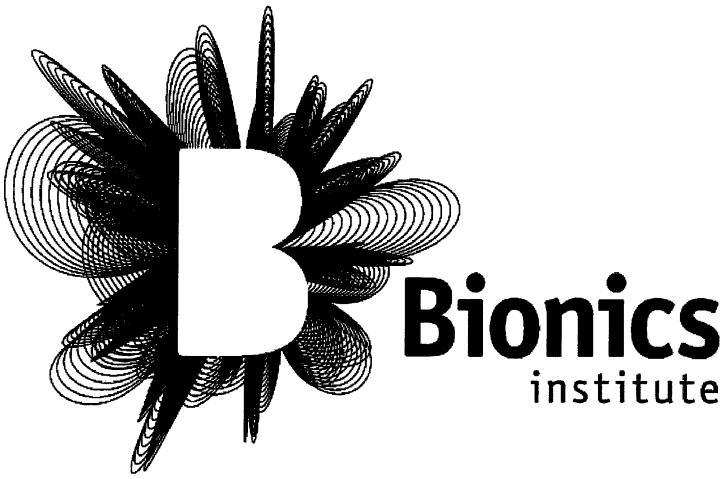

Title: Music for the cochlear implant: Audience response to six commissioned compositions

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Abstract

While cochlear implant (CI) users enjoy good speech understanding, music perception is still difficult or unpleasant for many. This study aimed to assess cognitive, engagement, and auditory responses to new music composed specifically for CI users. From 407 concertgoers who completed a questionnaire, responses from groups of normally-hearing listeners (NH, n = 44) and CI users (n = 44), matched in age and musical ability, were compared to determine whether specially-commissioned works would elicit similar responses from both groups. No significant group differences were found on measures of interest, enjoyment and musicality, whereas ratings of understanding and instrument localisation and recognition were significantly lower from CI users. Overall, ratings of the music were typically higher for percussion pieces. The concert successfully elicited similar responses from both groups in terms of interest, enjoyment and musicality, although technical aspects, such as understanding, localisation, and instrument identification continue to be problematic for CI users.

150 words

Keywords: hearing loss, cochlear implant, music appreciation

1. Introduction

With modern hearing devices, the majority of post-lingually deafened cochlear implant (CI) users achieve speech perception scores of above 80% in optimal listening conditions and without visual cues[1]. Despite technological advances in the CI itself, music is still not well perceived by many implantees[2-4]. Studies have shown that CI recipients tend to report reduced appreciation of music post-implantation[5-7]. In assessing the way CI recipients hear and appreciate music, researchers have mainly focused on the capabilities of the technology and comparisons of different sound processing strategies[3,8-10]. Rather than improve hardware and software in the implant, this project engaged composers to re-design the musical signals CI users receive. The aims were to generate and assess the reception of six new musical works specifically designed for CI users. We were interested in whether CI users and normally hearing (NH) listeners would have similar responses to these new works.

1.1. Sound and the cochlear implant

There are three aspects of music that are perceived with difficulty by cochlear implant recipients. The first is pitch: the ability to hear a note as high or low on a musical scale. In tasks involving the perception of spectral content, such as pitch discrimination, frequency difference limens, melody recognition, and pitch change detection, it has been shown that CI users perform significantly less accurately than NH listeners[9,11-14], suggesting that pitch is conveyed quite poorly by the CI. In most western music, the smallest common pitch difference between two notes is one semitone (about 6% difference in fundamental frequency, F0). However, CI users need on average a difference of at least 25% in F0 between notes to start to accurately assess a change in pitch direction[15].

