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REVISITING TINNITUS AUDIOLOGICAL REHABILITATION

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Abstract

Current research shows tinnitus as more than an auditory phenomenon, but an emotional and cognitive dimension experience. Besides issues involving tinnitus perception and reaction, there is a third dimension: cognition. Both audiological assessment and rehabilitation need to follow these principles and be more comprehensive. The use of sounds to treat tinnitus is described in several papers and has different purposes. It includes hearing aid fitting if hearing loss is detected and the use of sound generator devices. But there are some cases in that hearing loss rehabilitation is not enough and cases of tinnitus and/or sound intolerance suffering without detectable hearing loss in conventional measures. There is no exclusive way for tinnitus patients' auditory rehabilitation. Based on theoretical proposals and literature, we suggest possibilities of intervention to be even more explored and personally adapted for tinnitus patients: cognitive auditory training and the use of mindfulness-based exercises, sound stimulation during sleep, and restoring the pleasure of listening.

Keywords: tinnitus, hearing disorders, cognition, rehabilitation, audiology.

Different neurophysiological and psychological models have tried to demonstrate tinnitus subjacent mechanisms over years, leading to different approaches concerning sound therapies and counseling protocols (Ganger & Tyler 2022).

The Tinnitus Neurophysiological Model by Pawell Jastreboff is one of the most famous worldwide, and the consequent Tinnitus Retraining Therapy (TRT) uses these two pillars as a basis for tinnitus patient intervention (Jastreboff 2011). In a timeline, there are also some relevant theoretical proposals like Tinnitus Activities Treatment (TAT) (Tyler et al. 2007) and Progressive Tinnitus Management (PTM) (Henry et al. 2010).

The so-called sound therapy, that is, the use of sounds to treat tinnitus, is described in several papers and has different purposes: relaxation, partial or total masking of tinnitus, induction of the habituation mechanism, promotion of attention deviation, induction of neural plasticity mechanisms by neuromodulation or inhibition of lateral neural pathways, and sound stimulation for auditory training (Searchfield et al. 2017).

Research on tinnitus-related issues is challenging because it's a multifactorial symptom, with different concepts and definitions, studied pathophysiological substrates, causes, variable research methodologies, heterogeneity in tinnitus assessment and outcome evaluation protocols adopted, and in many other aspects (Mc Ferran et al. 2019).

There are communities interested in finding a cure for tinnitus, including patients, researchers, clinicians, and companies, but there is not a unique and potentially resolutive option available (Mc Ferran et al. 2019).

According to guidelines published, there is recommendation for education and counseling for patients with persistent and bothersome tinnitus (Tunkel et al. 2014), providing information and support as an essential part of treatment (Cima et al. 2019), mention of sound

therapy as a treatment option (Tunkel et al. 2014), and no recommendation for TRT or sound therapy (Cima et al. 2019).

A systematic review of clinical guidelines revealed a consensus agreement of providing information about tinnitus and treatment options as a therapeutic approach and a lack of consensus regarding sound therapies (Fuller et al. 2017).

While a path to a cure for tinnitus is not defined, what we do have are practical evidence-based recommendations to help manage tinnitus and hyperacusis patients and restore quality of life (Stockdale 2021). Thus, there are strategies that can be used for the treatment of tinnitus and its associated reactions, combined, or used alone, in a personalized manner and according to the patient's needs.

The starting point of tinnitus assessment includes audiological evaluation (Fuller et al. 2017), which contributes to the physical investigation and audiological rehabilitation directions. Whether or not the patient has detectable hearing loss in conventional pure tone audiometry assessment (0.25 to 8kHz) determines possible paths within the therapeutic process.

Psychoacoustic measures can also provide information on possible prognoses with sound therapies (Fournier et al. 2018) and directions to other strategies, such as amplification (Parthasarathy et al. 2021) and the use of sound generators (Pienkowski 2019).

Another important factor is controlling possible clinical conditions underlying the symptom, which may contribute to its modulation in amplitude. Communication between the audiologist and the attending physician needs to be direct and facilitated, since unstable conditions may impair the progress of the therapeutic process and require further medical attention.

