INTRODUCTION

• Individuals with bilateral cochlear implants (BiCIs) show large variability in their sensitivities to interaural timing differences (ITDs) 1. This variability may arise from a number of different factors, which include:
  1. Patients’ history: years of bilateral hearing impairment, experience with BiCIs etc.
  2. Surgical factors: different insertion depths between the ears.
  3. Hardware factors: lack of synchronization between processors.

• ITD sensitivity can be influenced by place of stimulation: the same numbered electrodes between the ears can stimulate different places along the cochlea (Fig. 1).

• Pitch-matching options are often used to choose pairs of electrodes that approximately stimulate the same place along the cochlea in each ear when measuring ITD sensitivity. However, there can be high inter-subject variability in pitch-matching outcomes, which can affect which pairs of electrodes are chosen. Hence, a poorly chosen pair may lead to poor ITD sensitivity.

The aim of this study was to investigate if variability in ITD sensitivity found in BiCI users is related to (a) patients’ hearing histories, and (b) ability to pitch match between the two ears.

METHODS

• Listeners: 36 BiCI listeners with Cochlear devices.
  • Stimuli: 300 ms constant amplitude pulse trains presented at 100 pps.
  • Delivered to the listeners using synchronized L34 processors.
  • Biphasic pulses with a 25-μs phase duration with monopolar stimulation.

• Experiment(s):
  • Pitch magnitude estimation (PME):
    • Pitch ratings from 0(low)-100(high) with randomized stimulation on each electrode in either ear at 10 reps per ear (Fig 2a).
  
  • Direct pitch comparison (DPC):
    • Three cochlear locations (Apex, Middle and Base) were selected in the left ear while the right ear was mismatched by 0 ± 2, and 4 electrodes for comparison.
    • Matching options are shown in Fig 2b.
  
  • ITD Discrimination:
    • 2–interval 2-alternative forced-choice task.
    • Listeners reported whether they heard the sound move to the left or right.
  
• IDTs = ±100, ±200, ±400, ±800 μs.
  • A psychometric function was fit to the percent correct data to obtain a just noticeable difference (JND) threshold at 71% using a bootstrap procedure.

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• Example responses to pitch tasks:
  • Pitch Magnitude Estimation:
    • Examples of pitch magnitude estimation for each ear.
  
  • Direct Pitch Comparison:
    • Examples of direct pitch comparison.

• Pitch Magnitude Estimation:
  • PME Slope = slopes of pitch magnitude estimation for each ear.
  • PME Slope reflects the range of pitch in each ear that listeners perceive from basal-most to apical-most electrodes.

• Direct Pitch Comparison:
  • Specificity = “same” pitch responses = mean difference between “same” responses between the electrodes pair to be matched.
  • Consistency = “same” pitch responses = mean difference between “same” responses between the electrodes pair to be matched.

• Specificity reflects the consistency of responses for the chosen electrode pairs to be matched.

• Consistency = “same” pitch responses = mean difference between “same” responses between the electrodes pair to be matched.

• The results show that:
  1. ITD thresholds do not appear to be related to listeners’ perceptual mapping of pitch as stimulation is varied in the basal-to-apical dimension along the electrode array. Thus, the impact of pitch matching on ITD sensitivity is likely to be small.
  2. Furthermore, ITD thresholds are not related to patients’ hearing history.
  3. The inability to account for the variation in ITD sensitivity might be due to a greater plasticity of pitch perception between the ears and the lack of ITD specificity in BiCI listeners.

REFERENCES

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