

25 Years of tinnitus retraining therapy

Introduction

Tinnitus retraining therapy (TRT) is a clinical implementation of the neurophysiological model of tinnitus. Both the model and TRT were proposed while I was working on the development of an animal model of tinnitus. During the 1980s, research on tinnitus was limited owing to the lack of an animal model of tinnitus and only clinical results were available. There was consensus that tinnitus was due to damage of the periphery of the auditory system. Consequently, all existing tinnitus models, therapeutic approaches, and research focused on the inner ear and auditory nerve. The dominant method of treatment—known as “masking”—was aimed at covering the perception of tinnitus by external sound. Counseling was minimal and limited to instruction on how to use masking devices, called maskers. The literature on the effectiveness of this approach and on the various aspects of tinnitus provided conflicting reports.

Animal model of tinnitus

An animal model of tinnitus was developed in 1983 and published in 1988 [1]. The animal model introduced the use of silence as a conditioned stimulus. One application of the model was on work to delineate the neuronal activity perceived as tinnitus (i.e., the tinnitus signal). The general belief has been (and still is) that an increase of spontaneous activity within the auditory pathways is responsible for the perception of tinnitus. However, single-neuron recordings taken from the external and dorsal nuclei of the inferior colliculus of rats with tinnitus suggested a dif-

ferent scenario. It turned out the increase of spontaneous activity was correlated with hearing loss, but not with the behavioral manifestation of tinnitus. At the same time, a bursting, epileptic-like activity was observed, which was not present in control animals. Interestingly, this activity was correlated with the behavioral manifestation of tinnitus, but not with hearing loss [2, 3]. These results suggested potential mechanisms for the emergence of tinnitus perception and its mitigation [4].

Work on the development of an animal model required a critical assessment of the available literature at this time. The epidemiological and psychoacoustic studies as well as clinical results indicated that while many people experience tinnitus, only ~20% have problems with it. Furthermore, the severity of tinnitus and the treatment outcome did not depend on the psychoacoustic properties of tinnitus (i.e., pitch, loudness match, minimal masking level) [4, 5]. These observations contradicted the dominant view at this time that auditory system dysfunction is exclusively responsible for tinnitus and resulted in the basic assumption of the neurophysiological model of tinnitus, namely, that in clinically significant tinnitus, the auditory system plays a secondary role and other systems in the brain are dominant [6].

An analysis of patients' reactions indicated the limbic and autonomic nervous systems (in addition to other systems in the brain) must be involved in clinically significant tinnitus because: (1) tinnitus patients show a strong emotional reaction to tinnitus and (2) overstimulation of the sympathetic autonomic system by any means results in the same negative reactions as reported by tinnitus patients, e.g.,

annoyance, anxiety, panic, problems with concentration, decreased ability to enjoy activities in life, sleep difficulties, depression, impaired concentration, and irritability. According to the model, if the tinnitus signal is present only within the auditory system, a person hears tinnitus but is not bothered by it. When the tinnitus signal spreads to other systems in the brain, and in particular activates the limbic and autonomic nervous systems, it evokes a number of negative reactions and tinnitus becomes bothersome.

Consequently, according to the model, to achieve the habituation of negative reactions to tinnitus and habituation of tinnitus perception, treatment should be aimed at blocking functional connections that transfer the tinnitus signal from the auditory system to other systems in the brain. Brain plasticity is crucial for retraining to occur and consequently for habituation.

The model was not disclosed until 1988 as all the results published in the literature at this time contradicted its predictions:

1. Fully covering tinnitus perception (masking) should be counterproductive, as it is impossible to retrain the brain when the tinnitus signal cannot be detected. (Masking was the dominant method of tinnitus treatment at the time and was promoted as highly effective.)
2. It should be possible to achieve relief from tinnitus without eliminating its perception. (At the time, no published data supported this hypothesis.)