The subject who has hearing loss, detectable by conventional audiometry, presents a recommendation for rehabilitation using hearing aids (Fuller et al., 2017). Audiological rehabilitation of hearing loss using amplification is also an important step regarding neuroplasticity and cognition benefits (Glick & Sharma 2020).

Most available treatment options for tinnitus focus on the impact of the symptom associated with the reaction rather than acting on perception. Treatments were able to improve aspects related to quality of life and reducing the suffering associated with the symptom but have a poor effect on loudness (McFerran et al. 2019).

Rehabilitating hearing loss allows focusing on the first link in this chain, the auditory perception. However, isolated hearing loss rehabilitation is not enough for all patients. In addition, tinnitus and sound intolerance may be conditions presented without detectable hearing loss according to conventional audiometry, and the use of sound generators may not be an option for all, due to the financial investment involved.

The idea that tinnitus is not only a sensory experience (location, pitch, loudness) but also a cognitive (thoughts, attention, behaviors) and an emotional (discomfort, suffering) experience (Noreña et al. 2021), has been gaining ground.

Tinnitus's underlying mechanisms remain unclear, but it has been defined as a maladaptive plastic mechanism involving auditory and non-auditory areas (Shore et al. 2016, De Ridder et al. 2021a). Tinnitus conscious awareness perception, related to the auditory or sensory component, can be distinguished from tinnitus disorder, which involves emotional, cognitive, and autonomic dysfunctions (De Ridder et al. 2021b).

Recent models are based on tinnitus' correlated brain networks beyond auditory areas, as proposed by De Ridder et al. (2022) with The Triple Network Model, reinforcing the role of central executive network interference, expressing cognitive disabilities in chronic tinnitus

126 patients. The emotional reaction is also involved, contributing to the suffering, as a behavioral
127 manifestation of tinnitus, attributed to the salience network.

128 Executive control of attention failures may explain tinnitus's impact on cognitive
129 function (Tegg-Quinn et al. 2016), and hearing levels can be a critical factor to tinnitus effects
130 on cognitive performance (Waechter & Brännström 2015, Waechter et al. 2019). Poorer
131 cognitive performance at different domains such as executive function, processing speed,
132 general short-term memory, general learning, and retrieval had been related to tinnitus (Clarke
133 et al. 2020).

134 Sounds that cause annoyance can become a disorder, as in tinnitus internal perception
135 sound or as in external sounds that induce intolerance. In these cases, brain is activated in a
136 different manner from other sounds that are thought to be neutral or pleasant. Unwanted
137 thoughts and memories related to sounds can lead to a priority processing of this signal, and
138 misinterpreting sounds can mean unnecessary additional processing routes that cause negative
139 consequences (Fagelson 2022). The way sounds are interpreted and categorized is crucial to
140 the way the brain is triggered by sounds.

141 Audiological assessment and rehabilitation need to follow these actual concepts and be
142 more comprehensive. Audiologists have a fundamental role in this process if trained and based
143 on scientific research. During audiological rehabilitation work, aiming for an effect on the
144 perception of tinnitus, and the consequent impact on the associated reaction, here are some
145 strategies to be even more studied and explored by audiologists.

146

147 Cognitive auditory training and the use of mindfulness-based exercises

148 Therapeutic proposals such as Tinnitus Activities Treatment (TAT)(Tyler et al. 2007)
149 and Progressive Tinnitus Management (PTM) (Henry et al. 2010) incorporate attentional

exercises with involvement of sounds. There is a proposal for attentional control, with exercises that stimulate auditory skills of free attention, alternating focus, and directed attention, using the tinnitus sound, environmental sounds, music, or noise.

Auditory cognitive training has been studied in different populations as older adults (Kawata et al. 2022), adults with hearing loss (Lawrance et al. 2018), pathologies such as schizophrenia (Molina et al. 2021), and animals (Guercio et al. 2020), showing beneficial intervention effects.