The second aspect of poor music perception is timbre: the ability to distinguish between two instruments playing the same note at the same loudness level. Normally-hearing listeners are able to identify different instruments based on spectral and temporal cues in the acoustic signal. Some of these cues are not available for CI users, who therefore may have difficulty

distinguishing a flute from a cello for example. Studies have shown that timbre recognition tasks tend to be performed more poorly by CI users than NH listeners[13,16-18]. However, while high resolution spectral content is not well preserved by the CI, temporal envelope cues are conveyed well enough that the temporal characteristics particular to each instrument can be perceived. A study of instrument recognition found that CI users relied upon these temporal envelope cues in identifying instruments, with percussive instruments (i.e. those with distinctive temporal characteristics) identified correctly more often than non-percussive instruments[13].

The third aspect is the ability to segregate the multi-layered texture found in much music. This ability to group and separate sound sources, called auditory stream segregation, is based on perceptual differences between the sources. Musical elements that differ in pitch (such as a high-pitched melody and low-pitched harmony played on a piano), timbre (when different instruments play in an ensemble), loudness, or any other perceptual quality can be perceived separately. Unfortunately, the CI degrades the acoustic cues that give rise to perceptual differences between sound sources, thus reducing listeners' ability to segregate different sound sources[19]. This in turn reduces the ability to separately hear multiple lines of melody and different instruments, as well as particular voices amongst many.

1.2. Music for the cochlear implant

There have been very few attempts to look beyond technological development and create music specifically for the CI, with the strengths and limitations of current technology in mind. In 2007, Scottish composer Oliver Searle was commissioned by MED-EL (Innsbruck, Austria) to compose music for CI recipients. The resulting concert, *Noise Carriers,* was performed in Glasgow in 2008 and generated mainly positive responses from the 44 adult implantees who attended and completed the post-performance questionnaire. No peer-reviewed publications about this project were found at the time of writing; however, brief details of this and a similar performance of *Deacon* by Zack Moir are outlined in MED-EL's newsletter, *Listen, Hear!* [20,21]

The current project aimed to expand the number of works composed specifically for CI users, and to judge the success of these works by comparing ratings between CI users and NH listeners on a number of different post-performance questionnaire items. In addition, six different composers were involved, each bringing different aspects of their artistic practice to bear on the problem, and made use of extensive background information from scientists and active feedback from CI users during the composition process.

1.3. Audience Response Tools

In order to capture and quantify the perception of a live musical performance, a method of recording audience response is required. Both works previously discussed were assessed using questionnaires distributed at the end of the performance. This type of post-performance questionnaire can take the form of an Audience Response Tool (ART), which has sections relating to gathering qualitative and quantitative versions of affective and cognitive reactions as well as demographic data from audience members.[22,23] The ART was originally designed to measure audience reactions to contemporary dance performances, as well as investigate the effect of variables such as pre-performance information sessions, audience expertise and choreographic intention.[24] The present study used a questionnaire based on the ART, completed at the conclusion of each of the six new works.

1.4. Aim

Six composers were commissioned to create works for performance at two concerts intended to be accessible to both NH listeners and CI users, whilst accounting for the limitations in the signals that CI recipients receive. The aim of this study was to determine whether CI users and NH listeners might, for the first time, report similar ratings on cognitive, engagement and technical aspects of the music, as measured using subjective rating-scale items. If CI users are sensitive to the measured dimensions of the commissioned works then there should be no difference between NH listeners and CI users in their ratings for each piece of music. As CIs

transmit temporal cues relatively well, we additionally predicted that CI users would assign relatively positive ratings to pieces with percussion instruments compared to those without.

2. Method

2.1. Participants

In the lead up to the two concerts, invitations were sent to implantees through the Cochlear Implant Clinic at the Royal Victorian Eye and Ear Hospital in Melbourne, and details of the concerts were made available on the Bionics Institute website and the Arts Centre Melbourne website. The concert was described in advertising as 'new music, specifically designed for cochlear implant recipients, their normally-hearing friends and family, as well as music-lovers.' Participants in this study were audience members who attended the concerts; a mix of hearing aid users, CI users and NH listeners. Questionnaires were distributed to the 588 people who attended; of those, 407 participants returned a completed questionnaire at the end of the performances. Due to the substantially larger sample size of NH participants (n = 301) compared to the CI users (n = 44), a subsample of 44 NH participants was selected to be part of the analyses, and the two groups were matched on the variables of age range (*Mean range* = 31–50 years) and musical ability[a] (M_{NH} = 1.7; M_{CI} = 1.6) as closely as possible. The matching was performed as follows: If a single match was available, that case was chosen. If more than one match was available, a case was chosen randomly. The hearing aids group was excluded from the analyses due to the small sample size (n = 13).

