

Designing for Empathetic Listening Interactions

Lloyd May, So Yeon Park, Aaron Hodges, Blair Kaneshiro, Jonathan Berger

Introduction

- Music appraisal varies greatly between CI users, some reporting a decline in music enjoyment and listening time post implantation^{1,3}. Others report increased enjoyment in music correlated with higher speech perception scores and age^{1,5}
- Many CI users have noted music being a strong factor in undergoing implantation despite difficulties in perceiving music and show better postoperative quality of life^{1,6}
- Simplifying musical signals by focusing on better perceived features such as rhythm, voice, and low frequency stimulus while reducing more complex elements has led to increased music appreciation in CI users^{2,4}
- Heterogeneity of CI users and difference between CI simulation and CI user listening experience may warrant individual tailoring of musical signals^{4,7}

Methodology

We recruited 10 professional audio engineers and 10 Cochlear Implant (CI) users. The audio engineers were asked to mix various multi-track music projects of different genres, as well as one speech in noise clip, under three different intervention conditions:

1. A baseline mix for commercial release with no intervention
2. Refine Mix 1 while mixing through a Cochlear Implant simulator
3. Refine Mix 2 with written feedback and optional written correspondence with a CI user

Audio engineers were surveyed regarding their experience after each round of mixing and thematic analysis was performed on the CI user's feedback.

8 CI users also used a hearing aid and 1 participant used two CIs.

Musical Elements prioritized by Users of Cochlear Implants Differ by Personal and Genre Preferences

Themes extracted from CI user's feedback to the audio engineers:

Separation of Elements

Separation of Streams
Volume Balance
Clarity & Intelligibility

Subjective Preferences & Affective Perceptions

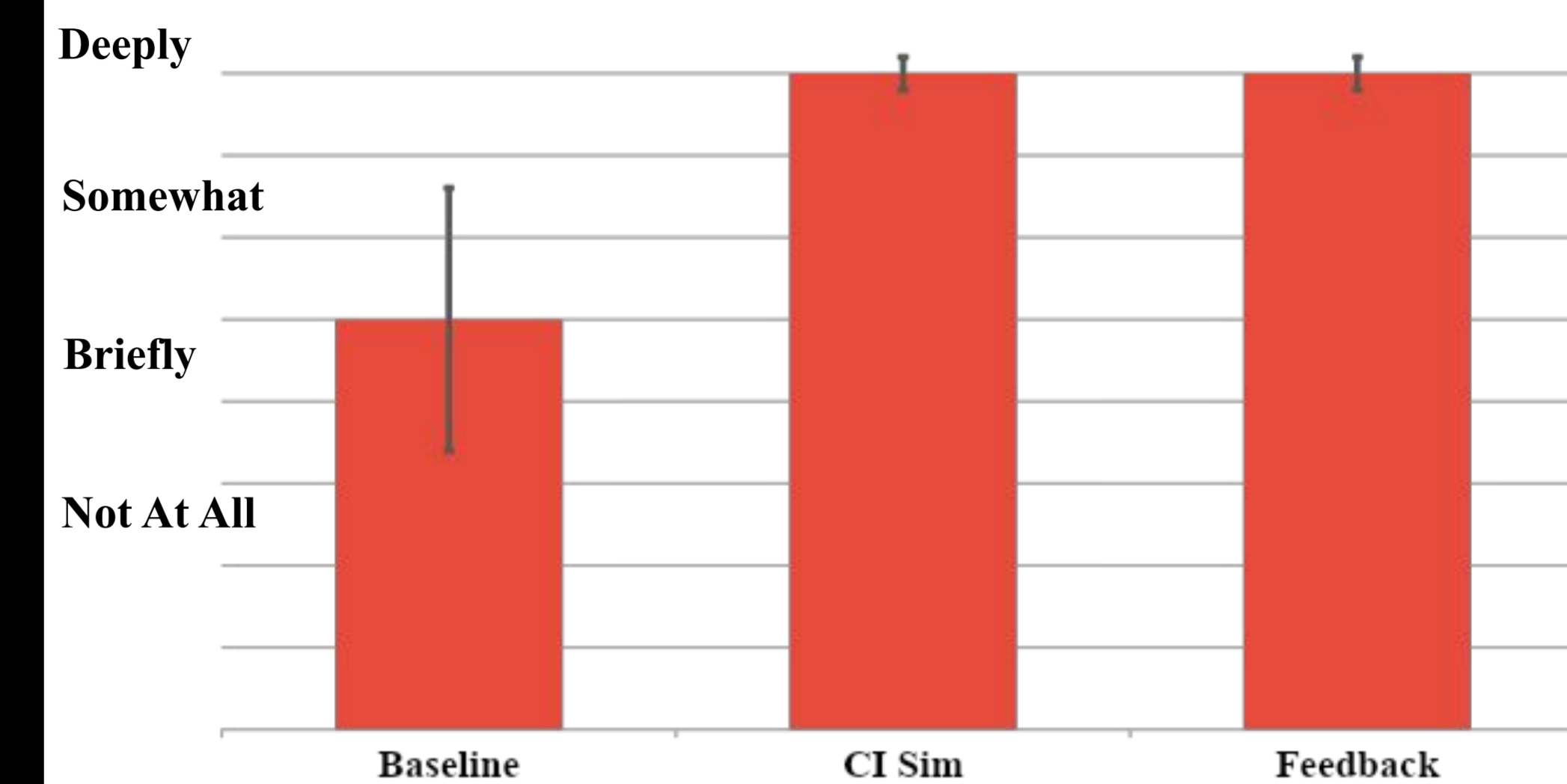
Affective Qualities
Genre & Style Preferences
Role & Effect of Assistive Technologies

