow accurate music perception, are not sufficiently transmitted through current-day implant processing (Galvin III et al., 2007; Gfeller et al., 2000a; Gfeller et al., 2007; Sucher & McDermott, 2007).

For all musical styles, CI+HA users felt that they were significantly more able to follow the melody-line and identify the style, and they also rated musical styles, in general, to sound significantly more normal than CI-only users. This is unsurprising as there are strong positive correlations between being able to follow the melody-line, identify the style and sounds 'normal' (as shown in Section 3.4). The finding that CI+HA users felt that they were more able to follow the melody-line than CI-only users is consistent with research which shows that acoustic hearing provides more-salient cues to aid pitch perception (Kong et al., 2004; Turner et al., 2004). However, this is not consistent with the fact that there was little difference between the mean ratings given by CI+HA users and CI-only users in terms of how melodies or pitches are perceived post-implantation (as rated in Question 26 of the UCMLQ, Section 3.2.3). It is possible that the benefits of combining low-frequency acoustic hearing with electric hearing is more perceptible for more-naturalistic stimuli, such as country and western, and jazz, as opposed to melody-alone excerpts. Hence, there was a significant difference between the self-reported ratings of CI+HA users and CI-only users in terms of their ability to follow the melody-line of various musical styles, but no significant difference between their ratings for how melodies sounded post-implantation. This is also consistent with the previously-mentioned findings by Gfeller et al. (2000b), who found that training resulted in a significant improvement in complex song recognition but not for simple melody recognition. The authors hypothesised that this was due to subjects developing

compensatory strategies for recognition from cues available in complex songs (e.g. timbre cues) that were not available from simple melodies. In regards to musical styles sounding more normal to CI+HA users than CI-only users, this is consistent with the finding reported earlier (Section 3.2.3), where the majority of respondents (who had tried both the CI+HA and the CI-only) reported that the CI+HA gave a *better* sound quality than the CI-only. Participant #79 also added that music sounds "more natural" and "warmer" with the CI+HA than with the CI-only. In addition, Participant #74 wrote, "Both is better - organic hearing rounds out the sound and provides additional cues (particularly low frequencies)". Lastly, regarding the ability to identify musical styles, as CI+HA users felt that they were more able to follow musical styles and that they found music to sound significantly more normal than CI-only users , it follows that CI+HA users also felt that they were better-able to identify musical styles than CI-only users.

In comparing the ratings given for the different musical styles, respondents (both CI+HA users and CI-only users) gave significantly higher ratings for Country and Western than for all of the other styles, except for Classical-choir. In other words, compared to all of the other styles (except for Classical-choir), Country and Western was rated to be significantly pleasanter, easier to follow and identify, and sounded significantly 'more normal'. This is consistent with the finding that these four factors are strongly correlated to each other.

The higher ratings given for Country and Western may be related to the perceived complexity of different musical styles. In Gfeller et al.'s (2003) study, which investigated the effect of musical complexity on 'liking' for the three musical styles, Classical, Country and Western, and Pop music, measures of liking and complexity were obtained for 36 items (12 of each style).[12] It was found that CI users did not show a significant preference for any of the 3 styles. However, the 36 items were ranked according to their mean liking scores, from most likeable to least likeable, and it was found that there was a strong negative correlation (r = -0.72) between liking and complexity. That is, CI users preferred music that was perceived to be simpler. In addition, it was observed that 80% of Country and Western items appeared in the top two tertiles for liking, compared to 67% of Pop items. In contrast, half of the Classical items appeared in the lowest third tertile for liking.

[12] In Gfeller et al.'s (2003) study, respondents rated the complexity and likeability of these styles on 100 mm bipolar visual analog scales, where 0 equalled 'simple' or 'dislike' and 10 equalled 'complex' or 'like', like the bipolar visual analog scales used in the UCMLQ.

In regards to the complexity of musical styles, it was shown in that same study (Gfeller et al., 2003) that CI users perceived Classical music as significantly more complex than both Country and Western ($p < 0.0001$) and Pop music ($p < 0.004$), and Pop as significantly more complex than Country and Western music ($p < 0.03$). Although the differences were not statistically significant, the findings from the UCMLQ followed a similar trend in that Classical-orchestra was rated the most complex style (mean rating = 5.70), followed by pop/rock (5.20), and Country and Western (4.99). It is unsurprising that classical music was rated the most complex. Although there exists a continuum of 'simple to complex' within all three styles, in general, Classical music tends to have more complex melodic, rhythmic, and harmonic structures than those found in typical Pop, and Country and Western music (Gfeller et al., 2003). In contrast, Pop, and Country and Western music are generally shorter in length, have prominent melodic lines and lyrics sung by a soloist or a small ensemble, and a simple harmonic accompaniment (Gfeller et al., 2003).

In the UCMLQ, a slight positive correlation was found between respondents' ratings for pleasantness and complexity. In other words, respondents perceived more-complex music to be pleasanter. These results are the opposite of those found in Gfeller et al.'s (2003) study. It is also inconsistent with respondents' preference for smaller numbers of performers over larger numbers of performers (as will be discussed later.) This inconsistent finding may be due to respondents mistakenly assuming that higher ratings were equivalent to more-positive ratings. In the UCMLQ (Appendix 2) there were 5 rating scales for musical styles. Each scale was from 0 to 10, where 10 equalled 'pleasant', 'complex', 'can always follow melody-line', 'can always identify this style by listening-alone' and 'sounds exactly as I would expect it to sound to a person with NH'. The 'complexity' scale was the only scale where 10 did not necessarily denote a more-positive concept. Thus, it was possible that respondents automatically gave higher ratings for complexity as they were giving higher ratings on the other scales, resulting in the slight positive correlation between respondents' ratings for pleasantness and complexity.

Keeping in mind that the UCMLQ asked respondents to make comparisons to 'how they would expect musical instruments/singers/musical styles to sound to a NH person', it is worthwhile noting that an overwhelming majority of respondents said that they would like them to sound like they would to NH listeners. In other words, what music sounds like to a NH person can be considered as the 'gold standard' for comparative judgements. As Participant #153 wrote, "Of course I would love

to hear music as it should be. […] I would love to be just anywhere appreciating the sound of music."

4.4 Music Preferences

In this section, a greater proportion of respondents preferred male (38%) to female singers (11%), although, 50% of respondents had no preference. This is consistent with the sound quality ratings that were given for male and female singers (as shown in Section 3.3), where respondents rated the female singer negatively on four counts (emptier, tinnier, noisier and rougher), two more than the male singer (emptier and rougher). It was also found that a greater proportion of respondents preferred low-pitched (53%) to high-pitched instruments (7%). This is consistent with findings by Gfeller et al. (2002b) where CI users gave significantly higher ratings of liking for low-frequency strings and woodwinds (cello and saxophone) compared to high-frequency strings and woodwinds (violin and flute). Research involving perceptual tests has shown that CI users may be more accurate at perceiving stimuli with lower fundamental frequencies than higher fundamental frequencies. This may be partly related to the availability of temporal-based pitch cues for lower-frequency stimuli. For the ACE speech processing strategy, used by the respondents in this study, the amplitude modulations at the output of the CI filterbank would occur at a rate corresponding to the input signal's fundamental frequency. These amplitude modulations can provide a pitch percept (McKay, McDermott, & Clark, 1994; 1995). However, most CI users seem to be only able to extract reliable pitch cues from these amplitude modulations at frequencies up to around 300 Hz or 'middle-C'. This suggests that the majority of CI users would have difficulty in obtaining reliable temporal-based pitch cues if the stimuli's fundamental frequency is above approximately middle-C (McKay, 2004). For stimuli with higher fundamental frequencies, the CI users would be more reliant on place pitch cues associated with stimulating different electrodes. However, these place-based cues are often less reliable and less accurate than the temporal-based cues. It is beyond the scope of this thesis to discuss all of the possible reasons for this. One example is the likelihood of a mismatch in the tonotopic place of stimulation, with simulation occurring at a more-basal location than what occurs for normal acoustic hearing. This is due to the implanted electrodes not being inserted deep enough to stimulate regions below 1000 Hz. For example, a 500 Hz signal may stimulate a location on the basilar membrane normally tuned for 1000 Hz, thereby creating a mismatch in the frequency information presented to the CI user (Oxenham, Bernstein, & Penagos, 2004). These factors collectively suggest that CI users may be more accurate at perceiving the pitch of sounds with lower

fundamental frequencies. This may in turn contribute to their preference for lower-pitched musical stimuli.

In regards to their preferred type of music, it was found that 30% of respondents preferred music with ‘instrument and voice’, 17% preferred ‘instrumental-only’ music, 6% preferred ‘voice-only’ music, and a large proportion of respondents (46%) had no preference. From this, it appears that respondents enjoyed the combined timbres of instrument and voice, although this was not essential for their music listening enjoyment.

Lastly, in this section, it was found that respondents preferred smaller numbers of performers to larger numbers of performers. This is likely to be related to the previously-discussed issue of complexity, where existing research suggests that respondents prefer music that is simpler.

4.5 Factors Affecting Music Listening Enjoyment

In the UCMLQ, factors that were commonly rated to have a positive effect on music listening enjoyment were: a quiet environment, high quality speakers, high quality recordings, using a hearing aid with the CI, listening to music at a medium volume, listening to music with the aid of visual cues (e.g. watching the performer, following the musical score or words), familiarity with the music, lyrics or song title, knowing the context in which the music is being played, increased time or experience with the CI, music with a slow rhythm/beat and music with words. Factors which were rated most frequently to hinder listening enjoyment were an ‘echoey’ room and a loud volume. Gfeller et al.(2000a) also investigated which factors affect CI users’ music listening enjoyment. Similar to the findings in the UCMLQ, factors that were reported to have a positive effect on music listening enjoyment were a quiet listening environment, good quality recordings, watching the performer, having the musical score or words to follow along with, familiar music, knowing the song title, and music listening practice. Thus, it appears that CI users can enhance their listening enjoyment to some extent by (i) controlling environmental conditions, such as choosing to listen to music in a quiet room or with good sound equipment, (ii) making use of external cues, such as watching the performer or following the musical score or words, and (iii) by being selective in their choice of music, for example, choosing music with a slow rhythm/beat.

4.6 Music Training Program

As the goal of this questionnaire was to obtain information that would assist in the development of a MTP, the results from this section of the UCMLQ are worth reviewing. Slightly over half of the respondents indicated that they would be interested in undertaking a MTP. The two skills that were rated to be most important for music listening enjoyment were the ability to recognise previously-known tunes (known before implantation), and commonly-known tunes. In a study by Schulkind, Hennis, & Rubin (1999), older adults (65-70 years old) and younger adults (18-21 years old) listened to 20-second excerpts of popular songs drawn from across the 20th century. They then gave emotionality and preference ratings, and where possible, provided objective information about the songs, such as the title, artist, etc., for each excerpt. It was found that older adults preferred, knew more about and had stronger emotional responses to the music popular during their youth compared to music popular later in life. Thus, the 'ability to recognise previously-known tunes' being rated as a key skill for aiding music listening enjoyment is in-keeping with the finding by Schulkind et al. (1999). It is also possible that respondents wished to recognise previously-known tunes (known before implantation) and commonly-known tunes because they would like to retrieve an aspect of their previously 'normal' hearing lifestyle. Adults who use CIs are typically postlingually-deafened adults who still embrace the cultural values of hearing people, even after many years of deafness (Gfeller et al., 2001). For instance, in the UCMLQ, Interviewee 2 expressed regret for being unable to enjoy the same music that her peers enjoy:

> "[I miss] being able to enjoy [music]. Like go out to a concert or my friends would be raving about this band or whatever but I feel a bit excluded when it comes to things like that. Because I don't get as much out of it as they would. Because some of my friends are really passionate about music and they don't really understand. They're like why don't you like this music? It's great, you know! You try listening to it. Like it's just a waste of time, I can't be bothered with that. Yeah, I guess I do, I feel envious. You're lucky [to be able to hear music]."

The preferred logistics for the MTP were 30-minute sessions, 2 times per week. Four respondents also commented on the need for flexibility regarding the length of training sessions. Various reasons were given for this. Participants #75 and #131 felt that individuals would prefer different durations depending on their circumstances or their 'level of passion' for music. Participant #53 felt that it was

important to have session times of varying lengths, as individual motivation levels varies from day-to-day:

> "I have been fortunate to have been able to do a music perception training programme just recently. […] I found it important NOT to schedule, say 30 minutes of training each day as it depended on the 'mood'. Some days, it may have been 15 minutes, others, 40 minutes – times were shown. It was important not to rush."

Almost half of the respondents preferred a DVD as the mode of delivery for the MTP, with 5 respondents commenting that the DVD should have subtitles. The inclusion of subtitles would allow CI users with poorer speech perception abilities to participate in the MTP. For example, Participant #159 said:

> "[…] I have to use Closed Captions [CC] with TV and have difficulty with radio broadcasts as with normal conversations [… a] DVD without CC is a no-no."

4.7 Implications for a MTP

It was shown in this study that CI users preferred certain types of instruments and music. They preferred: (i) low-frequency instruments as opposed to high-frequency instruments, (ii) certain instruments (e.g. the guitar) over others (e.g. brass instruments), (iii) smaller numbers of performers as opposed to larger numbers of performers, (iv) Country and Western music as opposed to Pop/Rock, Jazz, Classical-small group, and Classical-orchestra, and (v) music with a slow rhythm/beat and words. Thus, introducing CI users to these types of music may be a good starting point for a MTP.

Respondents also considered the ability to recognise tunes known before implantation, and commonly-known tunes, as most important for their music listening enjoyment. In addition, the majority of respondents would like the MTP to focus on a wide range of music rather than their preferred style of music. As 'tunes known before implantation' and 'commonly-known tunes' may be somewhat dependent on the age of participants, the MTP should offer well-known or popular

songs from each decade, starting from the 1950s to now (e.g. 1950s, 1960s, etc.), as well as popular classical music, to cater for the range of individual preferences and ages. Also, in this way, respondents would have access to a variety of musical styles from which to choose from.

The findings in this study are consistent with studies that have shown that pitch perception is problematic following implantation. These findings are, firstly, that respondents, in general, were somewhat ambivalent about how melodies sounded post-implantation, giving an overall mean rating which corresponded to the midway of the 'monotonic-to-melodic' scale. Secondly, respondents generally rated music to be 'difficult to follow'. Thirdly, visual cues, such as having the musical score or words to follow along with, or watching the performer, were rated to enhance music listening enjoyment. Lastly, respondents prioritised being able to recognise tunes as the skill they would most like to improve. These findings suggest that many CI users have difficulty with pitch perception and in turn, melody recognition. For western music, the listener would need to be able to discriminate frequency changes as small as 6% or a one-semitone interval. Sucher & McDermott (2007) reported that CI users only performed at chance level in differentiating between pitches one-semitone apart. Even for intervals six-semitones apart, CI users scored only 60% correct where the chance score was 50%. This suggests that pitch training in a MTP should begin with wide pitch intervals. Also, an adaptive procedure should be incorporated to account for the large degree of individuality. In addition, as research by McKay (2004) suggests that CI users are better-able to perceive low frequencies (up to 300 Hz) than high frequencies, and it was found that CI users preferred low-pitched to high-pitched instrumental sounds, the MTP should start with lower pitches. Lastly, in order to assist CI users in interpreting and learning new melodies, initial exposures to new melodies or musical excerpts should be paired with visual cues, such as visual representations of the sound.

As previously mentioned, implantation not only affects pitch perception but also timbre perception. As was shown in this study, respondents rated all instruments as significantly 'emptier', and more than half the instruments as significantly 'tinnier' than they would have expected them to sound to a person with normal hearing. Factors, such as a quiet environment, high quality speakers, high quality recordings, and wearing a contralateral hearing aid in conjunction with a CI,were shown to improve music listening enjoyment. As such, these factors are likely to have a positive influence on musical sound quality. Thus, it appears that the timbre of music can be enhanced to some extent by firstly, controlling environmental conditions, such as choosing to listen to music in a quiet room or

with good sound equipment and secondly, listening to music with a contralateral hearing aid. Therefore, where possible, CI users should be encouraged to wear a contralateral hearing aid in conjunction with the CI, and to listen to music in a quiet room with good sound equipment. Finally, as many respondents indicated that they were unable to recognise certain instruments or styles, this suggests that a MTP should incorporate timbre-based tasks, such as musical instruments and styles identification.

4.8 Limitations of Study and Directions for Future Research

The participants in this study were all implanted with the Nucleus CI24 implant and the ACE speech processing strategy, therefore, the findings of this study may not be generalisable to users of other implants and speech processing strategies. For example, Lassaletta et al. (2007) found that Med-El users gave a significantly higher rating on the bipolar visual analog scale, 'doesn't sound like music – sounds like music' than Nucleus users (Chi-square test, $p=0.01$). However, no differences were found for the other rating scales ('dislike—like', 'mechanical—natural' and 'difficult to follow—easy to follow') between both CI types. Moreover, no significant associations were found between music listening enjoyment and the type of implant (Gfeller et al., 2000a; Lassaletta et al., 2007). Therefore, further research is required to confirm whether different types of current-day implants and speech processing strategies have a significant impact on the sound quality and 'likeability' of music.

The questionnaire that was developed in this study consisted of 48 questions, not including the sub-questions, and it was found in the pilot-study that six out of the ten participants took over one hour to complete the questionnaire. Existing music questionnaires consisted of 21 questions (Gfeller et al., 2000a) and 27 questions (Mirza et al., 2003). The response rate (45%) for this study was comparatively low compared to other music questionnaires, for example, Gfeller et al. (2000a) obtained a response rate of 94% and Mirza et al.(2003) obtained a response rate of 78%. This suggests that there is a trade-off between the response rate and the amount of detail a questionnaire can obtain.

In this study, respondents gave ratings on seven scales for each of the eight instrumental sounds (individual instruments, instrumental families and singers), and on five scales for each of the six musical styles, based on their memory and knowledge of them. Although respondents were

instructed that they could skip the instrumental sounds or musical styles that they were unfamiliar with, the questionnaire still required respondents to give numerous quality ratings based on their memory alone. Therefore, in order to encourage more-considered and possibly more-accurate sound quality ratings from respondents, future studies should consider instructing respondents to listen to appropriate or relevant music (i.e. music of a particular style that they are rating), where possible, prior to giving their ratings. For example, respondents could give 'liking' and 'quality' ratings after listening to standardised recordings of individual instruments in a standardised listening environment. This would reduce the variance in respondents' ratings in a number of ways. Firstly, as respondents in this study were asked to rate instruments and instrumental families based on their memory and knowledge of these instruments, they could be mistakenly rating one instrument (e.g. clarinet) thinking it was another (e.g. flute). The study tried to minimise this somewhat by using instrumental families instead. However, the inclusion of instrumental families may also have contributed to the variance as some instruments cover a wide frequency range (e.g. the piano), and instrumental families contain both low-frequency instruments and high-frequency instruments. Secondly, the listening environment and the quality of the sound equipment were shown to affect the sound quality of music. Therefore, a standardised listening environment would minimise this potential source of variance.

It should be noted that respondents' ratings in the current study were not validated. For example, CI+HA users were not tested to see whether they were actually more able to follow and identify musical styles than CI-only users.

Finally, more research is required to assess the benefits of music training, the efficacy of different training tasks, and the musical skills more (or less) amenable to music training. Despite the wealth of research into technological and engineering-related advances for improving music perception, it appears that these improvements to the CI-device itself are still someway off. Hence, further research from a training and rehabilitative perspective is warranted to see if this approach can help overcome some of the shortcomings for music listening reported by current CI users.

5 Summary and Conclusions

Existing music questionnaires have shown that postlingually deafened adult CI users generally find music to be less enjoyable post-implantation. However, they did not investigate, in detail, which factors influence CI users' music listening enjoyment, nor did they investigate the approach a music training program should take. In order to obtain such information, the University of Canterbury Music Listening Questionnaire (UCMLQ) was developed. The UCMLQ investigated: (i) the effect of implantation on CI users' music listening enjoyment (determined by comparing the levels of enjoyment experienced post-implantation to pre-hearing loss, and just before implantation); (ii) the effect of a hearing aid in the unimplanted ear on CI users' music perception and appreciation; (iii) the effect of timbre on music listening enjoyment whereby respondents will be asked to rate the pleasantness and naturalness of common instruments and voices, and also, give ratings on the instruments' sound quality based on what they *expect* these instruments to sound to a person with normal hearing; (iv) whether respondents have a preference for a particular musical style (e.g. Country and Western, Jazz, Classical, etc); (v) whether respondents' have a preference for, firstly, low-pitched versus high-pitched instruments/voices; secondly, music with instruments-only, voice-only, or both instruments and voice; and lastly, music with smaller number of performers versus greater number of performers; (vi) practical methods or 'tips' for enhancing everyday music listening enjoyment were collated; and finally, (vii) respondents were asked for their views and opinions on the content and logistics of a 'take-home' MTP for improving their music listening enjoyment.

One hundred postlingually deafened adult Nucleus CI24 users, ranging in age from 18 to 88 years (mean = 62.1, SD = 17.1), completed the UCMLQ. Respondents generally reported decreased levels of music listening enjoyment, post-implantation, and a reduction in the amount of time spent listening to music, post-implantation, compared to pre-hearing loss. However, it was found that many CI users still retained preferences for certain types of instruments and music. For instance, it was found that a greater proportion of CI users preferred low-pitched to high-pitched instruments. In terms of instrument ratings, the guitar, male singer and piano were rated as more pleasant and more natural than the other instruments, and in particular, significantly more pleasant and more natural than brass instruments. In regards to the specific sound qualities of instrumental sounds, such as, their fullness, sharpness, noisiness, etc, respondents rated all instruments, except the drum kit, as

significantly ‘emptier’ than they would have expected them to sound to a person with NH, and more than half the instruments as significantly ‘tinnier’ they would have expected them to sound to a person with NH. As quieter harmonics are often excluded by implant processing (Grasmeder & Lutman, 2006), it is unsurprising that CI users judged instruments to sound significantly emptier or tinnier than expected. However, it appears that the sound quality of music can be enhanced to some extent by wearing a contralateral hearing aid in conjunction with the CI, or by controlling listening conditions, such as choosing to listen to music in a quiet room or with good sound equipment.

It is also worthwhile noting that an overwhelming number of respondents stated that they would like musical instruments, singers, and music, in general, to sound like they would to NH listeners. Therefore, what music sounds like to a NH person can be considered as the ‘gold standard’ for these perceptual judgements.

In terms of musical styles, it was found that respondents preferred smaller numbers of performers to larger numbers of performers. Similarly, significantly more-favourable ratings were given to Country and Western when compared with the styles of Classical-orchestra, Pop/Rock, Jazz, and Classical-small group. In other words, compared to these styles, Country and Western was rated as significantly pleasanter, respondents reported that they were significantly more able to follow and identify this style, and this style sounded significantly ‘more normal’. These findings are likely to be related to the perception of complexity, where existing research suggests that respondents prefer music that is simpler.

In the UCMLQ, nearly equal numbers of respondents used either a CI+HA or a CI-only to listen to music. Of those who had tried both a CI+HA and a CI-only, the majority reported that the CI+HA gave a better sound quality for music. In addition, CI+HA users reported that they were significantly more able to follow the melody-line of musical styles, identify musical styles, and they also rated musical styles to sound significantly ‘more normal’ than CI-only users. This is consistent with studies by Turner et al. (2004) and Kong et al.(2004) which showed that simultaneous acoustic and electric hearing results in more-accurate pitch perception than electric hearing alone.

Lastly, more than half the respondents stated that they would be interested in a ‘take-home’ MTP. Respondents also reported that the MTP should focus on improving CI users’ ability to recognise tunes, in particular, tunes known before implantation, and commonly-known tunes, and offer a wide

range of musical styles. In addition, training sessions should be 30-minutes in duration, 2 times per week, and the MTP should come in the form of a DVD with subtitles.

In summary, it was found that certain types of instruments and music were preferred over others. Respondents preferred: (i) low-pitched to high-pitched instruments, (ii) certain instruments (e.g. the guitar) over others (e.g. brass instruments), (iii) smaller numbers of performers as opposed to larger numbers, (iv) Country and Western music as opposed to Pop/Rock, Jazz, Classical-small group, and Classical-orchestra, and (v) music with a slow rhythm/beat, and words. Thus, introducing CI users to these types of music may be a good starting point in a MTP. In addition, research reports that many CI users have difficulty with pitch perception and in turn, melody recognition, as well as timbre perception. It thus appears that pitch and timbre training would be an integral part of a MTP. Furthermore, as the majority of respondents indicated firstly, that they would like the MTP to offer a wide range of music, and secondly, that being able recognise 'tunes known before implantation' and 'commonly-known tunes' would enhance their listening enjoyment, the MTP should offer well-known or popular songs from each decade, starting from the 1950s to now, as well as popular classical music. In this way, the range of individual preferences and ages are catered for, and respondents are able to choose from a variety of musical styles.

Overall this study has provided information for the development of a MTP for improving music appreciation for CI users. Although there a was a lot of individual variation in responses, the general consensus across respondents was that music did not sound as they would expect it to sound to a person with NH and that they would like to be able to enjoy music more. As participant #183 wrote:

> "The implant has given me so much but I still really grieve for real music. Music can elicit so many emotions and bring such pleasure, it is like having a large part of my life missing…"

References

Arnoldner, C., Riss, D., Brunner, M., Durisin, M., Baumgartner, W. D., & Hamzavi, J. S. (2007). Speech and music perception with the new fine structure speech coding strategy: preliminary results. *Acta Oto-Laryngologica, 127*(12), 1298-1303.

Bismarck, G. V. (1974). Timbre of steady sounds: a factorial investigation of its verbal attributes. *Acustica, 30*, 146-159.

Blamey, P., Arndt, P., Bergeron, F., Bredberg, G., Brimacombe, J., Facer, G., et al. (1996). Factors affecting auditory performance of postlinguistically deaf adults using cochlear implants. *Audiology and Neuro-Otology, 1*, 293-306.

Fetterman, B. L., & Domico, E. H. (2002). Speech recognition in background noise of cochlear implant patients. *Otolaryngology-Head and Neck Surgery, 126*(3), 257-263.

Fu, Q. J., Shannon, R. V., & Wang, X. S. (1998). Effects of noise and spectral resolution on vowel and consonant recognition: Acoustic and electric hearing. *Journal of the Acoustical Society of America, 104*(6), 3586-3596.

Galvin III, J. J., Fu, Q. J., & Nogaki, G. (2007). Melodic contour identification by cochlear implant listeners. *Ear and Hearing, 28*(3), 302-319.

Gfeller, K. (1998). Music appreciation, from the perspective of implant recipients. *Contact, 12*, 24-25.

Gfeller, K., Christ, A., Knutson, J., Witt, S., & Mehr, M. (2003). The effects of familiarity and complexity on appraisal of complex songs by cochlear implant recipients and normal hearing adults. *Journal of Music Therapy, 40*(2), 78-112.