In October 1988, during a meeting with Dr. Jonathan Hazell and Ms. Jacqui Shel-drake, who had been using masking treat-

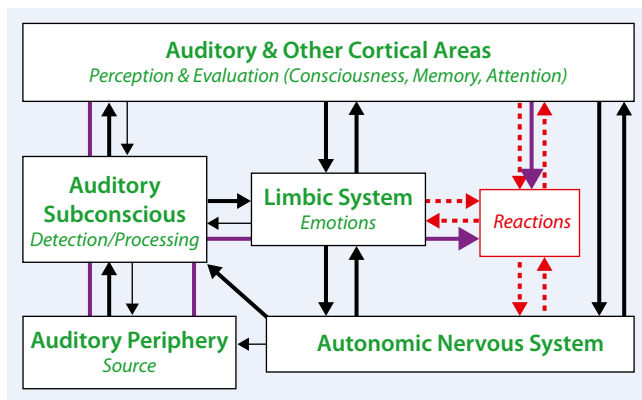


Fig. 1 ◀ Block diagram of the neurophysiological model of tinnitus

ment since 1976, it turned out the majority of their patients were not masking. Rather, they were using a lower level of sound and could still perceive tinnitus. But patients were getting better. This observation supported a prediction of the model, and its clinical implementation—which involved the use of extensive counseling to explain the model and sound therapy, the avoidance of masking, the use of sound below the level of tinnitus, “partial masking” (known as mixing point), and the use of sound at a non-annoying level—was presented to Jonathan and Jacqui. They began using this approach in their clinic and soon reported positive results. The first center to use TRT was created in 1989, in London, followed by a center in Baltimore in 1990. Currently, clinics in 33 countries use some form of TRT.

Neurophysiological model of tinnitus

A paper describing the neurophysiological model of tinnitus and the basis of TRT was published in 1990 [6]. All postulates of the model were established at the handbook level, but when the model was published in 1990, there were no experimental results that showed the involvement of non-auditory systems of the brain with tinnitus. The first results supporting the model, published in 1998, showed a strong activation of the limbic system in tinnitus patients [7]. Many subsequent studies showed the involvement of various systems of the brain in tinnitus; currently there is consensus that tinnitus activates many systems in the brain [8].

An analysis of the mechanisms of tinnitus suggested that to achieve optimal

results, decreased sound tolerance (DST) consisting of hyperacusis and/or misophonia, as well as hearing loss, should be treated concurrently. Consequently, TRT is a method aimed at habituation of reactions evoked by tinnitus and/or DST. Habituation of perception is achieved automatically as a consequence of the brain habituating all unimportant stimuli. In practice, TRT consists of counseling and sound therapy, both based on the neurophysiological model of tinnitus. The main goal of retraining counseling is to reclassify tinnitus into the category of neutral stimuli, while the main goal of sound therapy is to decrease the strength of tinnitus-related neuronal activity.

Habituation of tinnitus changes the functional connections between the auditory and the limbic and autonomic nervous systems. These connections involve two loops:

1. The upper loop, which involves higher cortical centers, cognition, verbalization, conscious perception, and evaluation
2. The subconscious path, which is governed by the subconscious loop directed by the principles of conditioned reflexes (■ Fig. 1)

It has been well established that reflex reactions and learning can occur without the conscious perception of a stimulus. The analysis of results from over 300 patients suggested that the subconscious path plays a dominant role in chronic tinnitus. Therefore, even when patients are not aware of the presence of tinnitus, they can still be negatively affected by it [9]. Consequently, an important part of TRT is to focus on the extinction of subconscious

conditioned reflexes connecting the auditory system with the limbic and autonomic nervous systems.

A unique aspect of TRT is that because treatment is aimed to work above the tinnitus source, and at connections linking the auditory and other systems in the brain, the etiology of tinnitus is irrelevant. Any type of tinnitus, as well as somatosounds, can be successfully treated by TRT. TRT does not attempt to suppress the tinnitus source or to directly attenuate tinnitus-evoked reactions. As the tinnitus signal is prevented from reaching brain systems, activation that is responsible for tinnitus being bothersome, the negative reactions disappear and there is no need to suppress them. This unique feature of TRT differentiates it from pharmacological or psychological methods, which are oriented toward suppressing the tinnitus source or alleviating or improving coping with tinnitus-evoked negative reactions.