TABLE 1. Summary of relevant data for subsample of NH listeners and CI users.

[a] Musical ability was self-rated on a scale ranging from 1 (no musical ability) to 5 (performance-level musical ability). Age was rated on an 8-point scale ranging from 1 (0-10 years) to 8 (90+ years).

	NH group	CI group
N (females)	44 (22)	44 (27)
Mean age group (years)	31-50	31-50
Musical ability	1.7	1.6
Unilateral CI	NA	34
Bilateral CI	NA	10

2.2. Materials

Biographical data were collected for age, gender, musical ability, hearing impairment, music enjoyment before and after impairment, and type of hearing amplification used. For each of the six pieces of music, 16 items were scored on a seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). In the present study, six of these items were chosen for analysis, measuring cognitive response, engagement and technical aspects of the music, such as localisation and timbre recognition. An open-ended question asking participants to record their thoughts and reactions was also included for each piece of music.

Prior to each concert, one of the authors (E.S.) gave brief instructions relating to the questionnaire. The audience was instructed to complete the relevant part of the questionnaire immediately following the performance of each piece. The instructions emphasised that the data were being collected for a scientific study, that answers would remain anonymous, and that candid responses were requested. The questionnaire items are listed in Appendix 1.

2.3. Music development

Six Australian composers of contemporary experimental music were commissioned to write new works specifically designed for listeners using a CI. The composers were Robin Fox, Rohan Drape, Ben Harper, Natasha Anderson, James Rushford, and Eugene Ughetti. The composers met with scientists from the Bionics Institute, who discussed the aims of the project and explained the strengths and limitations of current CI technology with regard to music perception. A group of four CI users was invited to attend subsequent meetings once the composers had some experimental material to present. The composers also had access to

software providing a sonification (an auditory display[25]) of the output of a simulated CI sound processor which they could use in their studios. The final pieces of music, each approximately 10 minutes long, largely resulted from the feedback gleaned from the implantees at these meetings. The full development process took approximately nine months.

The works were performed at the Fairfax Studio at the Arts Centre Melbourne. The 370-seat auditorium featured an 11.1 channel audio diffusion system. The works were a mixture of live instruments played on stage, and pre-recorded instrumental, vocal, or synthesised audio. The stage was a wooden semi-circular corner-stage design with arc length of 13.2 m. The rest of the auditorium was carpeted, and movable sound-dampening panels were extended to their maximum position to reduce reverberation as much as possible. Eleven semi-circular rows of seating were arranged on a raked floor with the first row at stage height and the 11th row 2.3 m above the stage and approximately 12 m back from the stage. Eight speakers were arranged in a ring shape around the circumference of the auditorium, and three speakers were on stage. A large sub-woofer was positioned below the seating. Pre-recorded audio was played through this system using 11-channel audio files, and the signals from microphones mounted on live instruments on the stage could also be routed selectively through any audio channel. Each composer combined aspects of their own artistic practice with the knowledge obtained from the learning program to develop their composition. The six resulting pieces varied widely in their approach and style as briefly reviewed below. All were approximately 10 minutes in duration. More detailed descriptions can be found in the concert program, available at http://www.bionicsinstitute.org/interiordesign/Program.pdf.

Piece 1 - Variations: The composer explored the contours and intervals created by using dynamics, duration, pitch, and repeated variations on a simple theme. Instrumentation: pre-recorded piano with live clarinet, viola and cello.