Gfeller, K., Christ, A., Knutson, J. F., Witt, S., Murray, K. T., & Tyler, R. S. (2000a). Musical backgrounds, listening habits, and aesthetic enjoyment of adult cochlear implant recipients. *Journal of the American Academy of Audiology, 11*, 390-406.

Gfeller, K., Knutson, J. F., Woodworth, G., Witt, S., & DeBus, B. (1998). Timbral recognition and appraisal by adult cochlear implant users and normal-hearing adults. *Journal of the American Academy of Audiology, 9*(1), 1-19.

Gfeller, K., Mehr, M., & Witt, S. (2001). Aural rehabilitation of music perception and enjoyment of adult cochlear implant users. *Journal of the Academy of Rehabilitative Audiology, 34*, 17-27.

Gfeller, K.E., Olszewski, C., Turner, C., Gantz, B., & Oleson, J. (2006). Music perception with cochlear implants and residual hearing. *Audiology Neurotology, 11*(12-15),

Gfeller, K., Turner, C., Oleson, J., Zhang, X. Y., Gantz, B., Froman, R., et al. (2007). Accuracy of cochlear implant recipients on pitch perception, melody recognition, and speech reception in noise. *Ear and Hearing, 28*(3), 412-423.

Gfeller, K., Witt, S., Adamek, M., Mehr, M., Rogers, J., Stordahl, J., et al. (2002a). Effects of training on timbre recognition and appraisal by postlingually deafened cochlear implant recipients. *Journal of the American Academy of Audiology, 13*(3), 132-145.

Gfeller, K., Witt, S., Stordahl, J., Mehr, M., & Woodworth, G. (2000b). The effects of training on melody recognition and appraisal by adult cochlear implant recipients. *Journal of the Academy of Rehabilitative Audiology, 33*, 115-138.

Gfeller, K., Witt, S., Woodworth, G., Mehr, M. A., & Knutson, J. (2002b). Effects of frequency, instrumental family, and cochlear implant type on timbre recognition and appraisal. *Annals of Otology, Rhinology & Laryngology 111*(4), 349.

Grasmeder, M. L., & Lutman, M. E. (2006). The identification of musical instruments through Nucleus cochlear implants. *Cochlear Implants International 7*(3), 148-158.

Kong, Y. Y., Cruz, R., Jones, J. A., & Zeng, F. G. (2004). Music perception with temporal cues in acoustic and electric hearing. *Ear and Hearing, 25*(2), 173-185.

Lassaletta, L., Castro, A., Bastarrica, M., Perez-Mora, R., Madero, R., De Sarria, J., et al. (2007). Does music perception have an impact on quality of life following cochlear implantation? *Acta Oto-Laryngologica, 127*(7), 682-686.

Loizou, P. C. (1998). Mimicking the Human Ear. *IEEE Signal Processing Magazine*, 101-130.

McDermott, H. J. (2004). Music perception with cochlear implants: a review. *Trends in Amplification, 8*, 49-79.

McKay, C. M. (2004). Psychophysics and electrical stimulation. In F. G. Zeng, A. N. Popper & R. R. Fay (Eds.), *Cochlear Implants: Auditory Prostheses and Electric Hearing* (Vol. 20, pp. 286-333). New York: Springer.

McKay, C. M., McDermott, H. J., & Clark, G. M. (1994). Pitch percepts associated with amplitude-modulated current pulse trains in cochlear implantees. *Journal of the Acoustical Society of America, 96*(5 Pt 1), 2664-2673.

McKay, C. M., McDermott, H. J., & Clark, G. M. (1995). Pitch matching of amplitude-modulated current pulse trains by cochlear implantees: the effect of modulation depth. *Journal of the Acoustical Society of America, 97*(3), 1777-1785.

Mirza, S., Douglas, S. A., Lindsey, P., Hildreth, T., & Hawthorne, M. (2003). Appreciation of music in adult patients with cochlear implants: a patient questionnaire. *Cochlear Implants International, 4*(2), 85-95.

Moore, B. C. J. (2003). Coding of sounds in the auditory system and its relevance to signal processing and coding in cochlear implants. *Otology and Neurotology, 24*, 243-254.

Oxenham, A. J., Bernstein, J. G., & Penagos, H. (2004). Correct tonotopic representation is necessary for complex pitch perception. *Proceedings of the National Academy of Sciences of the United States of America., 101*(5), 1421-1425.

Pressnitzer, D., Bestel, J., & Fraysse, B. (2005). Music to electric ears: pitch and timbre perception by cochlear implant patients. *Annals of the New York Academy of Sciences, 1060*, 343-345.

Schulkind, M. D., Hennis, L. K., & Rubin, D. C. (1999). Music, emotion, and autobiographical memory: They're playing your song. *Memory & Cognition, 27*(6), 948-955.

Sucher, C. M., & McDermott, H. J. (2007). Pitch ranking of complex tones by normally hearing subjects and cochlear implant users. *Hearing Research, 230*(1-2), 80-87.

Turner, C. W., Gantz, B. J., Vidal, C., Behrens, A., & Henry, B. A. (2004). Speech recognition in noise for cochlear implant listeners: Benefits of residual acoustic hearing. *Journal of the Acoustical Society of America, 115*(4), 1729-1735.

Wilson, B. J. (2004). Engineering design of cochlear implants. In F. G. Zeng, A. N. Popper & R. R. Fay (Eds.), *Cochlear Implants: Auditory Prostheses and Electric Hearing* (pp. 14-52). New York: Springer.

Appendices
Appendix 1
Interviews Transcripts and Notes

With Interviewee 1
Date of interview: 16th March 2007
People present: Interviewee, Interviewer 1 (Q^1), Interviewer 2 (Q^2)

Demographic details:
Age: 29 years old
Age when noticed or was diagnosed with a hearing loss: 14 years old
Length of profound deafness: 2 years.
Length of implant use: 3 years

Q^1. Before your implant, how much time did you spend listening to music with normal hearing?
Difficult to say. Learned how to play organ before hearing loss got to the stage where required two hearing aids. Music was always part of my life. With normal hearing, listened to music once a day, usually everyday.

Q^1. About the nature of the Interviewee's hearing loss e.g. degree of loss when wore hearing aids.
Hard to pinpoint as wasn't tested until I was sick one day and when I went to the doctor, he did the test with the tuning forks, then I was realised I wasn't hearing what I was suppose to. Then was referred to audiologist.

Notes:
- Had this test at aged 14-15 years and then wore her first hearing aid, just one hearing aid, one to two months after the test, then had two hearing aids. Two ITE hearing aids.

- Hearing loss at this initial stage was moderate. Then hearing worsened to moderately-severe, then profound. This deterioration happened over a period of 10 years.

- 24 years old when had profound hearing loss / was first assessed for CI.

- Have worn CI for 3 years.

- Both ears same degree of loss.

Q^1. With a CI, do you wear a hearing aid on the other ear?
No, I don't wear a hearing aid. It was recommended as it may help with sense of direction. But I hadn't bothered. Expensive enough maintaining a CI let alone a hearing aid! No I haven't tried wearing a hearing aid on the other ear. Not much point as pretty much no sound [can be heard through that ear].

Q^1. What is the make and model of your CI?
Espirit 3G, Nucleus 24. Does not know if a contour or straight array.

Q^1. What is the speech processing strategy of the CI?
Don't know. (Q^2: Probably ACE)

Q^1. At what point of time after implantation did you listen to music?
Was in the car, and tried to listen to music.

Q^1. What was your initial reaction to music?
Was weird. Just turned radio off as it was hard enough to listen to speech. Everyone sounded like chipmunks.

Could hear water running from the tap when brushing teeth. Seeing cars reverse and hearing the beeping, and things like that. Wow, they make sounds! I mean I knew what they were but I never realised, possibly how much I couldn't hear.

Q^1. And how long was this after your switch-on?
No, I could hear those sounds straightaway. I could hear speech and make sense of speech, just that everything sounded so funny. Sounded like chipmunks and robots and there was a delay too, like people will talk and the sound will come out like 2 milliseconds later, like you experience sometimes with long-distance conversations.

(Could perceive speech and environmental sounds well and identify them even at switch-on.)

Q^1. So that was when you first started listening to music, in the car, how about after?
I haven't really persevered too much with music, because to me, it's designed for speech, it's a speech processor rather than music. I've just found that music, just seems like noise to me. It's just annoying. Like having a radio on in the background, it's just annoying, really. But having said that, it's quite weird because if I put on a CD or the music that I used to listen to before I went deaf, I can quite easily recognise the music and enjoy listening to it. In terms of new music, I find it hard to.. I don't really persevere and try to pick up new songs. So "my music" is stuck in the eighties!

Q^1. Does it sound different than music pre-implant, even the ones you knew?
No, it doesn't sound different. I can still pick up the words. But in terms of tone, it's like when I'm watching, say, Australian Idol, they'll come on and they'll sing, and I'll have to ask "were they good or were they not good" because I can't tell because of the tone. I mean you can hear music and you hear the singing. But it all kinda sounds the same. If someone was singing really badly, I probably wouldn't even notice.

Q^1. When you're saying 'tone', what aspect of the tone? How would you describe it?
I don't know. Like when someone is singing off-key, I can't pick that up, in that way. I think that's the best way I could explain it.

Q^1. So you can't tell the difference between different singers? Even like male and female, you can't tell?
Yeah, I can tell the difference. But what I mean is that if they sing the song really badly I can't tell that they were making a bad job of it. But I'll know if they were male or female.

Q. How about the quality of the sound? E.g. if you were listening to a CD before and you listened to the same CD with the implant. Can you notice any difference in sound quality?
I can pick up the words better, the words of the lyric, but it still seems like…

… Beside myself.. I can't hear words…I don't know the words because it's important.

But I think with the implant I can actually pick up the words better [compared to hearing aids]. But, overall, I think, I don't really listen much to music now. Unless it's songs I know the words to and how it [the music] goes.

Q^1. How about music without words?
Music without words, no I haven't' tried.

Q^1. So what music were you listening to before..?
Pop music from the eighties and then the nineties.

Q^1. Any particular artists?
No, not really.
Acutally, I went out last night and I listened to Crowded House for the first time, for a few years, since I'd received.. It was quite good listening to that again.

Q^1. Are you quite familiar with them?
Yeah.

Q^1. Was that a concert?
No. Just at the pub on a TV that they were playing. There was a background noise and I couldn't really hear it properly but I knew what they were singing.

Q^1. But if it was say, not on TV.. would you still.. ?
No, it takes a while to pick up. Sometimes I'll be listening to something and think that sounds like such-and-such a song but then it'll take me, I guess, I'll be thinking, yeah, I think it's that song, it'll take me probably half a song to figure out what it actually is and sometimes I'm right and sometimes no. I thought it must've sounded like that song but it wasn't.

Q^1. What are the main cues you are listening to in order to try and pick up what the song is, like, what do you think you are concentrating on the most?
The words.

Q^1. What about the rhythm?
Mmm… Yeah I can say because I listened to some music demonstration in class and there was no singing in it. Oh, I thought it sounded like "Midnight Oil". Actually it was Madonna.

Q^1. Going back to music minus the words.. How music would sound, like, say, in an ideal world or how a normal-hearing person would hear it, compared to what you hear with an implant, what are the differences? Compared to what you hear and what a normal-hearing person would hear?
I guess frequency because it is related to the noise aspect. Radio just seems like noise. If I haven't got it turned up loud enough to hear it (?) or if I'm not really concentrating on it, it's just annoying, so I guess that would have to be the frequency. Just seems like noise.

Q^1. Noise?
Like constant, like babbling in the background. Like being in foreign languages. .. ? .. Just seems confusing. Too much effort to concentrate on it.

Q^1. So it's hard to follow and try and make sense of it?

Yeah. Other people with normal hearing just switches on the radio, just work away, just listen, know there's music or the radio in the background, are conscious of it and are enjoying it. But for me, it's just a distraction, too hard to figure out what this noise is, and the purpose of it. So I just turn it off. I don't work with music playing or anything like that. Too much of a distraction. Just confusing.

Q^1. That's music in general. What about say, orchestra music?
It might be different if it was some sort of orchestra music. But I don't really persevere with it. I'd just rather have silence(?) To me, it was just more important to hear speech rather then music. It didn't really worry me to much. I enjoyed listening to music.. like I learnt how to play the organ but.. ?

Q^1. Have you tried playing the organ post-implant?
No, I haven't. I gave it up when I went to high school. Between the ages of 10 and 13. I only played it for a couple of years.

Q^1. Was this before your hearing started to decline?
Possibly. Never tested then. Who would know.

Q^1. Do you miss, perhaps, not being able to continue playing music?
Not so much playing music, it's more, being able to enjoy it. Like go out to a concert or my friends would be raving about this band or whatever but I feel a bit excluded when it comes to things like that. Because I don't get as much out of it as they would. Because some of my friends are really passionate about music and they don't really understand. They're like why don't you like this music? It's great, you know! You try listening to it. Like it's just a waste of time, I can't be bothered with that. Yeah, I guess I do, I feel envious. You're lucky.

Q^2: Can you think of adjectives you might use to describe how music sounds through the implant?
Unfamiliar, because with new stuff, you can't establish, sort of, any rhythm with it.

Q^2: What about in terms of sound quality? For example, say with speech, people sounded like chipmunks.

Yeah, yup. Even when people are singing, the speech doesn't sound like normal speech. So I guess it would be a bit more robots than chipmunks.

Q^1. What about instruments?
The drum sounds normal, like in the bass. It all sounds within context. But I think overall, pitches, I can't pick up whether it sounds good or whether it doesn't sound good and that's where it's hard because I always ask someone else, are they're doing a good job of playing that song? I just think it's real good. Can't tell! I wouldn't be a good judge on Australian Idol, or anything.

Q^1. When you say music sounds within context, are you talking about individual instruments?
I can differentiate between them, like what is drums, like what is the guitar or piano. I can make out pretty much what each instrument is. But, which would be fine, like I think if someone is playing the piano, I'll just sit there and listen to it but when other things are added, it just becomes a whole, like overloaded [over] what my processor can actually cope with. And that's when it starts seeming like noise.

(Interviewee's said however, that she may not be able to differentiate instruments from the same family e.g. flute vs. clarinet etc)

Q^1. If you listened to the piano without actually seeing it being played, would you know it's the piano?
Yes.

Q^1. And you could hear the guitar is a guitar?
Yup, yup.

Q^1. It's just that when everything is sort of..
Added together. I could probably still pick out which instruments. You know, if I had to sit and listen to a song, I could say, oh yup, that's the piano or that's the guitar. I could still differentiate between instruments. But I think, I dunno, it's a personal choice, I just can't be bothered with that. Like I would rather listen to speech, I never really persevered.. I don't really do much with music now.

Q^1. You haven't haven't really experimented much?

Not really. It was just after the initial switch on. Everything just sounded weird. It's only been two years since I've been switched on, which really, isn't a long time. But I just [focus] on speech. And environmental noises, just everyday noises, rather than.. Like I'll get up now, like my flatmates they'll get ready and they have the radio on in the background before they go to work. And as soon as I get up and they go away, I just turn it off. It's just annoying.

Q^1. Have you tried a Direct Audio Input?
No.

Q^1. Would you go to a music concert?
I haven't been to one since my implant. I went to one a concert in ChCh before my operation and that was with hearing aids. I enjoyed it but I was too far away so it wasn't really loud enough, really.

Q^1. That was when your hearing was quite bad?
Yes, yes it was. I didn't find it loud enough. It was actually at Jade stadium and I was right at the back. And I couldn't really hear that well.

Q^1. What was playing?
Meatloaf concert, the Last World Tour. There was a lot of people that were disappointed with that concert anyway. I don't think it was just the fact that it wasn't loud enough. A combination of things.

Q^1. So you haven't been to any..?
No, I haven't been to any other concerts since then. There was a concert that I was invited to go to but I ended up being sober driving and went away and did something else while everyone went along to the concert. Cos it was pretty much, not long after I've been switched on. I felt like it would be too overwhelming. Just seems to be with concerts.. concerts with a lot of background noise and a lot of people, which just seems to me a lot to deal with.

Cos I went to the movies last night and that was the first time I've been to the movies since I've had the implant. A lot of things I missed. People were laughing, obviously funny things were being said but I didn't hear them. Some things weren't too bad. But. It was loud enough but it just didn't seem to be clear enough.

Q^1. How about TV shows? And the background music, mood-music, used?
It's funny, I sometimes put the subtitles on teletext and when the music comes on like "exciting music", it makes you laugh because I can hear it and I can pick it up and it does sound like exciting music or di-di-di-di.. [have] expectations.. can still hear that.

Q^1. So you could do without the background music or the mood-music?
It doesn't bother me, cos I know what they're trying to do. It depends, if they're trying to talk as well.. Like it's fine if it's separate, that's fine. I think it's when it starts getting.. when people are talking and they're playing music, like combining the two, that's when it gets annoying.

Q^1. Comparing hearing aids to cochear implants, what's the difference? Which would you prefer?
[With] hearing aids, I think music would sound more natural, the way like it's suppose to be. With the cochlear implant, I don't know what happens but it just sounds unnatural.

Q^2*: In what way would you say it's unnatural?*
That you can't tell, for example, if someone's a good singer or a bad singer. If they're thrashing the song. Like pitch, like being out of tune. Like instruments getting the right note, or the singing. You just tell can't tell with an implant, whether it's the right note they're getting.. It's a bit sad. Although, with an implant, it's better in the way that you can pick up the actual words. I don't think I could do that with hearing aids. Very hard to pick up words.

Q^1. With pitch – do you think it's out-of-tune or not enough difference *between pitches?*
Yeah, I think not enough difference between pitches. It doesn't sound out of tune to me.

Q^2*: Monotonic? More monotonic than it should be?*
I don't know what it should be, cos I don't know.. you know what I mean? I can't tell what is normal. Maybe if there was a song, someone was playing a song, it was how it should be sounding, normal, and then, the same song but they played it out of tune, out of pitch, out of key, whatever, maybe I might be able to tell the difference. I don't know but it just seems with an implant that I can't.

Q^1. What if they used exactly the same notes but did it in a different order, like a completely different melody, would you be able to pick that up?
Don't know. Don't know. I've never done that before.

Q^1. But with hearing aids you can follow the pitch, the melody?
I think so. Yeah, more so than with an implant.

Q^1. Would you say.. How satisfied are you with a cochlear implant for music?
I guess I'm not satisfied. But, I don't want that to be a like bad thing, I think it's more a personal choice with me. Cos I think some people with implants, they do really well with music. But to me, I would rather.. speech is more important than anything else. Probably motivation.. I can't be

bothered trying to listen to music. I don't have the time to sit down, trying to appreciate music more. I mean I listen to my.. I have an ipod that's full songs from, like I said, before I had my implant.

Q^2*: How do you plug it in?*

No, I don't, not the earphones.. it doesn't work. Just in my car. If I had a car, just plug it [ipod] in and play it through the stereo.

Q^2*: Now, you don't listen to it now?*
No.

Q^2*: Can you put an input jack into your ipod? Connect your ipod to your processor.*
Right. Only got earphones, haven't got..

How is your cochlear implant in general?
It's great, it's brilliant for one-on-one. Telephones, I haven't had any dramas at all. I never used to be able to talk on the telephone.. I hated the telephone when I had hearing aids I really was so not confident using them when it rung. If the phone rang, I kind of run away and get somebody else to answer it. It affected me in terms of employment. Not many jobs where you didn't have to answer the telephone. Things like that, it was really hard. But with my implant, I think it's great, I can use telephones. Speech, if not in a noisy background.. yeah, but they have limitations and that's with music and background noise.

Q^1. From switch-on, was it like a big improvement over time, with listening to speech and environmental sounds, or was it pretty much just instant?

I think because it never got to the point where I was profoundly deaf for too long, I think I progressed quicker because I hadn't lost the ability to recognise sounds. So, when I had switch-on, I basically spent everyday, a couple of hours everyday at the audiology clinic, each week, things got better and better I would say, in the first few months. And now, I don't think, I think it's stopped. I don't think that I'm improving. I don't know if there's anywhere, anyway I can improve so I just think this is as good as it's ever gonna get and I'm happy with that. As long as I don't (?)

Q^1. Have you found anything that helps you listen to the radio? Like any strategies, like helps.. makes music-listening any better for you? Or certain circumstances that you think are slightly better than other circumstances?
Only, in the context, I really only listened to music, like I said, when I had my ipod in my car when I had to drive in weekends.

Q^1. Why, was it because they were songs your knew? Or maybe the car was quieter?
No, the car was noisy, like it was good when the car was going I to turn up the stereo really loud. But when it was turned off, it was good to listen when it was quiet in the car, yeah. But I think, more, I didn't have anything else.. (?).. So I only used it in the car. Otherwise, I wouldn't listen to music. Or maybe they'll have it, the radio going on in the background and it'll just annoy me so I'll just go and turn it off.

Q^1. Would you like to add anything?
[No]

End of interview.

With Interviewee 2
Date of interview: 19th March 2007
People present: Interviewee, Interviewer 1 (Q^1), Interviewer 2 (Q^2)

Demographic details:
Age: 41 years old
Age when noticed or was diagnosed with a hearing loss: 15 years old
Length of profound deafness: 17 years.
Length of implant use: 5 years

Q^1. What is your age?
41 years

Q^1. What was your age when you first noticed your hearing loss?
Probably 15 years old.

Q^1. What was your age when you had a severe hearing loss?
Severe or profound? Severe, probably 21. Because that was the first time when I did something about it. I was declared severely deaf and they couldn't believe why I wasn't wearing hearing aids or how did I cope. But I was an extremely good lipreader, I put it down to that.

Q^1. So between 15 and 21 years of age, you didn't have any hearing aids?
Yes, I didn't have any aids at all. Well, looking back, I know [I had a hearing loss]. People would say things like, "Oh, you're a snob. You ignored me when I called out". And of course, you know, I wouldn't hear people behind me. Or, you know, they'd say, "Oh pin your ears up, [Interviewee's name]". You know, and it was, it was a lot but I wasn't really aware that that's what it was.

Q^1. What made you sort of, take that step forward [to get your hearing checked]?
Oh, because I was sick of, of friends saying, "Oh, you're deaf, [Interviewee's name], get your ears checked." And I was nursing, doing my nursing training and I was working at the Ear, Nose and Throat department. So I thought, oh, well why not, I'll prove them all wrong. So I went and had my hearing tested and they were, you know, just shocked. And so was I. So it was 21 before I got any aids and I just got one to start with. But then it progressed quite massively (Q. Was it a behind-the-ear?) Yes, yes.

Q^1. Similar loss in both ears?
Yes, yes.

Q^1. When did you start wearing two [hearing aids]?
Um, I was 15. Probably about 25, maybe? Yeah.

Q^1. And then, you said that it [hearing] deteriorated…?
It was on a slippery slope and every year I'd notice that it was and you know, I'd go for yearly audiograms and things and every year, it just went, you know, dropping and dropping. I did notice that, I've got 3 children and after each child was born, or through each pregnancy, I lost more

hearing, which is probably, you know, hormonal or I don't know but there seems to be a correlation between being pregnant and losing your hearing.
Q^1. Does it [the hearing loss] have an aetiology or reason for your.. ?
It is hereditary. There's a, it's a recessive gene that causes it. My aunt who's 70 has just received a cochlear implant but she didn't start losing her hearing til she was 40, so her's is a later onset but exactly the same graph(?) [as] has happened to me. And my father is heading that way. And my brother has also got a hearing loss so there's a strong family history of, yeah.

Q^1. At what stage did your hearing loss become profound?
Um. Have to work backwards when I got my implant I was 36.. so.. I was probably profound from 30 years old, I would imagine.

Q^1. So about 6 years between profound and getting your implant?
Yes.

Q^1. You don't wear a hearing aid in the other ear, do you?
No. Pretty much when, sort of, with a gradual decline and then probably at the age of 33, it just literally fell of the end and end up had nothing, basically, so I wasn't getting any benefit from wearing hearing aids at all. I continued to wear them but really, there was no point. But, between my lip-reading and possibly, just getting noise from my hearing aids, it did help maybe a little bit. But I could lip-read and communicate with the two of them just as easy with them as without them. It didn't really make much difference.

Q^1. What is the make and model of your implant? The ones you're wearing now?
I started with a 3G but I've converted to a Freedom.

Q^1. Just last year?
Yes. On a trial basis at the moment. Cos I wanted to know the difference between 3G and Freedom.

Q^1. Do you found a difference?
I do, I think it's better. With your 3G there's 2 electrodes that have to be switched off in the highs, high frequencies, because of earthing and you know, requiring an earth, and you can switch these, those back on with a Freedom. So I immediately noticed that there was a crisper sounds of speech, eventhough it was pretty crisp before, it could give it that extra little bit, I think. I must put my 3G in again, you know I haven't put it in for about 3 or 4 months because I didn't want to on purpose just to see how different it really was cos I still have it so I must do that one day soon and find out. But I think it is, I think it is better.

Q^1. Is it better for music, do you think?
Nope! Definitely not! When I say that though, there are more programs so therefore there's probably more opportunity to fiddle round in terms of mapping with possibly getting a better.. but um I can talk to you a lot about music but you think I…

Q^1. So you have a 24 contour array?
Yes, that's the one.

Q^1. Do you know what speech processing strategy it uses?
Yes, I'm on the most common one, ACE.

Q^1. ACE 900 Hz?
Yes, I think that's right. SPEAK is slower, isn't it? SPEAK is slower? *(*Q^2 *- Yes.)*
Q^1. And just the standard 900 Hz?
I'm not sure. I think so. I wear one but I don't know much about it. Yes, I think so.

Q^1. Do you have an idea of when you started to listen to music when you first got it (the implant)?
Yes, on day one. I tried the radio. It sounded like a foreign language. I couldn't understand a single word.. of.. of.. music. I couldn't make head or tails out of it. The more you listen, the better it gets. And of course, your brain is doing a fair bit of rewiring in terms of understanding speech via an implant so to start with it was, it was terrible. I was really musical before my implant. I used to sing and I used to play the piano and had a fairly intimate knowledge of music. And, I'm probably jumping the gun here on your survey, but to say that from my own observation of people coming through, people who were very intimately connected to music before their implant, find it terrible with an implant, and I think that's just because the brain has a memory of music and a very intimate memory. Whereas people who really don't care so much about music, think it's wonderful, which really, amuses me. But that is the way it seems to go, so there are definitely people out there who do appreciate music with their implant. But you can guarantee that they weren't singers, that they probably never've played a musical instrument and you know, they enjoyed music but just on a very broad sense. So for those with a really intimate knowledge, it takes years I think in terms of, your brain,.. you have to, .. your brain has to either reprogramme itself for one, but also two, I mean you have that physical challenge of there not being enough frequencies in an implant to give you that music appreciation. So it's a double sword really, I see. I do believe you can improve and I certainly have improved in my appreciation of music but it.. it would never be probably the way it used to be.

