REDUCED FUNCTIONAL DISABILITIES AFTER TRAUMATIC BRAIN INJURY: ROLE OF SIMPLE ASSISTIVE TECHNOLOGY IN THE FORM OF A HEARING FILTER

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INTRODUCTION

Traumatic brain injury (TBI) has been referred to as the "silent epidemic" because of the way in which it creates neurobehavioral deficits, without necessarily imparting a physical scar. Though the majority of brain injuries are classified as "mild", the functional consequences are far from mild. Indeed, mild TBI impacts most life dimensions including cognitive, emotional, psychological and physical. For example, cognitive impairment can manifest as processing errors, as well as difficulties in multi-track thinking, reasoning, attention and concentration. Another common occurrence following mild TBI is the development of difficulties in auditory filtering, which results in hypersensitivity to auditory input and information processing deficits. When coupled with cognitive impairments, these can lead to significant cognitive and functional disabilities. Thus, ***a study was conducted to determine whether wearing hearing filters following mild TBI could reduce auditory processing difficulties and to determine in which life domains this was functionally most useful.***

METHODS

Participants were identified based on referrral from cognitive rehabilitation therapists, psychologists, psychiatrists and/or neuropsychologists following a diagnosis of auditory processing (specifically auditory filtering) difficulties subsequent to mild TBI.

Protocol Using standard techniques, subjects underwent an otoscopic inspection to determine if the external auditory canals were clear. Next, a pure tone bilateral hearing screening was done under headphones at 20 dB at frequencies of 500-8000 Hz without the ear filters in place. To be included in the study, subjects had to have hearing within the normal limits or no greater than "mild" hearing loss (up to 40 dB), otherwise the hearing filters could exacerbate already existing hearing loss when in place. An ear impression was taken with silicon, and this was sent to the lab which formed the ear plug out of soft material.

At the same time, the filters were ordered based on the following criteria: **1)** if functional needs were greatest at work and/or the home environments, a 15 dB filter was ordered; **2)** if functional needs were greatest at the store or in restaurants, then a 25 dB filter was ordered and **3)** if functional needs were great in both of these types of domains, both types of filters were ordered. Once constructed, subjects were fitted with the ear plugs and the detachable filters.

An advantage of the hearing filter design is that it reduces noise evenly across the entire frequency range. For this reason, perception of speech is not decreased. In contrast, over-the-counter solid plugs or unfiltered ear plugs decrease high frequency input more so than they do low or middle frequency ranges. Consequently, these types of ear plugs decrease speech perception and can have negative secondary consequences.

Surveys were mailed out to 112 subjects (93 females, and 19 males, 22-62 years of age, approximately 2 months-4 years post-TBI) who had been fitted with the hearing filters 2 months-6 years prior. Using a 7 point Likert scale, subjects were asked to rate the "degree of difficulty" experienced in 6 environmental domains (e.g., home, car, store, work, restaurant, social gathering) and 4 experiential domains (e.g., attention span, adequate energy, irritability, family interactions) at three distinct time points: (1) prior to the brain injury, (2) after the brain injury, yet prior to using the hearing filters and (3) after the brain injury while wearing the hearing filters. A response of "1" signified "no problem", while a "7" signified a "severe problem". Space was provided at the end of the survey for additional comments. Self-identification was optional.

RESULTS

Response Rate = 42% (n = 47)