Sonic Characteristics & Musical Function

Pitch, frequency, or register
Musical Function – Melody; Harmony; Voice; Rhythm, Beat, & Percussion
Timbre
Acoustics & Physical Space
Perception of Depth & 3D Space
Veridicality

Additional Results

Audio Engineers' Response to "How deeply did You considered diversity of hearing abilities while mixing?"



Both use of a CI simulator and the reception of CI user feedback encouraged engineers to consider the diversity of hearing abilities of their future listeners. However, many acknowledged the tensions present in making a single mix to cater to a diverse audience as well as diverse listening situations.

No clear group consensus around one of the specific genres being tested, - EDM, Hip-Hop, Folk, Soft Pop, & Funk – as being inherently or unanimously more pleasant or desirable

Future Work

Future work aims to identify meaningful elements to include in a remixing tool for CI users to personalize and customize their music according to their preferences. This includes in-person co-operative mixing sessions with CI users and engineer as well as the development of a simplified, online mixing interface for use by CI users.

References

1. Gfeller, K., Christ, A., Knutson, J. F., Witt, S., Murray, K. T., & Tyler, R. S. (2000). Musical backgrounds, listening habits, and aesthetic enjoyment of adult cochlear implant recipients. *Journal of the American Academy of Audiology*, 11(07), 390–406. <https://doi.org/10.1055/s-0042-1748126>
2. Kohlberg, G. D., Mancuso, D. M., Chari, D. A., & Lalwani, A. K. (2015). Music Engineering as a novel strategy for enhancing music enjoyment in the cochlear implant recipient. *Behavioural Neurology*, 2015, 1–7. <https://doi.org/10.1155/2015/829680>
3. 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. <https://doi.org/10.1179/cim.2003.4.2.85>
4. Nemer, J. S., Kohlberg, G. D., Mancuso, D. M., Griffin, B. M., Certo, M. V., Chen, S. Y., Chun, M. B., Spitzer, J. B., & Lalwani, A. K. (2017). Reduction of the harmonic series influences musical enjoyment with cochlear implants. *Otology & Neurotology*, 38(1), 31–37. <https://doi.org/10.1097/mao.0000000000001250>
5. PrevotEAU, C., Chen, S. Y., & Lalwani, A. K. (2018). Music enjoyment with cochlear implantation. *Auris Nasus Larynx*, 45(5), 895–902. <https://doi.org/10.1016/j.anl.2017.11.008>
6. Riley, P. E., Ruhl, D. S., Camacho, M., & Tolisano, A. M. (2018). Music appreciation after cochlear implantation in adult patients: A systematic review. *Otolaryngology–Head and Neck Surgery*, 158(6), 1002–1010. <https://doi.org/10.1177/0194599818760559>
7. Wright, R., & Uchanski, R. M. (2012). Music perception and appraisal: Cochlear implant users and simulated cochlear implant listening. *Journal of the American Academy of Audiology*, 23(05), 350–365. <https://doi.org/10.3766/jaaa.23.5.6>