Q^1. How does speech sound to you when you first got it?
When I first got it? Like Donald Duck. But it's understandable Donald Duck. I could understand what was being said. And that was quite amazing for me was that, you know, without looking eventhough they sounded like ducks, like ducks quacking, I could still understand what they were saying. Pretty amazing. So I did understand speech immediately eventhough the speech was Ducky and robotic. So my children all sounded like squeaky mice. And because you know kids speak quite high pitched so they all sounded like mice speaking. And, but as I say, even so, I still understand, I could understand the speech. But they would say to me "Oh Mum, you're talking like a robot" and well I say that's because "I'm hearing like a robot. You all sound very monotone." And it's very hard to intonate your voice when what you're hearing when you speak is monotone. (Q^2: So speech sounds monotone".) Yeah, yeah. So you have to concentrate hard cos what was coming out was completely flat eventhough I knew my voice was going up and down. But yeah, so I would fall into a monotone speech if I wasn't thinking. I had to really think hard but that was only probably the first month that it sounded bad.

Q^1. How do you make that leap?
I think your brain makes the leap and between the mapping and your brain, it just suddenly starts to make sense. And after each mapping, you know we'll do regular mappings for that first month, so after each mapping, you know, it wasn't quite so, you started getting an intonation. This is hard to explain but it sounded like there were two layers involved and you could hear, kind of two layers and it was almost, they needed to join together. That's how it, that's how I'd describe it. And gradually as the weeks passed those layers got closer and they started to mesh (?). But initially, it was very offputting because you sort of had a, had a double, it's almost like an echo and two layers there, that you had to try to bring together and I think your brain does a lot of that, as well as you.., as well as the mapping.

Q^1. So do you think your brain turns what you're hearing into, a bit, to what you remember it (music) as?

Yes, it definitely has. And that's particularly true with music. Like I'm stuck in a time-warp, music-wise, in the sense that music that I can still remember before I went deaf, with an implant, sounds an awful lot better than music that I'm completely not familiar with. And that's memory, that's memory. So if you do have that memory.. you.. it's much easier, it's much easier. So you take people who have no memories of music or speech [they] would really struggle with an implant. because your brain does rely on that memory. I mean that's not to say that you wouldn't get there but it would take an awful lot longer, I think. Yeah.

Q^1. I read somewhere that, perhaps, people that have no memory of music they do enjoy it more?
Well. Yes. If you have no memory of music whatsoever then you have nothing to.. your brain's got no.. nothing to fight (?) against. *(Q^2: Children.)* Yes, yes, yes. But with an adult, if you had, and especially if you had an intimate knowledge of music, your brain really rebels against that. It rebels against so much what it's hearing, doesn't like it at all. In saying that, 3 years.. It's been nearly 5 years since I've had my implant and when I hit the three year stage, we went to a jazz festival in Queenstown or we happened to be in Queenstown when a jazz festival was on and I love, I love jazz. And we went and sat in different bars and some groups were playing outside and some were in. But it was the first time that I actually, could almost say that that music sounded like how I remembered it. I don't know why it was, cos cos not all music does that but the jazz for some reason and I put it down to.. Music is very much also dependent on the type of, what you're listening on or through, and so if you're listening to it on a tinny little walkman it's gonna sound tinny but if you get yourself state-of-the-art speakers and good sound equipment it does sound an awful lot better. So I put it down to the wonderful speakers and the sound systems that they had and live music is always an awful lot easier than other music. So if you go to a live concert, that actually sounds quite good. You know or a live orchestra, sounds good.

An orchestra is an interesting one, cos initially, about a month after switch on, I had a, my father-in-law was singing in a huge orchestral concert. And I went to that and it was just the most awful thing I've ever heard in my life. It was just, a big bad noise, and it gave me a headache and I had to turn my implant off, it was that bad. There was about a 100 in the choir and it was a full orchestra. But I persevered because I knew that I had to, in order to appreciate music. I had to listen to it over and over and over again and eventually, over time, my brain was able to separate out the different instruments so now I can hear, like the violins and I can hear the flutes and I can hear the various different instruments. I think my brain has been able to separate those out but that took a lot of time and a lot of listening to tune the brain into what it was hearing. So now, I do have an appreciation of music, where I can sit and listen and almost enjoy it. Well, pretty much enjoy it, not not to the same level of enjoyment as before, but not where I'm thinking I've got to get out of here, this is awful. Because it was like that for quite some time, where this isn't even nice to listen to, but I forced myself, I made myself stay and listen and I, just cos I knew that the more did it the better it was gonna get. And so it has got better. And just for an example, you know, Bic Runga? *(Jenny: Yup.)* I decided that I was gonna get a cd and listen to that and absolutely thrash it until I became familiar with her music. Because I remember a couple of her songs before I got too deaf to appreciate it. So the children would listen to a cd and I'd remember picking up thinking that I know that song but none of the other songs on that cd were familiar. So I thought, right, I'm gonna do an experiment here and I'm gonna thrash it, I'm gonna absolutely, well, Bic Runga myself out. And I did that and I'd do it like for about a week and then I'd stop for a week and then I'd go back to it. And it was

definitely better, you know, if I kept doing it and kept going back I almost got to the point where I could recognise the song. And that'll come on and I'd think, oooh, I know that, it's Bic Runga. So, it proved to me that through sheer hard work you could to it, you can do it. Yeah. There is that limitation, there's always gonna be that limitation of the frequency range within the implant, but in saying that, your brain's a pretty amazing thing and it can compensate as well so, so I think it can be done.

Unfortunately (?) I wanted to do, well, myself.. [?]… I wanted to do more with singing because I was a singer and I just can't sing now. Well, I can but it's dreadfully out of tune and I can't pitch myself. You can hear it but you can't quite pinpoint the pitch. You're either slightly high or slightly low but you just can't quite get it and it's very frustrating because you think you're on the button but then, if you listen hard you're suddenly thinking, oh help I'm listening to the wrong strain, there's like about 3 layers and you're tuning into a layer and you're thinking, oh no, that's not the right layer, so you tune into a different layer and you think, ooh, is that the right layer? No, that's not the right layer either. Very very hard to um yeah, very hard to pinpoint the pitch. And I would very much like to know whether by going to a singing lesson and having intensive training with a teacher, whether I could actually get to pitch myself, by myself. So I'm not quite sure yet, whether that's possible to do. And I don't know of anyone whose done it or have tried it. Q^2, you might know, I don't know. *(*Q^2*: No. Have you ever tried like playing a note on the piano and trying to match your pitch to that and having someone with normal hearing tell you how far off you are.)* Yes. *(*Q^2*: And how did they say?)* I'm off, I'm always off. Sometimes it's like half a tone. *(*Q^2*: Can they then find the note that you are singing?)* I don't think I've tried that far, it was a long time ago that I did that and I didn't have a piano that was in tune. *(*Q^2*: It'll be interesting… if you have a musical friend, if you play a note on the piano and you tried singing it and then if you're out, get them to maybe play the note, show you the note and then you can have a look, visually, how much difference it is. And you'll probably find might be very different across the frequencies, like the lower…* (**Tape finished**.)

Yeah, so an organ, people just can't get it and I think there's just too many stops, too many layers upon layers of sound. (Q^2: It's a multi-instrument, really, it's not one..) It is. Not a single.. yeah. So that would make sense. So I say to people, for goodness sake, don't go to church too soon! You know, they find that the organ is terrible and that the choir is like squeaky mice. There's nothing.. And I must say, singing, a choir is not, it's not easy to follow, again because of that pitch problem. You know, I do not find it easy to follow a choir.

Q^2*: Besides pitch, what else can you say about the sound quality of a choir or singer? Of singers?* Um. Again, it's the bass really, it's the bass that is missing the most. Because I'm sure if there was more, if you were able to put more bass in it, it would sound a lot better. So again, it's that trebly, you know, that you get that tinny sound (?). So that could be too, why, you know I haven't really thought about it much, maybe that's why jazz is much better. Because you have more brassy instruments anyway. You know jazz. Quite possibly that was why it sounded really, but you know, it was exceptionally good. To the point, where you know, my husband said, oooh, you're really hearing it properly, aren't you? Because I was sitting there like this (leaning forward, elbows on table and hands under chin). And normally, you know, I could sit for 10 or 15 minutes and then I'll get fidgety and you know, couldn't be bothered anymore because it wasn't sounding right. And he went home. He said, I'll leave you to it.. this is like, one in the morning. I said I'm staying till the end, this is sooo good. I hadn't heard it so good for so many years that I just had to stay. It was just amazing.

Q^2*: Have you tried CDs of jazz music or DVDs?*
No, I haven't actually, and I should, I should get some and find out what the CD or DVD would be like. I have a feeling that.. I have listened to music that is similar, sort of jazzy, and it's not as good again but I think therefore, that's what made me think well, live music is better because of your better speakers and sound system and probably better control by them as to what sort of sound quality comes out? Because I have no problems at live concerts either. That's much much better and you do get the basal, you know, the bassy sounds coming through. And the louder the better. The louder it is, the better it is. You know, while other people are sort of standing there with their hands over their ears...(?) it doesn't matter.. you can't ruin or you can't damage your hearing. There was always that threshold so you can't blow yourself out. But loud music is really good, really good. So, um, you definitely notice that. But I must get a jazz, I haven't actually got a jazz cd, but I must get one and see. But I have a feeling that it won't sound as good just because of what you're using.

Possibly, if I got some of the Boise headphones and listened to it through them *(*Q^2*: And a stereo with bass lift (?)…)* Yes, and a Boise stereo worth $6000, it'll probably sound fantastic! Yeah, so you do.. So I often say to people, don't go and buy yourself cheap CDs, the replica CDs, their quality is terrible. They're digitally remastered. They're not good quality. So buy yourself, if you want to listen to anything decent, buy yourself, decent, you know, $35 cds because they are the good quality ones. And give yourself the best opportunity to, if you are really a music buff, you know, you need to buy really good equipment and then you would possibly find that it was much, well, it will be, much nicer than if you've just got a tiny little boombox, you know. So definitely, the quality of the equipment you use, has a bearing on it, yeah.

People always get the beat so that's quite good. You know, they go from not being able to dance, to being able to dance again, so that's pretty neat. Old time dancing or rock and roll or something and they can go back and they can do that because they can at least get the beat. Yeah, so that's something that's pretty good.

Q^1. So you are able to learn new songs that you weren't familiar with, prior.. ?
You can. It takes a long time and it takes a huge amount of listening but you can get there. Definitely, definitely.

Q^1. And you chose the Bic Runga one because it was.. ?
Just because she's got nice, easy melodies and there's not too much other.. She plays the guitar and that's about it. So you're not overridden by drums and guitars, and... You're really just hearing her voice and the guitar so it's much easier for your implant. I always tell people for music perception, don't, for goodness sake, go and listen to the orchestra as your first introduction because it will just sound a mess. Start with simple strand, like a flute or guitar, country music, you know, where it's easy melodies. Don't go for something complicated.

Q^2*: Do familiar melodies sound like how you remember them, even things like nursery rhymes, and or..?*
Pretty much. *(*Q^2*: Not out of tune or anything?..)* Like the music that I loved, like Dire Straits and Elton John and things like that. It sounds pretty good, it's not exactly the same because again, there's that pitch problem. You kind of have to pull in, on your brain, and concentrate. Once you have got where they're at, then it's, "Ah! Yes I know". It's very difficult to turn on the radio or the stereo and know immediately, what the song is. Someone will say, What's this, [Interviewee's name]? And I'll have to sit there and listen for about 30s and allow my brain to hear a bit more of it And then I can say but I couldn't tell you straight away. I'd have to listen quite hard and then, I'll

start to, “Ah yes, I know what this is”. So it still takes time to tune into it. As I say, I don’t know why, but that jazz festival was the first time and only time for me, that it sounded *exactly* how I remembered music. Music, since then, has not sounded the same.

Q^2*: Ok, so what’s the difference then, between what you heard at the jazz festival that sounded exactly how you remembered it as, and other times?*

I think, the jazz festival, it was live music. *(*Q^2*: I mean, what was the difference in terms of the sound quality?)* It had body, it had richness, it had bass. It had the guts! It was whole again. And that made the difference. Huge difference.

Q^2*: So you used some, .. like you said music sounds tinny and flat. Any other adjectives you can think of, to describe how music sounds? Or even other adjectives that, other implant users have used to describe how music sounds?*

Tinny. Gutless! *(*Q^2*: Not rich.)* Yeah, yeah. Sparse, maybe, sparse. And, maybe, non-melodic. It’s quite difficult to get the melody, you know, so, so, yeah. Dunno if there are really any other words. That tinny, really sums it up, I think. Sort of, yeah.

Q^2*: You said that you have a piano. Have you gone and tried going up, like playing chromatically up the piano, does each note sound different to the last or.. Like I had a couple of subjects saying to me that they can go through an octave and it would all sound the same and they’ll hear a sudden change. And other subjects say, no,I can go up, sometimes I go down. So everyone’s a bit different. How have you found it, when you’re going chromatically up the piano..?*

That would sum it up quite well, really, because sometimes there is too subtle a difference to hear the difference until you’ve maybe gone up half an octave and then, it might sound a wee bit different. You know, so if you played C and you played G, you could hear the difference but C, C sharp, or D, D sharp, chromatically, there’s not a lot in it. Again, as I say, I haven’t tried that for a long time and I should try that again because I’m five years down the track now. I probably tried that at two years down the track and you’ll definitely find, I’m sure, as time goes on, you do get subtle improvements and so it pays to keep revisiting it. And that’s why I say to people, don’t give up on it. Keep at it. Because, I think, as time goes by, the difference is subtle but if you leave it two years you’re gonna notice quite a difference.

Q^2*: If you do experiment, it’s good if you could get someone else to go up chromatically and you have your back turned because you’re gonna have expectations to go up but the sound is gonna be different, even if the pitch is not different, the timbre maybe different. So you get them to play and you say if it’s the same or if it’s different.*

Yes that’s a good idea. As I say, I struggle because my piano is so old and decrepit that it’s not the right one to be experimenting with but I need to get to someone who has a piano that’s in tune, to do that. Because I would be interested to know because years have passed now and I would like to know whether my brain has started to take over or whether it’s made no difference at all. Cos I am constantly being exposed to music but that’s the other thing I say to people it’s not just, you can’t just.. You have to sit and concentrate on the music. Having the radio playing in the background while you’re doing something else is not training yourself to listen to music. You actually have to solely focus on the music. It requires concentration to do that. (Q. Did you do that, like for fifteen minutes, or..?) Yeah, probably no more than that because it’s quite hard to concentrate for that long

on one thing so I tend to listen to shorter spurts, of a shorter period of time, rather than listening for 6-8 hours(?), yeah. So 15-30 minutes is really about your concentration span.

Q^2*: What aspects of music did you start-off focusing on? Like what was the first thing, there's instruments and timbre.. When you were trying to train yourself to listen, what did you try and train first? Like, what was your goal initially, when you started, that you wanted to be able to achieve?*

Good question. What was I trying to do? I wanted to get, um, what came first? I haven't really thought of it like that. I wanted to be able to understand which instrument was playing, for a start. Identification of what was being used. And then, it went to, perhaps, you know, to try... the melody, you know, get the melody. To understand the melody. Now, I could understand it better if I had the music in front of me so I could see where it was going, which makes sense. Without the melody in front of me, it was pretty difficult to do. I also wanted to, I was hoping, that tinniness would, you know, we could overcome that. But I realise that that really is an implant, it's a hardware thing rather than a brain thing. And that tinniness can be improved with the quality of the gear that you're using. You can improve it but it's more of a hardware thing rather than a brain thing. Yeah. So that was, I guess, what I was aiming for, to be able to identify what was playing and then being able to identify melody, which is very difficult to do.

Q^2*: So based on your own experiences and your work, if we were to go ahead with the training program, because there are so many aspects of music to train, what would you suggest to start with? Recognising instruments?*

Yes.

Q^2*: Because, recognising instruments doesn't necessarily mean you enjoy it. So if you want to improve music appreciation, that's why I was wondering would it be melodies to start of with or..?*

I think, music appreciation, yes. As you say, that can be quite broad, that. Like do they just want to appreciate music as whole, which includes, well it does include everything, doesn't it, to appreciate music, you have to appreciate everything. But I still believe you need to start off with identification of what you're listening to. So are you hearing a piano or are you hearing a flute? What are you hearing to start with because that.. You have to have that grounding first. Then maybe, then you can get some appreciation of music if you have identification. Yeah. And people now, I have noticed, to start with, people, they may hear the singer but they have no idea what they're saying. But in time, they are actually able to start understanding what the singer is saying, which is pretty amazing, actually hear the song. They might not get the melody right but at least they can hear what the person's singing. To hear the words, if it involves words, yeah.

Again, music appreciation, I would be really strongly recommending if they really want to get that appreciation they have to use good quality equipment. Because it's like anything and I've often said to my husband, or my children, "Ugh, that sounds really tinny! Is that me or is that, that music?" And they'll say, actually "No Mum, it's the music". So therefore, it's not always the implant that's giving me that tinniness, it's the equipment. To people, I say don't… if you're really really are passionate about your music go to a shop. It's interesting because when I was trying to buy a small stereo unit, I thought, the only way I'm gonna do it is to take a CD around to the store and put it in to each one because they have different qualities, a different sound. So I say to people you have to

go and actually physically listen to each one. Get the people in the store to turn off their background music because that is really distracting and actually listen. And you will find there is a difference. And it doesn't matter because you have an implant. If you want to appreciate music, it's what you hear. Not what someone else recommends that you hear. Not a hearing person. You need to do it yourself. Because only you will be able to tell which one gives you the best quality of sound. But interestingly enough, I did take a person who could hear with me, and the one I picked out, was the one that they would have said was the best quality of sound. You know, so in saying that, do it yourself but as an experiment, I did have somebody with me and they said, yes, well, out of all those units, I would've said that that was the best quality of sound. So it's important that you have reasonable quality gear. Yeah.

Q^2*: Do some instruments sound better than others, to you? Easier to recognise than others, apart from percussion, which is easier to recognise?*

Yes, like, the flutes are much easier. I'd be hard pushed now to identify.. but the general layperson wouldn't either be able to identify between a trombone and a trumpet, I mean they wouldn't know, unless you played one or had that intimate knowledge, you probably wouldn't know anyway. That's probably not a very good comparison. I do find the flute good. Piano's ok. I know it's playing but it doesn't sound particularly wonderful but I know what it is. I can identify most [instruments].. but I can't identify what brass instrument, I know it's brass. So I do know that much. It's the single-stranded instruments are probably the easiest. Violins don't sound that flash. And that's understandable, they're very squeaky when they get up there so I find it very hard to follow the melody of a violin. But I can follow the melody of a flute, no problem.

Q^2*: Other woodwinds, like the clarinet?*

Yeah, they're fine. Wind instruments are good.

Q^1. How about the cello? Do you have the same dislike for the cello?

Mmm. Again, it's still a bit squeaky, you know, like the violin. But the cello's a bit deeper than the violin so it's not so bad, it's not so bad, yeah. Anything with bass is ok. The lower it goes, the better it sounds.

Q^1. But, perhaps strings would be ones that you don't like as much, compared to..?

No, no, I can now understand them better. But they're harder to get the melody, harder to get the melody.

Q^2*: Female singers vs male singers?*

Oh yes, can do that now. Wouldn't able to do that initially. It was very hard to distinguish a man's from a women's voice when you first were first switched on. My rationale for that is because, you know, the implant is not fully inserted into the basal, you know, into the very centre of your cochlear so therefore, it takes time for you brain to compensate and to be able to do that in a different area of the cochlear, which I believe it does. So that's why, to start with, you can guarantee that, well, women think their husbands sound like women! And you speak to a man and you were sure it was a

woman, much to the disgust of most men. But that does improve and I now have speech recognition to the point where someone can ring me up on the phone and I know who it is, they don't have to say their name.

Q^2*: Any preference for a female singer vs a male singer?*

Not really, no. (Q^2: Does any give a better quality than the other?)

I guess, probably anyone with a bass sounds better. So I guess, a man, in that point of view. Depends on your music type too, doesn't it, whether you're into heavy rock or whether you're into sort of classical music.

Q^2*: I was thinking more, maybe generically. If they were singing the same thing, would a man would sound better than a woman?*

I don't know, I haven't tried it. I wouldn't imagine it would make too much difference. But possibly again, maybe someone with a deeper voice would be easier, easier to understand. Would be more within the frequency range than a soprano, or something like that, yeah.

Q^2*: So compare it to how music sounded with hearing aids just before you got your implant?*

Hearing aids were better. *(*Q^2*: For music? Even if just before implant?)*

Prior to the implant, I didn't, I stopped listening to music because you could not get a melody. Or you couldn't even, or you could get a beat, just I could just get a beat. But I couldn't even hear the singer. I didn't even know that there was somebody singing.

Q^2*: So say when you had a severe loss, and you could get sound, right..*

The instrumental music sounded better than an implant. *(*Q^2*: Why?)* Because you still had the fullness, you still had the fullness of sound. Though, you couldn't understand what was being sung. And you had the bass. Because most people, you know, they had an implant because they suffer from a high tone loss so.. with their hearing aids you still get the bass. And I guess the bass is where you get your richness. So you've still got the richness. That is the worse thing I felt is because with the implant it takes away any bass that you did have and so that's why it sounds so foreign, it's because you're not getting any bass at all.

Q^2*: Do you have residual hearing in the other ear?*

No.

Q^2*: Oh ok. There would be some patients who would have, have they tried a hearing aid as well as the implant because as you've said, the implant does give you the highs and the hearing aids give you the lows and the lows also help with the perception of pitch because they would give you the fundamental frequency..*

I would imagine if you could and were able to wear a hearing aid, I reckon it would help. I haven't actually come across anyone who has because most of them throw their hearing aids away once they get their implant because they find that they get more.

Q^2*: It's worth suggesting maybe they keep it even if they only do it for music.*

Yeah. Exactly. Some people have and it varies between people. *(*Q^2*: Yes, it does.)* Some say it makes no difference at all. Others say, "ooh yes, it might give me a bit". But I do say, we recommend that people don't wear a hearing aid for their first 3 months, just to allow their brain to adjust to an implant and then, after that, it's fine to put the two together. And some people do find that they get a much richer sound when they can wear a hearing aid, where they do have some residual hearing. They get a much better sound quality. So yes, definitely would be worth trying for music. Mmm. Especially, maybe with some noise-reduction headphones, though with hearing aids, you'll probably get it squealing because you'll probably get feedback. If they're big enough so they weren't sitting right over the aid, it'll probably be ok. It could definitely be something that someone could try. I would be interested to know. Because I cover such a broad range of things, I don't really concentrate solely on music but that would be interesting to do, for people that were able to wear hearing aids.. that could get some.. have some residual hearing that may benefit. Again, it's something I would like to try. I have a tiny bit, like maybe 10%. It's not enough to give me any speech perception but maybe it would with music. But again, I donated my hearing aids to my father, I don't have it [the hearing aids] anymore. But it would be something that I could experiment with because it may give me a little bit more. Yeah. I find that I get that busy that music isn't a priority anymore and because it's not how it used to be, it's not something you're hankering to listen to because it's never gonna be as good. So I guess I've become a little bit lazy but I still enjoy being able to go to a concert and being able to listen to that live music, I really enjoyed that, yeah.

Q^1. How about on TV, background music on TV or in the cinema?

If I'm happy with it? If I can understand it, if I'm not, it doesn't make any sense. And again, it's that coming through those TV speakers, which are not very flash, they're not very good.

Q^2*: So you mention like having good quality equipment help with music listening, having the music in front of you has helped, knowing it beforehand has helped, any other thing, or things that you suggest might help.. ?*

Yes. Things that are of an advantage. When you're first learning to listen to music, again to listen to the music that you remember because your brain has that memory so that is the easiest stuff to start on. Don't start on something that you've never heard before. So I'd say dust off all those old tapes and CDs that you haven't listened to for years. Because they definitely sound better. And persistence. Don't expect to listen to it three times and for it to make sense. You really got to persevere. It requires an awful lot of discipline, I think, to get there. But some people will say to me, oh, you know, it's been a year and music still sounds terrible. And I'll say, ok, well what are you doing? Oh, I don't listen to it. Ok, if you don't listen to it, it's never going to sound.. it's always gonna sound terrible. So you really have to stress the importance of repetition. And do the repetition with your familiar music and then, get music that you may think that you might enjoy, you know, the style, in the style that you enjoy. And then find something that is unfamiliar to you and then thrash it. Over, and over and over again until you drive yourself..(?) That way, when.. and you leave it for a week or so and then when you go back to it, you start getting that feeling of familiarity or

start hearing that it's becoming a little bit more familiar. So that's a good way to start appreciating music, I think.

Q^2*: Do you think style, your choice or people's choice in music styles that they prefer pre-implant and post-implant change or can change? Because I had one subject who used to love classical music before her implant, and hated rock, got her implant and says to me now, "I would have sworn I'd never have made this comment I love rock music now and I hate classical music because rock music sounds so much better with the implant than classical.*

I could believe that. I haven't met anyone's that made the flip but I could believe it. And just purely for that, you know, you can get there with classical music but it takes a lot longer because there are just more instruments playing at once so it makes sense to me. It's gonna take longer than say, if you really enjoyed guitar music, or flute music or piano music, it's easier. And orchestral music is the hardest. People who love orchestral music and want to appreciate that again, I'd say, you've got to repeat and you're got to try and focus on one particular instrument. Until you can hear it because you will hear it eventually but it may take awhile. And play orchestral music that you remember. Go to live concerts. Don't just do stuff on tapes, do live concerts and you'll get a much, you'll gain a much better appreciation. I can still enjoy classical music. I love rock. I love both, actually. I'm somebody that enjoys all styles of music but I can enjoy all of them now. I can go and sit, and eventhough it is not like what it was before, it is good enough for you to be able to sit and stick through it, but yeah, it is ok, it was pleasant.

Q^2*: Have you ever tried oriental music? The reason I ask is because it is a pentatone scale so there's only 5 pitches instead of your usual (?) so your differences between yours pitches are smaller.*

Oh, right. No, I haven't.

Q^2*: That was for interest because someone said to me, "Oh, I actually found that I can hear oriental music a lot more accurately because there's fewer pitches, pitch differences.*

I could believe that cos it's like listening to a chime or a doorbell (doong, doong, doong, doong [imitating the tune of Big Ben]) and you can actually hear those. You can hear the different pitches of the chimes. So I would imagine with oriental music, it would be quite similar.

Q^2*: ? ..they have fewer notes.*

Yes, yes. It's not something that I've done but I could believe that.

Q^1. About different people. Say like if they went to the same training program and yet the outcomes are different. Are there situations like that and why?

Because we are all individuals and so no two people are going to be the same. You can put them all doing the same training program doing the same things and they'll come out with a different outcome. And it's just how their brain is wired, whether, I'm sure some people will find it easier than others and it's just the way their brains function. That's why I say to people who come for an

implant and they're 70, and they'd say, "Oh, will I be slower than a 40 year old?" And I'd say, "No."

[Interrupted by phone.]

Q^2*: Have you ever tried different strategies or more importantly, different rates? Like you're on 900 Hz, like trying 1800 Hz ACE, a faster rate. I know it uses more batteries..*

Yes, yes I have. And I have 2 programmes in here that I have been set up with, for a faster rate, and I don't think it really makes a difference though. I haven't noticed.. it's certainly not a "wow, that's great". Too be honest with you, I haven't practiced with it a lot, enough to know, to really find out. But I have got a programme there that.. but the difference will be extremely subtle. Yes, very subtle. Not something where you go, wow that's so much better!

