Predicting the benefits of spatial and spectrotemporal cues

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1. Objectives

The problem addressed is that older and hearing-impaired listeners often have more difficulties in complex environments than predicted by their performance in quiet. It is hypothesized that this is due, at least in part, to a failure to benefit from acoustical cues to sound source segregation. The goal of the research is to develop clinical tests capable of predicting the benefit individual listeners will obtain from spatial and spectrotemporal differences that could be used to distinguish multiple talkers.

2. Plan:

Experimental work will involve groups of younger and older listeners with a range of peripheral auditory sensitivity. Each listener will participate in a range of experiments, the correlations among which will be examined to attempt to predicted performance in a multi-talker environment.

3. Methods:

All listeners will perform speech identification tasks either in the NCRAR anechoic chamber or under headphones and performance will be correlated with threshold sensitivity to binaural, spectral, and temporal differences in a range of laboratory-designed stimuli. For a subset of listeners, performance will also be correlated with localization ability in the anechoic chamber and under headphones. After those measures that best predict speech intelligibility have been identified, a set of clinically-appropriate measures will be evaluated to determine the method that most accurately predicts performance in the shortest period of testing.

4. Findings to Date:

Data collection has not yet begun, but preliminary data suggest that binaural sensitivity is independently degraded by aging and hearing loss and is a strong predictor of speech intelligibility in a multitalker environment when spatial separation among talkers is present.

5. Clinical Relevance

It is currently very difficult to predict which listeners will benefit from hearing aids. The data to be collected in this study would improve this prediction and would thus benefit the patient in allowing a more realistic assessment of benefit to be generated. The design of rehabilitation technologies such as directional microphones and encoding of temporal fine structure by hearing aids could also be informed by stronger indications of what proportion of the target population would be likely to benefit.

6. Relevance to VA Mission

Hearing loss and aging are two of the most common conditions associated with our Veteran population. This project seeks to improve diagnosis and rehabilitation of auditory dysfunction associated with age and hearing loss, thereby improving communication ability and social integration of our older Veteran population. The lessons learned from this population has great potential relevance for those Veterans with auditory dysfunction associated with Traumatic Brain Injury as well, and it is anticipated that the clinically-relevant tests developed based on these experiments will prove useful for any population suffering from central auditory dysfunction.

MESH Terms: Auditory perception, binaural hearing, aging

Central auditory processing deficits associated with blast exposure

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1. Objectives: To determine the degree to which exposure to blasts is associated with central auditory processing (CAP) dysfunction. To examine the relationship between abnormal performance on CAP tests on which blast-exposed Veterans show dysfunction and functional tests of hearing ability based on behavioral testing and self report. To determine the amount of overlap in dysfunction among blast-exposed Veterans and two other groups with potentially similar dysfunction: older listeners and TBI patients injured in motor vehicle accidents or other events not involving blast exposure.

2. Plan: Test blast-exposed and non-blast-exposed individuals to determine the extent to which CAP performance is associated with blast exposure and to develop a statistical and theoretical model relating CAP performance to functional auditory ability in a manner that captures the potential impacts of age, mild hearing loss, and traumatic brain injury.

3. Methods: Up to 200 participants (150 test subjects and up to 50 who are anticipated to be lost to attrition) in four groups will be recruited: Veterans with recent (within the past 10 years) exposure to high intensity blast waves; Veterans and non-Veterans with non-blast-related TBI; older participants (60 years and older) with no history of blast-exposure or TBI; and an age-matched control group with no history of blast-exposure or TBI.

All participants will undergo the following battery of clinical tests of auditory and cognitive function: Gaps-in-Noise, Staggered-Spondaic-Words, Masking Level Difference, Brief Test of Attention, Mini-Mental Exam, Reading Speed. A battery of neurophysiological measures will be administered, including the Auditory Brainstem Response, the Binaural Interaction Component, the Long Latency Response, and cortical tests of binaural functions. Two functional tests will examine auditory abilities in realistic situations: the Speech and Spatial Qualities of Hearing questionnaire, the Hearing Handicap Inventory, and a behavioral test of spatial and spectral release from masking administered in an anechoic chamber. In addition, results of routine audiological testing including pure-tone sensitivity and tympanometry will be included, as well as the responses to a questionnaire related to blast exposure and/or traumatic brain injury.

Measures will be compared across subject groups using Repeated-Measures ANOVA and the results of the various tests will be related to one another using multiple regression and correlation (MRC) analysis. It is anticipated that each subject will participate in 6-12 hours of testing, spread over 3-6 sessions.

4. Finding to Date. Data collection has not yet begun, but previous data found that blast-exposed patients were three-times more likely than control subjects to perform abnormally on one or more clinical tests of central auditory processing.

5. Clinical Relevance. As reported by Dennis (2009), the estimated prevalence of traumatic injury to the brain among Veterans who have served in OEF/OIF is 11.4%, using a fairly conservative methodology. To date, no large-scale, prospective study has investigated thoroughly the impact of blast exposure on the central auditory system, but results from a prior study suggest that CAP dysfunction may be widespread and undiagnosed.

6. Relevance to VA's Mission. CAP dysfunction can lead to deficits both in communication and in awareness of the auditory environment. The detrimental effect that these deficits can have on quality of life is a significant issue for those of our newest generation of Veterans with CAP dysfunction. In addition, rehabilitative measures for other injuries and deficits among this Veteran population may be negatively impacted by difficulties in communicating with health care professionals. This is a problem much more likely to impact Veterans than other members of the public, and so it is the responsibility of VA to take the lead on developing the appropriate diagnostic and rehabilitative tools for addressing this issue.

MESH Terms: Blast Injuries, TBI, Auditory Processing Disorder