



# **Brain Stimulation: Chapter 36. Tinnitus: therapeutic use of superficial brain stimulation (Handbook of Clinical Neurology)**

*Berthold Langguth, Dirk De Ridder*

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Tinnitus is a common disorder and traditional treatment approaches such as medication, active or passive sound enhancement, and cognitive behavioral therapy have limited efficacy. Thus, there is an urgent need for more effective treatment approaches. Functional imaging studies in patients with tinnitus have revealed alterations in neuronal activity of central auditory pathways, probably resulting as a consequence of sensory deafferentation. However, nonauditory brain areas are also involved. These nonauditory brain areas might represent both an “awareness” network involved in the conscious perception of the tinnitus signal as well as areas related to a nontinnitus-specific distress network consisting of the anterior cingulate cortex, anterior insula, and amygdala. Moreover, memory mechanisms involving the hippocampus and the parahippocampal region may play a role in the persistence of the awareness of the phantom percept, as well as in the reinforcement of the associated distress. All of these networks represent potential targets for treatment via pharmacological treatment or noninvasive and invasive brain stimulation. Repetitive transcranial magnetic stimulation (rTMS) is a noninvasive method of applying electromagnetic fields to the brain that can induce alterations of neuronal activity that outlast the stimulation period. Single sessions of rTMS over the temporal or temporoparietal cortex have been successful in transiently reducing tinnitus perception. Repeated sessions of rTMS have resulted in tinnitus relief in a subgroup of patients, lasting from several days to several months. However, effect sizes of rTMS in the treatment of tinnitus are only moderate, and interindividual variability is high. Larger and longer lasting effects have been observed with direct electrical stimulation of the auditory cortex via implanted epidural electrodes. Transcranial direct current stimulation (tDCS) has also shown potential for the treatment of tinnitus. Both auditory and frontal tDCS have shown tinnitus reduction in a subgroup of patients. In spite of the promising results of the different brain stimulation approaches, further research is needed before these techniques can be recommended for routine clinical use.

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