Q^1. How does the ability to listen to and appreciate music impact on your life?

It's certainly something I miss. In terms of, I don't get the same quality that I use too. And having loved music and being a singer and a piano player etc I do miss that. But in saying that I'm forever hopeful and I'll never stop trying to improve it. With an implant and all, it effects not just music, you have to continually work at it and it get better and it becomes better and to me, it's great now. So from going from, "oooh, this is a horrible thing" to start with, to "wow, this is the best thing that's happened to you", it requires a lot of hard work and music is no different. And I guess is that, at this point in time, until they, well, this is what I believe, until they work on an implant that can give you a wider frequency range, that you'll never ever really going to get, for music appreciators, it's going to be difficult until that happens. For those that are just.. enjoy music for the sake of music, you know they actually get quite a degree of well, an appreciation.. they get an enjoyment out of it and they like it so it's great for them. And as I say, it's definitely improved but it's got a long way to go.

Q^1. You won't really be able to get there until the implant itself is improved.

Yes, yes, I think they'll need to devise another implant before we really get a good result with music, for those of us who had it [a good appreciation of music] before [deafness]. But in saying that, I still listen to it and I still get some sense of enjoyment out of it. It's not all horrible by any means. And occasionally, you get those wow moments like that concert. I'll just never forget it and I'll have to go and do it again to see if it's still like that because it was just amazing.

Q^2*: There's a jazz festival coming up in Christchurch next month.*

Yes, I've been looking at the programme thinking, "ooh" cos I've just got to go to some, especially after having such a fantastic experience with jazz, I got to. And I am, I'll be off to them because it would be really interesting, you know, from that point of view to see how it is.

End of interview.

Additional notes
(Parts of the interview were not recorded as the tape ran out.)

- Discussed the use of an electronic guitar tuner (with an indicator to demonstrate whether an instrument or a singer is in tune or not) to assist with singers pitching themselves. Interviewee suggested the computer game, "Singstar" (?) which also crudely indicates whether the singer is in tune or not.
- Success with an implant is dependent on 90% of the user's brain/attitude and 10% on the implant.
- Interviewee preferred listening to music through headphones rather than through a personal cable (Direct Audio Input) as music sounded tinny with the latter.
- The violin sounded almost computerised. The flute sounded good; it had warmth. The trumpet sounded brassy.
- In terms of music training, Interviewee ranked the following aspects from most important to less important:
    - Recognising instruments
    - Recognising or being able to follow melodies (having music in front, definitely helps with this)
    - Overcoming "tinniness" with a good quality sound system
    - To be able to hear the words of songs

Notes from Interview with Interviewee 3
Date of interview: 27th April 2007
People present: Interviewee, Interviewer 1 (Q^1), Interviewer 2 (Q^2)

Demographic details:
Age: 40 years old
Length of profound deafness: 4 years.
Length of implant use: 1.5 years
Musical background (prior to implantation): Professional violin player

Q^1. How does music-listening now with your CI compare with how music sounded before with normal hearing?
Rhythm is similar to normal hearing. Pitch is distorted with CI, similar to pitch discrepancies of metal wind chimes ie middle 'C' somewhere between 'C' and C sharp'.

Q^1. How would you describe the sound quality of music as heard through your CI?
Tinny, metallic and without depth, difficult to distinguish what instrument is being played. Most instruments, excepting those absent of harmonic resonance, sound computer generated with pitch distortion not unlike hearing while underwater.

Q^1.What adjectives or descriptors would best describe how music generally sounds with your implant?
Almost mono-tonal, without definition and mono-dimensional. Similar to listening to AM radio with faulty batteries or a cassette with the tape speed continuously changing speed. [Distorted, like so.]

Q^1.If a music training program was developed to improve CI users perception of music, what do you think should targeted?
Personally, I believe the biggest hurdle to overcome regarding music appreciation is pitch discrimination, which may probably be more the problem of the current technology rather than the listener. Any CI recipient really interested in improving music appreciation should learn to read sheet music as my brain seems to catch on better with prompting.

Q^1. What needs to improved in order for music to sound better through the implant?
Definitely pitch recognition as without pitch, music doesn't really exist. To correctly understand and hear a diatonic scale is imperative to truly appreciating western music. Music = ordered pitch and rhythm. CI technology is great with rhythm, I still wait for pitch.

Q^1. Any final comments?
As a deaf person for only 4 years before receiving the CI, I was fortunate to have a well-developed hearing vocabulary and a brain well versed. Due to that, I think I am able to utilise all that the current CI technology is able to offer. Speech comprehension is almost as good as natural hearing and environmental sound improve still weekly. Unfortunately, I feel that pitch discrimination is still lacking in the current technology and without that music appreciation will always be lacking for those needing full discrimination.

Appendix 2
The University of Canterbury Music Listening Questionnaire[13]

LISTENING TO MUSIC WITH A COCHLEAR IMPLANT 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: CI = Cochlear Implant.

Music Listening & Music Background

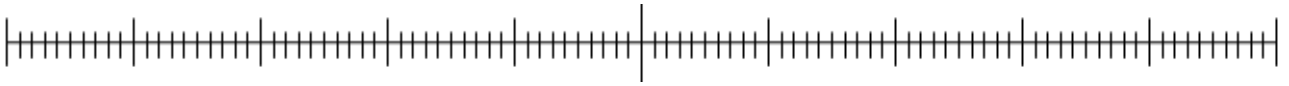
1. What is your age? _____ years

2. At what age were you first diagnosed with a hearing loss? _____ years

3. At what age did your hearing loss drop to a severe to profound level (i.e. the level where you were considered for a CI)? _____ years

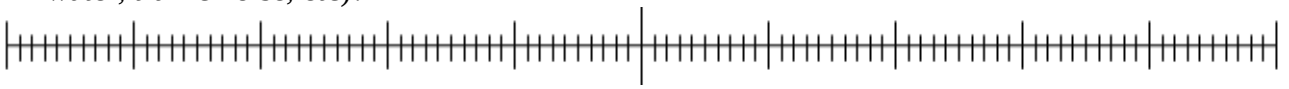
4. How long have you had your CI *(months or years)*? _____

5. What difference has the CI made to your ability to hear speech?



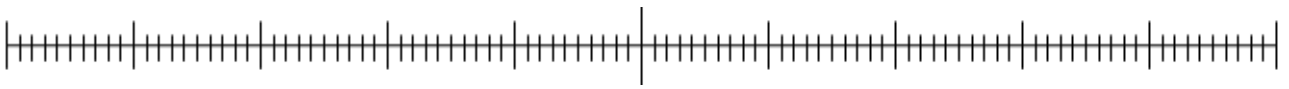
Greatly worsened — No difference — Greatly improved

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



Greatly worsened — No difference — Greatly improved

7. What difference has the CI made on your overall quality of life?



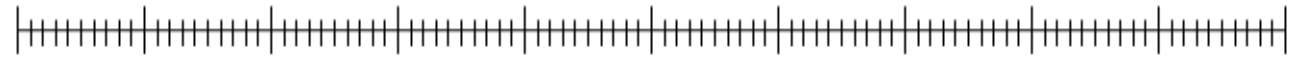
Greatly worsened — No difference — Greatly improved

\

[13] Please note that the layout of the actual UCMLQ is a little different to as shown here - more space was provided and the questions were not broken over two pages like they are shown here.

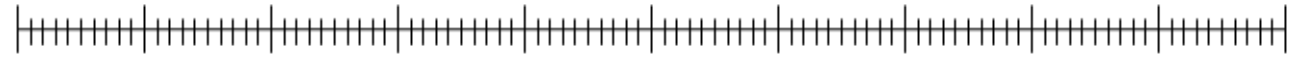
8. How often did you listen to music:

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



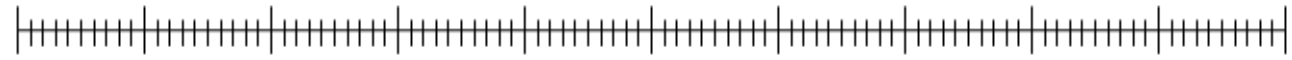
Never Sometimes Very Often

b. In the time just prior to getting your CI?



Never Sometimes Very Often

c. How often do you listen to music, now, with your CI?



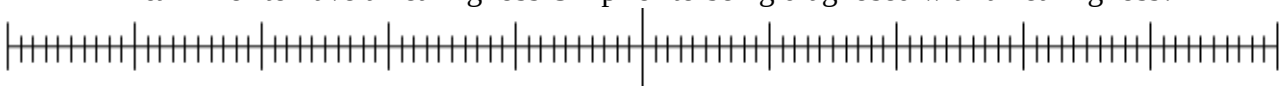
Never Sometimes Very Often

d. Has the amount of time spent listening to music with your CI changed since when you were first implanted?

Greatly decreased No difference Greatly increased

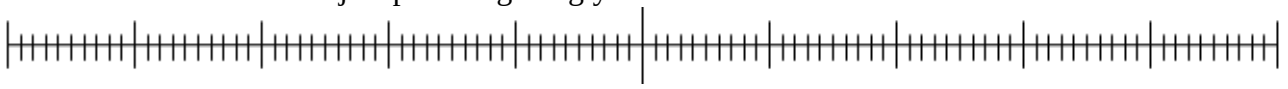
9. How much did you enjoy listening to music:

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



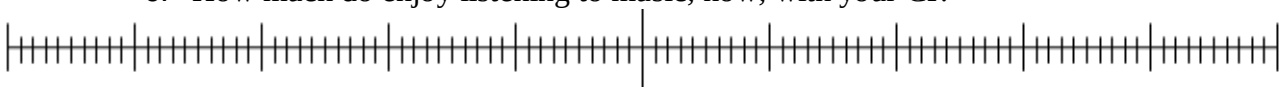
Did not enjoy at all Neutral Greatly enjoyed

b. In the time just prior to getting your CI?



Did not enjoy at all Neutral Greatly enjoyed

c. How much do enjoy listening to music, now, with your CI?



Do not enjoy at all Neutral Greatly enjoy

10. Did you have formal music training (e.g. music lessons) before your CI? YES / NO

If 'Yes', please detail the type of training, length of time and level attained (if applicable):

11. Do you have formal music training now, with your CI? YES / NO

If 'Yes', please provide detail:

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

If 'Yes', please detail the type and length of involvement:

13. Do you take part in musical activities now, with your CI? YES / NO

If 'Yes', please detail the type and length of involvement:

14. Does your music training and/or involvement in musical activities *prior* to implantation impact on your current music listening enjoyment with your CI? YES / NO / NOT APPLICABLE

Comments:

15. How much has the CI impacted overall on your enjoyment of listening to music?

Greatly decreased enjoyment with a CI — No effect — Greatly increased enjoyment with a 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*

** Direct Audio Input is a cable which allows you to plug the music player (e.g. stereo or iPod) directly into your Cochlear Implant or Hearing Aid.*

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 _____

If you answered 'Yes' to any of the above in Question 17, please answer Question 18. Otherwise, skip to Question 19.

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 _____

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

20. Describe how music sounded when you *first* listened to it with your CI.

21. Has the sound of music changed over time, with longer use of the CI? YES / NO
If 'Yes', please provide detail.

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

23. Which style of music sounds *best* with your CI? *Please tick <u>one</u> 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*) _____

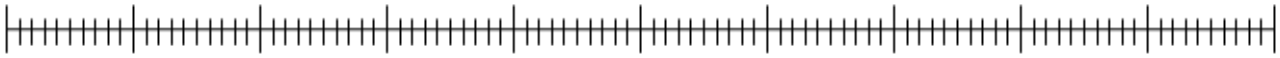
24. Which style of music do you listen to most often with your CI? *Please tick <u>one</u> response only.*

____ 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*) _____

25. Which style of music sounded best *before* your hearing loss (or before you were diagnosed with a hearing loss)? *Please tick <u>one</u> 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*) _____

26. How do tunes (or melodies) sound with a CI?



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)

27. Do you have any additional comments on how tunes (or melodies) sound with your CI?

Sound Quality

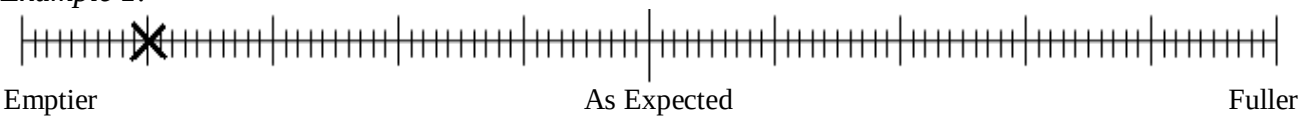
28. Instruments, Instrumental Families, and Singers

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.

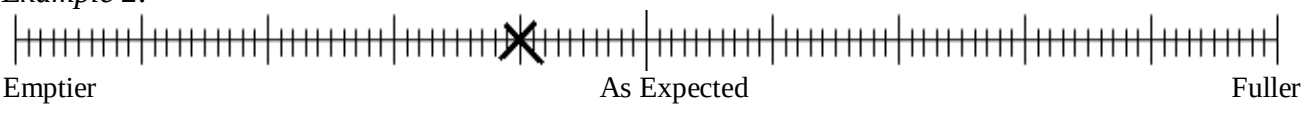
If you are unfamiliar with a particular instrument or instrumental family, please write ✗ in the box beside the instrument/instrumental family and skip to the next one.

Example 1:



Emptier As Expected Fuller

Example 2:



Emptier As Expected Fuller

a. Piano ☐

Overall sound quality

Unpleasant — Pleasant

Unnatural — 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 instrument, please use the space below:

b. Strings (e.g. Violin, Cello) ☐

Overall sound quality

Unpleasant — Pleasant

Unnatural — Natural

How does this instrumental family 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

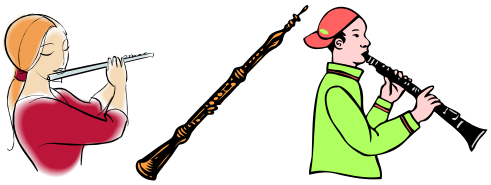
More Noisy — As Expected — Less Noisy

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

Unpleasant — Pleasant

Unnatural — Natural

How does this instrumental family 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:

d. Brass (e.g. Trumpet, Trombone) ☐

Overall sound quality

Unpleasant — Pleasant

Unnatural — Natural

How does this instrumental family 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

Unpleasant — Pleasant

Unnatural — 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 instrument, please use the space below:

f. Guitar ☐

Overall sound quality

Unpleasant — Pleasant

Unnatural — 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 instrument, please use the space below:

g. Male Singer ☐

Overall sound quality

Unpleasant — Pleasant

Unnatural — Natural

How does this singer 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, please use the space below:

h. Female Singer ☐

Overall sound quality

Unpleasant — Pleasant

Unnatural — Natural

How does this singer 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, please use the space below:

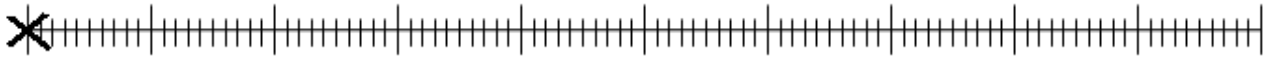
29. If it were possible, would you like musical instruments and singers to sound (with the CI) like you think they would sound to a normally hearing person? YES / NO

If no, please provide more information.

30. **Musical Styles**

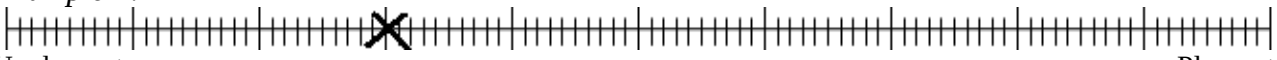
For the following musical styles, please mark your opinion with ✗ on the scales provided. For instance, in Example 1, the position of the ✗ means that the musical style sounds unpleasant to you, and in Example 2, the position of the ✗ means that the musical style is unpleasant but less so than for Example 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 CI, please write ✗ in the box beside the musical style and skip to the next one.*

Example 1:



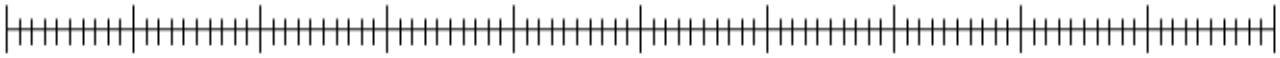
Unpleasant Pleasant

Example 2:

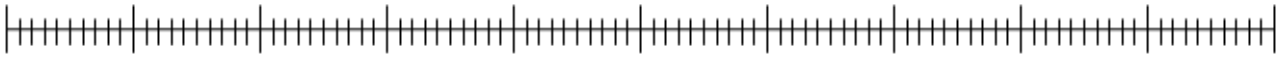


Unpleasant Pleasant

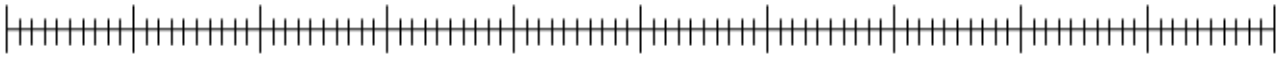
a. **Classical – (orchestra)** ☐



Unpleasant Pleasant

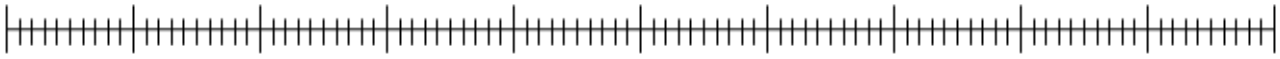


Simple Complex



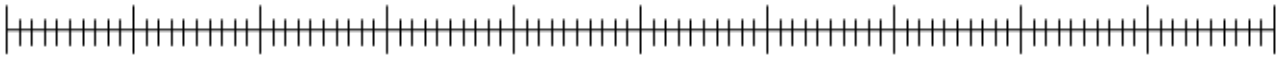
Can *never* follow melody-line (i.e. excluding the words)

Can *always* follow melody-line (i.e. excluding the words)



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

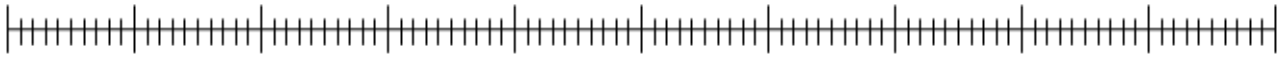
Can *always* identify this style *by listening-alone*



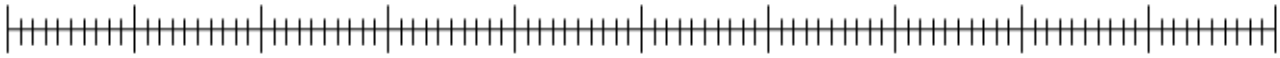
Sounds *nothing* like I would expect it to sound to a person with normal hearing

Sounds *exactly* as I would expect it to sound to a person with normal hearing

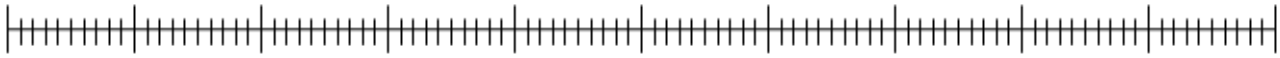
b. Classical – small group (e.g. 2 to 5 instruments) ☐



Unpleasant Pleasant

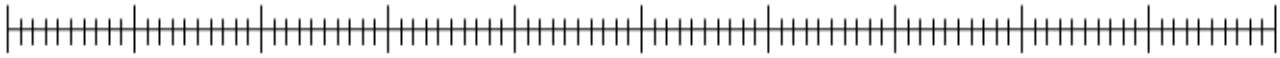


Simple Complex



Can *never* follow melody-line (i.e. excluding the words)

Can *always* follow melody-line (i.e. excluding the words)



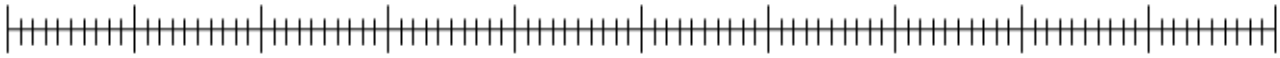
Can *never* identify this style *by listening-alone*

Can *always* identify this style *by listening-alone*

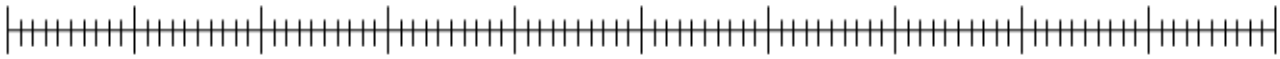
Sounds *nothing* like I would expect it to sound to a person with normal hearing

Sounds *exactly* as I would expect it to sound to a person with normal hearing

c. Classical – choir ☐



Unpleasant Pleasant



Simple Complex

Can *never* follow melody-line (i.e. excluding the words)

Can *always* follow melody-line (i.e. excluding the words)

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

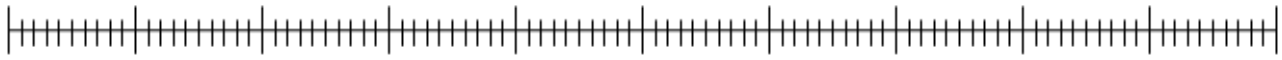
Can *always* identify this style *by listening-alone*

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'*) ☐ _____

Unpleasant Pleasant



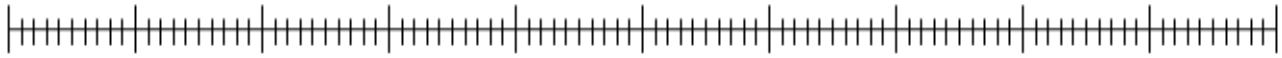
Simple Complex

Can *never* follow melody-line
(i.e. excluding the words)

Can *always* follow melody-line
(i.e. excluding the words)

Can *never* identify this style
by listening-alone

Can *always* identify this style
by listening-alone

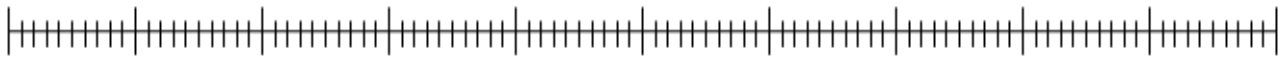


Sounds *nothing* like
I would expect it to
sound to a person with normal hearing

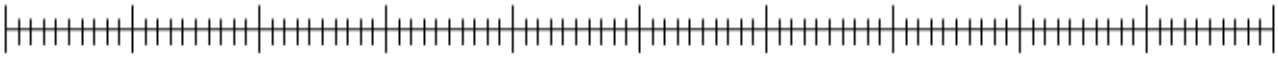
Sounds *exactly* as
I would expect it to
sound to a person with normal hearing

e. Country and Western ☐

Unpleasant Pleasant

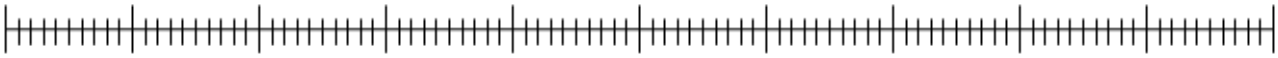


Simple Complex



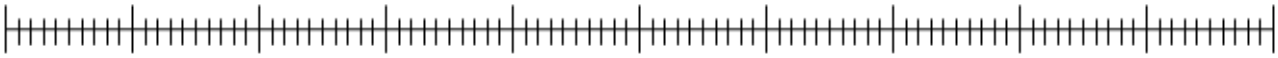
Can *never* follow melody-line
(i.e. excluding the words)

Can *always* follow melody-line
(i.e. excluding the words)



Can *never* identify this style
by listening-alone

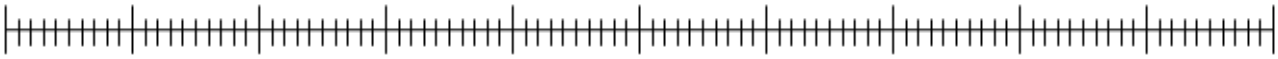
Can *always* identify this style
by listening-alone



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

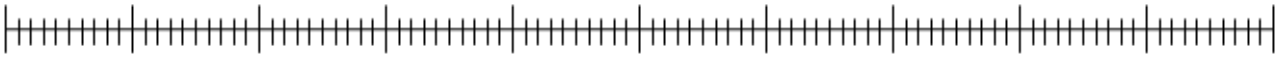
Sounds *exactly* as
I would expect it to
sound to a person with normal hearing

f. Jazz ☐



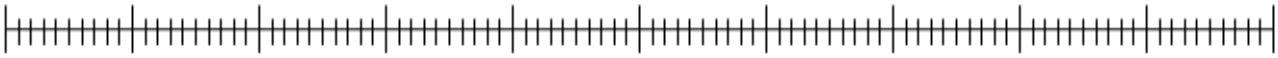
Unpleasant

Pleasant



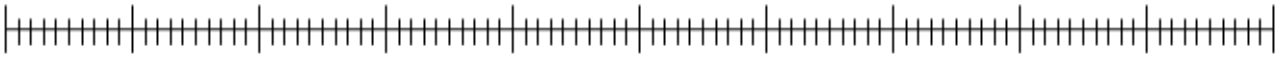
Simple

Complex



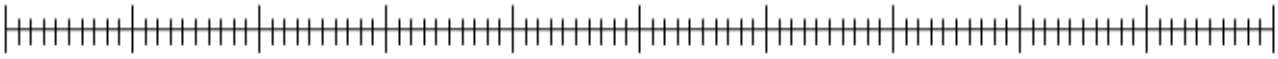
Can *never* follow melody-line
(i.e. excluding the words)

Can *always* follow melody-line
(i.e. excluding the words)



Can *never* identify this style
by listening-alone

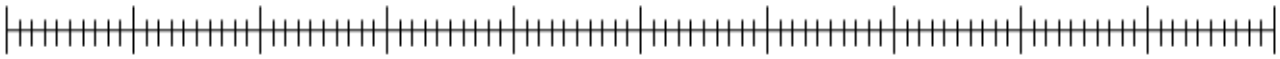
Can *always* identify this style
by listening-alone



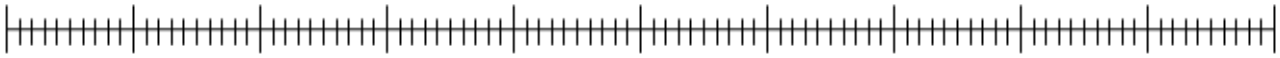
Sounds *nothing* like
I would expect it to
sound to a person with normal hearing

Sounds *exactly* as
I would expect it to
sound to a person with normal hearing

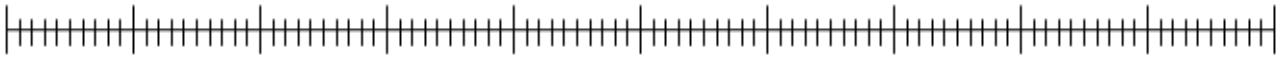
g. Other (*please specify*) _____



Unpleasant Pleasant

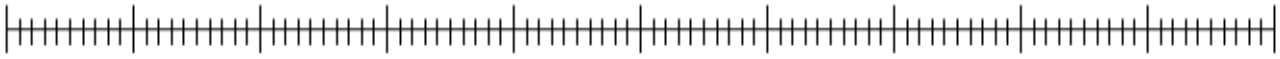


Simple Complex



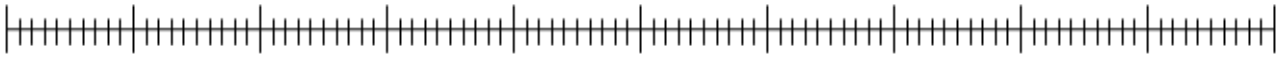
Can *never* follow melody-line (i.e. excluding the words)

Can *always* follow melody-line (i.e. excluding the words)



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.