Treatment approaches

Various approaches have been used in the past to assess the effectiveness of tinnitus treatments. Currently, the predominant view is that the ultimate goal of treatment is tinnitus does not interfere with the patient’s life or, at least, the severity of tinnitus decreases in a clinically significant manner. To determine a potential change in tinnitus severity, it is necessary to use tinnitus-specific validated questionnaires to access tinnitus severity before, during, and after treatment. A number of questionnaires have been proposed, with the Tinnitus Handicap Inventory (THI) [10] and the Tinnitus Functional Index (TFI) [11] the most recognized. When analyzing data, is it important to recognize the difference between results that are statistically significant versus clinically significant results. Clinically significant improvement on a questionnaire needs to be statistically significant, but statistically significant improvement alone is not sufficient to claim clinically significant results. For the THI, a decrease of 20 points in its score has been shown to be clinically significant.

Over 100 publications can be found on Medline when using “tinnitus retraining therapy” as a search term. The majority of these publications indicate TRT of-

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25 Years of tinnitus retraining therapy

Abstract

This year marks 25 years of tinnitus retraining therapy (TRT), the approach that aims to eliminate tinnitus as a problem by extinguishing functional connections between the auditory and the limbic and autonomic nervous systems to achieve habituation of tinnitus-evoked reactions and subsequently habituation of perception. TRT addresses directly decreased sound tolerance (DST) as well as tinnitus. TRT consists of counseling and sound therapy, both based on the neurophysiological model of tinnitus. The main goal of retraining counseling is to reclassify tinnitus into the category of a neutral stimulus, while the main goal of sound therapy is to decrease the strength of tinnitus-related neuronal activity. A unique aspect of TRT is that because treatment is aimed to work above the tinnitus source, and at connections linking the auditory and other systems in the brain, the etiology of tinnitus is irrele-

vant. Any type of tinnitus, as well as somatosounds, can be successfully treated by TRT. Over 100 publications can be found on Medline when using “tinnitus retraining therapy” as a search term. The majority of these publications indicate TRT offers significant help for about 80% of patients. A randomized clinical trial showing the effectiveness of TRT has been published and another large study is in progress. The principles of the neurophysiological model of tinnitus, and consequently TRT, have not changed in over 25 years of use, but a number of changes have been introduced in TRT implementation. These changes include the recognition of the importance of conditioned reflexes and the dominant role of the subconscious pathways; the introduction of the concept of misophonia (i.e., negative reactions to specific patterns of sound) and the implementation of specific protocols for its treatment; greater emphasis on the

concurrent treatment of tinnitus, hyperacusis, misophonia, and hearing loss; extensive modification of counseling; and refinements in sound therapy. The effectiveness of TRT has increased significantly during the past 25 years, presumably due to changes incorporated in its implementation. The main improvement has been to shorten the average time until seeing clear improvement from 1 year to 1 month, with a statistically significant improvement seen at, and after, 3 months. Furthermore, there is a higher effectiveness and a shorter treatment time for DST and an increased extent of help for hearing loss.

Keywords

Tinnitus · Neurophysiological model of tinnitus · Tinnitus retraining therapy · Misophonia · Treatment

