Esteem Middle-ear Implant Users’ Perception of Own-Voice Loudness

Elizabeth Anderson, Dragan Barac-Cikoja, Peggy Nelson

Envoy Medical Corp
CATSS, Gallaudet University
CATSS, University of Minnesota

Research Questions:
1. How do Esteem users judge the relative loudness of their own voice, individually and as a group?
2. Does relative bone conduction gain provided by the Esteem for an individual listener relate to perceived own-voice loudness?
3. Do subjective ratings of own-voice loudness agree with loudness-matching measures?

Introduction and Background

Objectives are not uncommon among new users of hearing aids. With closed-fit hearing aids, occlusion effect can be a cause – bone-conducted sound from vocal production leaks into and is trapped in the ear canal by the hearing aid and is transmitted to the cochlea via air conduction.

Recipients of the Esteem middle-ear implant also often report their own voices as seeming loud. In this study, however, it cannot be due to the occlusion effect, since there is nothing blocking the ear canal.

Because the Esteem system apparently amplifies bone-conducted (BC) sound, it might add additional amplification of BC energy produced by vocal productions... loudness of one’s own voice?

Previous studies of BC relative to AC sensitivity of one’s own voice... of bone-conducted energy produced by vocal production added significantly to the perceived loudness of one’s own voice?

Prevalence of BC relative to AC sensitivity of one’s own voice... and... (von Békésy, 1949; Pörschmann, 2000; Reinfeldt et al., 2010) have shown that the relative perception of BC and AC are of approximately equal importance, but frequency dependent.

Barac-Cikoja et al. (2011, 2012) reported on a method for investigating relative loudnesses of speech feedback during speech production that involved matching the loudness of live speech and its recorded playback.

Results with normal-hearing (NH) subjects... showed that for most subjects, the speech playback had to be significantly attenuated in order to match the loudness of live speech...

Subjects and Instrumentation

Participants:
- Eight adults with an Esteem middle-ear hearing implant (age range: 51–69 years; mean = 66.5 years; one female, seven males)
- Subjects were paid for their participation
- Subjects used their Esteem at typical everyday-use settings

Instrumentation:
- Subject’s speech recorded with omnidirectional microphone (Sennheiser MKE 2-4 Gold-C) placed above non-Esteem ear
- Microphone output amplified (485 VL23 Premium Micphone) and routed into SFG (Cappabia X: Symbolic Sound Co) for experimental manipulations
- Output of Capybara sent through Hafler P1000 amplifier, presented monaurally via insert earphone to subject’s Esteem ear
- Kyma X (Symbolic Sound Co) software controlling Capybara provided automated presentation of visual prompts, registered subject’s responses, performed adjustments of gain values, and recorded data
- Testing conducted in audiometric testing booth

Results

- Five subjects’ PSE was not significantly different from 0, suggesting that they perceived live speech (listening while-speaking interval) as equally loud as its level-matched replay (listening only interval).
- Two subjects showed negative PSE, suggesting they perceived live speech as substantially louder than its level-matched replay.
- One subject (circled) had large, positive PSE, suggesting that he perceived live speech as substantially louder than its level-matched replay.
- Mean of seven of the Esteem subjects excluding the outlier (red square) = 0 dB
- One normal-hearing (NH) listener from this study (green triangle)
- Barac-Cikoja’s (2011) median of data for NH listeners (purple X); error bars indicate range

Discussion

- More than half of the Esteem users behaved like HI subjects (PSE near 0 dB). Two subjects behaved like NH subjects (PSE in negative range), suggesting no obvious interpretation of this finding. It could reflect response bias – or it may be that the calculated PSE actually underestimates the magnitude of deviation from zero in the negative direction.
- No systematic relationship was found between individual BC gain and PSE for these listeners.
- Recipients of the Esteem implant also often report their own voices as seeming loud. In this case, however, it cannot be due to the effect of the acoustic reflex during speech production.
- Five subjects’ PSE was not significantly different than 0, suggesting that they perceived live speech (listening while-speaking interval) as equally loud as its level-matched replay (listening only interval).
- Two subjects showed negative PSE, suggesting they perceived live speech as substantially louder than its level-matched replay.
- One subject (circled) had large, positive PSE, suggesting that he perceived live speech as substantially louder than its level-matched replay.
- Also shown: mean of seven of the Esteem subjects excluding the outlier (red square)
- One normal-hearing (NH) listener from this study (green triangle)
- Barac-Cikoja’s (2011) median of data for NH listeners (purple X); error bars indicate range

Conclusions

- In this study, the majority of these Esteem subjects did not perceive their own live speech as louder than its level-matched replay, suggesting that the amplification of bone-conducted sound produced by the Esteem system did not result in significant increase in perceived loudness of their own voices.

References


Work supported by Envoy Medical, CATSS, and Gallaudet University