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# Retraining therapy for chronic tinnitus

## A critical analysis of its status

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Tinnitus retraining therapy (TRT), as conceived of mainly by PJ Jastreboff, has recently received increasing attention in the media, as well as in seminars and congresses on treatment methods for chronic tinnitus. It is often claimed, though not explicitly in scientific publications, that TRT is currently the most efficacious therapy for tinnitus, obtaining improvement rates exceeding 80%. This assertion is highly significant in light of the most likely increasing prevalence of chronic tinnitus and ensuing urgent demand for effective therapies. Before examining the evidence regarding the effectiveness of TRT, Jastreboff's theoretical idea of tinnitus as a neurophysiological disorder is examined and evaluated. This idea is plausible and is supported by some evidence. The interaction between neuro-acoustic and emotional processes emphasized by Jastreboff is, however, neither new nor sufficiently elaborated with respect to the underlying psychological factors. The TRT intervention technique and its main components 'directive counselling' and use of 'noise generators' are found to be theoretically well grounded. The lack of detailed information concerning TRT implementation and the potential consequence that differing interventions may be labelled TRT are criticized. Jastreboff's obvious opposition to psychologists' participation in TRT, despite the increase in efficacy they could affect through utilization of cognitive restructuring techniques and behaviour modification interventions, is also criticized. Finally, studies regarding the efficacy of TRT are reviewed and severe methodological shortcomings (e.g. lack of controlled randomized group studies) in TRT research are noted. Taking the current state of evidence into account, we conclude that there is no convincing empirical support for the assumption that TRT is superior to other treatments, since no comparative studies have been conducted. It is contended that there is more substantial empirical support for the efficacy of cognitive-behavioural interventions in reducing tinnitus annoyance and tinnitus-related suffering. The necessity for methodologically well-designed studies to pinpoint effect sizes of TRT and compare them with other techniques, especially cognitive-behavioural ones, is emphasized.

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## Introduction

Tinnitus, a term that in the not so distant past was familiar only to otological specialists, has now become a 'popular disease'. Whether or not the current prevalence of chronic tinnitus has increased beyond the 14-18% reported by Coles (1984) has not, as yet, been determined. Numerous researchers and practitioners, however, are of the firm belief that chronic tinnitus is a

problem of growing importance, afflicting an ever-increasing portion of the population. It also appears that in certain countries (e.g. Germany and the UK) tinnitus is viewed as a real 'illness', a legitimate cause of suffering, and consequently as a justifiable ground for seeking medical help and even applying for compensation. The belief that tinnitus is a serious health problem requiring treatment can be regarded as psychosocial risk factor for the dysfunction to become a source of

disability. Environmental factors (e.g. increasing noise stress) most likely add to the physiological risk of developing tinnitus. Whether this biopsychosocial process has led to an increase in the number of patients seeking medical help, cannot currently be answered by empirical data.

The medical system is eager to offer its support for this health problem. However, in the case of chronic tinnitus, many medical treatments, pharmacological or other, have failed to reach their ends. This includes one of the latest 'fad' treatments, 'hyperbaric oxygenation' (Lutz 1998), which (against indication) is often administered to patients with chronic tinnitus. Thus, for chronic tinnitus especially, there is a definite demand for new therapies.

A large number of publications in expert journals and public media now designate tinnitus retraining therapy (TRT) a breakthrough in the treatment of chronic tinnitus. TRT was developed by the neurophysiologist PJ Jastreboff in co-operation with the audiological physician JWP Hazell (Jastreboff & Hazell, 1993). Jastreboff, originally a basic scientist, turned his attention to clinical application some years ago. In public media TRT is now generally referred to as the most efficacious treatment modality available, boasting a success rate of about 80% or more. As a consequence, for example in Germany, the number and popularity of TRT training courses held for otologists and acousticians, are growing. Retraining Centers for tinnitus treatment have sprung up in nearly every major city. Thus TRT clearly raises great hopes in patients and physicians.

The authors of this article, all active in the field of tinnitus treatment, either as researchers and/or practitioners, were motivated by this widespread enthusiasm to take a sober look at TRT, its neurophysiological founding, its treatment concept and the status of its evaluation.