25 Jahre Tinnitus-Retraining-Therapie

Zusammenfassung

In diesem Jahr können wir auf 25 Jahre erfolgreiche Tinnitus-Retraining-Therapie (TRT) zurückblicken, den Ansatz, der durch die Tilgung der Verbindung zwischen dem auditiven, dem limbischen und dem autonomen Nervensystem dazu beiträgt, die Gewöhnung an tinnitusevozierte Reaktionen bzw. die Gewöhnung an die Wahrnehmung des Tinnitus zu trainieren. TRT richtet sich gleichermaßen an Patienten mit verringerter Hörtoleranz als auch an Tinnituspatienten. TRT besteht aus Beratung und Hörtraining (Klangtherapie), beides basierend auf dem neurophysiologischen Modell des Tinnitus. Hauptziel der Beratung ist dabei die Schulung des Patienten, seinen Tinnitus mehr als einen neutralen Stimulus zu betrachten, während das Hauptziel der Klangtherapie die Verringerung der Stärke der tinnitusbezogenen neuronalen Aktivität darstellt. Einen einzigartigen Aspekt des TRT bildet die Ausrichtung der Behandlung unabhängig von der Ursache des Tinnitus – indem man die Verbindungen zwischen dem auditiven und

anderen Systemen im Gehirn unterbricht, ist die Ätiologie des Tinnitus irrelevant. Mit TRT kann jede Art von Tinnitus, auch objektiver Tinnitus, erfolgreich behandelt werden. Über den Suchbegriff „Tinnitus-Retraining-Therapie“ können auf Medline über 100 Publikationen gefunden werden. Ein Großteil der Veröffentlichungen zeigen, dass TRT in über 80% der Fälle hilfreich war. Es wurde bereits eine randomisierte klinische Studie veröffentlicht, welche die Wirksamkeit der TRT zeigt. Eine weitere große Studie wird derzeit durchgeführt. Die Grundsätze des neurophysiologischen Modells des Tinnitus und folglich TRT sind in den letzten 25 Jahren nicht verändert worden, dennoch wurde die Umsetzung von TRT weiterentwickelt. Zu diese Änderungen zählen die Anerkennung der Bedeutung der konditionierten Reflexe und die dominante Rolle des Unterbewusstseins; die Einführung des Konzepts der Misophonie (d. h. negative Reaktionen auf spezifisches Klangmuster) und die Umsetzung spezieller Anleitungen für ihre Behandlung; mehr

Aufmerksamkeit auf die gleichzeitige Behandlung von Tinnitus und Hyperakusis, Misophonie sowie Hörverlust; umfangreiche Modifikation der Beratung und Verfeinerungen in der Tontherapie. Die Wirksamkeit der TRT konnte in den letzten 25 Jahren deutlich erhöht werden, was vermutlich auf die Integration verschiedener Änderungen in der praktischen Anwendung zurückzuführen ist. Die wichtigste Verbesserung liegt in der Verkürzung des durchschnittlichen Zeitraums von einem Jahr bis zu einem Monat, in dem eine deutliche Verbesserung beim Patienten zu beobachten ist; statistisch signifikante Verbesserungen sind bereits nach 3 Monaten nachweisbar. Darüber hinaus gibt es eine höhere Wirksamkeit und kürzere Behandlungszeit für die verringerte Hörtoleranz und in erhöhtem Ausmaß Hilfe bei Hörverlust.

Schlüsselwörter

Tinnitus · Neurophysiologisches Modell des Tinnitus · Tinnitus-Retraining-Therapie · Misophonie · Behandlung