Piece 2 – Percussion/Vibraphone: Percussion instruments were chosen based on feedback that CI users found them to be easy instruments to distinguish. A bowed vibraphone

was used to add a controlled pulse to the sound produced. Synthesiser bursts designed to rapidly stimulate sequential electrodes were also used to create sound textures that could potentially be interpreted by the CI user. The live performance enabled listeners to make use of visual cues provided by the movements of the performers, while pre-recorded material was used to create spatialized sound from the 11.1 channel audio diffusion system in the auditorium. Instrumentation: live bongo and conga drums, shaker, and bowed vibraphone, with spatialized diffusion of pre-recorded piano, cello, and synthesised sound.

Piece 3 – Spoken Word: Based on the well-established speech processing capabilities of the cochlear implant, this piece primarily used fragments of spoken phrases superimposed over short electronic melodies that emulated the rhythm and intonation of the speech fragments. Instrumentation: pre-recorded voice with spatially-diffused synthesised keyboard/vibraphone using tuning system based on CI sound-processor channel frequencies.

Piece 4 - Pitch: This piece involved multiple lines of melody in a trio for cello, viola, and tape-recorder. Extended technique (when the performer plays the instrument in an unconventional way, i.e. slapping the body of the cello) and preparation (such as the attachment of adhesive to strings) of the live instruments introduced differences in the instruments' timbre and attack, sustain and release times. Instrumentation: live cello and viola, pre-recorded processed tape recordings of cello and viola.

Piece 5 - Electronic: Pulse, rhythm and tone were separately explored in this three-part piece. Study (1): spatialisation of a constant pulse was achieved via the 11.1 channel diffusion sound system. Study (2): rhythmic patterns were created using complex tones with fundamental frequencies set at the centre frequencies of the 22 filters present in a cochlear implant (250, 375, 500, 625, 750, 872, 1000, 1125, 1250, 1437, 1687, 1937, 2187, 2500, 2875, 3312, 3812, 4375, 5000, 5687, 6500 & 7438 Hz). Study (3): chords were generated by gradually introducing single pure tones through different channels of the 11.1 channel sound system. Finally, screens with

colour fields synchronised to the audio signal were used throughout the piece to provide congruent audio-visual cues.

Piece 6 – Percussion: Male voice and a wide variety of tuned and untuned percussion instruments were exclusively used in this piece, taking advantage of the implant's ability to convey amplitude envelope fluctuations. Familiar rhythms were overlayed and varied. Instrumentation: large percussion ensemble with three players.

2.4. Procedure

Two concerts were held at the Arts Centre Melbourne on 13 February, 2011, both containing identical material performed in the same order. Each concert was approximately 1 hour, with no interval. At the beginning of each concert, members of the audience were provided with the questionnaire and instructed to complete the relevant section immediately after each piece. The questionnaires were collected at the end of each concert. Data from both concerts were combined for analysis.

2.5. Statistical analysis

Statistical analyses were carried out using SPSS 19.0. Six items from the questionnaire were chosen for analysis. These items were selected in order to explore three main areas of interest: *cognitive response to the music* (as measured by items 1 and 2, addressing interest and understanding), *engagement with the music* (measured by items 7 and 8, asking whether the concert was musical and enjoyable), and *technical aspects of the music* (measured by items 15 and 16, addressing localisation and timbre recognition ability). As the rating data was ordinal, and not normally-distributed, non-parametric analyses were performed. In order to test for the overall effect of group (CI users vs NH listeners), Mann-Whitney tests were performed on the mean responses across pieces for each of the six items analysed. To test for the effect of each piece, Friedman ANOVAs were run for each of the six questionnaire items analysed. Significant main effects were followed up by post-hoc Wilcoxon signed rank tests. In order to test the hypothesis that pieces with percussion would have higher ratings that those without, only the eight

combinations including the two percussion pieces were tested. A Bonferroni correction was applied, so these pairwise tests were reported as significant when $p < .006$. The open-ended questions will require further thematic analyses which are beyond the scope of this paper.