Subjects with bothersome tinnitus were submitted to a computer-based auditory cognitive training program showing no statistically significant changes after training, compared to the control group (Xing et al. 2021). Besides that, the authors support that studies in this area remain relevant due to the neuroplasticity potential effect of auditory cognitive training in tinnitus patients.

Recent studies addressing auditory training in tinnitus patients had developed strategies that considered attentional factors and multisensory pathways. Attentional auditory skill stimulation applied to improve tinnitus showed positive results considering at least one outcome measure and may be explored in future research (Barros et al. 2024).

Mindfulness-based strategies aim to improve attention, in a conscious and intentional way, in the present moment, without judgment. Intervention through formal exercises requires an effort to effectively maintain attention to experience at a given moment (Creswell 2017).

In a systematic review to determine the effect of mindfulness-based strategies on tinnitus-associated distress and on anxiety and depression symptoms in tinnitus patients, there was a positive effect on the symptom-associated distress, regardless of the methodological approach (Rademaker et al. 2019).

Mindfulness-based exercises can strengthen attentional skills promoting a shift in focus, away from tinnitus and bothersome sounds. And it can be also the basis for auditory attentional exercises that include use of different sound stimuli.

It is possible to adapt these strategies to the individual needs of the patient, with progressive graduation regarding the degree of difficulty of the tasks, exploring the different sound stimulus types, with different degrees of complexity.

Strengthening attentional auditory skills, through a gradual auditory training process, with a progressive degree of difficulty, can help the patient learn how to manage the focus of attention and leave tinnitus and problematic sounds in the background.

Sound stimulation during sleep

Since hearing is an alert and active sense 24 hours a day, sound stimulation during sleeping time is explored as a strategy for tinnitus management. One possibility to reduce the prominence of tinnitus, as recommended in TRT, TAT, and PTM, is using background sounds for sound enrichment, through environmental sound generators, when the patient is trying to sleep, and leaving it active for passive stimulation throughout the night (Tyler et al. 2007; Henry et al. 2010; Jastreboff 2011).

Brain activity during sleep, with and without sound stimulation, was investigated with electroencephalogram examination in patients with tinnitus. The measured changes, mainly in the temporal region, showed that auditory stimulation during sleep can influence the electrical activity of the brain (Pedemonte et al. 2014).

Theodoroff et al. (2017) tested a new device for sound stimulation during sleep that generated different types of sounds in a sample of tinnitus patients. Deniz et al. (2020) found

positive changes in psychoacoustic measures of tinnitus, Tinnitus Handicap Inventory (THI), Visual Analog Scale (VAS), and Beck Depression Inventory at six months follow-up, after auditory stimulation during sleep, using music combined with noise centered on the frequency of tinnitus perception.

Sound generators, with an appropriate methodology, considering exposure, stimulus intensity level, and consistency in the way it is presented, can be another resource used to induce neuroplasticity mechanisms and promote partial masking.

Restoring the pleasure of listening

TAT recommends a list of pleasurable activities in which the subject can engage, as a facilitating strategy to change the reaction to tinnitus. Also, the identification of sounds that the subject likes and does not like (Tyler et al. 2007). One of the PTM recommendations for patients with discomfort from everyday sounds is listening to sounds they like as often as possible (Henry et al. 2010).

Negative associations to sound, whether internal, as in tinnitus, or external, as in cases of sound intolerance, are part of the brain's vicious circle activation related to the symptom, feeding the maladaptive pattern triggered by sound perception.

The association of tinnitus and problematic sounds with negative meanings can lead the subject to present negative experiences with the sound most of the time. In addition, the association of tinnitus with some intolerance to external sounds is common (Onishi et al. 2018).

From theoretical proposals, such as TAT and PTM, strategies of involvement with pleasurable listening activities can be extrapolated, gradually and with a method, favoring the recovery of pleasure in listening, and contributing to the establishment of new patterns in

neuronal activity, or rescue of paths in auditory memory, which were in the background, by strengthening positive associations to sound.

