Gentle Amplification for Those With Negligible Hearing Loss, Traumatic Brain Injury, and Tinnitus

By Steven Benton, AuD

Approximately 2.8 million people in the United States are diagnosed with traumatic brain injury (TBI) every year, and roughly 56 million Americans (17% of the population) experience tinnitus, 17 million of whom report that it is disturbing enough to be a “moderate” to “very big” problem in their lives. Both TBI and tinnitus patients often experience hearing difficulties regardless of the presence or absence of hearing loss. The use of hearing aids, once provided only to individuals with moderate hearing loss or worse, has been expanded to include the delivery of low-level amplification to individuals with normal or near-normal hearing. Such “gentle amplification” is commonly used as a tinnitus-management strategy in the U.S. Department of Veterans Affairs (VA) healthcare system: 96 percent of VA audiologists responding to an informal survey reported using gentle amplification with their normal-hearing tinnitus patients. Understanding the potential benefits of gentle amplification requires understanding the impact of tinnitus and TBI on auditory processing.

TBI and Tinnitus

TBI can cause tinnitus because of damage to the ear itself or because of damage to the auditory nerve pathways and/or the brain’s auditory processing centers. More than half of individuals who sustain TBI develop some degree of tinnitus.

Tinnitus can be a major contributor to TBI symptoms, and studies indicate “More than half of individuals who sustain TBI develop some degree of tinnitus.”
Tinnitus is perceived as louder by TBI patients than by non-TBI patients. In other words, the relation between TBI and tinnitus is bidirectional: tinnitus can worsen TBI symptoms, and TBI can worsen tinnitus symptoms. As a result, the impact of tinnitus and TBI when they coexist is greater than that of only TBI or only tinnitus.

**TBI, Tinnitus, and Working Memory**

“Working memory” is a brain function responsible for attention, problem solving, and memory. People with impaired working memory demonstrate difficulty with multi-tasking, require more time to recall information, and are slower taking in and making sense of information. Both TBI and tinnitus negatively influence working memory by increasing the total amount of mental effort required in any one moment (cognitive load). Speech is rapid and requires intact working memory for retention, processing of, and responding to auditory information. Environments in which speech is degraded, such as noisy places, put an even greater burden on working memory. The cognitive effort needed to identify speech in challenging listening situations requires brain resources that would otherwise be used for sentence comprehension and for storage in memory.

**TBI, Tinnitus, and Central Auditory Processing**

In audiology, symptoms of impaired working memory can manifest as central auditory processing disorders (CAPDs). Individuals with CAPD demonstrate hearing problems comparable to those of individuals with hearing impairment. Therefore, it is not surprising that 90 percent of normal-hearing tinnitus patients report some degree of hearing difficulty and that nearly half (45%) report severe hearing difficulties. TBI often results in CAPD because of damage to the brain’s auditory processing centers: approximately 60 percent of all TBI patients demonstrate CAPD, and up to a third of mild TBI patients exhibit CAPD and normal hearing. In cases where TBI and tinnitus coexist, CAPD may be expected to interfere substantially with speech processing, resulting in an even greater impact on hearing.

One of the most common complaints of individuals with CAPD is understanding speech in noise. Personal FM listening systems that allow a speaker to transmit his or her voice wirelessly to a receiver with headphones have been used to help TBI patients in difficult listening situations. Personal FM systems increase the loudness of the desired signal relative to environmental noise. Improving the signal-to-noise ratio in this way may reduce cognitive load and improve speech processing.

Hearing problems reported by patients with TBI and tinnitus are not limited to noisy situations. Other common complaints include difficulty hearing and understanding TV and radio, frustration and arguments when communicating with family members and friends; such hearing difficulties may lead to social isolation.

**Gentle Amplification**

Gentle amplification is the provision of low-level amplification through state-of-the-art digital hearing aids for individuals with disturbing tinnitus and normal or near-normal hearing. Gentle amplification has been shown to improve performance on auditory processing tasks in children with CAPD, in hearing-impaired adults, and in blast-exposed veterans with TBI. To date there is no standardized protocol for fitting gentle amplification on either TBI or tinnitus patients. At the Atlanta VA Medical Center, gentle amplification for tinnitus management is provided in the context of Progressive Tinnitus Management Level 5, Individualized Tinnitus Management. Regular follow-up appointments are scheduled to verify progress and outcome. Providers are cautioned against using gentle amplification as a single-visit attempt to provide tinnitus
relief. Providing gentle amplification requires an understanding of the responsibility to provide ongoing care and support. In addition to providing aid adjustments as necessary and caregiver support, the provider should be documenting progress and providing directive counseling to help patients understand the principles of brain function, the causes of tinnitus, and tinnitus disturbance. By itself, reclassification of tinnitus from the unknown (“a potential threat”) to the known (“a common experience”) can substantially reduce tinnitus disturbance.

At the Atlanta VA, real-ear measurements allow the audiologist to verify aid performance, and programming is adjusted so the aid provides 5 dB of flat gain across the hearing aid range. Maximum output is controlled carefully to minimize the risks of hearing changes or of producing an aversive and excessive loudness experience. Others have recommended 10 dB of gain,16 but there are no data comparing outcomes using various levels of gentle amplification. At the Atlanta VA, use of a 5 dB protocol has resulted in an average 60 percent decrease in tinnitus-related distress and an average 55 percent decrease in subjective hearing problems in tinnitus patients with normal hearing thresholds.21

Conclusion

Gentle amplification is a potentially valuable method for decreasing both tinnitus disturbance and subjective hearing difficulties in individuals with tinnitus and TBI. The impact of impaired working memory when tinnitus and TBI coexist may be expected to be greater than when patients experience only TBI or only tinnitus. Gentle amplification may take advantage of existing working memory resources to allow more effective and efficient speech processing, thereby improving overall quality of life for both TBI and tinnitus patients.

Steven Benton, AuD, is the Tinnitus Program Manager at the Atlanta, Georgia, VA Medical Center. He completed his doctorate at Salus University and his master’s degree in health services administration at Barry University. His research interests include the bidirectional relationship of mental health status and tinnitus severity, and tinnitus management for individuals with normal hearing. Dr. Benton has presented his research at numerous national and international scientific meetings, including those of the American Academy of Audiology, the American Auditory Society, the Joint Defense-Veterans Audiology Conference, and the International Tinnitus Seminar.