3. Results

3.1. Cognitive response to the music

Item 1 Interest: 'The piece was very interesting': Figure 1A shows the median ratings for the 6 pieces and the two groups. There was no significant effect of group, however the main effect of piece was found to be significant, $\chi^2(5) = 106.2, p < .001$. Post hoc tests revealed that the ratings for interest were significantly higher for the two percussion pieces (2 and 6) than each of the other four pieces.

*** Figure 1 around here ***

Item 4 Not-understanding: 'I did not understand the piece': In order to make sure that the participant read each questions carefully, some negative assertions were added. Therefore positive responses were located on the negative side of the scale (*Strongly disagree*). Significant effects were found for group, $U = 738.5, p = .05$, and piece, $\chi^2(5) = 25.8, p < .001$. The NH group (*Mean Rank* = 39.1) had a better understanding (lower not-understanding ratings) of the music than the CI group overall (*Mean Rank* = 49.0). Post hoc tests revealed that the ratings for interest were significantly higher for the two percussion pieces (2 and 6) than each of the other four pieces (Figure 1B).

3.2. Engagement with the music

Item 7 Musicality: 'I found the piece very musical': The main effect of piece was found to be significant, $\chi^2(5) = 65.4, p < .001$, but not the main effect of group. Post hoc tests revealed that the ratings for interest were significantly higher for the two percussion pieces (2 and 6) than each of the other four pieces (Figure 1C).

Item 8 Enjoyment: 'The piece was very enjoyable': The main effect of piece was found to be significant, $\chi^2(5) = 84.0, p < .001$, but not the main effect of group, or the group x piece interaction. Post hoc tests revealed that the ratings for interest were significantly higher for the two percussion pieces (2 and 6) than each of the other four pieces (Figure 1D).

3.3. Technical aspects of the music

Item 15 Localisation: 'I can tell where all the sounds were coming from': The electronic piece and spoken word piece used only sampled recordings, while the other four pieces all featured live instruments on stage. As this item was a measure of the ability of participants to localise, it was not useful to include pieces with and without the visual cues generated by the instruments on stage. Thus, only the *electronic* piece and the *spoken word* piece were included in the analysis. There was a significant main effect of group, $U = 589.0, p = .02$, indicating that the NH group (*Mean Rank* = 47.3) reported to be able to better localise sounds than the CI group (*Mean Rank* = 35.1). There was no significant main effect of piece for this item. It is important to note, however, that responses related to localisation may have been affected by the location of each respondent in relation to the instruments and elements of the sound diffusion system, a factor which was not able to be controlled for.

Item 16 Timbre recognition 'I can distinguish different instruments': Again, only the *electronic* and *spoken word* pieces were included to avoid confounds related to the presence of instruments on stage. There were significant main effects of group, $U = 580.0, p = .04$. The NH group ratings (*Mean Rank* = 45.5) were significantly higher than the CI group (*Mean Rank* = 34.7).

4. Discussion

For items measuring interest, musicality, and engagement, there was no difference in the ratings made by NH listeners and CI users. Where the main effect of group was found to be significant, however, the median rating of NH listeners was invariably more positive than that of the CI group. Significant differences for piece were found across all three areas of cognitive response, engagement, and technical aspects; and the ratings from both groups in these areas

were typically higher for the pieces involving percussion when all six pieces were part of the analysis.

4.1. Cognitive response to the concert

Measures of interest and understanding were used to explore this category. For the item measuring interest, there was no significant difference in the mean rating provided by CI users and NH listeners, suggesting that CI users were just as interested in the music presented as the NH listeners. This result is encouraging, and indicates that CI users were able to perceive the music sufficiently well to engage their interest. However, despite equivalent levels of interest, the group effect for the item measuring understanding suggests that inherent differences between the two groups enabled the NH listeners to have a better understanding of the music than the CI users. This could be due to limitations of the CI preventing it from transmitting musical features such as pitch and timbre that would help facilitate better understanding. Another reason could be attributed to the musical preference of the audience as a confounding variable. While the CI users were invited to attend the concert, NH participants who were not friends or relatives of the CI users may have chosen to attend based on their existing interest in the music to be performed. It could thus be reasoned that those NH listeners who attended were perhaps more experienced listeners of contemporary music and were better able to understand the music than were CI users.