## Neurophysiology of tinnitus and TRT

Tinnitus, as yet, can only be assessed by subjective report in humans (except for very rare so-called objective tinnitus). This fact, together with the circumstance that invasive experimental neurophysiological methods are limited due to ethical reasons, make it difficult to study the neurophysiological mechanisms

underlying tinnitus. One of PJ Jastreboff's accomplishments as a basic scientist was the development of an animal model of tinnitus (Jastreboff et al., 1986; Jastreboff & Sasaki, 1988) providing the means for behavioural and neurophysiological studies on tinnitus not otherwise possible in humans. Jastreboff's work, in line with evidence from other research studies, revealed increased spontaneous activity of auditory nerve fibres as well as an abnormal pattern of activity, e.g. in the inferior colliculus, in animals with salicylate-induced tinnitus. Jastreboff proposes that this abnormal neural activity within the auditory pathways is erroneously interpreted as sound by the auditory centres. Tinnitus generation therefore seems to originate in the cochlea and involve a dysfunction of the outer and inner hair cells. Numerous hypotheses concerning the nature of this dysfunction have been put forward, which, however, cannot be discussed within the constraints of this paper. The consequence of the damage in the cochlear system is an altered information input in the CNS. Jastreboff (1990) argues, in accordance with other neurophysiologists, that the CNS compensates for a reduced input by increasing the sensitivity of the systems involved in processing auditory input. According to Jastreboff this abnormal neural activity in the auditory pathways is of 'crucial' significance (Jastreboff, 1990:235) for the generation of tinnitus. He, furthermore, assumes that the representation of tinnitus within the auditory system is very different from the representation of external sounds: 'I propose that detection of the tinnitus signal occurs in a pattern-detection manner by neuronal assemblies and that this detection process undergoes plastic changes', (Jastreboff, 1990:237). This theory emphasizes the adaptivity and plasticity of the neuronal networks involved. Trying to explain the persistence of tinnitus Jastreboff (1990:238) argues that the abnormal pattern of activity may be the reason why it is much more difficult to suppress or habituate to tinnitus than to external sounds. Furthermore, although the peripherally produced signals may fluctuate, the integrated manner in which fragments of the original pattern are processed leads to a perception of relative persistence. Persistence is also due to the inborn mechanism by which attention and orientation systems are activated by new, ambiguous or anxiety-evoking information (Sokolov, 1963).

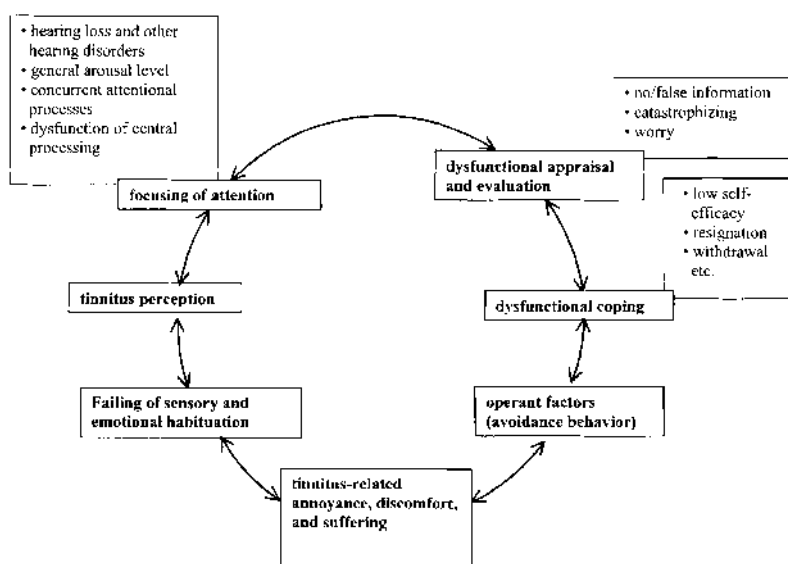


Fig. 1. A vicious-circle model of tinnitus (Kröner-Herwig, 1997, after Hallam & Jakes, 1987).

All in all Jastreboff's model of tinnitus generation relies heavily on the plasticity of the nervous system and its capability of organizing and structuring its activity into perceptions, regardless of whether this is dependent on stimulation or not (Jastreboff, 1990, 1996).