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

    If no, please provide more information.

Music Preferences

32. 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 the space below.

33. 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

34. 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

35. With your CI, 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).

36. 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.

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

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

38. 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

39. 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 hearing aid in conjunction with your cochlear implant
____ Direct Audio Input (DAI)
____ Increased length of time or experience with the cochlear implant
____ Practice listening to music

____ Familiar lyrics/words
____ Familiar music (e.g. tunes you knew prior to getting a CI)
____ 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 will help us to design a Music Training Program for improving music listening enjoyment for CI 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.

40. Would you be interested in a Music Training Program if one becomes available?
YES / NO

41. 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 implantation
____ 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)
_____

42. 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.

43. 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.

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

____ minutes

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

____ times a week.

46. 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)

_____

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

48. 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 use the following pages.

Appendix 3

Summary of Results I

The Results for all the quantitative questions in the UCMLQ are presented below. Additional comments, as well as the answers to all qualitative questions are in Appendix 4.

Q1-4

Demographic Statistics	Mean	Stdev	n	Range
Age /yrs	62.08	17.11	100	18 - 88
Duration of severe-to-profound deafness /yrs	13.4	12.77	99	0 - 60
Length of CI use /yrs	4.11	3.07	100	1 - 19

Speech Perception Scores*	Mean	Stdev	n
CNC word score in quiet (%)	50.78	22.47	63
CUNY sentences in quiet (%)	88.18	20.57	63
CUNY sentences in noise (+10 dB SNR) (%)	66.31	26.12	58

* These scores were obtained when respondents have had their CI for at least one year.

Q5-7

	Mean	Standard Deviation	n	Range
The difference the CI has made to their ability to hear speech (from '0=greatly worsened' to '5=no difference' to '10=greatly improved').	8.873	1.599	99	0 - 10
The difference the CI has made to their ability to hear environmental sounds (from '0=greatly worsened' to '5=no difference' to '10=greatly improved').	8.982	1.438	99	0 - 10
The difference the CI has made to their quality of life (from '0=greatly worsened' to '5=no difference' to '10=greatly improved').	9.041	1.214	98	5 - 10

A 1-sample t-test on the mean rating for the 'difference the CI made to their ability to hear speech' and the 'no difference' score of 5 revealed that respondents felt that the CI has significantly improved their ability to hear speech ($t = 24.102$, $df = 98$, $p<0.001$).

Similarly, a 1-sample t-test on the mean rating for the 'difference the CI made to their ability to hear environmental sounds' and the 'no difference' score of 5 revealed that respondents felt that the CI has significantly improved their ability to hear environmental sounds ($t = 24.557$, $df = 98$, $p<0.001$).

Lastly, a 1-sample t-test on the mean rating for the 'difference the CI made to their quality of life' and the 'no difference' score of 5 revealed that respondents felt that the CI has significantly improved their quality of life ($t = 32.948$, $df = 97$, $p<0.001$).

Q8a-c

Amount of time spent listening to music (from 0=never, to 10=very often)	Mean	Stdev	n	Range
Prior to having a hearing loss	7.199	2.934	96	0 - 10
In time just prior to getting a CI	3.302	3.124	99	0 - 10
Now, with a CI	4.583	3.344	99	0 - 10

A paired t-test showed that there was a significant *decrease* in the self-reported amount of time spent listening to music, now, with a CI, compared to 'pre-hearing loss' (t=6.087, df=95, p<0.001), and a significant *increase* in the self-reported amount of time spent listening to music, now, with a CI, compared to 'just prior to getting a CI' (t=-3.050, df=98, p=0.003).

Q8d

Whether there was a change in the amount of time spent listening to music since first implanted (from 0=greatly decreased, to 5=no difference, to 10=greatly increased)	
Mean	5.556
Stdev	2.777
n	98
Range	0 - 10

A 1-sample t-test on the mean rating for 'whether there was a change in the amount of time spent listening to music since first implanted' and the 'no difference' score of 5, revealed that respondents felt that there was a slight increase in the amount of time spent listening to music since first implanted (t =1.982, df = 97, p=0.05).

Q9

Enjoyment of music (from 0=did not enjoy at all, to 10=greatly enjoyed)	Mean	Stdev	n	Range
Prior to having a hearing loss	8.367	2.169	92	0 - 10
In time just prior to getting a CI	3.706	3.283	97	0 - 10
Now, with a CI	5.148	3.610	96	0 - 10

A paired t-test showed that there was a significant *decrease* in the self-reported enjoyment of listening to music, now, with a CI, compared to 'pre-hearing loss' (t=7.334, df=90, p<0.001), and a significant *increase* in the self-reported enjoyment of listening to music, now, with a CI, compared to 'just prior to getting a CI' (t=-3.044, df=95, p=0.003).

Correlations

Shown in Table 1 is the correlation matrix for age, time spent listening to music, music listening enjoyment, demographic characteristics and speech perception measures. The Spearman's RHO test was used as data for all categories, except "words in quiet", failed the normality test (Kolmogorov-Smirnov).

Table 19: Correlation matrix for age, time spent listening to music, music listening enjoyment, demographic characteristics and speech perception measures

		Age	Time spent listening to music	Music listening enjoyment	Length of implant use	Length of severe-to-profound deafness	CNC word score (%) in Quiet	CUNY sentence score in Quiet	CUNY sentence score in Noise (+10dB SNR)
Age	r	1.000	**-0.208(*)**	**-0.231(*)**	-0.025	-0.059	**-0.301(*)**	**-0.340(**)**	-0.220
	p	-	0.039	0.023	0.808	0.560	0.016	0.006	0.098
	n	100	99	96	100	99	63	63	58
Time spent listening to music	r	**-0.208(*)**	1.000	***0.853(**)***	0.039	0.092	0.153	0.164	**0.375(**)**
	p	0.039	.	0.000	0.699	0.365	0.236	0.203	0.004
	n	99	99	96	99	98	62	62	57
Music listening enjoyment	r	**-0.231(*)**	**0.853(**)**	1.000	-0.031	0.170	0.190	0.170	**0.359(**)**
	p	0.023	0.000	-	0.765	0.100	0.149	0.197	0.007
	n	96	96	96	96	95	59	59	55
Length of implant use	r	-0.025	0.039	-0.031	1.000	0.058	0.137	0.036	0.091
	p	0.808	0.699	0.765	-	0.569	0.284	0.780	0.498
	n	100	99	96	100	99	63	63	58
Length of severe-to-profound deafness	r	-0.059	0.092	0.170	0.058	1.000	**-0.370(**)**	**-0.314(*)**	-0.233
	p	0.560	0.365	0.100	0.569	-	0.003	0.012	0.078
	n	99	98	95	99	99	63	63	58
CNC word score (%) in Quiet	r	**-0.301(*)**	0.153	0.190	0.137	**-0.370(**)**	1.000	***0.773(**)***	***0.747(**)***
	p	0.016	0.236	0.149	0.284	0.003	-	0.000	0.000
	n	63	62	59	63	63	63	63	58
CUNY sentence score in Quiet	r	**-0.340(**)**	0.164	0.170	0.036	**-0.314(*)**	***0.773(**)***	1.000	***0.675(**)***
	p	0.006	0.203	0.197	0.780	0.012	0.000	-	0.000
	n	63	62	59	63	63	63	63	58
CUNY sentence score in Noise (+10dB SNR)	r	-0.220	**0.375(**)**	**0.359(**)**	0.091	-0.233	***0.747(**)***	***0.675(**)***	1.000
	p	0.098	0.004	0.007	0.498	0.078	0.000	0.000	-
	n	58	57	55	58	58	58	58	58

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

r = correlation, p = p-value, n = number of participants responding.

Q10-11

Formal music training e.g. having music lessons				
	Yes	No	n	Comment
Before CI	32.3%	67.7%	99	
With CI	1.0%	99.0%	100	The one participant was taking basic lessons on the guitar.

Q12-13

Musical activities e.g. choirs, orchestras, musical or bands, or playing an instrument, singing or dancing				
	Yes	No	n	Comment
Before CI	43.4%	56.6%	99	
With CI	9.0%	91.0%	100	

Q14

Whether music training or musical activities *prior* to a CI have an impact on current music listening enjoyment with a CI.				
Yes	No	Don't know	n	Comment
21%	23%	57%	92	Seems subjects may have misinterpreted question e.g. 7 / 19 subjects focused on how they are unable to hear music, now, with an implant, rather than whether music training or involvement in musical activities prior to their CI have an effect on their music listening appreciation, now, with a CI.

Q15

How much the CI has affected their overall enjoyment of music (from '0=greatly decreased to '5=no effect' to '10=greatly increased enjoyment').		
Mean	Standard Deviation	n
5.752	3.188	97

A 1-sample t-test showed that there was a significant difference between the 'no effect' score of '5' and the mean rating for the 'effect of a CI on their overall enjoyment of listening to music' (M=5.75; p=0.022). In other words, CI users generally felt that there was a slight increase in their overall enjoyment of listening to music with a CI.

Q16-17 Device or combination of devices that are used by respondents for listening to: (i) recorded music and (ii) live music.

Device or combination of devices	**Recorded Music**	**Live Music**
CI and Hearing Aid	41.5%	47.0%
CI-only	46.2%	45.0%
Hearing Aid-only	2.8%	1.0%
CI with DAI	2.8%	-
HA with DAI	0.0%	-
CI with T-coil	0.9%	-
CI and Hearing Aid (x2)	0.9%	-
Not applicable	4.7%	7.0%
Did not answer	9	5
n*	106	100
*Some respondents use more than one device or combination of devices to listen to music.		

Q18a

Whether they notice any difference in the sound quality of music when listening to it with a 'CI-only' compared to 'CI+HA'.		
	n	
Noticed difference	37	39.8%
Not noticed difference	15	16.1%
Never tried	41	44.1%
n total	93	

For the respondents that *did* notice a difference in the sound quality of music, the number of respondents (n) that felt that the following device/ combination of devices gave a better sound quality.			
	n		Comment
CI-only	2	7.1%	
CI+HA	26	92.9%	Both is better: more natural sound, "warmer" with HA also. CI + HA - the sound becomes less mechanical than with CI only. Need both. Seems to balance it better when used together. CI+HA - truer sound.
Don't know	0	0.0%	
Did not answer	9		
n total	37		

Q18b

Whether they notice any difference in the sound quality of music when listening to it with a 'CI-only' compared to 'HA-only'.

	n	
Noticed difference	31	38.3%
Not noticed difference	14	17.3%
Never tried	36	44.4%
n total	81	

For the respondents that *did* notice a difference in the sound quality of music, the number of respondents (n) that felt that the following device/ combination of devices gave a better sound quality.

	n		Comment
CI-only	23	82.1%	Please see Appendix 4
HA	5	17.9%	
Don't know	0	0.0%	
Did not answer	3		
n total	31		

Q18c

Whether they notice any difference in the sound quality of music when listening to it with a 'HA-only' compared to 'CI+HA'.

	n	
Noticed difference	15	19.0%
Not noticed difference	24	30.4%
Never tried	40	50.6%
n total	79	

For the respondents that *did* notice a difference in the sound quality of music, the number of respondents (n) that felt that the following device/ combination of devices gave a better sound quality.

	n		Comment
CI-only	1	8.3%	Please see Appendix 4
CI+HA	11	91.7%	
Don't know	0	0.0%	
Did not answer	3		
n total	15		

Q18d

Whether they notice any difference in the sound quality of music when listening to it 'with a Direct Audio Input (DAI)' or 'without'. (A DAI is a cable which allows the user to plug the music player, e.g. stereo or CD player, directly into their CI or HA.)		
	n	
Noticed difference	7	8.3%
Not noticed difference	5	6.0%
Never tried	72	85.7%
n total	84	

For the respondents that *did* notice a difference in the sound quality of music, the number of respondents (n) that felt that the following device/ combination of devices gave a better sound quality.			
	n		Comment
CI-only	3	60.0%	Please see Appendix 4
CI+HA	1	20.0%	
Don't know	1	20.0%	
Did not answer	2		
n total	7		

Q19

Device or combination of devices that provides the *best* sound quality for recorded music.		
	Yes	Comment
CI + HA	50.6%	
CI only	28.2%	
HA only	3.5%	
CI with DAI	7.1%	
HA with DAI	0.0%	
Other	3.5%	Others: HA on loop; CI and HA + T-coil; one participant felt that if the music was loud enough, e.g. at a night club or concert, with her residual hearing she "could hear the bass notes and they seemed to come together" and it was "not as good on a home stereo".
Not applicable	7.1%	
Did not answer	18	
n	103	Some people gave more than one response.

Q20

Please see Appendix 4

Q21

Whether the sound of music has changed over time, with longer use of the CI.	
Yes	56.5%
No	42.4%
Don’t know	1.1%
n	92

Q22

Whether they have tried to improve their music listening or enjoyment since getting their CI.	
Yes	43.2%
No	56.8%
Don’t know	0.0%
n	95

Q23 **Which musical style sounds best with the CI?**
Q24 **Which style do you listen to most often with your CI? (note that respondents could only choose one style)**
Q25 **Which style sounded the best before your hearing loss? (note that respondents could only choose one style)**
(Note that for Q23-5 respondents could only choose *one* style. Respondents that chose more than one style were excluded.)

Q23		**Q24**	
Musical Style	Proportion of respondents that indicated the following styles as sounding the best with the CI	Musical Style	Proportion of respondents that indicated the following styles as sounding the best with the CI
Easy Listening	12.9%	Country & Western	11.9%
Classical	11.8%	Older style Pop	11.9%
Country & Western	11.8%	Jazz	8.3%
Older style Pop	10.6%	Easy Listening	8.3%
Musicals	9.4%	Religious	8.3%
Religious	8.2%	Rock n' Roll	7.1%
Jazz	5.9%	Modern Pop	7.1%
Rock n' Roll	3.5%	Classical	4.8%
Modern Pop	3.5%	Musicals	4.8%
Opera	1.2%	Folk	1.2%
Rap	1.2%	Heavy Metal	1.2%
Hip hop	1.2%	Opera	0.0%
Folk	0.0%	Rap	0.0%
Heavy Metal	0.0%	Hip hop	0.0%
Other	3.5%	Other	4.8%
All	1.2%	All	1.2%
Not applicable	14.1%	Not applicable	19.0%
n	85	n	84

Q25	
Musical Style	Proportion of respondents that indicated the following styles as sounding the best with the CI
Older style Pop	17.9%
Rock n' Roll	13.1%
Country & Western	9.5%
Easy Listening	9.5%
Religious	7.1%
Modern Pop	7.1%
Musicals	6.0%
Classical	4.8%
Jazz	3.6%
Folk	1.2%
Heavy Metal	1.2%
Opera	1.2%
Hip hop	1.2%
Rap	0.0%
Other	1.2%
All	4.8%
Not applicable	10.7%
n	84

Q26

How melodies sound with a CI (from '0=monotonic' to '10=melodic').			
	Mean	Standard Deviation	n
CI+HA users	5.032	3.478	37
CI-only users	5.009	3.350	43
Overall	5.020	3.388	80

An independent t-test showed that there was no significant difference between the mean ratings that were given by the 'CI+HA' users and the 'CI-only' users (t = -0.0303, df = 78, p=0.976).

Q27

Please see Appendix 4

Q28 Descriptive statistics for *all* instruments' ratings

		Piano			**Strings**			**Woodwind**			**Brass**		
		CI+HA	CI	O'all	CI+HA	CI	O'all	CI+HA	CI	O'all	CI+HA	CI	O'all
Pleasant and Natural[a]	Mean	**6.229**	**5.939**	**6.085**	**5.834**	**5.116**	**5.431**	**6.273**	**4.912**	**5.555**	**5.434**	**4.438**	**4.886**
	Standard deviation	*3.169*	*2.852*	*3.009*	*3.122*	*3.172*	*3.157*	*2.799*	*3.247*	*3.105*	*3.431*	*3.274*	*3.368*
	n	75	74	149	53	68	121	51	57	108	53	65	118
Pleasant#	Mean	**6.282**	**5.889**	**6.086**	**5.773**	**5.169**	**5.426**	**6.374**	**5.014**	**5.670**	**5.544**	**4.321**	**4.872**
	Standard deviation	*3.178*	*2.978*	*3.065*	*3.235*	*3.140*	*3.169*	*2.731*	*3.371*	*3.127*	*3.452*	*3.357*	*3.426*
	n	38	38	76	26	35	61	27	29	56	27	33	60
Natural#	Mean	**6.176**	**5.992**	**6.085**	**5.893**	**5.061**	**5.435**	**6.158**	**4.807**	**5.431**	**5.319**	**4.559**	**4.900**
	Standard deviation	*3.203*	*2.754*	*2.971*	*3.070*	*3.252*	*3.173*	*2.929*	*3.171*	*3.107*	*3.474*	*3.234*	*3.336*
	n	37	36	73	27	33	60	24	28	52	26	32	58
Fullness*	Mean	**4.195**	**3.856**	**4.030**	**4.668**	**3.766**	**4.187**	**4.752**	**4.241**	**4.496**	**4.943**	**4.052**	**4.490**
	Standard deviation	*2.359*	*2.313*	*2.328*	*2.429*	*2.179*	*2.324*	*2.181*	*2.235*	*2.203*	*2.475*	*2.353*	*2.435*
	n	41	39	80	28	32	60	27	27	54	30	31	61
Sharpness*	Mean	**4.884**	**4.456**	**4.673**	**5.476**	**4.628**	**5.000**	**4.996**	**4.373**	**4.672**	**5.479**	**4.820**	**5.138**
	Standard deviation	*2.921*	*2.541*	*2.729*	*2.551*	*2.416*	*2.490*	*2.189*	*2.427*	*2.314*	*2.465*	*2.506*	*2.487*
	n	37	36	73	25	32	57	24	26	50	28	30	58
Noisiness*	Mean	**4.343**	**4.521**	**4.433**	**4.941**	**4.065**	**4.472**	**4.887**	**4.196**	**4.528**	**4.668**	**3.529**	**4.058**
	Standard deviation	*2.295*	*2.012*	*2.143*	*2.501*	*2.170*	*2.351*	*2.027*	*1.717*	*1.886*	*2.110*	*1.958*	*2.093*
	n	37	38	75	27	31	58	24	26	50	26	31	57
Richness*	Mean	**4.377**	**3.978**	**4.172**	**4.263**	**3.827**	**4.033**	**4.413**	**4.165**	**4.284**	**4.965**	**3.477**	**4.168**
	Standard deviation	*2.638*	*2.224*	*2.425*	*2.849*	*2.160*	*2.497*	*2.635*	*2.445*	*2.515*	*2.536*	*2.083*	*2.403*
	n	35	37	72	27	30	57	24	26	50	26	30	56
Smoothness*	Mean	**4.770**	**5.103**	**4.978**	**4.123**	**4.143**	**4.134**	**4.404**	**4.454**	**4.430**	**4.581**	**3.860**	**4.195**
	Standard deviation	*2.029*	*1.832*	*1.919*	*1.901*	*2.031*	*1.954*	*2.356*	*2.288*	*2.297*	*2.078*	*2.069*	*2.086*
	n	33	38	71	26	30	56	24	26	50	26	30	56

[a] An average of the ratings given for the scales 'pleasant' and 'natural'.

For these scales, ratings were given on a scale from 0-10 where '0' indicates 'unpleasant' or 'unnatural', with '10' indicating 'pleasant' or 'natural'.

*For these scales, ratings were given on a scale from 0-10 where '5' indicates that the instruments sound 'as expected'.

Q28 ctd

		Drum Kit			Guitar			Male Singer			Female Singer		
		CI+HA	CI	O'all	CI+HA	CI	O'all	CI+HA	CI	O'all	CI+HA	CI	O'all
Pleasant and Natural[a]	Mean	**5.994**	**6.039**	**5.995**	**6.780**	**5.862**	**6.298**	**6.484**	**5.899**	**6.162**	**5.837**	**5.571**	**5.669**
	Standard deviation	*2.917*	*3.001*	*2.951*	*2.685*	*3.032*	*2.899*	*2.704*	*3.139*	*2.956*	*3.098*	*3.203*	*3.145*
	n	61	70	131	66	73	139	67	82	149	70	76	146
Pleasant#	Mean	**5.935**	**5.747**	**5.834**	**6.785**	**5.964**	**6.357**	**6.424**	**6.234**	**6.319**	**5.884**	**5.792**	**5.837**
	Standard deviation	*3.032*	*3.194*	*3.098*	*2.811*	*3.006*	*2.923*	*2.840*	*2.956*	*2.887*	*3.166*	*3.119*	*3.121*
	n	31	36	67	33	36	69	33	41	74	37	38	75
Natural#	Mean	**5.953**	**6.347**	**6.163**	**6.776**	**5.762**	**6.240**	**6.541**	**5.563**	**6.007**	**5.785**	**5.350**	**5.552**
	Standard deviation	*2.844*	*2.797*	*2.804*	*2.597*	*3.095*	*2.895*	*2.608*	*3.314*	*3.034*	*3.068*	*3.311*	*3.185*
	n	30	34	64	33	37	70	34	41	75	33	38	71
Fullness*	Mean	**5.917**	**5.285**	**5.586**	**4.426**	**4.103**	**4.260**	**4.349**	**4.420**	**4.387**	**4.414**	**4.470**	**4.442**
	Standard deviation	*2.267*	*2.605*	*2.451*	*2.190*	*2.089*	*2.130*	*1.714*	*2.385*	*2.085*	*2.476*	*2.305*	*2.376*
	n	30	33	63	34	36	70	35	40	75	37	37	74
Sharpness*	Mean	**5.970**	**5.494**	**5.721**	**4.903**	**4.321**	**4.608**	**4.573**	**4.605**	**4.590**	**5.282**	**5.003**	**5.143**
	Standard deviation	*2.200*	*2.107*	*2.148*	*2.328*	*2.264*	*2.297*	*1.884*	*2.125*	*2.000*	*2.273*	*2.190*	*2.219*
	n	30	33	63	32	33	65	33	37	70	34	34	68
Noisiness*	Mean	**4.203**	**3.359**	**3.744**	**4.669**	**4.336**	**4.500**	**5.264**	**4.303**	**4.756**	**5.115**	**3.835**	**4.466**
	Standard deviation	*1.971*	*2.792*	*2.471*	*1.995*	*2.026*	*2.002*	*1.060*	*1.893*	*1.620*	*1.830*	*1.983*	*2.001*
	n	31	37	68	32	33	65	33	37	70	33	34	64
Richness*	Mean	**4.983**	**4.569**	**4.766**	**4.616**	**3.840**	**4.210**	**4.630**	**4.303**	**4.457**	**4.200**	**3.750**	**3.978**
	Standard deviation	*2.176*	*2.058*	*2.108*	*2.070*	*2.221*	*2.169*	*2.440*	*2.259*	*2.334*	*1.963*	*2.164*	*2.061*
	n	29	32	61	32	35	67	33	37	70	35	34	69
Smoothness*	Mean	**4.453**	**4.506**	**4.481**	**4.809**	**4.612**	**4.709**	**4.448**	**4.473**	**4.461**	**4.261**	**4.350**	**4.306**
	Standard deviation	*1.985*	*2.136*	*2.049*	*2.177*	*2.110*	*2.129*	*1.475*	*2.148*	*1.848*	*1.518*	*2.038*	*1.788*
	n	30	33	63	33	34	67	33	37	70	33	34	67

[a] An average of the ratings given for the scales 'pleasant' and 'natural'.

For these scales, ratings were given on a scale from 0-10 where '0' indicates 'unpleasant' or 'unnatural', with '10' indicating 'pleasant' or 'natural'.

* For these scales, ratings were given on a scale from 0-10 where '5' indicates that the instruments sound is 'as expected'.

Q29

Whether they would like musical instruments and singers to sound 'normal'.		
Yes	98%	
No	2%	
Don't know	0%	
n	62	Comment: Many respondents missed this question as it was placed at the bottom of the page.

Q30 Descriptive statistics for *all* the ratings on musical styles.

		Classical - Orchestra			**Classical – Small Group**			**Classical - Choir**		
		CI+HA	CI	O'all	CI+HA	CI	O'all	CI+HA	CI	O'all
Pleasantness, ability to follow, identify and 'sounds normal'[a]	Mean	**5.348**	**3.718**	**4.554**	**5.146**	**4.081**	**4.611**	**5.186**	**4.451**	**4.820**
	Standard deviation	*3.125*	*3.221*	*3.269*	*3.367*	*3.063*	*3.254*	*3.192*	*3.062*	*3.143*
	n	121	115	236	109	110	219	112	111	223
Pleasantness#	Mean	**6.013**	**5.145**	**5.586**	**5.530**	**5.119**	**5.324**	**4.882**	**5.607**	**5.245**
	Standard deviation	*3.191*	*3.529*	*3.361*	*3.438*	*3.188*	*3.291*	*3.362*	*3.086*	*3.218*
	n	30	29	59	27	27	54	28	28	56
Complexity*	Mean	**5.931**	**5.442**	**5.696**	**5.725**	**4.592**	**5.158**	**5.633**	**5.574**	**5.602**
	Standard deviation	*2.864*	*2.942*	*2.883*	*3.092*	*2.769*	*2.960*	*2.747*	*2.870*	*2.785*
	n	26	24	50	24	24	48	24	27	51
Ability to follow melody-line[b]	Mean	**4.797**	**2.921**	**3.890**	**5.014**	**3.529**	**4.271**	**5.111**	**3.811**	**4.461**
	Standard deviation	*3.019*	*3.020*	*3.139*	*3.389*	*3.070*	*3.290*	*3.263*	*3.169*	*3.254*
	n	31	29	60	28	28	56	28	28	56
Ability to identify style[c]	Mean	**5.763**	**3.518**	**4.679**	**5.515**	**4.037**	**4.762**	**5.357**	**4.433**	**4.904**
	Standard deviation	*3.124*	*3.323*	*3.388*	*3.357*	*2.996*	*3.235*	*3.119*	*3.160*	*3.145*
	n	30	28	58	26	27	53	28	27	55
Sounds normal[d]	Mean	**4.837**	**3.283**	**4.073**	**4.564**	**3.675**	**4.120**	**5.393**	**3.954**	**4.673**
	Standard deviation	*3.132*	*2.650*	*2.984*	*3.376*	*2.907*	*3.153*	*3.167*	*2.638*	*2.978*
	n	30	29	59	28	28	56	28	28	56

[a] An average of the ratings given for the scales 'pleasantness', 'ability to follow', 'ability to identify' and 'sounds normal'.

