Evaluation of a Binaural Processing Test Battery for Adults
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Abstract

An auditory processing deficit is a prevalent issue affecting how the central auditory nervous system understands and makes use of auditory information. Auditory processing disorders are typically associated with the pediatric population, however, some research evidence and the recent focus on central auditory effects of traumatic brain injury (TBI) suggests that auditory processing deficits may be present among adults with symptoms of an auditory processing deficit often occurs within the same range as standard clinical assessments. The objective of the current study was to target measures of binaural processing to identify and characterize auditory processing deficits within the adult population. Three groups were recruited: adults with subjective listening difficulties, adults with a history of TBI, and a control group. Binaural processing was measured using: (1) The Revised Speech Perception in Noise test measured monaurally and binaurally; (2) dichotic word recognition with and without low-pass filtering; and (3) the listening in Spatialized Noise Test. Results suggest that individuals with subjective listening complaints and individuals with a history of TBI have lower than normal performance on auditory processing tests within their individualized.

Introduction

• Some adults have substantial difficulty understanding speech in complex listening situations.
  • These adults often have normal hearing sensitivity as measured by a standard clinical evaluation. However, specialized testing is conducted, auditory processing deficits may go undiagnosed.
  • Auditory processing deficits often result in difficulty with communication, frustration, and fatigue. For individuals with traumatic brain injury (TBI), these symptoms are exacerbated (including social isolation and depression).
  • Individuals with TBI present with normal auditory and cognitive behaviors in quiet and structured settings. When presented with noisy, complex and distracting environments, however, the same individuals can break down both behaviorally and cognitively (6).
  • Research has demonstrated that patients with TBI present with abnormal findings on measures of auditory processing (2, 3, 4).
  • The ability to make use of sound input from both ears (i.e., binaural processing) is often compromised for adults with auditory processing deficits.
  • The purpose of the present study, therefore, was to target measures of binaural processing to identify and further characterize auditory processing deficits within the adult population, with emphasis on those with TBI.

Methods

• Subjects
  • Three groups of normal hearing (thresholds ≤ 20 dB HL) right-handed adults participated:
  - 12 adults 19-21 years without TBI and with no history of the R-CHAMPSS (i.e., normative group)
  - 4 adults 18-54 years without TBI and subjective complaints of auditory processing deficits
  - 5 adults 16-27 years with a history of TBI

Materials/Procedures

• Questionnaire
  • Revised Children’s Audiological Performance Scale (R-CHAMPSS) [5, 6]
  • 36-item assessing report of listening ability in various environments (relative to the average listener)

• Binaural Processing Measures
  • Revised Speech Perception in Noise Test (SPIN) [7]
  • Monaural right, monaural left and binaural
  • Signal-to-noise ratio (SNR) of -4 to 0 dB
  • Dichotic Word Recognition (8)
  • Left and right with low-pass filtering (48 dB/octave with a center frequency of 1500 Hz)
  • Response conditions: free recall and directed recall (right and left)
  • 550 Hz Masking Level Difference (MLD) [9, 10]
  • SNL and SNR thresholds were calculated using the SpeechAid-Kraller method
  • MLD was calculated as the difference between the SNL and SNR thresholds

• Listening in Spatialized Noise Test (LiSN-S) [11, 12]
  • Same voice at 0° (DV0) and 90° (SV90); different voices at 0° (DV0) and 90° (DV90)

Results

• SUBJECT GROUP
  • R-CHAMPSS Subject Group
  • TBI Group
  • RE (right ear) vs. LE (left ear)

• FIGURE 1: Mean R-SPIN recognition performance (in % correct) as a function of SNR for the control group (left panel), the subjective group (middle panel), and the TBI group (right panel). Recognition performance is plotted as psychometric functions for sentence type (high predictability: HP, circles), and low predictability: LP, squares), and for listening condition right ear (red), left ear blue), and binaural (green). On average, the control and TBI groups performed with the expected binaural advantage for HP and LP sentences, whereas the subjective group failed to demonstrate a consistent binaural advantage.

• FIGURE 2: Mean dichotic word recognition performance (in % correct) for the right ear (RE) and left ear (LE) as a function of subject group: control (left panel), subjective (middle panel), and TBI (right panel). Data are presented for unbinned and filtered words for both response conditions: free recall (blue) and directed recall (green). Although data are not continuous, the RE and LE data groups are connected by dotted lines for illustration purposes. The control group performed as expected. The subjective group exhibited performance consistent with an auditory-based processing deficit. The TBI group shows substantial variability in performance across and within subjects.

Subject Characteristics

• Preliminary data suggest that a binaural processing test battery is sensitive to subjective reports of listening difficulties.
• The subjective group self-reported significant difficulty in auditory function across multiple listening environments (via R-CHAMPSS questionnaire).
• On average, they also demonstrated poorer binaural processing performance for the R-SPIN, dichotic word recognition and the LiSN-S.
• Individual data for two subjects from the subjective group (S-03 & S-04) revealed reduced binaural processing for the R-SPIN and dichotic words (i.e., competitive listening environments), yet performance within the normal range for the MLD and LiSN-S (i.e., ability to take advantage of phase/temporal cues).
• Primary data from individuals with TBI demonstrate substantial variance across and within binaural measures. Due to the inherent variability associated with this group, it may be necessary to control for multiple variables such as amount of time post-injury, severity of injury and LOC.
• Further data collection for both the subjective group and the TBI group are needed to draw meaningful conclusions regarding binaural processing abilities in these individuals.

Conclusions

• In summary, this study evaluated the sensitivity of a new binaural processing test battery to subjective reports of listening difficulties.
• The subjective group self-reported significant difficulty in auditory function across multiple listening environments. Although binaural processing tasks were only mildly sensitive, the test battery was able to capture this variability within the subjective group. Further work is necessary to determine the impact of multiple variables associated with TBI on binaural processing abilities.