Jastreboff's line of reasoning is plausible and is in accordance with knowledge accumulated in recent years regarding the plasticity of the nervous system. The link between tinnitus generation and attentional processing is not only plausible and supported by extensive evidence, it also explains the arousal value of early tinnitus perception. Nevertheless, it is evident that Jastreboff's theory remains partially vague, relies on global knowledge, and lacks specificity regarding tinnitus-related neurophysiological processing. In future years neuro-imaging methods are likely to deliver more specific and detailed evidence from humans. So far the model presented here does not explain why tinnitus can be highly resistant to habituation and thus become an annoying disorder in some, though not all, individuals experiencing the phantom sounds.

Being aware of this, Jastreboff broadens his explanatory concept by including the emotional system in his model. Tinnitus is accordingly not regarded as a neutral perception, but as a perception that may be associated with a personal meaning and may therefore possess specific negative valence. This, in turn, can prevent early habituation. The author further suggests that tinnitus itself is subject to evalua-

tion. It may be perceived as a threat, a cause for worrying (e.g. about a serious illness) or a cause for anxiety. The inexplicability and the lack of control over tinnitus can be stressful to an individual and may evoke constant negative emotional responses. Thus, Jastreboff by including psychological processes into his neurophysiological model explains the persistent disturbance some individuals experience by tinnitus. In accordance with some neurophysiologists, Jastreboff assumes that there are 'loops in the neuronal network which under the condition of continuous sensory signal (tinnitus) with significant emotional tone (concern, fear, inability to control it), further amplify the perception of tinnitus by creating positive feedback within the cortical networks' (Jastreboff, 1990: 242). The limbic system in particular is involved in the loops (Jastreboff et al., 1996).

These ideas regarding the role of affective processes in the persistence of the attention given to tinnitus and its disruptive effects are, however, not new. They are integral parts of earlier concepts such as that from Hallam et al. (1984, 1987) or from other psychologists (see Fig. 1), thus Goebel (1997) called Jastreboff's reformulation of well-known concepts 'old wine in new bottles'. The psychological model developed by Hallam describes a vicious circle in which different factors interact and create positive feedback loops generating and maintaining tinnitus-related annoyance and discomfort. Tinnitus is viewed as an internal stressor on which the individual focuses his/her attention.

Specific dysfunctional cognitive processes of appraisal, such as catastrophizing and worrying, lead to negative emotional consequences, which in turn are worsened by maladaptive coping strategies. Furthermore, dysfunctional appraisal and attention tend to interact, keeping each other at a high level. These psychological processes augment the disability and suffering attributed to tinnitus. Also, illness behaviour is developed, often based on avoidance learning (e.g. subjective justification of absenteeism from stressing work condition because tinnitus is hampering performance). All these processes act together and maintain tinnitus as a severe stressor with disabling consequences.

Following this, psychological model treatments developed in the last 15 years emphasize the role of interventions aimed at modifying the crucial factors mentioned above. These psychological interventions, and multimodal cognitive-behavioural tinnitus-coping trainings in particular, have recently demonstrated impressive success in decreasing tinnitus-related disability, i.e. reducing the disruptive consequences of tinnitus (for a review see Frenzel & Kroener-Herwig, 1997).

Thus there is nothing new in Jastreboff's psychological ideas, they are even less specific than those shown in Fig. 1. The fact that he relates them to neurophysiological structures and processes (e.g. the limbic system), however, may make them more acceptable to physicians.

In most aspects Jastreboff's treatment procedure is derived directly from his conceptual model. The attentional and emotional defocusing of tinnitus is the main goal of TRT interventions. Therefore, according to Jastreboff counselling is the most important treatment component, since habituation to tinnitus cannot be reached without segregating the emotional response from the experience of tinnitus (Jastreboff, 1996).

Jastreboff extends his notion of the significance of emotional processing. He claims that a general psychophysiological state of 'non-verbal feelings of tension or discomfort' (Jastreboff, 1996: 502), not necessarily directly dependent on the symbolized evaluation of tinnitus can serve as a reinforcer and may be a further cause for the lack of habituation. Though these assumptions are not derived from psychological concepts, they incorporate the experience frequently reported by patients that stress increases the disruptive effects of tinnitus. This aspect,

however, is not explicitly dealt with in Jastreboff's interventional concept, since no methods for reducing general arousal, tension or discomfort are included.