For this scale, ratings were given on a scale from 0-10 where '0' indicates 'unpleasant', and '10' indicates 'pleasant'.

* For this scale, ratings were given on a scale from 0-10 where '0' indicates 'simple, and '10' indicates 'complex.

[b] For this scale, ratings were given on a scale from 0-10 where '0' indicates 'can never follow melody-line', and '10' indicates 'can always follow melody-line'.

[c] For this scale, ratings were given on a scale from 0-10 where '0' indicates 'can *never* identify this style by listening-alone', and '10' indicates 'can *always* identify this style by listening-alone'.

[b] For this scale, ratings were given on a scale from 0-10 where '0' indicates 'sounds *nothing* like I would expect it to sound to a person with normal hearing', and '10' indicates 'sounds *exactly* as I would expect it to sound to a person with normal hearing'.

Q30 ctd

		Pop/Rock			Country & Western			Jazz		
		CI+HA	CI	O'all	CI+HA	CI	O'all	CI+HA	CI	O'all
Pleasantness, ability to follow, identify and 'sounds normal'[a]	Mean	**5.500**	**4.195**	**5.071**	**6.625**	**4.933**	**5.759**	**5.495**	**4.202**	**4.910**
	Standard deviation	*2.989*	*3.077*	*3.019*	*2.811*	*2.935*	*2.991*	*2.964*	*3.127*	*3.070*
	n	107	123	230	102	107	209	98	112	210
Pleasantness#	Mean	**5.441**	**4.494**	**4.934**	**7.065**	**5.760**	**6.425**	**5.516**	**4.507**	**4.974**
	Standard deviation	*3.212*	*3.415*	*3.327*	*3.004*	*3.055*	*3.070*	*3.346*	*3.572*	*3.474*
	n	27	31	58	26	25	51	25	29	54
Complexity*	Mean	**4.492**	**5.767**	**5.200**	**5.335**	**4.711**	**4.992**	**6.025**	**4.885**	**5.432**
	Standard deviation	*2.721*	*2.722*	*2.770*	*3.009*	*2.658*	*2.810*	*3.113*	*2.883*	*3.020*
	n	24	30	54	23	28	51	24	26	50
Ability to follow melody-line[b]	Mean	**5.074**	**3.368**	**4.162**	**6.204**	**4.686**	**5.402**	**4.833**	**3.670**	**4.218**
	Standard deviation	*3.191*	*2.989*	*3.176*	*2.937*	*3.018*	*3.048*	*3.042*	*3.086*	*3.091*
	n	27	31	58	25	28	53	24	27	51
Ability to identify style[c]	Mean	**5.900**	**4.027**	**4.896**	**6.812**	**4.992**	**5.884**	**6.004**	**4.343**	**5.110**
	Standard deviation	*2.713*	*3.284*	*3.150*	*2.483*	*2.929*	*2.845*	*2.810*	*2.982*	*2.995*
	n	26	30	56	25	26	51	24	28	52
Sounds normal[d]	Mean	**5.600**	**3.271**	**4.355**	**6.412**	**4.386**	**5.361**	**5.620**	**3.657**	**4.583**
	Standard deviation	*2.912*	*2.988*	*3.153*	*2.871*	*2.730*	*2.954*	*2.673*	*3.059*	*3.023*
	n	27	31	58	26	28	54	25	28	53

[a] An average of the ratings given for the scales 'pleasantness', 'ability to follow', 'ability to identify' and 'sounds normal'.

For this scale, ratings were given on a scale from 0-10 where '0' indicates 'unpleasant', and '10' indicates 'pleasant'.

* For this scale, ratings were given on a scale from 0-10 where '0' indicates 'simple, and '10' indicates 'complex.

[b] For this scale, ratings were given on a scale from 0-10 where '0' indicates 'can never follow melody-line', and '10' indicates 'can always follow melody-line'.

[c] For this scale, ratings were given on a scale from 0-10 where '0' indicates 'can *never* identify this style by listening-alone', and '10' indicates 'can *always* identify this style by listening-alone'.

[b] For this scale, ratings were given on a scale from 0-10 where '0' indicates 'sounds *nothing* like I would expect it to sound to a person with normal hearing', and '10' indicates 'sounds *exactly* as I would expect it to sound to a person with normal hearing'.

Results of two-way repeated measures ANOVAs on instrument sound quality ratings (For Q28)

Ratings	n[a]	Group Effect	Instrument Effect	Group by Instrument Interaction Effect
Pleasantness and Naturalness	500	F(1, 405) = 0.696, p=0.406	F(7, 405) = 4.381, p<0.001*	F(7, 405) = 0.676, p=0.692
Emptiness--Fullness	537	F(1, 439) = 0.430, p=0.514	F(7, 439) = 5.521, p<0.001*	F(7, 439) = 0.310, p=0.949
Dullness--Sharpness	504	F(1, 407) = 2.359, p=0.128	F(7, 407) = 3.591, p<0.001*	F(7, 407) = 0.176, p=0.990
Tininess--Richness	502	F(1, 409) = 1.117, p=0.294	F(7, 409) = 2.013, p=0.052	F(7, 409) = 0.715, p=0.659
Less--More Noisiness	510	F(1, 414) = 3.033, p=0.085	F(7, 414) = 2.807, p=0.007*	F(7, 414) = 1.240, p=0.280
Roughness--Smoothness	500	F(1, 407) = 0.408, p=0.525	F(7, 407) = 2.995, p=0.004*	F(7, 407) = 0.434, p=0.881

[a]Missing data

Significance: *p<0.05, **p<0.005

Results of two-way repeated measures ANOVAs on musical styles ratings (For Q30)

Ratings	n[a]	Group Effect	Style Effect	Group by Style Interaction Effect
Combined Ratings[b]	308	F(1, 224) = 5.035, p=0.028*	F(5, 224) = 3.567, p=0.004**	F(5, 224) = 0.261, p=0.934
Unpleasant--Pleasant	332	F(1, 244) = 0.895, p=0.347	F(5, 244) = 2.344, p=0.042*	F(5, 244) = 0.558, p=0.732
Complexity	304	F(1, 221) = 2.052, p=0.156	F(5, 221) = 0.321,p=0.900	F(5, 221) = 2.088, p=0.068
Can Never--Always Follow Melody-line	334	F(1, 243) = 6.333, p=0.014*	F(5, 243) = 3.576, p=0.004**	F(5, 243) = 0.479, p=0.792
Can Never--Always Identify Style	325	F(1, 239) = 6.998, p=0.010*	F(5, 239) = 2.203,p=0.055	F(5, 239) = 0.734, p=0.599
Sounds like/Doesn't sound like normal	336	F(1, 249) = 7.063, p=0.009**	F(5, 249) = 3.223, p=0.008*	F(5, 249) = 0.296, p=0.915

[a]Missing data

[b]An average of all the ratings except the complexity ratings

Significance: *p<0.05, **p<0.005

Q31

Whether they would like music with a CI to sound 'normal'.		
		Comment
Yes	98%	
No	2%	
Don't know	0%	
n	92	

Q32

Rank instruments from 1 to 8, where 1 means the instrument "sounds most natural" to 8, where the instrument "sounds the least natural"*	
	Median
Piano	3
Female singer	3
Male singer	4
Strings	4
Drum kit	4
Guitar	4
Woodwind	5
Brass	5

* n=65. Included respondents that ranked ALL instruments, only.

Results of a One-way RM ANOVA on Ranks revealed that there was a significant difference in the ranking of the eight instruments from "sounds the most natural" to "sounds the least natural" (chi square = 32.786, df = 7, p=<0.001) . Post-hoc pair-wise multiple comparisons procedure using the Tukey test revealed that respondents ranked the piano as significantly more natural than both brass and woodwind, and the male singer as significantly more natural than woodwind.

Q33a

Whether they prefer a male singer to a female singer.	
Male singer	37.5%
Female singer	11.4%
No preference	50.0%
Don't know	1.1%
n	88

Q33b

Whether they prefer a low-pitched instrument to a high-pitched instrument.	
Low-pitched instrument	53.4%
High-pitched instrument	6.8%
No preference	38.6%
Don't know	1.1%
n	88

Q33c

Whether they prefer instrumental-only music, voice-only music or voice with instrument music.	
Instrumental-only music	17.4%
Voice-only music	5.8%
Voice with instrument music	30.2%
No preference	45.3%
Don't know	1.2%
n	86

Q34 **Rank number of performers from 1 to 5, where 1 means the "most preferred" to 5, "the least preferred"**

Number of Performers	Median*
One performer	1
Two performers	2
Three performers	3
Small group (e.g. 4 to 5)	4
Large group of performers (e.g. orchestra)	5

* n=83 (respondents that ranked ALL types of performers).

Results of a One-way RM ANOVA on Ranks revealed that there was a significant difference in the ranking of the number of performers from "most preferred" to "least preferred" (chi square = 133.011, df = 4, p=<0.001) . Post-hoc pair-wise multiple comparisons procedure using the Tukey test revealed that respondents significantly preferred:

- one, two and three performers over a "large group";
- one and two performers over a "small group";
- one performer over two and three performers; and
- two performers over three performers.

Q35

132

Whether there are tunes that they can *always* recognise		
		Comment
Yes	72.5%	A frequent comment was that they recognised tunes by the rhythm/beat only. Another frequent comment was that they recognised tunes by a combination of words and rhythm, or by a combination of words, rhythm and melody-line.
No	26.4%	
Don't know	1.1%	
n	91	

Q36

Whether there are tunes that they *cannot* recognise		
		Comment
Yes	62.2%	A common sentiment was the desire to be able to recognise anything and everything.
No	35.4%	
Don't know	2.4%	
n	82	

Q37

Whether there are instrument that they can *always* recognise by listening-alone.		
		Comment
Yes	72.8%	Instruments that were commonly identified as "can always be recognised by listening alone" were: piano (n=43), violin (n=37), strings (n=26) and guitar (n=27). Some common comments were that respondents: 1. can hear the *bass* or the heavy beat of instruments (piano, violin, strings and drum) 2. can identify all instruments, only if they are playing solo 3. can't separate instruments in the same family e.g. strings and woodwind. 4. personal 'tests' or music programmes have proved them wrong or have shown that they have "difficulty separating instruments".
No	25.0%	
Don't know	2.2%	
n	92	

Q38

Whether there are instrument that they *cannot* recognise by listening-alone. (n=83)		
		Comment
Yes	56.6%	A frequent comment was that they cannot recognise all or most instruments.
No	41.0%	
Don't know	2.4%	

Q39 The proportion of respondents that felt that the following factors improves, detracts from or made no difference to their music listening enjoyment.

Features of Music	Improves	Detracts	No difference	Don't know / Have not tried	n
Medium volume	56%	6%	27%	11%	89
Slow rhythm or beat	51%	6%	33%	10%	90
With words (to any style of music)	45%	13%	29%	12%	89
Tune with harmony/accompaniment	38%	13%	34%	14%	91
Soft volume	24%	32%	31%	14%	85
Without words (to any style of music)	23%	25%	38%	15%	88
Tune with no harmony (or accompaniment)	18%	36%	30%	16%	88
Loud volume	15%	58%	14%	13%	85
Fast rhythm or beat	14%	31%	42%	14%	88
Listening Experience	Improves	Detracts	No difference	Don't know / Have not tried	n
Familiar with music	78%	2%	12%	8%	93
Familiar with lyrics/words	77%	3%	10%	9%	88
Knowing the song title	70%	3%	21%	6%	90
Watching the performer	67%	3%	20%	10%	87
Having the musical score or words to follow	56%	5%	18%	21%	85
Knowing the context	53%	8%	28%	10%	86
Increased time/experience with CI	49%	2%	34%	15%	86
Practice listening to music	35%	7%	33%	25%	85
Listening Enivronment	Improves	Detracts	No difference	Don't know / Have not tried	n
Quiet environment	76%	4%	11%	9%	92
High quality speakers	48%	6%	16%	31%	90
Using a HA with CI	44%	6%	13%	37%	89
High quality recordings	43%	5%	20%	33%	86
Sitting at the front of a hall/theatre	26%	14%	26%	34%	88
DAI	20%	4%	10%	67%	84
Live concert, indoors	19%	31%	18%	32%	88
High quality headphones	18%	3%	19%	59%	88
Live concert, outdoors	10%	34%	16%	40%	86
Echoey room	3%	71%	11%	14%	87

Q40

Whether they are interested in undertaking a music training program (MTP)	
Yes	53.6%
No	44.0%
Don't know	2.4%
n	84

Q41 **Rank music listening skills from 1 to 8, where 1 means the "most important" to 8, "the least important"***

Music Listening Skills	**Median***
Ability to recognise previously-known tunes (before CI)	1
Ability to recognise commonly-known tunes	2
Ability to recognise commonly-known instruments	3
Ability to hear changes in pitch	3
Ability to recognise musical styles	4
Ability to "pick out" the tune when it is presented with harmony.	4
Learning new tunes	5
Ability to hear more complex rhythms	5.5

* n=64 (respondents that ranked ALL music listening skills, only).

Results of a One-way RM ANOVA on Ranks revealed that there was a significant difference in the ranking of the music listening skills from "most important" to "least important" (chi square = 72.659, df = 7, p=<0.001) . Post-hoc pair-wise multiple comparisons procedure using the Tukey test revealed that respondents felt that:

- the ability to recognise previously-known tunes (before CI), commonly-known tunes and commonly-known instruments are significantly more important than the ability to hear more complex rhythms;
- the ability to recognise previously-known tunes (before CI) and commonly-known tunes are significantly more important than learning new tunes;
- the ability to recognise previously-known tunes (before CI) and commonly-known tunes are significantly more important than the ability to recognise musical styles; and
- the ability to recognise previously-known tunes (before CI) is significantly more important than the ability to the ability to "pick out" the tune from the harmony.

Q42

Whether there are instruments, instrumental families, musical styles or songs that they would like to hear better.		
		Comment
Yes	55.7%	A common desire was the ability to hear the violin or strings better.
No	43.0%	
Don't know	1.3%	
n	79	

Q43

Whether they would like the MTP to focus on their preferred style of music or a wide range of musical styles.	
Preferred style	29.5%
Wide range	63.9%
Both of the above	1.6%
Don't know	4.9%
n	61

Q44-5

	How long each music training session should last for (minutes).	How many times a week the music training sessions should be.
Mean	35.6	2.7
Stdev	14.50	1.58
Minimum	10	1
Maximum	60	7
Most common	30	2
n	60	61

Q46

In what form they would like the MTP to come in.		
CD	28.6%	
MP3	5.5%	
CD-ROM	12.1%	
PDA	3.3%	
DVD	47.3%	Two respondents added that the DVD should have subtitles.
Other	2.2%	
Don't know	1.1%	
n	91	

Q47

Whether they would find a written manual with information and exercises, to accompany the MTP, helpful.		
Yes	79%	
No	18%	
Don't know	3%	
n	80	

Q48 Please see Appendix 4.

Appendix 4

Summary of Results II

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

Q. 10 – Formal Music Training Pre-CI.

Ptpt #	Comment
5	Formal training for 2 years side drumming? Taught side drumming in City Pipe Band. 6 hours teaching a week for 5 years and band engagements. Competed in many competitions.
11	Piano as teenager. Electric organ 30-37 years old.
17	Grad 7 piano, Music A - VCE (last year of secondary school). From age 8-18.
23	Piano 5 years? Singing 1 year + choral training.
27	Piano lessons aged 10 years. Singing lessons aged 16 years.
53	Studied music from aged 7 to 15. 8 years with classical piano. Subject passed for junior certificate in 1954.
55	Violin (6 years) and piano (2 years). Violin - Grades 2, 3, 4, 5, 6 and musical theory and perception.
67	Learned to play organ for 3 years
74	Piano, trained for 8 years, achieved Grade 6.
83	60 years ago music lessons.
87	I played in a bass band (cornet for approximately 20 years).
92	I learned to play the piano from 7 years old.
100	Basic guitar and drum lessons.
104	Just a little piano- on and off for a year or so. Had to stop as my hearing was getting worse.
108	I learned to play piano at 9yo. Learnt for 9 years.
113	I learnt piano for 2 years at school.
128	Piano lessons - about 2 years
131	I would have to say yes because I grew up in the Salvation Army and was very involved in the timbre (tambourine) brigade that involved intense choreography. I was also in the singing choir (even though I am tone-deaf). In primary school, I took up recorder and treble recorder. Also, Mum taught me briefly the piano
133	Piano 2 years
143	Had piano lessons as a child. As I got older, I played by ear.
164	I learnt the piano as a child for approx 4 years. As an adult, I had further lessons on the organ for about 2 years.
172	Just school
179	A couple of years of piano when I was about 10.
180	School off - saxophone after all types of instrument music.
191	Piano for 1 year at 17 years of age, choirs as a small boy
197	Play piano but I don't like it because I don't understand.
201	I learnt the violin for about 10 years but I gave it all away. I certainly enjoy the classics now.
203	Small number of piano lessons during pregnancy. Ballet training when young - music accompaniment.
223	Learned banjo before I went deaf as then I could hear the tune.

Q. 11 – Formal Music Training now, with CI.

Ptpt #	Comment
100	Guitar
197	I want to listen to music from radio or song on CD but I confused and don't understand words but I can hear sound/music e.g. pop music, slow music, etc.

Q. 12 – Participation in musical activities, pre-CI.

Ptpt #	Comment
5	Side drumming in band; band engagements and competitions.
17	Choir (13-18 years old), Magical (16-18yo), played piano (8-18yo).
23	Choirs, playing piano/organ.
24	School choirs - 17 years old.
27	Yes, singing choirs, dance.
55	Sang in church and school choirs, played violin in orchestra for 1 year when 15 yo, played violin in dance

	band for 4-5 years when 18yo.
74	10 years ballet, to age 14.
83	Dance - played piano and electric organ.
87	Yes. Played cornet in band for 20 years.
92	I also learned ballet at an early age at school. Probably I was about 6 or 7 years old.
101	Ballroom dancing from school age up to 30s or 40s.
104	Was in my school choir during my teenage years.
108	Played in several musicals (amateur) for 3 years.
123	Played a brass instrument as a teenager. Enjoy brass band music still. Sang in a church choir 40 years or more, until hearing loss was too much.
128	Played the church services.
131	Salvation Army musicals - "Joseph & the Technicolour Coat", "David & Goliath", "Glory".
140	Church choir until 14-15 years ago.
141	School choir 1974-1975.
143	I used to do ballroom dancing for about 15-20 years. Also played a keyboard socially.
145	Listened daily doing housework etc- sang most days in car and with kids. Danced almost daily with kids to music.
157	I used to be a dancer.
164	I was the organist in my church for about 5 years.
169	Piano, accordion 13-25 years (band 6 months). Electric organ at home (play occasionally).
175	I sing with a church congregation.
179	8 years in choir.
180	Dance bands.
183	Sang in choirs throughout childhood and high school. Danced during childhood (formal lessons). Informal dancing socially throughout adulthood.
184	Important aspect of work environment. Employed in trust with young people. Drama presentations, etc.
191	Choirs as a small boy (as per comment in Q10)
199	Austrian Choir until I became profoundly deaf. With implant, no longer possible as I cannot recognise notes accurately. However I still play piano.
201	I learnt the violin for about 10 years but I gave it all away. I certainly enjoy the classics now.
203	Yes - ballet and dance (<18 years old)
217	Choir member for many years, approx 40 years.
220	Church choir, church brass band.

Q. 13 – Participation in musical activities, now with CI.

Ptpt #	Comment
21	Very limited. I subscribe to the Australian Ballet and really enjoy that music however I do not enjoy any recorded music.
27	No training now started 15 years ago at music group.
55	I had hearing aids and ear operations (stapedectomy) which distorted all musical sounds.
74	Play piano occasionally.
128	Still play for church services but with great difficulty.
131	Although I am interested taking up some kind of Ballroom Dancing but I have different priorities right now.
154	Kinda learning bass guitar at home (teaching myself).
157	I cannot seem to get the rhythm, the tune or melody.
164	Play the organ but only for personal enjoyment.
175	I sing with a church congregation.
180	Not anymore.
199	At my sister's birthday played guitar for her. I still play piano (as per comment in Q12).
220	Church choir.

Q. 14 – Does prior music training pre-CI impact on current enjoyment now with CI?

Ptpt #	Comment
5	I can pick out the beat and sound of side drumming in pipe band.
17	Hard to tell consecutive notes apart on piano; when more than one note played harder to hear melody etc.
23	Prior to implant, I could listen to various types of music.
24	A little.

27	Singing and piano now seems off-key.
55	Cannot get involved as music is distorted.
74	I have a good "musical" memory which helps me "re-construct" music heard via my CI (& hearing aid).
92	I don't pick up a beat or rhythm.
113	I don't try to listen to music as I only hear the bass.
121	I was absolutely and completely stone deaf prior to my cochlear implant. After two operations, I worked on about 10 out of 22 electrodes, which leaves gaps in my hearing. I have difficulty with speech, cannot use a phone or understand a TV. Music does not really exist for me.
123	I love singing. Brass band, organ, piano. If tune is familiar, I can understand and hear. I can't seem to be in tune with it as I sing. I know in my head what should be the sound.
128	It seems to me that I only hear some notes. Even to play well known hymns, I need to play sometime before it seems to penetrate the brain.
131	Hard to say - life just moves on and life changes its priorities. I grew up in a family that loves music & I married a husband who loves music so music is often in the air.
140	I'm unable to distinguish music per se: instruments, voice (lyrics), actual melodies/tunes.
143	Find it hard to hear the melody with CI.
164	Combined with the hearing aid on my other ear, I get reasonably good quality of sound for music.
175	Only that singing is very enjoyable to me.
183	I loved music and can recognise music/songs now with implant but I know from having full hearing and music playing a large part of my life that what I hear now lacks depth and richness. It is not the same.
191	The reported inability to hear music enjoyably was my last contraindication to CI. When high-pitched music (soprano, violin, descants) became out of tune anyway, I had the operation which was wonderful for speech.
197	I like music but confused in word music.
199	I no longer play for sing-along's, etc. Music on the radio or TV, I enjoy, although I only hear sound not accurately. If someone tells met the tune titles, can understand.
217	I cannot recognise new tunes - music I have memory of and know how melody sounds in my head I can follow to a degree. I am not confident anymore if I can sing in tune or not.
220	Helps to ascertain or recognise how it SHOULD sound.
223	Enjoy it more now but still have trouble picking up tune.

Q. 18a – CI vs CI+HA

Ptpt #	Comment
11	Stereo sound.
13	Different sounds.
20	More added depth - not so tinny.
23	CI + HA do hear me.
27	Neither.
31	CI as with HA, could hear music.
67	More back-up noise.
74	Both is better - organic hearing rounds out the sound and provides additional cues (particularly low frequencies).
79	Both is better: more natural sound, "warmer" with HA also.
81	Clearer, clarity identify instruments.
92	Hearing aid.
96	Both - hear a wider range of sounds.
100	CI as it amplifies the sound greater without HA.
104	Have no hearing in my R ear.
112	CI+HA - truer sound.
113	It is only slightly better with both.
123	It sounds a bit better with sound from both

Q. 18b – CI-only vs HA-only

Ptpt #	Comment
11	CI requires further mapping.
13	CI better - ability to hear more.
21	I cannot hear speech or music with HA only.
27	Neither not better.
30	CI is better. With HA it is hard to make out music, distorts music.
46	CI clearer.
55	CI is worse, HA is better, clearer. HA is not so boisterous but not good.
67	If I want to hear clearly.
74	CI only is generally better - I can't hear much with HA only.
87	I could hear a tune with a hearing aid.
96	Hearing aid more comfortable at this stage.
101	Clearer tone.
113	CI is better as it picks up more variation.
124	HA best because of more volume and natural sound.
131	Definitely CI only as I have very little hearing in the HA.
141	CI - no distortion of sound better lyrics interpretation.
152	CI much better, HA very distorted.

	ears.
124	CI + HA best because I can hear high frequencies.
127	CI + HA as it is clearer.
128	Listen with both HA and CI but it's hard work and I don't bother. See comment for Q 21.
131	CI+HA is better because both ears are being stimulated.
151	Need both. Seems to balance it better when used together.
152	CI+HA much clearer.
164	CI + HA - the sound becomes less mechanical than with CI only.
180	CI is not helping on its own.
197	CI is clear better HA.
199	Without CI deaf.
200	Able to hear a better tone.
203	CI+HA. Better balance of tone/sound. CI - higher tone.
220	CI and HA evens up the sound.
222	CI and HA is better for overall sounds. Without aid, no balance.
161	CI is better. HA has minimal effect as only gives me awareness of where a noise came from - no speech differentiation.
164	HA - slightly better - sound more natural.
173	Residual hearing very poor.
187	Varies greatly with the type of music and listening environment.
196	Can actually feel music not feel it as I used to.
197	CI is clear.
199	Only can hear with CI.
203	CI (HA not sensitive enough).
222	CI is better - cannot hear music well with aid - not powerful enough.
223	Can't understand it with hearing aid only.
227	CI is better as more clarity of sounds.

Q. 18c – HA vs CI+HA

Ptpt #	Comment
11	CI adds hugely to hearing aid.
27	No better.
55	HA is not as strong as CI.
91	Not applicable, no aid.
96	Both - hear a wider range of sounds.
131	CI+HA as I have very little hearing in the HA.
141	CI by a mile.
152	CI much better, HA very distorted.
164	CI + HA - is definitely better. CI full range of notes, HA more natural sound.
173	HA insufficient on its own.
180	I use most days HA only.
187	CI and HA x 2 allows me to hear a much greater range of frequencies and therefore instruments.
203	CI+HA (HA not sensitive enough).
222	Cannot hear without CI. Aid not powerful enough for my loss.
223	CI as HA is only for safety sounds as I am vision impaired.

Q. 18d – DAI vs no DAI

Ptpt #	Comment
11	Infra-red RI 810S puts sound into both ears simultaneously.
17	Sound is clearer through audio loop. Limited to speech frequencies.
30	No difference.
104	I do not know if this will help me.
131	I use it for work just like any other wearing earphones - but it is nice to hear it without them hearing it.
135	I use both nearly always.
152	I find very little difference.
173	DAI - good sound quality, no room response, no external noise sources.
199	More direct sound.

Q. 19 – Best sound quality for recorded music

Ptpt #	Comment
2	Don't listen to music.
11	Car radio - lots of bass.