The significant effect of piece for both interest and understanding in this category indicates that some pieces were more successful than others in facilitating appreciation of the music. In particular, the ratings for interest and understanding were higher for the percussion/voice piece and the percussion/vibraphone piece. This is an important finding in the context of CIs, as implants preserve the amplitude envelope fluctuations that convey rhythm quite well. Taken together, it is not surprising that the two percussion pieces were found to be the most interesting and the best understood by the CI group.

4.2. Engagement with the music

This category was measured based on ratings of how *musical* and *enjoyable* each piece was. The non-significant effect of group for these two items indicates that NH participants and CI users had similar levels of engagement with the music. This is a promising result, as one of the main aims of this study was to develop new music that could be appreciated in similar ways by both NH listeners and CI recipients. There were no significant differences between CI users and NH listeners in their ratings of enjoyment and musicality for each piece of music.

The significant effect of piece for these two items shows that pieces differed in how they engaged the audience. Ratings for the musicality and enjoyment items were higher for the percussion pieces than the others. This is consistent with the above finding on cognitive response to the music, and lends support to the experimental hypothesis that percussion instruments would be well perceived by CI users.

4.3. Technical aspects of the music

Instrument localisation and timbre recognition were used to explore the technical aspects of music perception. The significant effect of group for both items in this category indicates that NH listeners were better able to localize sounds and perceive their timbre. Localisation depends on the processing of differences in level and timing between the two ears. This result is therefore not surprising, considering that the CI users in the current study were mostly unilaterally implanted (Table 1).

Timbre recognition tasks are generally performed less accurately by implantees,[12,15,26] possibly owing to the implant's imprecise transmission of spectral content.[13,27-29] The significant main effect of group for the timbre item suggests that implantees were not able to distinguish between instrument sounds in the same way as the NH listeners. In general, the instrument identification ratings were lower for the electronic piece than the piece using spoken word, although this effect was not statistically significant. This could be attributed to the type of instruments represented in the sampled recordings: whereas the spoken word piece used

conventional instruments, such as synthesised keyboard notes, the electronic piece employed potentially unfamiliar computer-generated sounds that may have been difficult to recognise.

4.4. Further research

The works presented at the concert were written by composers of contemporary experimental music. These particular composers were chosen as they were able to work in an experimental manner – by iteratively proposing and testing works with CI users during the composition process. Although this unique process resulted in works which were interpreted similarly by CI users and NH listeners, the resulting works also contained unconventional musical structures and sounds which may have been unfamiliar to the listeners. Throughout the composition process, the composers learnt that many musical 'building blocks,' such as harmony and melody based on small intervals, could not be expected to be perceived in similar ways by CI users and NH listeners. Thus, musical structures such as radical shifts in timbre and dynamics, repetition of melody, the use of vocal elements, alternative tuning systems and synthesised sounds, and substantial use of rhythm were used. Some of these structures, such as rhythm, may have been familiar to both groups in the audience, whereas others, such as the alternative tuning systems, melodies with unusually large intervals, and synthesised sounds, may have been unfamiliar to the majority of the audience.