Conclusive comments

The audiological therapeutic process for tinnitus patients can be personalized considering the subject's daily life and the most challenging moments. In addition, it can include strategies acting on the symptom even before the patient directs attention to it, aiming to weaken the maladaptive brain activation pattern.

Monitoring and adequate professional intervention are essential, as in any other rehabilitation process. The use of sounds for audiological rehabilitation of tinnitus, as well as strategies that involve auditory stimulation associated with cognitive stimulation, or mindfulness-based practices, requires specialized methods and assistance.

Further research is necessary to define and improve technics approaches in audiological rehabilitation and show the effectiveness of these strategies regarding tinnitus treatment, but audiological rehabilitation for tinnitus can be more comprehensive and it means audiologists can go beyond counseling programs and sound therapy intervention.

Tinnitus therapeutic process is individual, personalized, and adapted to the patient’s real needs, and must be assisted by an audiologist, with specific training, after a thorough medical and audiological evaluation. Manifestations and comorbidities associated with the symptoms are heterogeneous and variable in degree of involvement and severity, with no single path to rehabilitation.

References

Baguley, D., McFerran, A., & McKenna, L. (2021). *Living with Tinnitus and Hyperacusis: New Edition*. Sheldon Press.

Barros, A. C. M. P., Lopes, R. V., Gil, D., Carmo, A. C. F. D., Onishi, E. T., & Branco-Barreiro, F. C. A. (2024). Auditory training for tinnitus treatment: a scoping review. *Brazilian Journal of Otorhinolaryngology, 90*(1), 101361. https://doi.org/10.1016/j.bjorl.2023.101361

Cima, R.F.F., Mazurek, B., Haider, H., Kikidis, D., Lapira, A., Noreña, A., & Hoare, D.J. (2019). A multidisciplinary European guideline for tinnitus: diagnostics, assessment, and treatment. *HNO, 67*(Suppl 1), 10-42. https://doi.org/10.1007/s00106-019-0633-7

Clarke, N.A., Henshaw, H., Akeroyd, M.A., Adams, B., & Hoare, D.J. (2020). Associations Between Subjective Tinnitus and Cognitive Performance: Systematic Review and Meta-Analyses. *Trends in Hear, 24*, 2331216520918416. https://doi.org/10.1177/2331216520918416

Creswell, J.D. (2017). Mindfulness Interventions. *Annual Review of Psychology, 68*, 491-516.

De Ridder, D., Adhia, D., & Langguth, B. (2021a). Tinnitus and Brain Stimulation. *Current Topics in Behavioral Neurosciences, 51*, 249-293. https://doi.org/10.1007/7854_2021_219

De Ridder, D., Schlee, W., Vanneste, S., Londero, A., Weisz, N., Kleinjung, T., ... Langguth, B. (2021b). Tinnitus and tinnitus disorder: Theoretical and operational definitions (an

international multidisciplinary proposal). *Progress in Brain Research, 260*, 1-25. https://doi.org/10.1016/bs.pbr.2020.12.002

De Ridder, D., Vanneste, S., Song, J., & Adhia, D. (2022). Tinnitus and the triple network model: a perspective. *Clinical and Experimental Otorhinolaryngology, 15*(3), 205-212. http://doi.org/10.21053/ceo.2022.00815.

Deniz, H., Bayazit, Y.A., Sarac, E.T. (2021). Individualized Treatment of Tinnitus during Sleep Using Combined Tinnitus Signal and Music. *ORL Journal for Oto-Rhino-Laryngology, Head and Neck Surgery, 83*(1), 35-40. https://doi.org/10.1159/000509981

Fagelson, M. (2022). Tinnitus and Traumatic Memory. *Brain Sciences, 12*(11), 1585. doi:10.3390/brainsci12111585

Fournier, P., Cuvillier, A.F., Gallego, S., Paolino, F., Paolino, M., Quemar, A., ... Norena, A. (2018). A New Method for Assessing Masking and Residual Inhibition of Tinnitus. *Trends in Hearing, 22*, 1-19. https://doi.org/10.1177/2331216518769996