17 Can distinguish more "sounds" in the music and understand vocalist better.
21 It is not a good quality sound with any combination.
23 With both I hear to some extent.
24 I can pick up tunes - before all I really received was the bang bang of drums.
30 CI is almost like I remember music. As with it, the words don't get distorted.
31 It gives a much for sound and speech.
51 Sounds natural.
53 A HA is of no benefit to me.
55 None really. HA provides me with great volume of sound but NO CLARITY with words. CI provides clarity and sound - very good but music is off-key (tune) and noisy. HA+CI too loud (racket) and boisterous. NOT COMPATIBLE AT ALL.
72 CI only is ok. Sometimes to have a DAI does improves the ability to hear but it depends on quality of the sound. If the sound is a bit soft, it is better to have DAI.
74 Because my hearing loss is at high frequencies the organic hearing in my HA ear is more "correct". It helps me discern the pitch so I can construct the rest of the music from the input from my CI.
87 Since CI, I have not tried to listen to music.
91 None - I cannot make sense of music.
92 Over time, my hearing with CI is picking up more sounds each day. The only time I can understand music is in the car. Then I can get it wrong.
104 With difficulty.
113 CI picks up more frequencies and hearing aid picks up a very small tone.
124 Neither is very satisfactory on its own but they combine well together because the CI picks up sounds the hearing aid doesn't.
125 I have only 20% hearing in my left ear so it has no effect.
127 Unable to hear properly without both of them in.
128 I've had one hearing aid for 35 years when I lost all hearing in the other ear. Music sounded OK with HA but as hearing got worse in that ear and 4.5 years ago, I had implant and that is not music-friendly at all.
131 Both ears being stimulated but I am currently only using the CI only and I guess I am getting used to it. I have only used DAI at work as I work on the computer.
135 If I use both it evens out the quality of sound.
140 HA on loop.
143 Without the CI, I wouldn't hear anything. But the CI isn't very clear.
144 Nothing. Have no hearing in other ear.
152 The clarity of sound for CI+HA is much better than for any other except HA with DAI which in my experience, is little different to CI+HA.
157 I did not know one (DAI) was available. As I have never tried a "DAI", I would imagine this would be the best as I use a direct input with the phone and find I can hear perfectly.
161 Have only used these.
164 The CI gives the full range of notes so that high notes are once again included. However, on its own, the sound is somewhat mechanical. The hearing aid seems to balance this with more natural sound. In other words, they compliment each other.
173 HA doesn't provide any useful information (profound hearing loss on that side).
175 Since having the implant, I no longer use a hearing aid.
179 None. Music is mostly just a noise.
180 HA or CI does not help me much.
183 CI enables me to hear what is being sung but if the music is loud enough e.g. at a night club or concert I have enough residual hearing in unimplanted ear to hear the bass notes and they seem to come together - not as good on a home stereo.
187 CI and HA x 2 allows me to hear a much greater range of frequencies and therefore instruments.
191 The old enjoyment has gone. I cannot hear tunes - it all seems to be on 1:1 (? or T? can't read) note. If I know the piece well, I barely recognise it but can "make" the notes go to the correct pitch. Piano is recognisable. Orchestral music is noise.
196 I have no hearing without the CI. No hearing aid powerful enough to resurrect my hearing.
199 No background noise. Earplugs on T. Cannot understand the music but nice to listen to.
200 Much better able to hear various sounds.
201 CI is all I have. I can't stand the beat of music but I love the old singers etc classics. At 82 years, I am a bit old fashioned.
203 CI alone - "bionic" sound. CI+HA - sound is more natural and lower frequencies from HA.
217 Because it is how I hear everyday speech and sounds.

220	I find the sound seems to be more even and the "computer sound" of the CI on its own is reduced.
222	Since CI - have enjoyed music as it is powerful and the music is clear. With aids only - just noise, couldn't tell which instrument is from another.
223	Can hear it.
227	I can hear higher frequency sounds, as before implantation I only pick up lower sounds.

Q. 20 – Describe how music sounded when first listened to it with CI.

Ptpt #	Comment
2	Noise
5	Distorted.
11	CI and hearing aid - wonderful (drew picture of tears running down face and smiling).
13	Very different from hearing aids and better.
17	I couldn't identify songs, even ones I knew well. Had to look for cues from other people to let me know when vocals started.
21	Cannot really remember but all sounds were really unnatural and that has improved with practice.
23	I could not hear it.
24	I heard the combined sound.
30	Loud and uncomfortable.
31	It's good just to hear it after not hearing or understanding what you're hearing.
46	Not good/impossible.
53	It was initially "tinny" but with update adjustments the music and piano sounds far better.
55	Noisy. Off-key. Racket. Monotonic.
67	Difficult at first when I tried to hear the words of the song I know.
72	Music sounded quite normal to me.
74	Like rubbish! At first it was weird, bird-noises and then the CI sounds "followed" the music but the pitch was completely off.
78	More clarity.
80	Blurred.
83	So so
84	Unnatural.
86	Rhythm and the ones.
87	Just noise. I can follow a beat but not hear individual notes or tunes.
91	Garbled noise.
92	There was no beat or rhythm with musical instruments. It sounded like a deep drowned out sound.
96	More higher pitched sounds
100	I first listened to music as soon as I was fitted with the CI. It was a tinny sound.
101	Blurred, took a while to get used to different sound.
104	Strange
105	Good.
108	Could recognise some music.
109	I couldn't tell what type of instrument was being played. It was a little better than before having the CI.
112	I could hear the beat/rhythm more so if I knew the song, then I can follow it as I remember some words.
113	I very seldom listen to music but I don't think it was worth trying.
121	Jumbled noise.
123	Very hard to get used to. I have to concentrate and watch players or singers to hear their voices or instruments tone.
124	I heard instruments I previously didn't hear.
125	Slow
127	It was much clearer than before.
128	Just a great mess of sounds.
131	Terrible.
134	Cannot hear music
135	Very loud, very clear.
140	Discordant noise.
143	Just a noise.
144	Terrible.
145	Like nothing I had ever heard before e.g. sort of badly static station that has no real sound.
150	There wasn't a great deal of definition to it. It was almost like a combination of noises rather than music

	with a tune. I had trouble picking up a tune and differentiating between instruments and voices.
151	Scrambled
152	It was harsh and distorted.
154	Terrible haha.
157	Nothing makes sense I know music is playing but what tune or song is a mystery.
161	Like big raindrops.
164	Dreadful - very artificial.
169	Very tinny, scratch, metallic sounds. A lot of instruments playing at the same time becomes a jumble of sounds.
172	Messy.
173	Pretty good! I could hear lots of stuff that I couldn't hear before.
175	A bit tinny and unnatural (I am speaking of a piano).
179	A bit better but still just a noise.
180	Clear.
183	Awful and discordant.
184	Mickey mouse sounds. Drum beats only clear sound.
187	"Electronic" like Dr Who theme - the old one.
191	Noise.
195	Very fast.
196	Music - I made the CI work for me.
197	I hear rhythm e.g. I hear to sound of pop music or slow music.
199	Very out of tune.
200	Took some time to adjust with CI.
201	Strange until I could hear by myself.
203	Terrible! No rhythm or sequence and could not identify the tune.
217	Clearer but tuneless.
220	One big jumble and noise.
222	A little mixed up and not clear.
223	Different tone.
227	Some music, then and now, has too many instruments and it becomes a messy noise and I'm unable to decipher, but some music is beautiful and I can make out different instruments (piano, flute etc).

Q. 21 – Has the sound of music changed over time, with longer use of CI.

Ptpt #	Comment
13	Became more familiar with sounds.
17	A lot of songs from the past (pre-CI) can now be recognised. As long as there are not too many instruments, I can hear and sing along to songs.
21	Only slightly - it is still very distorted.
27	Yes, sound now is sharp and off-key. Absolutely awful.
30	It's no longer uncomfortable. Words are clearer.
46	8 months after, you start to enjoy music.
53	After the adjustments, say 6 months, I don't believe the sound quality has changed.
67	Yes, more hearing as my brain tells me.
74	It changed significantly over time. The sound of music has resolved itself slowly over time with occasional "leaps" in quality. It's still improving. Over time, I've gained detail, depth, a sense of 3 dimensions of musical sound, I can hear some lyrics, the different parts of choir and different instruments and melodies.
78	Not really.
80	A bit.
83	Different sound altogether.
91	Only in if it is a song I know, I can understand it.
92	I only listen to the radio in the car. I am able to distinguish the music from the 50s, 60s, 70s era. Music of today, I have no sense of music sound.
100	Yes, as I adjust to the sounds through the CI, music became clearer and I was able to understand the lyrics which is something I was unable to do with a HA.
101	Became more clear and distinct.
105	Listen more.
109	Slightly better, but when listening to people sing everyone sounds the same. All voices have the same

	tone.
113	I think I can pick up a bit more music as time goes on after.
121	I work on low volume setting, loud noise irritates something with a heave. Background beat is ok.
123	I've learnt to listen and watch singer or player of instrument to try to identify different musical instruments.
127	As it can be heard much clearer.
128	It would seem that the HA help clarify the music I hear with the implant (and voices).
131	Just like any other sounds - it took some months for the sounds to naturalize and I have to say, it is clearer than when I had HA-only before but I still cannot "filter" the words as I still rely on lip reading.
135	It has quieted down and normal now but I do not listen to music very much.
140	Barely.
143	I can hear some of the melody.
145	I can sort of remember what the song is like if I have subtitles? I think anyway.
150	It has become far more definable. I can definitely hear the distinction between voices and instruments. I still find soprano and high pitched voices difficult to listen to. Also instruments in the higher pitched sounds are aggravating.
151	It sounds better but still hard to pick up the words.
152	Music now using CI+HA doesn't sound any different to how I remember it prior to my hearing loss.
154	Can hear more higher-pitched notes. Also, better overall quality.
161	If not much beat sounds ok. If complex - not enjoyable.
164	I seem to have an improved quality of tone the longer I use it and sounds are more natural than they were in the beginning.
169	I enjoy it a little more than in the beginning.
173	Better able to identify components of performance and vocals.
175	Yes, over the years, the sound of music has changed for the better!
179	I listen to the radio a bit more now.
183	Gradually started to make sense but still lacks something.
187	I think so but I'm not sure. I think it is sounding better as I get used to the sound.
199	I keep volume low when playing piano and it sounds more bearable.
200	Able to hear sounds and words.
203	After about 6 months of exposure to music it "all came together"! I had often played CDs waiting for this.
220	I seem to now be able to recognise the tune although sometimes it takes a minute or so for that to happen.
222	Music has become more clear and I'm able to tell which instrument is being played.

Q. 22 – Have you tried to improve your music listening since getting CI.

Ptpt #	Comment
11	Purchase of the Infra-red when watching TV.
13	Don't have time now.
17	We bought an ipod with cable to listen via t-loop. Bought audio loop for stereo system. Both of these have improved my enjoyment of music.
21	Only by attending ballet performances. Recorded music is not pleasant.
23	TV.
24	Just listening to music on TV.
27	I have tried only singing and piano but not good results so I hardly do either now.
31	I have tried to listen to CDs but must be in a quiet room nothing else going on - you know, noise and talking!
53	I regularly listen to DVDs and play the piano but have not updated my processor since the 3G.
55	Tried listening with HA+CI: too loud, racket. - Volume soft or loud. - CI on its own: Racket and no tune, Monotonic. - HA on its own: music distorted, no clarity with words, off-key.
67	Not really, if I want to sing, I tried harder with written words I follow.
74	I listened to music as much as I could from the first week I was switched on, often up to 8 hours a day if possible. I also had "test" songs that became my measure of what changed, particularly over first 12 mths.
80	With using memory of music from the past.
92	No, not really. I accept that this is part of my life. I sometimes get the beat of music on TV. I also have

caption which helps.
101 Normally, I am tone deaf, I persevere but not necessarily successful!
104 I do not know if there is any other way to help.
109 Yes, I have tried but it makes no difference.
123 By concentration on tunes familiar or otherwise.
131 Not really - I was just pleased that over time it became a bit clearer than when I had HA. Did not really change much regarding the interest of music. As I stated earlier, there is usually music in the air around me.
134 Tried to listen to music.
140 Many attempts and failure mainly.
141 No need.
143 I try altering the volume control.
144 But no change with time.
145 I listened to songs that I loved every couple of days for the first year or so and still try every few months now but with no luck. Sometimes, my family will lip-sync for me to remember.
150 I listen to music when driving as opposed to before. When I first received my implant, I would listen and concentrate on picking the voice from the music. Now, I don't find the need to do that as it happens naturally. I try to do the same with just music in picking out the different instruments. I have definitely found success with this and it has improved my enjoyment of music.
152 By frequent listening.
154 Came all by itself.
157 I was told it cannot improve that "this is good as it is going to get". I was hoping that one day, I would be able to dance again!
164 Because of my fondness of music, I listen frequently using both CI and HA for best results. I feel that over time, as I have adjusted to the CI, the quality of sound satisfies me regarding enjoyment of music. Not quite perfect (naturally) but pretty good.
169 I try and choose music that is simple, that is with not too many instruments in the background OR I may have it loud so I can "feel" the music.
173 Bought CD collection - quite successful.
183 By going to concerto, live music etc. Where I can use residual hearing.
184 Question of affordability.
187 Had an experimental program in my CI which I thought sounded better but it doesn't seem to work properly since it was wiped for a repair and the CIC can't put it back. Cochlear did put it back for me but it has never worked properly so I gave up!
191 Combination of settings on CI.
195 Have it playing every morning.
196 Reading lyrics while listening to music to see if I was "hearing" what I was supposed to hear. Great success.
199 Yes as above (I keep volume low when playing piano and it sounds more bearable - from Q21).
201 I took it for granted, I couldn't hear. I have no natural hearing.
203 Live music - one last night and this was great! CDs especially in car. Radio especially in car.
220 I have purposely played CDs etc to see if I can decipher the lead and parts.
227 I try to sit close to a speaker and have no other noise in the room. Rooms with hard surfaces are not good and the more soft furnishings around the room make it much better.

Q. 27 – Additional comments on how tunes sound with CI.

Ptpt #	Comment
23	I cannot hear them with CI only.
27	I like the old fashioned songs and melodies but now hard to understand the melody and words.
30	No longer make an error when hearing words in songs. Note, music is not affected, just words.
51	Normal.
55	All music and instruments sound off-key. Monotonic best describes it. But sometimes, with solo vocals or solo instruments, the sound is nearly perfect pitch and enjoyable but not too often, as usually a lot of background noise etc.
67	I can hear music tunes but cannot understand the words they sing.
74	The above answer is probably an average. New music takes a while for melodies to come through. I can hear the melodies of music I already knew pre-implant pretty much straight away (with context).

78	Little problem with the pitch variation but the lyrics in songs are still often difficult to pick up - unless I know the song. One of the reasons I don't listen to much new music.
83	Different sound.
84	Overall, I find music appreciation with CI not good.
91	My CI just does not like music - full stop!
92	Sometimes, totally impossible to understand tunes.
101	Enjoyable, specially tunes - various types - that I recognise from way back.
104	Very poor - can hardly pick up the tune.
105	Much better.
108	Seems to be better but still bit distorted.
109	Melodies sound robotic.
113	Boring - I only hear the beat.
128	Mainly terrible.
131	I can pick up whether they are high or low, quiet or loud, the rhythm, the beat, the emotions BUT I would not be able to pick the tune of what song it represents OR whether it is the "wrong" note or not.
145	They can all sound like Happy Birthday if you are thinking of that song.
150	Inst. with lower pitch sound a lot nicer than higher pitched. Higher pitched can almost be painful and feel to grate on your nerves even when combined with lower pitch. It is as though they jump out to annoy you.
152	There is a slightly muffled sound to music or vocal heard with the CI alone.
157	I can only add that music does not sound the same there seems to be a confusion. Music on its own or with vocal accompaniment all sounds with no meaning. I always ask "What is playing"?
169	Sometimes when I play the organ, I am not sure if I have pressed the wrong key as it sounds like I may have (when I have not).
172	Messy.
175	Music is not as "REAL" as before I had a hearing problem but nevertheless pretty good.
179	I seemed to have developed a "tin ear".
184	Some base sounds. More "beat". Comment for Q23: "Music appreciation lost."
196	Sounds as they should e.g. I hear what's there.
199	Cannot hear the difference between 1 note differences. But 2 or more note differences yes.
200	A much clearer sound.
203	Good now.
220	It would seem that the CI lowers the pitch and I actually hear the melody lower than it is.
223	Don't fully pick up tune.
227	Music and melodies sound much better when the room/area I'm in is quiet.

Q. 28 – Additional comments on instruments

PIANO

Ptpt #	Comment
27	Piano now sounds tinnier with the CI.
30	Piano sounds like it only played in one key. Hence I find it irritating.
67	My son is musician & bass player. He was disappointed that I cannot pick tune when he is playing the bass.
74	I have difficulty learning new pieces on the piano. G (above middle C) + A (above middle C) sound exactly the same if I play a scale. Recorded music tends to be easier than me playing myself, partly due to the resonance of the (live) piano (if I'm playing).
87	As with other instruments, I can hear individual notes but when played with both hands, I find it difficult to identify a melody or tune.
91	As I have said, although it sounds melodic, I cannot pick out a tune.
101	A lot depends on the type of music being played.
104	I used to play the piano a little bit - but I cannot do so now after the CI.
113	I find these questions difficult to answer.
123	Sometimes choppy.
134	Pleasantness scale rating: "Here it is but don't know what it is."
135	Cannot enjoy the loud notes.
144	I cannot tell the difference between instruments.
145	My daughter had been taking piano lessons and when she played I wasn't able to make out the song and I didn't enjoy listening to the noise that it made.
150	As with the singing voice, the higher notes are far more unpleasant than the lower notes.

157	The piano sounds like a piano but I can't distinguish the tune.
199	Gave a pleasantness rating of 8 with the comment, "Other pianos, not when playing myself". General comment for piano: "Perhaps other CIs make a difference."
203	High notes are flatter sounding.

STRINGS

Ptpt #	Comment
17	Have sometimes mistaken violin for a guitar. I did extensive testing with Cochlear on musical instruments and often got violin and guitar muddled.
24	When at boarding school we were taken to a recital by Y.. … - I was … but haven't heard much music since. (*Difficult to read*.)
27	Do not listen to strings seems out of tune.
30	I can't always distinguish between cello or violin.
74	I find strings quite easy to hear and identify.
78	I haven't done this one as I am not fond of violin, so don't listen to this type of music.
87	I hear the instrument only if it is played solo. In an orchestra it just becomes noise.
91	Never listened since my CI so cannot comment.
104	No idea about this instrument.
113	I can hardly hear a violin at anytime.
135	Too high pitched.
157	All string instruments sound as they should but I can't understand what is being played.
175	Not quite clear on these questions!
187	Comment for scales, "Emptier-Fuller" and "Duller-sharper": While sharp and scratchy, there is little content.
191	I once mistook a chainsaw outside for orchestral music! I would love to hear the Brahms violin concerto again.

WOODWIND

Ptpt #	Comment
27	Do not listen to these instruments.
55	With all the instruments, as with the vocals, one instrument playing solo, as with vocals, is reasonably pleasant and more on-pitch but all together sounds seem flat or sharp.
74	It can take me awhile to discern melodies with woodwinds - particularly high pitched ones like flutes+piccolos - I need context for those.
78	I like the flute etc but have little experience listening to it. Doubt I would recognise (or pick it out) in the orchestra.
87	Same comment as for other instruments.
91	Never listened.
104	No idea about this instrument.
113	I can't hear these instruments.
128	Haven't actually experienced these to make comparisons - but noise is very tiring to sit through.
136	I have participated in music programmes at CI and have had considerable difficulties separating instruments.
157	Do not understand the tune.
175	I have not tried to listen to any of the woodwind family.
184	Comment for scale, "Emptier-Fuller": Emptiness relates to notes blending together. Meaning is lost.

BRASS

Ptpt #	Comment
27	Too loud to listen to.
53	I have found that these two instruments sound as close to normal as I would expect (and remember).
74	Trumpets have been the easiest to identify and hear from the beginning (or 2-3 months in).
78	I like trumpet and trombone and clarinet. But can't necessarily pick which when listening to it.
91	Never listened.
104	No idea about this instrument.
113	Can't hear these either.
128	Going by other music did just leave well enough alone.
141	Most brass instruments are good with the exception of the saxophone, which sounds a little washed out from what I previously remember.
157	Do not understand the tune.
184	Again, the music is empty because it has become an assault of sounds.

191	I can sometimes recognise a muted trumpet.
220	I cannot decipher the tune when played by the top instruments (e.g. cornet) but if the tenor horn or euphonium have etc tune it is much better and enjoyable.

DRUM KIT

Ptpt #	Comment
17	Cymbals on drums don't sound as I remember.
27	Too loud for me.
53	Drums are generally noisy and loud at the best of times but they seem "normal" to me.
55	Very loud and rough.
67	Enjoy the beats of drum.
74	Drum beats tend to be omitted by my organic hearing. From discussion with others, it seems I can sometimes hear more detail in a drum beat (snare particularly) than they can.
78	Sometimes overpowers other instruments (or the voice).
87	Drums tend to obliterate the music but I can still identify the beat e.g. dancing.
91	Never listened - I shut off.
104	Can hear this a little but it sounds noisy and hurts. I do get bothered by the unnatural sounds.
128	I think this would just take my head with it.
157	Just sounds like one big uncontrollable ding.
173	Drums are fundamentally impulsive, so they sound really good to CIs.
175	Unclear on some of the questions. To my hearing, drums are OK if they are not too loud.
187	Difficult to rate. If too loud, an assault. A beat in the background of an overall musical piece is more "understandable". I can pick up on 1 feathered drumming.
187	Could hear cymbals before.
203	More detail in drum beats now (i.e. drum head).

GUITAR

Ptpt #	Comment
27	Guitar more pleasant to listen to.
78	Love the guitar so perhaps I am biased and my opinion unreliable.
104	No idea about this instrument.
113	I found these questions difficult.
128	Seeing I like the guitar, maybe I could tolerate it but I haven't had the opportunity to listen these last few yrs.
145	My nephew plays & I can't seem to grasp what song but some notes I think I can hear if it's only 1 at a time.
150	From memory, I feel that of all instruments, the guitar would be the closest to the real thing.
154	Have greatly improved acuity (I think this is the right word) when listening to guitar, electric and acoustic.
157	I can hear the instrument but cannot make out the tune.
164	It is hard to reply to this as I can scarcely hear it.
184	Again, low strumming easier for me to pick up on than heavy strumming.
200	The guitar with CI was very good much ricer etc.

MALE SINGER

Ptpt #	Comment
17	Cannot distinguish between male and female singers.
23	Only if a professional, otherwise I cannot hear it. This is with CI and hearing aid.
27	Depends on what songs a male sings. Tenor too high pitched.
31	It's very hard to explain - you hear sounds better but you have to really concentrate.
55	A male vocal is very pleasant to my ears with one accompanying instrument or harmony without too much b'grd noise. Much better listening alone to concentrate without noise.
67	Not sure how I hear his singing. Like I can't hear what they're singing about.
78	Voice rather general it is the words I have difficulty with.
101	Depending on type of singer e.g. blues, Western, operatic, etc.
128	Male singers would probably sound better than female - the lower sounds are not so hard to tolerate. But it is a long time since I was able to hear anything properly. I do a lot of lip-reading.
134	Can hear noise but cannot work out words or tune.
143	Mostly can't make out what is being sung.
145	Not a nice sound it sort of makes you cringe.
150	The mid to lower range male voice is generally very pleasant and similar to the guitar in that I feel it is

closest to natural for me.
157 Nothing makes sense. Do not understand what is being sung.
161 Too difficult to generalise - dependent on type of voice and beat of music.
184 Comment on "Dull-Sharp" rating: Difficult to rate. Depends on voice pitch. Better, lower, however still lyrics are quite ... stressful. (*Difficult to read writing*.)
201 I love music and am often wishing I could hear the old music. I can't stand the beat of the latest music so turn it off (TV).

FEMALE SINGER

Ptpt #	Comment
17	Cannot distinguish between male and female singers.
27	Sopranos sound too high pitched. I am soprano. Contralto easier to listen to.
31	It's very hard to explain - you hear sounds better but you have to really concentrate.
55	Female singers are not as pleasant to my ears as male vocals. Females sound emptier.
67	Again, can't hear what they're singing about.
78	As previous answer to male, although words a trifle clearer.
87	Don't listen to singers very often.
101	What hearing I had before CI has always been anti-female singers, unless low-pitched crooner type.
134	Can hear noise but cannot work out words or tune.
141	Love listening to Barbara Streisand with all her different pitches etc. Also - Linda Ronstadt.
143	Mostly can't make out what is being sung unless I can read their lips.
145	My daughter loves singing and is in the choir and I feel bad that I can't enjoy her voice but I can't go through it constantly and she understands.
157	Nothing makes sense. Do not understand what is being sung.
161	Too difficult to generalise - dependent on type of voice and beat of music.
172	This section is irrelevant to me as I avoid music - it's too messy to listen to and not enjoyable on any level.
179	Female singers seem to screech and I cannot pick up the words.
184	Comment on "More noisy-Less noisy": I associate noisy with a garbled effect.
191	CDs of Joan Sutherland out of tune breaks my heart.
193	Doesn't understand Q 28.
199	With singers because they sing words, if they sing clear pronunciation, makes music more enjoyable.

Q. 29 – Would you like musical instruments & singers to sound like you think they would sound to a NH person?

Ptpt #	Comment
30	Myself don't really hear any different from before hearing loss. Music quite comfortable with CI.
128	Would be a lot of fun. Higher sounds seem to pierce their way through & louder sounds seem to reverberate.
131	The problem is, I have never experienced normal hearing so I cannot really compare.
135	With the CI, everything sounds as thought it is higher pitched.
141	Of course - but what I hear now is very close to what it sounded like when my hearing loss was only mild to moderate.
144	Because my hearing is very defective with my CI, the answers to this question on instruments, music types, singers, music styles, is nearly impossible to quantify.
145	Of course!
152	For myself, I consider what I hear with both CI and HA is very close to natural but the CI on its own is not.
183	Very, very much!

Q. 30 – Musical Styles

ORCHESTRA

Ptpt #	Comment
184	Interesting - can identify, however have difficult staying with melody line.
191	It doesn't sound like music as I remember it. The old thrill has gone.

SMALL GROUP

No comments

CHOIR

Ptpt #	Comment

184	Can identify better on TV than without sight!

POP/ROCK

Ptpt #	Comment
184	Must have sight to identify!