In addition, the works were by definition new – none of the audience had previously heard any of the works. Thus, the generation of new works in addition to the deliberate avoidance of often-used musical structures resulted in unfamiliar music. Familiarity has long been known to affect judgements of enjoyment and the emotional response to music in normally-hearing listeners[30]. Repetition of unfamiliar works can lead to increases in the enjoyment of individual pieces with initially low ratings[31,32], and familiar pop songs elicit greater activity in emotion-related limbic brain areas than unfamiliar songs[33]. In CI users, however, ratings of the sound quality of selected pieces have been found to be independent of the familiarity of the piece[34]. This was the case when 'familiarity' was based on recognition ratings

from a large group of normally-hearing listeners, as well as when the ratings were compared with those of individual CI users' favourite songs. In future research, comparing responses from CI users and NH listeners to repeated presentations of the works over several weeks (as in the study by Mull[31]) would help disentangle the effects of familiarity from the hypothesised effect of the specifically-composed music itself. Future research may also benefit from a comparison of the works from the current study with other non CI-specific works from the same composers. If these works were presented in a randomised and blinded fashion, possible 'Hawthorne Effect'[35] issues with the current study may be avoided: Although the audience was asked to respond frankly and candidly, it is possible that the overall environment of the concert, having been designed to help the hearing-impaired community enjoy music, caused audience members as a whole to respond with a positive bias. This effect, if present, would cause overall increases in ratings for the whole audience, rather than group differences as examined in the current study.

4.5. Conclusion

The aim of the current study was to investigate the reception of new music that was intended to be interpreted and appreciated by both NH listeners and CI recipients. The results indicate that at least in terms of engaging with the audience, this was a success. Consistent with what is already known, CI users gave higher ratings on measures of interest, engagement and musicality for the pieces with percussion instruments. Overall, however, NH participants typically rated all items higher than CI users, and the effects of group were particularly large for localisation and instrument identification. This suggests that, for now, CI technology is still unable to deliver a complete musical experience to CI users. More novel methods of circumventing the limitations of CI technology may form the basis for future studies of this kind, with particular focus on preserving the technical elements of music. Finally, the findings also suggest that while technological changes are necessary to improve musical experiences for CI users, composers and performers also have an important role to play.

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Figure Captions

FIGURE 1. *Boxplots showing the distribution of responses from cochlear implant users (dark grey – CI) and normally-hearing listeners (light grey – NH) for the six items analysed, separated by piece. Boxes show the median, and 25th and 75th percentiles. Whiskers show the 10th and 90th percentiles. Small horizontal lines indicate the minimum and maximum values. A) Item 1 – Interest, B) Item 4 – Not-understanding, C) Item 7 – Musicality, D) Item 8 – Enjoyment, E) Item 15 – Localisation, F) Item 16 – Identification.*

Appendix 1: Questionnaire items

1. The piece was very interesting
2. I was moved by the piece
3. The piece was entertaining
4. I did not understand the piece
5. I was bored by the piece
6. I felt confused by the piece
7. I found the piece very musical
8. The piece was very enjoyable
9. The melodies were very enjoyable
10. The rhythms were very enjoyable
11. The overall soundscape was very enjoyable
12. I enjoyed the musician's performance
13. The piece made me very calm
14. The piece made me very happy
15. I can tell where all the sounds were coming from
16. I can distinguish different instruments

CEU Summary

As a result of this activity, participants will be able to 1) describe some of the difficulties cochlear implant users experience while listening to music and 2) list several ways that musicians and composers might overcome some of these difficulties.

Three multiple-choice questions

1] *Which element of music is relatively well perceived by cochlear implant recipients?*

a] Melody

b] Timbre

c] Rhythm

d] Harmony

2] The study showed that:

a] CI recipients can enjoy all types of music.

b] CI recipients can only hear the percussion.

c] It is possible to compose a piece of music that will be **appreciated** in a similar way by people with normal hearing and CI recipients.

d] It is possible to compose a piece of music that will be **perceived** in a similar way by people with normal hearing and CI recipients.

3] *Why were only 44 surveys among the 301 analysed for the NH group?*

a] It was too much work to analyse them all.

b] Only the best surveys were selected.

c] To minimise the difference between the CI and NH group.

d] To have a number of surveys that can divided by 4.

Answers: #3 for all the questions.