Nevertheless, it can be legitimately argued that the main objective of TRT is to induce psychological changes in the cognitive-emotional processing of the 'strange' experience of hearing noises not anchored in the physical world (it is noteworthy that Jastreboff never uses the term cognition). This objective does not differ from the objective of cognitive-behavioural training currently being conducted in outpatient and inpatient settings (Goebel et al., 1992a, b; Goebel & Hiller, 1996; Henry & Wilson, 1992, 1996; Jakes et al., 1986, 1992; Kroener-Herwig et al., 1995; Kroener-Herwig et al., 1999; Lindberg et al., 1988, 1989; Scott et al., 1985). Jastreboff obviously misunderstands the cognitive-behavioural approach, when claiming (1996: 500) that 'its implicit assumption that something is wrong in the psychological profile of the patient resulting in the problem of tinnitus is its main theoretical basis'. We know of no current serious psychological theory of tinnitus blaming the 'psychological profile', 'personality' or 'pathopsychology' of an individual for the generation of tinnitus, rather psychological models claim that psychological factors play a role in the development and maintenance of suffering from the disorder. Psychological training explicitly focuses on cognitive restructuring (e.g. dissociation of negative emotional association), attention directing processes (to direct attention to competing inner and outer events, auditory or not) on stress management (e.g. reduction of stress-related arousal and concurrent feelings of tension), coping with tinnitus (e.g. enriching one's sound environment systematically), and the modification of avoidance behaviour motivated by tinnitus (e.g. put new life to one's social contacts). The latter behavioural component, which can be of utmost importance for the development of disability due to tinnitus as well as of healthcare system utilization, is completely neglected in Jastreboff's model.

Following these arguments one can ask to what extent the noise generator use in TRT contributes to habituation of tinnitus in addition to counselling, which aims at dissociating negative affect and tinnitus and is said to be of central importance in the treatment. Jastreboff

recommends to supply patients with additional external sounds in the sense of auditory stimulation to down-regulate the hypersensitive auditory system. Patients are advised to use the noise generators with a sound level *below masking* for the duration of several months up to years. A binaural use is strongly recommended, but not theoretically substantiated. Jastreboff argues that the habituation process can be facilitated by 'decreasing the contrast between tinnitus related and background neural activity within the auditory pathways' (Jastreboff et al. 1996: 503). This can also be achieved through acoustic enrichment of the environment (e.g. listening to music) or the use of a hearing aid. However, sound will not be effective (Jastreboff 1996: 503), if the dissociation of negative emotion and tinnitus is not successful. Using noise generators aims at a retraining of the higher processing centres that involves 'a gradual reorganization of the recognition of tinnitus, particularly its association with the emotional state' (Jastreboff 1990: 243). The effect of it is conceptualized as a central, not peripheral, process facilitating tinnitus habituation.

Having pointed out the similarity in the pragmatic objectives of TRT and psychological therapies, our attention will now be turned to whether the strategies employed to reach these goals share similarity.

## Concept and conductance of TRT

Jastreboff & Hazell (1993) emphasize that usually TRT does not eliminate tinnitus but rather reduces its negative impact, insofar as they educate their patients to have realistic goals.

On occasion it has, however, been asserted that, contrary to psychological training, TRT 'blocks' the sensation (Jastreboff, pers. comm., Congress of Behavioural Medicine, Prien, 1999, Sheldrake et al., 1996), a statement which may raise illusionary hopes in patients.

After audiological testing (e.g. determining, minimal masking level, loudness discomfort level, tinnitus matching, audiogram) TRT begins with an individual diagnostic interview in which basic information concerning tinnitus is gathered. The patient is questioned about the subjective loudness of his tinnitus, whether it is perceived all the time, the degree to which it interferes with his activities, how annoying it is,

and so on. The diagnostic interview and the detailed discussion of audiological results are considered an important part of the counselling. Patients are educated about the auditory system and the model of tinnitus. They are also informed about the therapy concept. It is emphasized that tinnitus in itself is nothing to worry about, but rather that worrying keeps tinnitus alive and prevents habituation. The therapist explains that the audiological interventions will support habituation by helping the brain to reorganize the processing of the abnormal activity caused by peripheral dysfunction. Patients are informed of alternatives with which they can receive competing auditory stimulation (noise generator, hearing aid, environmental sound enrichment). In the majority of cases noise generators are recommended to the patient and adapted for individual use. In the following session the use of noise generators are explained and the patient is instructed to wear them for several hours each day. In each succeeding session the therapist asks the patient about changes in tinnitus perception and records changes on a protocol sheet. Any existing problems with the hearing devices are discussed and the counselling of the patient regarding the emotional side of tinnitus is continued. Whether further counselling sessions are held is up to the patient. Therefore the number of patient-therapist encounters and the total length of therapy are not fixed. In any case it is recommended to wear the noise devices at least several months for 6–8 h a day or the hearing aid continuously.