COUNTRY & WESTERN

Ptpt #	Comment
203	"Twangy"

JAZZ

No comments

OTHER

Ptpt #	Style	Pleasant	Simple	Follow Melody	ID Style	Sound NH
5	Pipe Bands (drums)	3	2	2	2	1
30	Folk music	7.5	4.6	7.2	7.2	5.4
34	Bagpipes	3	2	1	2	2
53	Religious	9.1	dna	9	8.8	8.8
55	Ballads (male)	9.5	dna	7.5	8.6	Dna
74	Electronic	8.4	6.4	6.4	7.4	6.5
75	Religious (church choral music & singing)	9.5	7.5	2	5	7
79	Reggae	9	9	9	9.2	8.2
101	Religious	9.9	7	9.9	9	9.8
105	Nursery Rhymes	7	7.1	1.6	7.6	2.2
113	Mouth Organ	2	8	2	2	3
131	Brass	7	3.5	1.5	1.5	2.6
140	Music in General	0.1	dna	0.2	0.2	0.2
145	All music	0	10	0	0	0
154	Heavy/Thrash/Black Metal	7.3	8.8	8.2	7.3	8.2
157	Music accompanying film	5	5	3	3	3
175	Church Organ	10	dna	8	dna	8
183	Techno	8	8.1	8.1	8	1
207	Blues	3	5	7	7	3
220	Hymns	8	6	4	7	5
223	Old Time	8.4	1.7	6.4	6.8	8.4

Q. 30 - COMMENTS ON MUSICAL STYLES

Ptpt #	Comment
2	I don't listen to any music as I cannot enjoy, it only old music I know the tune.
5	The CI is wonderful with the hearing aid in a situation of 1-1 person but 4-5 group gets distorted and more harder to cope. Large groups and rooms - impossible. I'm very sorry I couldn't help you more in the former questions.
23	With CI alone, I can hear a heavy beat but that is about all. With CI and HA, I cannot identify much. I always sang in harmony in choirs and not only can I not hear well enough but would sound too loud and upset the balance of voices.
51	If I'm in the car or a very noisy place, I find it very hard to understand what is being played. If I'm home listening, then I can understand all that is being played and it sounds all very natural.
72	I have no problems with music or style. I have never been a keen music listener but the music I do listen to sounds quite OK and natural to me.
84	CI not good for music appreciation. Rhythm section of popular, R&R, Jazz etc some appreciation (tap the feet).
92	I very rarely listen to music but I have tried to answer on as little information I have heard.
104	I used to play the piano for a number of years. I play by ear but have had a few years (2) with a teacher. Gradually as I lost my hearing I cannot play anymore even with the CI. Any other musical instrument sounds harsh and unnatural.

113	The only time I listen to music is when it has a beat or a relaxing low tone one. Mostly, I can't hear the rest.
121	Sorry. Music does not exist for me.
124	The CI + HA combine well, extra volume plus the CI picks up sounds I wouldn't hear with the HA alone.
125	My sound quality is very good. With the implant music sounds dull and slow.
128	Music just sounds terrible but without my CI I would now not be hearing too much at all and so I am eternally grateful.
140	I once enjoyed a wide range of music: classical, choral, Modern Standards and classical jazz; traditional that is. Now, music is just a discordant noise indistinguishable from majority of sounds.
150	Once again, I feel that instruments and music in the higher pitch are far more unpleasant than the lower range. For example, an all male choir would definitely sound more pleasant than an all female choir. Even though, choirs in general don't sound pleasant, almost like "too much information" to process it all. An orchestra is probably just as full on as a choir but you don't have to try and pick up the words as well, so there isn't so much to process.
152	Classical small group and choir I cannot comment as I have not really heard them but I would believe I would hear them similarly to other music.
183	While Techno is not my favourite music its beat makes it one of the easiest styles of music to listen to. Children play it a lot so am exposed to it daily.
184	I found this difficult to rate. I tend to mix up what I think I've heard associated with what I have seen on TV (text). The car radio is virtually impossible to listen to. When I view something, memory is a factor. Overall it is a big loss. It has been 5 years in which I have learned to overlook the detail i.e. when I hear music wise, because the sounds don't make "a whole".
199	Because music comes through to me not as a hearing person, I mainly listen to music that I heard as a hearing person. Nothing new. My brain adjusts to what I know.
200	The CI has given me a greater appreciation of music.
223	I enjoyed music and singing a lot before I had hearing problem. Now still like music but have problems with tune and words of people singing the old time songs I can understand better, not fully, as the singing is slower and music is softer.

Q. 31 – Would you like music to sound like you think they would sound to a NH person?

Ptpt #	Comment
11	(CI on its own)
13	It was fairly close enough for me compared with my parents. CI really helped me very well.
31	Who wouldn't.
67	Yes, I love to.
86	Not hear the person's voice until the implant improved as more channels than 24 channels.
91	Sorry but I've given up on music and give thanks for hearing speech.
135	With CI it is near normal. The only thing that is bad is loud high pitched music or two or three people or a crowd it is hard to understand much at all.
157	Of course I would love to hear music as it should be. With a listening device, would be good for home, but I would love to be just anywhere appreciating the sound of music e.g. theatre, concert, radio and even the shopping centres (Christmas time at the centres are just distressing instead of pleasant.)
161	As hearing decreased experienced frustration as this was one of my ways of relaxing pre-hearing loss. Felt very sad as it changed.
164	I have answered YES here because I can still pick a difference between listening with a CI and what would be more natural hearing as I wear a hearing aid on my other ear. Although that does not give me the higher range of notes, it gives enough to appreciate a more natural richness of tone when used with the CI.
184	Listening to music was an extremely important part of my life. The loss of music has been a dynamic in learning to cover my emotions. It is an element in the process of "grief and loss". I am told I was Auditory Digital (?difficult to read) prior to loss of hearing.
187	But I don't know what that is. Really, I want it to sound less "electronic" whatever that means!
197	Already sounds normal.

Q. 32 – Music Preferences

Ptpt #	Comment
30	Please note I have trouble distinguishing between piano and strings.
34	Don't understand question.
72	It is hard to make a preference as all would be ok.

78	Because I don't distinguish words very well, it depends on the pitch of male and female singers.
91	As I have said, it does not come across at all.
92	The only time I understand singers is on TV with caption. Then I have trouble picking up the beat.
105	Would love to hear more.
109	I don't listen to music because I don't enjoy it so it's hard to make a decision.
134	All sound the same jumbled up.
141	Saxophone - only instrument that sounds slightly different to before.
144	All sound the same.
145	Nothing sounds natural.
157	All I can say is music to me sounds on an even level, I just don't understand what is being played. No rhythm, no tune, no timing.
184	For Male and Female singer, comment: Not necessarily in this order! General comment: I loathe the sound of brass. Overwhelming.
187	It's not that simple, depends on the music!
223	People singing is hard to understand as music is usually too loud.
227	They all sound pretty normal/natural from what I can remember or may be even more clear than what I can remember. But when 2 or more are playing/singing at once it starts to go "spaghetti".

Q. 34 – Preferred group size

Ptpt #	Comment
72	My answer may not show it but I did give it some thought and possibly I have no problem or preference with any of them - all would sound OK (depending on music played).
144	Cannot answer this question.
161	Too difficult to answer - again different for different reasons.
179	The less noise the better I can distinguish the music or voice.
187	Depends on the instrument and the music. It's not that simple.
203	No preference.

Q. 35 – Tunes can always recognise

Ptpt #	Comment
5	By the rhythm/beat.
13	Sometimes, with rock music.
17	Rhythm/beat. I listen to a lot of 80s songs and it's the beat that cues me as to what the song is.
21	Sometimes the melody and sometimes the beat. At present, I am doing some research with a PhD student who said I was the first person who recognised "Old MacDonald had a farm" and "Twinkle Twinkle Little Star" first off. However, even these two tunes seem to become similar after hearing them many times.
24	By the beat.
27	Yes, by melody.
30	The opening melody or rhythm depending on what I'm listening to.
51	From the singer and the rhythm.
53	The melody line appears to be the best recognisable area followed by the words.
55	Melody line.
72	Generally, I can recognise tunes by a combination of words/the rhythm/and melody.
74	Usually the beat that identifies it for me, or from the 'beat' of the notes that are being played/sung.
78	Because of my age, I naturally recognise the older songs and music. From melody line and then words.
83	Rhythm or melody line when play the electric organ.
84	The beat.
86	Rhythm beat gives relax.
87	Rhythm/beat - or occasionally melody.
91	I only can follow if I know what the tune is to be, if for instance, in church, Psalm 23 is announced because I know it, or if someone starts singing Danny Boy - I know it.
100	Rhythm, words, melody-line.
101	Words and melody line.
104	Very slightly if it is the piano.
105	Rhythm and words, watching people, live shows and moving people. Would love to hear the words sung.
108	Bit of all.
109	Songs that I knew before loosing my hearing I can recognise and follow along with the words etc. However,

	if I have no prior knowledge of a song, it's not recognisable.
112	Wearing my CI and HA, I sit beside speakers (CI beside speaker) I can pick out some jazz - music with songs. Also follow the numbers and song titles on tape. I'm very happy when I can get some of Louis Armstrong or Ella Fitzgerald and those other singers.
113	Rhythm/beat - old sing-alongs!
123	Recognise from the words and melody line.
124	All three.
125	Melody line.
128	I can never be too sure of what I will hear - sometimes hearing is better than others. Possibly due to tiredness. Have a reasonably continual work load & often tired. But CI does a good job - just not music-wise.
131	Very few, based on rhythm/beat.
135	With CI it is nearly normal although loud high pitched music or a lot of people hard to understand much at all.
141	Rhythm - usually recognise in the few seconds.
145	Happy birthday.
150	Definitely the melody line. If it were any of the other 2 (rhythm, beat) on their own, I doubt I would recognise a tune.
151	Songs before I lost my hearing.
152	Melody line.
154	Recognise tunes from words, rhythm, melody-line and also, by time-changes (tempo).
157	I can never make out what tune is being played. It takes a while before I realise it is a tune I once knew. It is like piecing a jigsaw together.
161	Jazz easier.
164	Words or melody line.
169	Melody line.
175	Generally recognise tunes from melody line.
180	Tunes only.
183	Words and rhythm but have to listen for awhile. Prior to hearing loss, could recognise any music in the first few beats but no longer have that ability.
184	I may recognise a rhythm or a beat, however the whole will become blurred. I often think I am hearing into something only through a rhythm.
195	Melody.
196	Words, rhythm.
199	If someone tells me the name of the tune then I reocognise it. Although music sounds enjoyable even if I think I am hearing something that is not being played.
200	The CI gives me a clearer tone for music.
201	Remembering the tune. We were always musical when I was young.
203	Rhythm/beat.
217	From the words.
222	Rhythm and beat.
227	Sometimes it can be the rhythm, sometimes it's the melody or the beat or the combo of all.

Q. 36 – Tunes cannot recognise but would like to be able to recognise

Ptpt #	Comment
13	Some tunes I never ever heard and I didn't know what was it.
17	Old favourites like Stairway to Heaven, You took the words right out of my mouth (can understand chorus).
21	Too numerous to list.
23	Vocal, classic and religious.
27	Old fashioned melodies especially by Vera Lynn.
55	Most tunes I cannot recognise. Not even the words.
78	Today's occupation with improvisation makes some well-known tunes almost unrecognisable. Maybe with better hearing, I would be able to recognise them.
80	Country, vocal.
84	All.
86	The flute.
91	Old favourites.
101	Scottish type.
104	I love music and would like to hear all instruments.

105	Light opera and show songs, C&W music and music is fantastic to be able to hear.
112	"Red Sails in the Sunset". Some old war songs e.g. I'll be seeing you (maybe that's just a line). Strauss - I've never heard to my knowledge. I loved all kinds of music except C&W and way-out opera.
113	Some of the older songs.
128	NA to me - I like most music but not really too possible now.
131	I guess I just don't have the passion to really "dig" into it.
135	After a while with CI you are able to recognise tunes that you used to understand a few years ago.
140	Classical music, hymns.
143	Most tunes mostly popular ballades.
145	Any tunes or songs.
150	Sometimes, for example, my daughter will try and remind me of a song we both like and I cannot pick up which one she means. It may just be her "singing" but I don't think so.
151	Heaps.
154	Sometimes I can't get my bearings if I turn on the radio and a song is halfway through.
157	Anything.
169	Often very complex music with lots of instruments I may have trouble to recognise the tune.
172	All of them!
175	Hard to answer this one! Most tune recognised would be the old ones!
183	Usually recognise most of what I want to listen to.
184	Older style pop - Beatles, 60s-70s music, Country and Western, Sufi music, Nick Cave's work e.g. "God is in the House".
191	Old music hall standards, violin concertos, choir music with descants (church).
199	German folk songs and old 60s music.
203	Unfamiliar tunes are harder to recognise.
217	Any new tune.
220	Pop songs, hymn tunes.
223	Rock, C&W, Old Times, Ballroom.
227	All songs from past, present, too many to write.

Q. 37 – Instruments can always recognize

Ptpt #	Comment
2	Piano, drums.
5	Drums
11	All.
13	Guitar! My father plays it all the time!
17	Piano, cello, drums
24	String instruments, bagpipes.
27	Piano, guitar.
30	I can't always tell the difference between string and woodwind instruments (e.g. flute and recorders)
51	All
53	Piano, trombone, drums, trumpet.
55	Violin, piano, flute, guitar. Mostly all instruments if playing SOLO. All together is just noise, no tune to me.
72	Piano, guitar, trumpet. Again, my research results may contradict what I write here.
74	Violin (strings), trumpet, voice, piano, guitar.
78	Yes, guitar, piano, stringed instruments (but not which type), drums, of course.
80	Guitar, drum.
83	Guitar, electric organ
84	Drum - bass
87	Trumpet, flute, drums.
100	Piano, violin, guitar (electric and acoustic), drums, recorder, clarinet, trumpet.
101	Guitar, pipes and bagpipes.
104	Piano.
109	Drums can be recognised easily. Other than that when hearing an instrument e.g. guitar or other string instrument they sound the same. This also goes for wind instruments, etc.
112	Drums, guitar, piano, low key.
113	Drums, bass of the piano, bass of the violin.
121	Deep bass string and drums with heavy beat
123	Organ, piano, brass instruments (euphonium, bass, cornet, tenor horn, trombone).

124	Piano, guitar, violin, drums
131	Piano, guitar, violin, drums, trumpet, cymbals, triangle, timbre (tambourine), recorder, xylophone, flute, singing voice, saxophone.
135	Piano, guitar, drum, banjo.
141	All instruments are recognisable on their own.
145	Maybe drums but I'm not sure.
150	Piano, guitar, drums, harp, trumpet, ukelele.
154	Drums, guitar (electric and acoustic), double bass.
157	Solo: piano, guitar, wind instruments, stringed instruments, drums. I can recognise them but don't understand what is playing.
161	Don't tend to try
164	Piano, drums, string instruments
169	I think that I can identify all musical instruments provided they are played as a single instrument.
173	I can identify classes of instruments.
175	Piano, trumpet, trombone, clarinet.
179	Brass, strings, piano.
183	Drums, piano, violin, guitar, most instruments but not necessarily enjoy.
184	Flute, drums, piano, violin.
187	Drums, bass
191	Piano usually, muted trumpet sometimes.
195	Piano/guitar/drums
196	Drums
199	Piano, drums, clarinet
200	Piano, flute, oboe, clarinet, guitar, drums, violin.
201	Violin and piano.
203	Piano, drums, strings.
217	I can recognise instruments but not always the tune they are playing.
220	Euphonium, tenor horn, piano, violin, piano.
222	Guitar and drum kit
223	Drums, piano
227	Piano, guitar.

Q. 38 – Instruments would like to be able to recognise

Ptpt #	Comment
2	Strings, bass.
17	Violin, guitar.
21	All instruments.
23	Any.
27	Drums, bass, trumpet etc.
30	Violin, flute, saxophone, piano.
43	Country & Western, Folk songs.
53	Most music is a number of instruments.
67	Bass, piano and all other instruments.
72	As my music testing research would show, I cannot always identify the instruments played but that would be no different to my pre-hearing loss days. This note/answer would cover quite a few of these questions.
80	Violin, brass
84	All.
91	Most.
104	Most instruments - but I can hear the piano slightly.
105	Orchestra and group music, beat of any instrument.
108	Piano mostly.
109	Guitar.
112	Violin, woodwind, oboe, flute, the high note keys on a piano.
113	Flute, wind instruments, violin.
121	Most instruments
127	Always background music so don't take much notice.
128	I try not to worry about things out of my reach.
131	Probably more of the family members, like the woodwind family (the difference between oboe and clarinet).

134	The lot.
140	Piano, guitar, flute.
143	Piano, organ.
145	Piano and guitar.
150	Flute - many notes go out of my range completely.
152	In a group sometimes cannot distinguish between trumpet and trombone, and cello and bass.
154	Woodwind etc, clarinet/trombone/trumpet a bit iffy.
157	When all of the above are all together e.g. band, orchestra, choirs and any music over a P.A. system.
164	Wind instruments - flute etc.
172	Most
175	I find it difficult to recognise 2 violin sometimes a guitar.
184	My awareness is blurred. I would like to hear and differentiate between sounds and gain the larger picture. A total piece of music: a song.
191	Violin, cello, saxophone
201	I would love to be able to hear all music.
203	Not sure about this.
220	Trumpet, guitar.
223	All.
227	All of them.

Q. 39 – Other factors that improve, or detract from, music listening enjoyment.

Ptpt #	Comments
55	Improves: Slow rhythm & harmony, quiet environment, concentration to catch words if possible, no bgd noise
86	Live concert outdoor detracts as there is wind.
105	Bgd noise, distractions.
121	My tinnitus, noise, background echo.
128	Possibly high quality speakers and good things all make a difference but I am not in the position for these sort of luxuries so I don't think about them. Probably the quiet environment would help too. Familiar tunes would penetrate better too. Maybe slow rhythm compared to fast. But at my age, I'll probably get by OK.
131	The words being clearer than the instruments so that I can sing along (mouthing).
140	I cannot reasonably answer these questions: music, in any form is not possible for me.
141	I have been able to enjoy music as I previously remembered it from my 3rd MAP (2 wks after switch on). The CI has actually enhanced my ability to understand the correct lyrics.
184	Comment on "knowing the context": Memory associated with recognition of artist. However, I would be winging it.
196	Having the musical words or score to follow greatly helps.
200	Very loud music not at all beneficial.
203	Background noises.

Q. 40 – Interested in a music training program?

Ptpt #	Comments
2	Maybe.
11	Would be interested when/if I am CI only.
30	I'm doing one now with Pam Dawson.
104	I am too old now and find it difficult to travel.
128	I think I would have to give it a miss.
131	But it will not be of high priority.
141	Not needed.
161	Don't know - would depend on the time involved.
175	I would be but simply do not have the time.

Q. 41 – Skills important to help music listening enjoyment

Ptpt #	Comments
57	To appreciate good artists. (rank=9)
101	Follow instruments on video/DVD (rank=7)

105 Would love to be able to enjoy music and song.
106 Going alright without (rank=9)
131 Other = Being able to hear the words. (rank=1)
134 It would be how much time I could spend. Would have to talk to you about it. (rank=9)
203 Other = Being able to enjoy the music. (rank=1)
223 Singing (rank=1)

Q. 42 – Instruments, families, styles, or songs would like to be able to hear better.

Ptpt #	Comments
17	Strings in orchestral music.
67	Musical shows.
74	Less specific instruments, music styles, etc, than being able to listen to new music more readily.
78	Those with improvisation.
80	More complex music.
83	Like to hear speech better at my age.
84	Strings.
92	All instruments and different rhythms.
101	Some on TV etc where I need captions to help
104	Strings.
105	Light opera, show music, light pop music, C&W music, nursery rhymes.
108	Piano, violin, opera.
109	Guitar/classical music.
112	Anything.
113	Flute, sax, piano. I love flutes and music that goes with it. I also love music that makes you want to dance.
121	Would love to hear Judith Durham and the original Seekers.
128	Would be great to hear anything better.
134	The lot can't hear much at all.
140	Mahler.
141	Saxophone.
143	I would just like to hear and enjoy hearing music fairly clear again.
145	Songs in general for my son & daughter. Piano, so I can hear daughter play. Guitar, to hear nephew play.
150	I would prefer to be able to hear ladies' voices better - for instance, when watching a program like Australian Idol, you can give a better judgement on who is the better singer as opposed to it mainly being the males for me because the male voice is more pleasant, not necessarily more talented.
152	As stated better able to distinguish between instruments.
154	High-distortion (pedal) guitars.
157	I would like to hear melodies, words and all tunes.
164	Classical - string instruments, piano.
175	Musical styles like martial music. Old type love songs and the old top of the pops 30-40-50 years ago - I could understand the words then but cannot understand the present day shouting and meaningless noise!
183	Classical.
184	Older style pop - Beatles, 60s-70s music, Country and Western, Sufi music, Nick Cave's work e.g. "God is in the House". "Easy listening".
191	Opera, violin concerto, choirs with descants (anthems).
197	I like to hear piano.
199	Choirs and 60s-80s tunes.
200	Singers, at times unable to catch the words or tunes.
220	Have to do with Brass Bands in my "Worship" experience. Would like to be able to hear them better.
223	I like to understand them more.
227	All of them.

Q. 43 – Training program to focus on preferred style or introduce to wide range?

Ptpt #	Comments
105	Love to hear any music and songs.
134	Not sure.
141	Bloody Oath - Rock and Roll.
145	Either.

175	I cannot take part in any training program at present.
184	Older style pop - Beatles, 60s-70s music, Country and Western, Sufi music, Nick Cave's work e.g. "God is in the House".

Q. 46 – Form of MTP

Ptpt #	Comments
81	5 min intervals.
140	DVD with subtitles.
145	With subtitles would be good maybe.
157	Video or 1 to 1 contact. Any of the ones ticked would be ok. (Did point out that "3" was the "best".)
172	In person.

Q. 48 – Other comments on the training program.

Ptpt #	Comments
5	I feel I am beyond this particular training program.
24	No doubt you have realised I am not a music lover. We had no music when I was young as my mother was deaf. A little jazz I .. which I disliked. I enjoyed it whilst at boarding school but living in the country did not have the .. to educate my taste etc. I wish I could further help you as I am getting a great deal of enjoyment from my CI - unfortunately I am not well enough to have a second CI so must count the blessings(?) I have. *(Difficulty reading writing.)*
27	Would like to hear the old style singing and piano. Love the melodies.
53	I have been fortunate to have been able to do a music perception training programme just recently. Although working full time I did not have any problem with the schedule set out, I found it important NOT to schedule, say 30 min of training each day as it depended on the "mood". Some days, it may have been 15 mins, others, 40 mins - times were shown. It was important not to rush. I also felt because of the programme's intensity that a good break after was essential - for my wife as well!
55	Sorry, I am not available to take part in any MTP as I have serious health problems in the family and haven't any spare time available. Good luck with the program. It could certainly make an enormous difference and pleasure to unfortunate people. Thank you. I did my best with survey but got quite confused as questions seemed to be repeated. Hope some answers help with the program.
67	I have always loved to learn and read music and have music lessons from a young age. Took up organ lesson for 3 years at 40 years of age then never played again. It would be great, as I need encouragement, to learn with a patient music teacher and learn to hear different sounds.
84	I have been involved in several music appreciation (app) programs but at this time, I have a negative response to music app. However, overall benefits, i.e. speech perception, most positive. Of course, research is the only way to improve this.
91	It is all too late for me. It is 40 years since I last **really** heard music. Sorry to be so negative.
100	If the MTP becomes available, I would like to participate in a trial or purchase the program.
104	I am an epileptic and I take strong anti-epileptic medication. Training should not be too long and also not too concentrating as I cannot physically manage this.
105	I am very interested in the MTP as music is so much part of the world and can be calm and enjoyable to relax and learn with songs, live songs and shows would be marvellous to hear and live concerts. Barry Humphrey's concerts, Phantom of the Opera, Priscilla Queen of the Desert, Wiggles.
113	My problem is I am very busy all the time so I hope it won't be too consuming.
121	Too late in life for me to enjoy music training.
125	As I have answered "no" to the MTP, I have not answered all these questions.
128	I am very sorry that I didn't complete this questionnaire on time. The daughter-in-law that was responsible for assisting me during my implant is herself an organ recipient (kidney and pancreas) and has been hospitalised 3 times recently for tests and I have been very busy looking after her family and time just seemed to pass me by. Thanking you.
131	Have no idea [on the length and frequency of sessions]! Depends on your passion level so I would suggest a short, medium & an intensive one. Subtitles may be necessary to those who still rely on lip-reading.
134	A DVD would be easy for me to watch and could also have subtitles so I could read as well as listen.
140	My apologies if some of my responses appear negative. I've only recently been implanted - a possible factor in my not being able to convert(?) some sounds, even voice.
144	I have no expectation that I will be able to hear music after training program.
145	My hearing loss was overnight, I contracted meningitis and when I woke from a coma, I had total deafness in

both ears with bad tinnitus - so I remember what music sounds like and the implant just doesn't get music to sound anything like it did - don't misunderstand it's a godsend - much better than without it but music is just not a nice thing anymore, sadly! But my nerves were damaged differently to someone that had a progressive hearing loss so maybe my answers are not really suitable for you to take into consideration as I have spoken to others with a CI and they can hear music and enjoy it! Warm regards.

152 The program should be practical. Not all people understand musical pitch but most can follow rhythm. In my case, I would not be interested in modern rap or the like.

154 Great idea! Many thanks.

157 Is there a cost for this training program? If yes - how much? I think this is wonderful that there is a Music Training Program. I would dearly love to hear music again. Many thanks.

169 When listening to music, I choose simple style of music, that is, with not too many instruments. Complex music with lots of instrument/voice becomes a jumble of sounds. I'll try and explain how it sounds: Imagine thousands of little air bubbles coming up through water. Then add a pitch or note to these bubbles. The result is very unnatural. Overall, with the CI, the ability to experience emotion, "colour" or a rich full bodied sound is very limited. Having said that, I am very happy with my CI. It was the best decision I have ever made. My understanding of speech is 90-100% & that's the important bit. Enjoyment of music is a bonus.

173 Limitations on implantee's ability to listen to/appreciate music comes from the limitations of the technology, not from limitations in the implantee. Training may make a small difference, but it will not be large and will not enable implantees to hear music in the same way as people with normal hearing.

175 In response to Q 44-45: You have talked me into it! I would need more details before saying yes! In response to Q 48: Having a CI has changed my life. It's wonderful, however I am nearly 86 and find life very busy. I have many responsibilities. I have found that over the 4 years of implant experience, I have experienced a very definite improvement in my musical perception. The human hearing apparatus (apart from the implant) is a marvellous and miraculous design. (I am an Engineering Draughtsman and Designer). The Christian Bible records the fact: We are fearfully and wonderfully made! (Psalm 139, Verse 14.) AMEN!

183 The implant has given me so much but I still really grieve for real music. Music can elicit so many emotions and bring such pleasure, it is like having a large part of life missing! I would like to sing again but I know that I cannot hear pitch well enough to sing well. While I can recognise and understand a lot of music, it does not bring the same pleasure or emotion that it did when I was fully hearing prior to deafness.

184 I'm a little lost re Q 46. I no longer hear digital answering machines. Would like very much to be able to hear via a walkman while exercising (?). I've had difficulty hearing CDs. P.S. Attended a citizenship ceremony this evening. Could hear drums and bagpipes with ease! Astounding!

191 Since implantation I have tried to get used to music, especially in the car, but sadly no improvement. I'm scheduled for a 2nd implant - perhaps this might help.

199 I understand that they may be also trying to improve musical hearing in CI. Perhaps this may also help CI users someday. Thank you for sending this survey as music is an area that I really miss hearing perfectly.

203 Would like the written manual to be "not too technical" and to have a "voice backup" (?). "I am very happy with music perception using the CI + HA. This did take a while to come together though, possibly because of my persistence and continuing exposure to music. I have always enjoyed music, both before & after the CI.

220 Wrote a letter to us - was finally able to sing in tune!

227 Keep it simple.