Background and Significance

- **Tinnitus** (“ringing in the ears”) is the perception of sound without an auditory stimulus.
- According to the American Tinnitus Association, 50 million Americans have chronic tinnitus.
- Tinnitus has a negative impact on cognition, especially attention and processing speed.1,2
- The etiology is not well understood. Maladaptive changes in cortical networks are known to play a role.

Currently, there is no effective treatment for tinnitus

**HYPOTHESIS**

Compared to normative data, participants with more bothersome tinnitus will perform poorly on a set of standardized neurocognitive tests than a similar non-bothersome tinnitus cohort.

**MATERIALS & METHODS**

**Study Design**

Cross-Sectional Study

**Population**

- Non-Bothersome Tinnitus Participants (n = 18)
- Bothersome Tinnitus Participants (n = 20)
- Normative data from standardized neurocognitive tests

**Data Collection Forms**

- **Demographic:**
- **Tinnitus Handicap Index**
- **Tinnitus Description and History**
- **Medical Health Information**
- **Hearing History and Occupation Exposure**
- **Beck Depression Inventory**

**Neurocognitive Battery Description:**

- **California Verbal Learning Test (CVLT)** is designed to test verbal learning in which a participant learns a list of words and then is asked to repeat the list throughout the test.
- **Conners Continuous Performance Test (CCTP)** is a computer-based test designed to test attention by presenting a target (i.e., letter) as well as distractions (“X”). Target stimuli are presented randomly through time and a score is generated based on performance.
- **Stroop Color Word Test** measures selective attention, cognitive flexibility, and processing speed. It is based off the Stroop Effect, which describes the delay that occurs when color of the word does not match the test, e.g., “blue” spelled in red font.
- **Ruff 2 & 7 Test** is designed to target visual attention by incorporating 20 trials of visual search and cancellation task. Each trial contains “2” and “7” mixed with distractors, which are either numbers or letters. In order to obtain a high score, the participant needs to be selective.
- **Paced Auditory Serial Addition Test (PASAT)** is designed to measure information processing speed and flexibility. The participant starts the test by hearing a number. In 2 seconds, the next number is presented. The participant must add these two numbers together and add it to the last presented number. The test progresses and presents new numbers at a faster pace (estimate a new number is presented every 1.2 seconds). Correct responses are scored. An example of the PASAT: “2” (2.4 seconds)”2”, “answer 12”, “2.4 seconds”, “5” (answer 19), “2.4 seconds”, etc.

**RESULTS**

**Neurocognitive Tests**

- **California Verbal Learning Test (CVLT)**
- **Conners Performance Test (CCTP)**
- **Stroop Word Test**
- **Ruff 2 & 7 Test**
- **Paced Auditory Serial Addition Test (PASAT)**

**Discussion**

This study highlights the inadequacies of using a representative selection of standardized neurocognitive tests to reflect cognitive deficits in tinnitus. Previous researches have shown deficient cognitive deficits in participants by utilizing a “dual-task” approach. A dual-task incorporates a distractor in order to make the test more challenging. Under these testing conditions, tinnitus patients have shown slower reaction times and power accuracy (Eddon, 2014; Rossier, 2006).

This study is unique in that we not only screened for confounding co-morbidities (depression and anxiety), we have split the group depending on the severity of “bother” they experience from their tinnitus. Despite being very “bothered,” these patients are generally very successful in their promotion in part because they have adopted learning strategies to reduce the impact of their learning behavior noted in CVLT is the increase number of repetitions, or repeating the same word over and over again.

In our particular study, we conducted the neurocognitive battery during a session 1.5 hours. The last test in this session was a serial addition test (PASAT), which in itself is very a demanding task. Here, bothered tinnitus patients differed significantly from the non-bothered group, with the bother group showing a reduced ability to process information. These results indicate a compromised cognitive function in tinnitus patients

**REFERENCES**


**ACKNOWLEDGEMENTS**

- American Academy of Otolaryngology-Head and Neck Surgery Annual Scientific Meeting, Washington, DC, USA 2014
- Department of Otolaryngology-Head and Neck Surgery, Washington University, St. Louis, MO, USA
- Department of Psychiatry, Washington University, St. Louis, MO, USA
- American Academy of Otolaryngology-Head and Neck Surgery Annual Scientific Meeting, Washington, DC, USA 2014
- Department of Otolaryngology-Head and Neck Surgery, Washington University, St. Louis, MO, USA
- Department of Psychiatry, Washington University, St. Louis, MO, USA