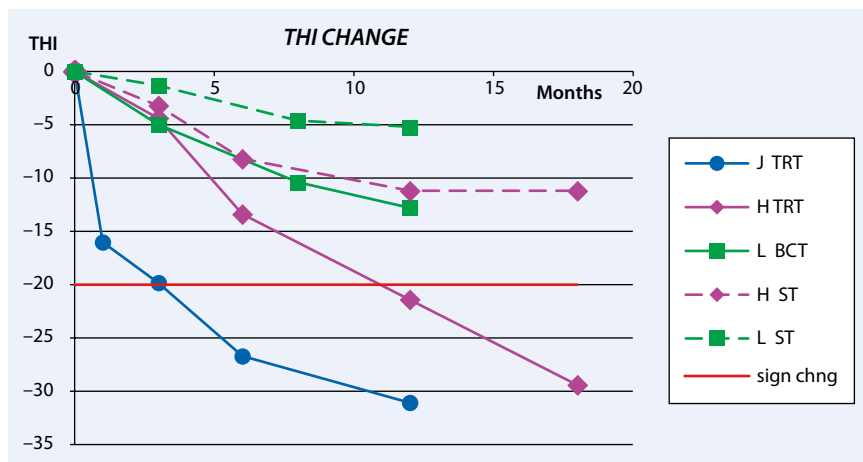


Fig. 2 ▲ Comparison of THI score changes over time of treatment for masking vs. TRT trial (H TRT—TRT, diamonds and continuous line, H ST—sound therapy, diamonds and dashed line), CBT Lancet trial (L BCT—CBT, squares and continuous line, L ST standard of care, squares and dashed line), and our results from Emory (J TRT—circles and continuous line). Horizontal line at –20 points represents minimal level needed to achieve clinical significance of improvement. Note the small effect for standard of care in the Lancet trial. Also note CBT was as equally effective as the masking group in Henry’s trial. These three groups did not reach a level of clinical significance. Henry’s and our TRT groups show highly significant statistical and clinical improvement and reached 30 points of THI decrease. THI Tinnitus Handicap Inventory, *chg* change

fers significant help for about 80% of patients. Randomized clinical trials showing the effectiveness of TRT have been published as well [12] and another large study is in progress [13]. Cognitive behavioral therapy (CBT) is promoted as a successful method for tinnitus treatment [14]. It is worthwhile to compare the results of a randomized TRT trial with a recently published CBT trial [15] and with the results obtained at the Emory Tinnitus and Hyperacusis Center. A direct comparison of the results can be made as the THI has been used in both trials as well as at Emory University.

In the Henry et al. [12] trial, the masking approach was compared with TRT. Masking was defined as occurring when the patient perceived any immediate relief caused by external sound. If possible, the suppression of tinnitus perception was recommended. Additionally, the avoidance of silence was recommended to all patients. This approach represents basic sound therapy, and therefore it is possible to expect that results of any type of sound therapy should be similar to the results from the masking group. In the trial recently published in *The Lancet* [15], CBT was compared with the “standard of care” approach. The standard of care group obtained sound therapy similar to the mask-

ing group in Henry’s trial, with added counseling performed by a social worker.

A comparison of the results of Henry’s trial with the CBT trial and the results obtained at Emory University are presented in **Fig. 2**. The standard of care group in the Lancet trial showed a very small improvement of only five points on the THI questionnaire. The CBT group showed an improvement of 12 points and was basically identical to the results of the masking group. These three groups, while showing statistically significant improvement, did not reach the level of clinically significant improvement (i.e., a 20-point decrease).

Results of the TRT group in Henry’s trial and the results obtained at Emory show a highly statistical and clinical improvement of 30 points. While both Henry’s and our results reached the same level of improvement, the improvement occurred faster at Emory.

The principles of the neurophysiological model of tinnitus, and consequently TRT, have not changed in over 25 years of use, but a number of changes have been introduced in TRT implementation.

The main modifications are:

- Recognition of the importance of conditioned reflexes and the dominant role of the subconscious pathways.

- Introduction of the concept of misophonia (i.e., negative reactions to specific patterns of sound [16, 17]) and implementation of specific protocols for its treatment.
- Higher stress of the concurrent treatment of tinnitus, hyperacusis, misophonia, and hearing loss.
- Extensive modifications of counseling.
- Refinements in sound therapy (e.g., introducing sound protocols for misophonia, step method for setting the sound level of sound generators, more stress on hearing rehabilitation, and expanded high frequency of amplification).

Conclusion

The effectiveness of TRT increased significantly during the past 25 years, presumably due to changes incorporated in its implementation. The main improvement has been to shorten the average time until seeing clear improvement from 1 year to 1 month, with statistically significant improvement seen at, and after, 3 months. Furthermore, there is a higher effectiveness and a shorter time of treatment for DST and an increased extent of help for hearing loss.

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Compliance with ethical guidelines

Conflict of interest. P.J. Jastreboff states that there are no conflicts of interest. The accompanying manuscript does not include studies on humans or animals.

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Hier steht eine Anzeige.