Fuller, T.E., Haider, H.F., Kikidis, D., Lapira, A., Mazurek, B., Norena, A., ... Cima, R.F. (2017). Different Teams, Same Conclusions? A Systematic Review of Existing Clinical Guidelines for the Assessment and Treatment of Tinnitus in Adults. *Frontiers in Psychology, 8*, Article 206. https://doi.org/10.3389/fpsyg.2017.00206

Ganger, P.E., & Tyler, R.S. (2022). Neurophysiological Models, Psychological Models, and Treatments for Tinnitus. In R.S. Tyler & A. Perreau (Eds), *Tinnitus Treatment: Clinic Protocols* (2nd ed., pp. 1-16). Thieme. [Sem DOI]

Glick, H.A., & Sharma, A. (2020). Cortical Neuroplasticity and Cognitive Function in Early-Stage, Mild-Moderate Hearing Loss: Evidence of Neurocognitive Benefit From Hearing Aid Use. *Frontiers in Neuroscience, 14*, Article 93. https://doi.org/10.3389/fnins.2020.00093

Guercio, G.D., Anjos-Travassos, Y., Rangel, I., Costa, S., Poleto, A., Costa, D., ... Panizzutti, R. (2020). Auditory cognitive training improves prepulse inhibition in serine racemase mutant mice. *Psychopharmacology (Berl), 237*(8), 2499-2508. https://doi.org/10.1007/s00213-020-05549-1

Henry, J.A., Zaugg, T.L., Myers, P.J., & Kendall, C.J. (2010). *Progressive Tinnitus Management: Clinical Handbook for Audiologists*. CA: VA Employee Education System. Retrieved from https://pueblo.gpo.gov/DOD/pdfs/HCE-850.pdf

Jastreboff, P.J. (2011). Tinnitus Retraining Therapy. In A. Mooler et al. (Eds), *Textbook of Tinnitus* (pp. 575-596). Springer. https://doi.org/10.1007/978-1-60761-145-5_73

Kawata, N. Y. S., Nouchi, R., Oba, K., Matsuzaki, Y., & Kawashima, R. (2022). Auditory Cognitive Training Improves Brain Plasticity in Healthy Older Adults: Evidence From a Randomized Controlled Trial. *Frontiers in Aging Neuroscience, 14*, 826672. doi:10.3389/fnagi.2022.826672

Lawrence, B. J., Jayakody, D. M. P., Henshaw, H., Ferguson, M. A., Eikelboom, R. H., Loftus, A. M., & Friedland, P. L. (2018). Auditory and Cognitive Training for Cognition in Adults With Hearing Loss: A Systematic Review and Meta-Analysis. *Trends in Hearing, 22*, 2331216518792096. doi:10.1177/2331216518792096

McFerran, D.J., Stockdale, D., Holme, R., Large, C.H., & Baguley, D.M. (2019). Why Is There No Cure for Tinnitus? *Frontiers in Neuroscience, 13*, Article 802. https://doi.org/10.3389/fnins.2019.00802

Molina, J. L., Joshi, Y. B., Nungaray, J. A., Thomas, M. L., Sprock, J., Clayson, P. E., ... Light, G. A. (2021). Central auditory processing deficits in schizophrenia: Effects of auditory-based cognitive training. *Schizophrenia Research, 236*, 135-141. doi:10.1016/j.schres.2021.07.033

Noreña, A.J., Lacher-Fougère, S., Fraysse, M.J., Bizaguet, E., Grevin, P., Thai-Van, H., ... Ohresser, M. (2021). A contribution to the debate on tinnitus definition. *Progress in Brain Research, 262*, 469-485. https://doi.org/10.1016/bs.pbr.2021.01.029

Onishi, E.T., Coelho, C.C.B., Oiticica, J., Figueiredo, R.R., Guimarães, R.C.C., Sanchez, T.G., ... Torres, S.M.S. (2018). Tinnitus and sound intolerance: evidence and experience of a Brazilian group. *Brazilian Journal of Otorhinolaryngology, 84*(2), 135-149. https://doi.org/10.1016/j.bjorl.2017.12.002