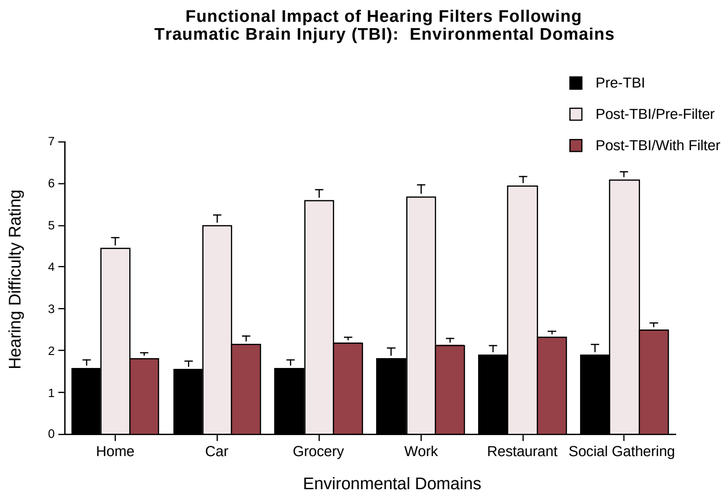
Surveys Analysed n = 43 *(4 excluded because of missing or ambiguous data)*

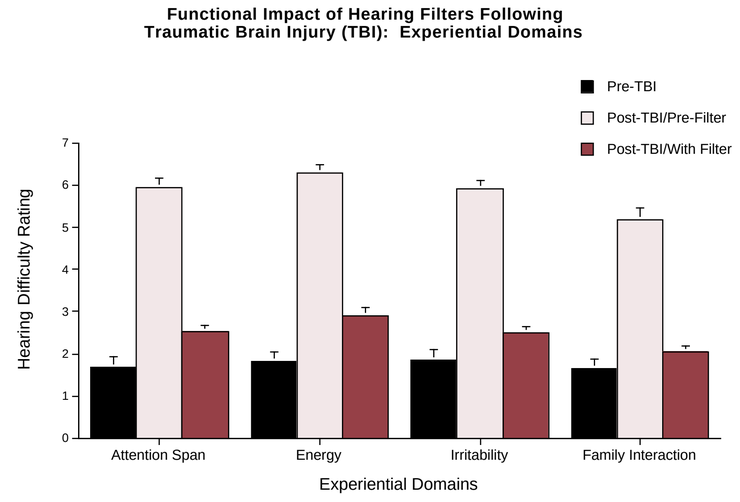
Participants Rating "work" as n/a after TBI = 27%

Hearing Difficulty Rating Across All Domains (mean; range)

Pre-TBI	***Post-TBI/Pre-Filter***	***Post-TBI/With Filter***
1.7 (range = 1.5-1.9)	5.6 (range = 4.4-6.3)	2.3 (range = 1.8-2.9)

Domains in which Hearing Filter Reduced Perceived Difficulty to Pre-Injury Levels
Work, Home, Car, Restaurant and Family Interactions





CONCLUSIONS

- TBI was associated with a significantly higher degree of hearing difficulties in *all* environmental and experiential domains, as compared to pre-injury levels.
- Wearing the hearing filters after TBI was associated with dramatic and significant decreases in hearing difficulties in *all* environmental and experiential domains.
- Hearing difficulties after TBI were *decreased to pre-injury levels* in the environmental domains of work, home, car and restaurant, as well as the experiential domain of family interactions.
- Taken together, these findings point to a powerful, yet simple tool that not only reduces perceived hearing difficulties after brain injury, but does so in crucial life domains.
- The degree to which decreased hearing deficits leads to decreased functional disability remains to be determined.

APPLICATION AND FUTURE DIRECTIONS

- The systematic study of the impact of hearing filters on post-TBI deficits and disability would inform physicians, care providers and insurers as to the *functional value* of hearing filters, thereby *increasing the availability* and *decreasing the cost* to those in need.
- To this end, studies should be done to:
  - Replicate and expand on these findings using more standardized measures to characterize the range of cognitive impairment *and* disability that can be diminished through the use of hearing filters after TBI.
  - Assess the functional consequences of the hearing filters in a laboratory setting, as well as in environmental and experiential domains at multiple timepoints before, during and after prolonged use.
  - Delineate the timecourse after TBI during which hearing filters can have the greatest functional benefit.

TECHNOLOGY

- Improve the design such that the hearing filter and plug become one unit allowing for filtering levels to be variable and adjustable by the individual while in place.

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