Tinnitus, Hyperacusis, and the Autonomic Nervous System

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Tinnitus and hyperacusis patients have altered functional networks, disrupted homeostasis, and vulnerability to comorbidities such as insomnia and psychopathology. This is especially true among patients diagnosed with debilitating conditions. In these cases, issues such as anxiety, distress, depression, sound confusion, and social withdrawal frequently develop. Since tinnitus-related distress or depression and perceived loudness are independent factors, reducing the psychological impact of this condition has been emphasized in the literature (*PLoS One.* 2013;8[6];e67778). Although medication may be of value in treating symptoms, no single treatment has proven to be universally effective. In fact, medications have side effects that may be counterproductive. New treatments using vagus nerve stimulation (VNS) have shown considerable promise. However, current methods continue to emphasize strategies for managing tinnitus perception, feelings and emotions, cognitive distortions, and reactions to the unwanted sounds to help patients self-manage and habituate their tinnitus and hyperacusis.

For patients with bothersome tinnitus, sound therapies, in addition to directive counseling and cognitive behavioral therapy, are frequently prescribed. During counseling, audiologists and psychologists may recommend relaxation therapy, including meditation and mindfulness, music therapy, physical exercise, and feel-good activities such as walking in the park, taking a ride in the country, or watching comedy. These are specifically targeted because they can have a direct effect on the autonomic nervous system (ANS) that governs homeostasis.

ROLE OF THE ANS

Simplistically, the ANS is composed of two subsystems working in opposition: the sympathetic nervous system (SNS) or the fight or flight system, and the parasympathetic nervous system (PNS), which helps the body come to rest, digest, and recover. The ANS targets all the organs and most tissues in the body to maintain homeostasis (*Organogenesis.* 2013;9[3];169). For example, the sympathetic system will rapidly increase heart rate in response to threats or stress, while the parasympathetic nervous system will gradually reduce it during recovery. These all occur automatically without conscious control. The system is not only reactive to threats, but also to levels of psychological stress related to auditory stimuli (*Ear Hear.* 2016;37 *Suppl* 1:118s). Some good examples are when we hear the sound of a rattlesnake and get frightened, hear unwanted noise, or try to listen to a conversation in a restaurant but fail.

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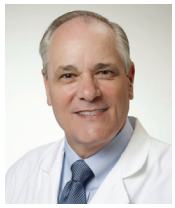
Phillip Low, MD, explains that "after the autonomic nervous system receives information about the body and the external environment, it responds by stimulating body processes, usually through the sympathetic division, or inhibiting them, usually through the parasympathetic division" (Merck Manuals, 2017). Furthermore, inputs from the hypothalamus, nucleus of the solitary tract, reticular formation, amygdala, hippocampus, and olfactory cortex may activate the system. At rest, the body is designed to favor the PNS. Unlike the SNS with its intricate system connected through the spinal column (T1-L2/3), the PNS receives approximately 75 percent of its innervations through the vagus nerve while the III, VII, and IX cranial nerves provide the rest. The vagus nerve is highly significant because it activates complex functions that affect organs from the larynx all the way down to the genitalia.

EXERCISE AND SOUND THERAPY

In a pilot study, VNS with sound therapy has shown to improve mood and decrease tinnitus handicap scores (*Acta Otolaryngol.* 2013;133[4]:378). This new technology has considerable promise because of its ability to modulate the central system. In view of the vast influence on homeostasis,



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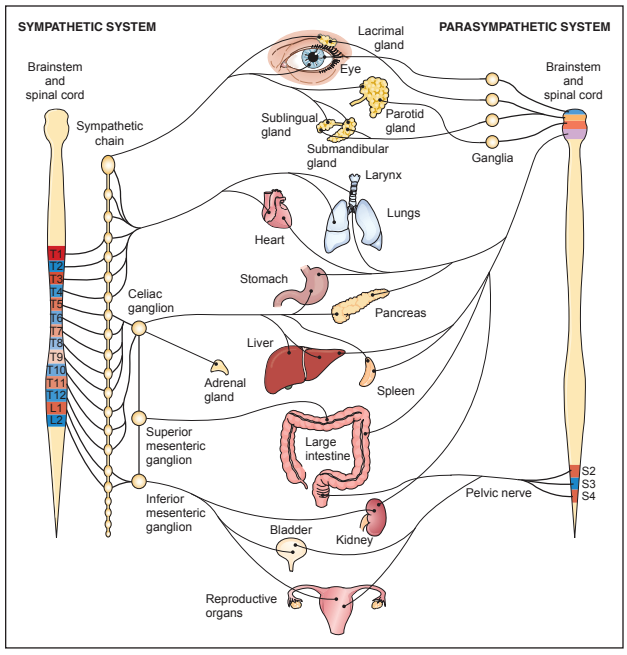

Figure. The autonomic nervous system with only one side shown for each division (Cohen BJ. Medical Terminology, 4th ed. Philadelphia. Lippincott Williams & Wilkins 2003).

VNS has been used to bring about a shift away from sympathetic preponderance and toward parasympathetic predominance to lower the impact of tinnitus (*Acta Otolaryngol.* 2017;137[4]:426). Activating the parasympathetic nervous system is a key factor in reducing the effects of tinnitus as well as other disorders. According to Choi, et al., chronic tinnitus more strongly affects autonomic conditions than acute tinnitus, and tinnitus patients experience vagal withdrawal and sympathetic overactivity (*Hindawi. 2013; Article ID 402585*).

Vagus nerve stimulation has considerable promise because of its ability to modulate the central system.

Audiologists who are considering sound therapy and counseling for patients with tinnitus and hyperacusis should include music listening and daily exercise as part of the landscape. Music is a primary tool to help this patient population take brain's attention away from the incessant head noise. Exercise offers many benefits in lowering stress, but when coupled with music, it better enhances parasympathetic activities. According to Jia, et al., "music may be an effective approach for improving post-exercise parasympathetic reactivation, resulting in a faster recovery and a reduction in cardiac stress after exercise" (*PLoS One.* 2016;11[2]:e0148648). In fact, they note that isochoric tones in conjunction with monaural and binaural beats have been shown to affect brain waves that reduce sympathetic nervous system activities and shift them toward a more parasympathetic response.

Recommending actions that activate or reactivate the parasympathetic system is beneficial for tinnitus patients. Activities that enhance pleasure and reduce stress may include daily exercise (walking, swimming, dancing, working out), meditation, deep breathing exercises, listening to calming music, and getting a massage. These and other stress-reducing activities should be done throughout the therapeutic process.