Since Jastreboff emphasizes 'directive counselling' as the most influential intervention component in determining the success of therapy, it is surprising that the descriptions of counselling topics and techniques that he offers remain rather vague ('explanation, encouragement, advice': M. Jastreboff, pers. comm., Congress of Behavioural Medicine, Prien, 1999). Wilson et al. (1998) in a critique of Jastreboff's counselling concept underline an important difference between directive counselling and cognitive intervention strategies: Though the latter comprise information giving, encouragement, and sometimes even 'advice', they are more than this. Special techniques (reality testing, disputation techniques, self-monitoring of cognitions and their consequences, dissonance techniques, etc.) are used to alter the patient's dysfunctional and emotion-

ally anchored belief system by leading the individual to discover his dysfunctional cognitions on his/her own and to develop realistic cognitions and adaptive beliefs, thereby modifying his/her emotional responses. This approach was developed by Beck & Greenberg (1977) and Ellis & Grieger (1979), because of their experience that simple instructions are often not effective in modifying cognitive schemata or solving emotional problems.

Jastreboff sees no necessity of involving specially trained psychologists in TRT counselling (Jastreboff, pers. comm., letter to Hellweg, 1998), but holds the conviction (that well-trained otologist or audiologist suffice for adequate counselling). Thus he is of the opinion that the vast majority of his patients can be helped using simple counselling techniques. The main principle of directive counselling according to Jastreboff is as follows: 'It is fundamental that the patient understands the basis for the approach, has a clear vision of the procedures, the reasoning for their use, expected results, and time course of recovery' (Gray et al., 1996: 497). The authors of this article share the experience that at least disabled chronic tinnitus sufferers are in need of more intensive, specific and sophisticated intervention programs in order to change their tinnitus-related cognitions, emotions and behaviour and thus decrease the disrupting and annoying consequences of tinnitus.

The fact that 79% of patients are advised to wear noise generators marks this as the routine treatment procedure. This is somewhat surprising, since counselling is always referred to as the most important treatment technique. Jastreboff nevertheless emphasizes that treatment is strictly 'individual'. What he means by this, however, remains unclear. He may wish to underline that there is no standardized treatment protocol and that patients are not treated in groups.

Since the TRT procedure does not have a published protocol (unless one participates in Jastreboff's TRT seminars detailed information cannot be found.), obviously different treatment centres handle TRT in different ways (according to our knowledge). Therefore, the fact that a tinnitus intervention technique is labelled TRT is not a guarantee that the treatment procedure is conducted in accordance with Jastreboff's suggestions. This was also underlined by the Clinical Guidelines Working Group of the British Tinnitus Association (1999).

## Methods of evaluation and efficacy of TRT

The diagnostic and evaluative instruments Jastreboff recommends (pers. comm., 2nd Tinnitus Seminar, Frankfurt, 1998) and uses himself are of a methodologically low standard compared with well-established and widely acknowledged standards in therapy research. Jastreboff suggests an interview as the best and only assessment strategy for collecting information from the patient at the start of treatment as well as during the course of therapy, when assessing the patient's progress. Information gathered this way is vulnerable to the influence of social desirability since it is probably difficult for a patient to renounce any therapeutic progress to a dedicated and committed therapist, with whom he is engaged in face-to-face interaction. Furthermore, the manner in which self-report data are assessed lacks methodological quality regarding the standards of validity and reliability. The questions are global, sometimes hard to understand and the scaling is not adequately visualized to the patient. It is questionable, whether the construct of interference and annoyance due to tinnitus is adequately assessed by the method employed (one dimensional scale 0–10). No standardized test of known reliability and validity is used. A tinnitus diary is rejected by Jastreboff, though it has often been observed that diary keeping in itself can be therapeutic in reducing annoyance (Kröner-Herwig et al., 1995; Kröner-Herwig, 1997). Moreover, diaries are advantageous in that the patient's experience and behaviour can be assessed not only in his everyday environment but also without time delay, thus limiting memory biases in the patient's self-report. It is furthermore regrettable and scientifically unacceptable that information on the recommended assessment methods are not offered in detail in Jastreboff's publications, but must be gathered from personal communications in lectures, seminars and workshops. Summing up the conclusion must be drawn that adherence to Jastreboff's assessment procedures not only impedes but prevents a methodologically sound evaluation of therapy outcome.

