Tinnitus and Its Relation to Emotion, Exercise

By Fatima T. Husain, PhD

Tinnitus is a fairly prevalent hearing disorder, affecting 12 to 30 percent of the general population (McCormack. *Hear Res* 2016;337:70). But only a minority of these people report bothersome or distressing tinnitus. In the U.S., about 50 million people report to have tinnitus, but only 20 million seek medical treatment and 2 million experience day-to-day debilitation. Thus, it is important to distinguish between the perception of the tinnitus sound and an individual's reaction to it.

Reaction to tinnitus sound is connected to a person's emotional processing system, mostly instantiated in the brain's limbic network (Heller. *Ann Otol Rihnol Laryngol* 1953;62[1]:73; Moller. *Ann Otol Rihnol Laryngol* 1984;93[1]:39; Hazell. *J Otolaryngol* 1990;19[1]:1; Tyler. *Thieme* 2005;1:1). The limbic network, however, does not act alone, but interacts with other large-scale networks that mediate auditory processing, attention, and other cognitive processes. Such interaction is also reflected in the hearing, concentration or attention, and sleep problems reported by patients. Brain imaging studies have been instrumental in increasing our understanding of the role the emotional processing network plays in the reaction to the tinnitus sound (Schmidt. *PLoS One* 2013;8[10]:1; Carpenter-Thompson. *Brain Res* 2014; 1567:28; Carpenter-Thompson. *PLoS One* 2015a;10[12]:e0144419; Carpenter-Thompson. *Neural Plasticity* 2015b;161478; Husain. *Brain Res* 2015;1620:81).

In one fMRI study, we investigated the differences in emotional processing between participants with mild tinnitus and those who rated their tinnitus as being more bothersome (Carpenter-Thompson, 2015a). Notably, the participants also had different physical activity levels. Subjects rated sounds as being pleasant, unpleasant, or neutral while being imaged in the MRI scanner. We compared brain imaging data of subjects with minimal tinnitus (and who also reported higher physical activity levels) with those with bothersome tinnitus (who happened to have lower physical activity levels). We found that the group with mild tinnitus engaged the middle frontal gyrus more than the group with more bothersome tinnitus (Fig. 1, top). In contrast, those with severe tinnitus activated the amygdala and parahippocampus more when processing affective sounds, compared with the first group (Fig. 1, bottom).

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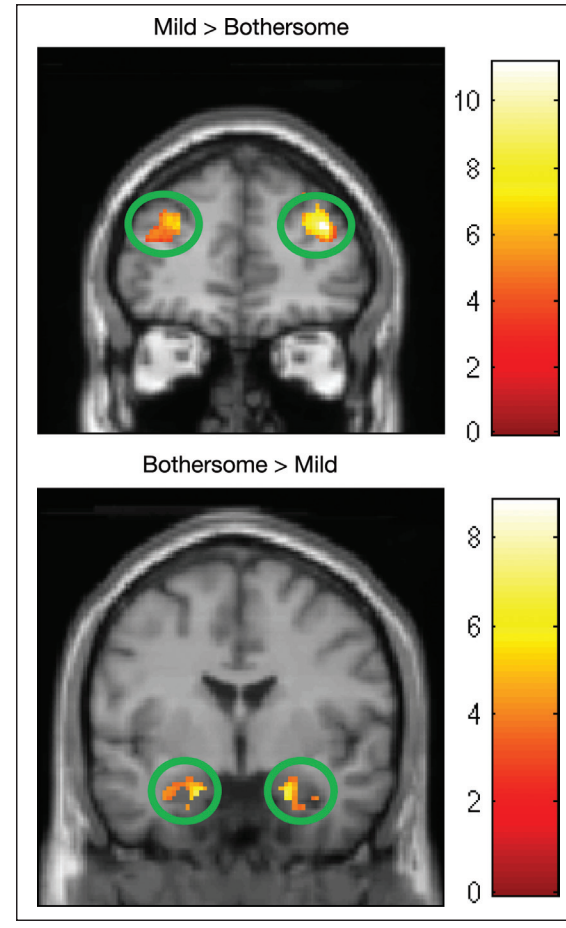

Figure 1. Brain activation patterns in patients with different tinnitus severity when rating non-speech sounds *(Carpenter-Thompson, 2015a; reproduced with permission).*

The results also point to the role of the frontal cortex, and by extension the attention system, in regulating the emotional response that leads to successful habituation. The fMRI study further indicates that physical activity may decrease tinnitus severity. This builds on our previous survey paper, which showed the link between higher physical activity levels and lower tinnitus distress, possibly via indirect effects on psychological well-being and quality of life. Future studies should investigate the duration, intensity, frequency, and type of physical activity and its effect on tinnitus severity. Together, our studies point to a new research direction in non-sound-based approaches for managing tinnitus that primarily focuses on an individual's reaction to chronic tinnitus.