Parthasarathy, S., & Shetty, H.N. (2021). Manipulation of Hearing Aid Gain and Tinnitus Relief: A Paired Comparison Study. *Journal of International Advanced Otology, 17*(2), 145-149. https://doi.org/10.5152/JIAO.2021.8873

Pedemonte, M., Testa, M., Díaz, M., & Suárez-Bagnasco, D. (2014). The Impact of Sound on Electroencephalographic Waves during Sleep in Patients Suffering from Tinnitus. *Sleep Science, 7*(3), 143-151. https://doi.org/10.1016/j.slsci.2014.09.011

Pienkowski, M. (2019). Rationale and Efficacy of Sound Therapies for Tinnitus and Hyperacusis. *Neuroscience, 407*, 120-134. https://doi.org/10.1016/j.neuroscience.2018.09.012

Rademaker, M.M., Stegeman, I., Ho-Kang-You, K.E., Stokroos, R.J., & Smit, A.L. (2019). The Effect of Mindfulness-Based Interventions on Tinnitus Distress. A Systematic Review. *Frontiers in Neurology, 10*, Article 1135. https://doi.org/10.3389/fneur.2019.01135

Searchfield, G.D., Durai, M., & Linford, T. (2017). A State-of-the-Art Review: Personalization of Tinnitus Sound Therapy. *Frontiers in Psychology, 8*, Article 1599. https://doi.org/10.3389/fpsyg.2017.01599

Shore, S.E., Roberts, L.E., & Langguth, B. (2016). Maladaptive plasticity in tinnitus – triggers, mechanisms and treatment. *Nature Reviews Neurology, 12*(3), 150-160.

Stockdale, D. (2021). *Foreword*. In D. Baguley, A. J. McFerran, & L. McKenna (Eds), *Living with Tinnitus and Hyperacusis: New Edition* (pp. vii). Sheldon Press.

Tegg-Quinn, S., Bennett, R. J., Eikelboom, R. H., & Baguley, D. M. (2016). The impact of tinnitus upon cognition in adults: A systematic review. *International Journal of Audiology, 55*(10), 533-540. https://doi.org/10.1080/14992027.2016.1185168

Theodoroff, S.M., McMillan, G.P., Zaugg, T.L., Cheslock, M., Roberts, C., & Henry, J.A. (2017). Randomized Controlled Trial of a Novel Device for Tinnitus Sound Therapy During Sleep. *American Journal of Audiology, 26*(4), 543-554. https://doi.org/10.1044/2017_AJA-17-0022

Tunkel, D.E., Bauer, C.A., Sun, G.H., Rosenfeld, R.M., Chandrasekhar, S.S., Cunningham, E.R. Jr., ... Whamond, E.J. (2014). *Clinical practice guideline: tinnitus*. *Otolaryngology–Head and Neck Surgery, 151*(2 Suppl), S1-S40. https://doi.org/10.1177/0194599814545325

Tyler, R.S., Gogel, S.A., & Gehringer, A.K. (2007). Tinnitus activities treatment. *Progress in Brain Research, 166*, 425-434. http://doi.org/10.1016/S0079-6123(07)66041-5

Waechter, S., Hallendorf, L., Malmstein, E., Olsson, A., & Brännström, K.J. (2019). The Impact of Tinnitus on N-Back Performance in Normal Hearing Individuals. *Journal of the American Academy of Audiology, 30*(3), 169-177. https://doi.org/10.3766/jaaa.17048

Waechter, S., & Brännström, K.J. (2015). The impact of tinnitus on cognitive performance in normal-hearing individuals. *International Journal of Audiology, 54*(11), 845-851. https://doi.org/10.3109/14992027.2015.1055836

Xing, M., Kallogjeri, D., & Piccirillo, J.F. (2021). Investigating the Impact of Cognitive Training for Individuals With Bothersome Tinnitus: A Randomized Controlled Trial. *Otolaryngology–Head and Neck Surgery, 165*(6), 854-861. https://doi.org/10.1177/0194599821994742

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