Nevertheless we want to examine the data on the evaluation of TRT presented by Jastreboff himself, before reviewing studies by other authors relevant to this topic. From 600 patients treated in Jastreboff's TRT centre, 124 were,

according to Jastreboff, randomly selected (Jastreboff, 1996) and evaluated regarding improvement. Two groups of patients are differentiated, one group having received full treatment (counselling plus an acoustic device) including several follow-up visits and one group having had a single counselling session. How especially the latter group came into existence, is not explained in detail. Improvement was defined by the following criteria: tinnitus-related interference of at least one activity has ceased, percentage of time the patient is aware of tinnitus is reduced by 30%, annoyance by tinnitus is reduced by at least 30%, quality of life has improved, and the patient has to confirm that tinnitus has improved (Jastreboff, 1996:505). TRT is considered successful when a patient meets more than one criterion. There are, however, inconsistencies in the reported percentage of change that is needed to fulfil the criteria by which success is defined. In a recent TRT seminar Jastreboff proclaimed that a reduction of 20% in the above mentioned tinnitus variables is defining improvement (Jastreboff, pers. comm., 2nd Tinnitus Seminar, Frankfurt, 1998). Thus it is not quite clear to what criteria Jastreboff exactly refers to when reporting TRT related improvement rates. According to Jastreboff's (obviously rather soft) improvement criteria about 79.4% of the 124 patients having received full treatment as well as 18.2% of the 21 patients treated in only one session can be classified as having improved. It should be mentioned, however, that neither the selection bias of patients turning to the centre for treatment (e.g. level of and variation in disability) nor the number of drop-outs is reported. Treatment conditions were not randomly assigned, nor was a control group used. Furthermore, the data are not presented as prescribed by scientific demands, i.e. they are lacking precision (e.g. Gray et al., 1996:497: 'Notably none of the patients ... showed a worsening of tinnitus.' Jastreboff et al., 1996:239: 'We have gathered data from 2100 subjects.') All in all Jastreboff's evaluation of TRT is characterized by various methodological weaknesses and cannot claim to be a rigorous test of treatment efficacy.

Besides reports of Jastreboff himself concerning the efficacy of TRT, we examined evidence from studies applying TRT-like treatments or using components of TRT.

Vesterager (1994) published the results of a clinical study on 181 consecutive patients who

took part in program providing supportive psychological therapy and 'instrumental' treatment (noise generator or hearing aid) in the Audiology Department of a Danish hospital. The sample was highly selective, including only patients who perceived tinnitus as a major problem, interfering with daily activities and hampering quality of life. The program instrument consisted of three standard sessions (information giving, counselling, psychological therapy, instrument fitting) and further treatment sessions according to individual needs. An outcome evaluation was carried out 0.5–4.5 years after the last therapeutic contact (postal survey). The results indicate that about one-third of the patients returned their instruments within 6 months of the fitting. Only 16% report using the noise generator or hearing aid daily. After therapy tinnitus loudness decreased, as did sleeping and concentration problems. For the majority of the variables significant changes were found only in the patient groups with a medium or high amount of tinnitus complaints. The study, however, is ridden with methodological limitations. Thus a conclusion regarding the relative importance of the instruments cannot be drawn. The treatment protocol is not adequately described. The evaluation procedure, designed as a means for quality assurance more than for treatment evaluation, is rather simple and does not include standardized instruments. Furthermore, no control group is used. Thus the scientific value of the study is limited regarding the issue of treatment efficacy.

Von Wedel et al. (1997) examined the significance of partial masking versus complete masking (either by maskers or hearing aids). Their analysis was retrospective and the therapy was not originally conducted in a TRT framework. Patients were asked whether they had used complete or partial masking and were accordingly grouped into different categories. Therapeutic outcome was determined by the Tinnitus Questionnaire (German adaptation of the version of Hallam et al. 1988; see Goebel & Hiller 1992; Hiller & Goebel 1992). Data were assessed 1, 2 and 3 years after therapy begin. For both groups of patients (equipped either with hearing aid or noise device) partial masking was more successful than complete masking in reducing disability due to tinnitus. The authors summarize that after 3 years in the condition of complete masking total relief from tinnitus was reached by 7–8% of all

