Binaural fusion and the effects of place of stimulation and interaural cross correlation

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Abstract

- **Background**: Processing of temporal information in auditory stimuli might vary across the cochlea. This effect may be task dependent and has not been studied in a binaural fusion task.
- **Aim**: To explore the effect of place of stimulation on binaural fusion for varying interaural cross correlations (ICC) in unilateral cochlear implant (CI) users.
- **Design**: 9 CI users participated in a fusion study where both ICC and region of stimulation were varied.
- **Results**: Fusion increased similarly for apical, mid and basal regions of the cochlea with increasing ICC; when the signal was diotic, the degree of fusion was comparable.

**Introduction**

- Processing of temporal information in the signal may vary across apical, mid, and basal regions of the cochlea.
- There is evidence for this in both CI and NH listeners.
- Kan et al. (2015) showed worse ITD sensitivity in CI users in the apical region and Dreyer & Oxenham (2008) showed better ITD sensitivity in the apex for NH listeners.
- The effect of region could additionally depend on the task.
- Binaural fusion is a phenomena that depends on tracking the temporal fluctuations across ears which can be manipulated by the ICC of the stimuli; it increases with increasing ICC.
- The purpose of this study was to investigate if there is an effect of region on temporal processing of the signal using a binaural fusion task.

**Experiment Design**

- **Participants**: 9 individuals with bilateral CI participated in this study. All subjects used Cochlear brand CIs.

**Subject ID** | **Gender** | **Age** | **Age Onset of Hearing Loss (y)** | **Duration of CI use (y)**
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I64 | Female | 62 | 45 (L&R) | 10 (L), 8 (R)
I67 | Female | 70 | 59 (L&R) | 2 (L), 5 (R)
I69 | Male | 62 | 51 (L&R) | 3 (L&R)
I70 | Male | 58 | 42 (L&R) | 12 (L), 11 (R)
I74 | Male | 62 | 0 (L&R) | 16 (L), 14(R)
I75 | Male | 55 | 22 (L&R) | 13 (L&R)
I76 | Female | 50 | 2 (L), 3 (R) | 22 (L), 13 (R)
I77 | Female | 61 | 3-4 years old (L&R) | 5 (L&R)
I78 | Female | 65 | 40 years (L&R) | 14 (L), 13 (R)

**Procedure**: Participants were presented with 1000 pps pulse trains modulated with temporal fluctuations under 100 Hz. The correlation of these envelopes were altered to manipulate the ICC of the signal.

- Electrodes 3, 11 and 19 in one ear represented the apical, mid and basal regions, respectively and were paired with 5 electrodes in the contralateral ear: 3, 7, 11, 15, 19.
- Listeners indicated the spatial diffuseness, lateralization, number of auditory “images” of the perceived sound by rotating a dial to manipulate a visual representation as shown.

**Results**

- Fusion increases similarly for apical, mid and basal regions of the cochlea with increasing ICC, and when ICC is 1 (ditotic), the degree of fusion is comparable.
- All three regions show a significantly (p <0.05) negative Spearman correlation between fusion score and ICC (Apical: r = -1; Mid: r = -0.81; Basal: r = -0.94).
- Friedman test showed no significant difference in fusion scores (p >0.05) across the regions.

**Conclusions**

- Fusion increases with increase in ICC similarly for apical, basal and mid regions of the cochlea.
- The degree of binaural fusion for perfectly correlated signals was similar for all three regions.
- Processing of temporal information for binaural fusion is not significantly different across cochleotopic regions.

**References**

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