ABSTRACT

Speech intelligibility improves when target speech and interferers are spatially separated, compared to when they are co-located, an effect known as spatial release from masking (SRM). SRM was studied in children with bilateral cochlear implants (BiCl), hearing-ages (HA) 4-0.6-5 and 6.5-9.0 years, and in children with normal hearing (NH), matched for HA. SRM was measured for male-voice target stimuli in the presence of interferers that comprised of male talkers, and compared with previous results using female talker interferers, to evaluate effects of informational masking. In addition, effects of spatial cues were investigated by having the interferers positioned in azimuth either symmetrically (±90°) or asymmetrically (+/−90°). On average, normal hearing groups exhibited greater amounts of SRM with the male than female interferers, especially in the asymmetrical condition which allowed users to take advantage of both binaural and monaural (better ear) cues. In contrast, the two BiCI groups showed very small SRM with both male and female interferers. This may be due to the fact that cochlear implant processors do not preserve fine structure, interaural difference and pitch cues which are relevant for source segregation in complex listening situations.

INTRODUCTION

• Cochlear Implants (Ci's), which supply hearing through electrical stimulation to the auditory nerve, are now being provided to a growing number of recipients. In particular, bilateral cochlear implants (BiCl) are becoming more prevalent, especially in children.
• In a normal auditory system binaural benefits can be large when listening to speech in the presence of competing sounds; particularly, when the speech and interfering sounds can be perceptually separated using spatial cues.
• Because CI sound processing lacks coordination between stimulation at the two ears as well as fine structure cues, binaural cues may either be absent or inconsistent in complex listening environments.
• In difficult listening situations, informational masking often occurs when the target and interferers are, for some reason, confusable. Informational masking is associated with difficulty in the central auditory system which cannot be explained by overlapping neural firing patterns in the periphery.

Purpose:
1) To determine if spatial cues are greater with increased informational masking. Do spatial cues become increasingly important in the male interferers tasks as opposed to the female interferers?
2) To see if monaural headshadow and “better ear” effects are reduced in the symmetrical vs. asymmetrical condition, the integration of binaural cues is used to target spatial effects.

METHODS

• Listeners
  • Bilateral Cochlear Implant (BiCl)
  • 8 Young (BiCl-Y) (F: 4; M: 4)
  • 4 Old (BiCl-O) (F: 3; M: 5)
  • Normal Hearing (NH)
  • 8 Young (NH-Y) (F: 4; M: 4)
  • 6 Old (NH-O) (F: 3; M: 5)

• Conditions
  • Hearing Age (HA):
    • 4-0.6-5 yrs (NH-Y)
    • 6.5-9.0 yrs (BiCl-Y)
    • 4-0.6-5 yrs (BiCl-O)
    • 6.5-9.0 yrs (NH-O)

• Stimulation
  • Target:
    • Male-talker (adaptive starting at 60 dB SPL)
    • List of 25 spondees (e.g., “rainbow,” “cupcake”)
  • Interferers: 2 male-talkers (fixed at 55 dB SPL)
  • Harvard IEEE sentences

• Procedure
  • Identify target in the presence of interfering speech
  • Speech reception thresholds (SRTs) measured using an adaptive tracking algorithm (hybrid PEST/3-down, 1-up [Litovsky, 2005]). Threshold determined with performance reaching 80% correct; computed using Matlab and psignifit (Wichmann & Hill, 2001)

• SRM: Target-interferer similarity
  • Figures 2 and 3: NH-O, NH-Y, and BiCI-Y groups showed greater SRM with male than female interferers. NH-O, NH-Y, and BiCI-Y groups were again similar in that they exhibited significantly greater SRM (p=0.03) between the asymmetrical and symmetrical conditions, when using the male interferer.

• Speech Reception Thresholds

• CONCLUSIONS

• SRM varies with age, integrity of the binaural system, target-masker similarity, and the spatial configuration of the interferers relative to the head.
• In children with bilateral cochlear implants (BiCl) and children with normal hearing (NH), SRTs were elevated with the male interferers (same-sex) compared with the female interferers (different-sex), suggesting effects due to informational masking resulting from target-masker similarity.
• SRM depends on a combination of ‘better ear’ and binaural effects. SRM is greatest when better ear and binaural effects are both present. When the better ear effect is minimized (symmetrical condition), SRM is reduced, but still prominent in the NH groups and, in particular under conditions of informational masking (male-interferer).
• The small amounts of SRM demonstrated in the BiCl groups suggests limitations that could be due to the CI device, such as lack of fine-structure cues and interaural time synchrony, which are important for spatial hearing and source segregation.

REFERENCES


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