

Introduction

This poster describes the design, implementation, and initial evaluation of vibrotactile concert furniture, aiming to improve the live music experience of cochlear implant (CI) users. The system was the result of a series of participatory design sessions involving CI users with different hearing assistive setups: bi-implant, bi-modal, and mono-implant, and was evaluated in a jazz concert scenario (drums, bass, female vocals) at the Royal Danish Academy of Music. The project aimed to create a better live music experience for CI users by providing a multisensory concert designed with CI limitations in mind, but not excluding normal hearing individuals from participating in the event.

Hand grip in concert



Materials

The system used for the concert consisted of two leaning benches paired with four angled footrests; the benches were actuated with a *ButtKicker Mini Concert*, while the footrests had a single *ButtKicker LFE*^a attached to them. The benches were reproducing the signal captured by the vocalist's microphone, and the footrest played the one from the double bass. The second setup consisted of a single tactile display designed to be grabbed, built around the *Brüel & Kjær 4809*^b transducer; both the bass and vocal signals were reproduced through it. This particular setup was the result of participatory design sessions with 3 CI users; several goals were set for the system:

- ▶ Should enhance the concert experience by providing congruent vibrotactile feedback.
- ▶ Should afford multiple interaction modes to accommodate the variate needs of CI users.
- ▶ Should feel like furniture and not like a medical apparatus.
- ▶ Should encourage a social experience.

^a<https://thebuttkicker.com/>

^b<https://www.bksv.com>

Benches and footrest in concert



The set list was decided together with the jazz musicians during rehearsal sessions; the numbers were chosen to have simple rhythmical content, to be recognisable and to be perceived easily through the hardware. The final set list consisted of:

- ▶ *Fever by Little Willie John*
- ▶ *Seven Nation Army by Postmodern Jukebox*
- ▶ *Billie Jean by The Civil Wars*
- ▶ *Something's Got a Hold on Me by Etta James*
- ▶ *What a Wonderful World by Louis Armstrong*

Evaluation

A total of 5 CI users participated in a group interview after the concert. The initial experience was generally well received for several reported reasons:

- ▶ The bass frequencies were not overwhelming as they would be in a concert since the acoustic level was low
- ▶ Participants could associate voice melody with the bench vibrations
- ▶ The system provided a clear, distinct feel for both bass and singing

Furthermore, preliminary results were sent back to participants by email, for approval and further elaboration. Three participants responded, approving the conclusions gathered from the interview but some critiques of the system were also expressed:

- ▶ The vocal microphone also captured the double bass sound, altering the tactile sensations felt on the bench. The participant underlined that this was not a desired behaviour, as the bass was already reproduced through the footrest.
- ▶ The participant indicated a moment when the amplitude of the benches was too high, resulting in uncomfortable vibrations. This was due to a re-adjustment of amplitude pre-encore.
- ▶ The hand grip was not as desirable because it mixed bass and vocal signals that resulted in confusion.

Conclusion

This project reaffirmed that multisensory concerts including vibrotactile stimulation can provide a better live-music experience for CI users, but the technology and music need to be strongly congruent in supporting the CI users' particular set of needs. This can be achieved by designing systems that allow the user to personalize their experience, to some extent. Furthermore, it was discovered that audio-tactile mixing and especially tactile mixing and mastering are crucial in providing a good experience, but there is limited information and experience on how to produce the perfect signal chain; this undelies a great opportunity for research into audio-tactile mixing and mastering paradigms.

Prints on the footrests, encouraging experimentation