Table I. Empirical studies relating to the evaluation of TRT

Study	Design	n	Intervention	Control	Assessment	Results
Biesinger et al. (1998)	Clinical trial	42	Counselling, noise generator, relaxation (psychological therapy)	No	TQ* 2, 4, 6, 12, 24 months	Distinct reduction of tinnitus related annoyance (no improvement in 6 patients)
Dineen et al. (1997)	Randomized group study	71	a) information b) information + noise generators c) information + relaxation d) information + noise generators + relaxation	Comparative treatment conditions	Audiological measures, standardized questionnaires relating to tinnitus, stress and coping	Best outcome in group d) No statistical differences between groups a-d
Goebel et al. (1999)	Clinical trial (not randomized)	80	a) counselling, cogn. therapy, noise generator b) noise generator alone  c) cogn.-behav. tinnitus coping training	Waiting list	TQ and various self-report questionnaires	Study not completed; preliminary results: Use of noise gen. alone not efficacious In treatment a) and c) distinct reduction of annoyance and disability
McKinney et al. (1998)	Group study	279 (TRT: 129)	TRT (directive counselling, sound therapy)	Untreated	Annoyance, quality of life, awareness (NRS 0–10) at 1 year after start of therapy	Significantly greater positive change in all three variables in TRT Criterion: change from baseline $\geq 20\%$ in at least two variables: 78% in TRT 18.8% in control
McKinney et al. (1999)	Group study	186	a) counselling alone b) counselling + just audible noise generators c) counselling + noise generators set at, or just below mixing point with tinnitus d) counselling + hearing aid e) counselling + combination instruments f) counselling + high frequency emphasis hearing aids	Comparative treatment conditions	Annoyance, quality of life, awareness, loudness (NRS 0–10) at 1, 2, 6, 12, 24 months audiological measures	69.8% improvement in the whole treatment group Best outcome in group c) No statistical differences between sub-treatment groups a–f
Sheldrake et al. (1996)	Clinical trial	149	Counselling + noise generator	No	Interview data	Improvement in 96%
Jastreboff et al. (1996)	Clinical trial	124	Counselling, one session (n = 21) counselling + noise generator or hearing aid	No	Interview data	Improvement in 79.4% of TRT treated patients Improvement in 18.2% with one counseling session pat.
Vesterager (1994)	Clinical trial	181	Information, counselling, psychological treatment, noise generator or hearing aid	No	Self-report by questionnaire (postal assessment) at different follow-up periods	Overall significant reduction in tinnitus loudness, sleeping and attention problems
von Wedel et al. (1997)	Clinical trial (retrospective)	216	Partial masking (masker/hearing aid) complete masking unspecified further interventions	Comparative treatment conditions	TQ	Partial masking more successful All patients: 38–41% complete relief 38% partial relief

\* Tinnitus Questionnaire.

patients treated, partial relief by 25% of the patients using hearing aids and 16% of the noise device users. It must be emphasized that the criterion of partial relief as defined by the authors was rather 'hard' (reduction of 10 points in the TQ). Under conditions of partial masking, total relief from tinnitus was found in 38–41% of the patients and about 38% experienced partial relief. It is also mentioned that all patients received some counselling and that stress management techniques were included. No detailed information on these treatment components is offered.

These are impressive results that seem to support Jastreboff's assertion that total masking

of tinnitus is not helpful. However, as the method of determining partial and complete masking is of unknown reliability and since the contribution of counselling and stress management techniques to treatment success cannot be determined it is open whether or to what extent the application of a noise generator has a significant impact on treatment success. Since, again, no control group is used, it is furthermore open whether the development of tinnitus in patients receiving the crucial treatment is different from the development that might be observed in patients who did not receive the crucial treatment or any treatment at all.

In a study by Dineen et al. (1997) a randomized group design was used to determine the efficacy of noise generator utilization. Four treatment conditions were compared: information alone/information; noise generator/information; relaxation/information; relaxation and noise generator ( $n = 71$ ). Measures of good methodological quality were used. There were no statistically significant differences in the various outcome measures (change scores) between conditions. The largest effects were seen in the group receiving all three treatment components. Though the study's design is methodologically acceptable in contrast to the aforementioned studies, it allows no definite conclusions on the efficacy of TRT, since there is no explicit use of counselling or it remains unclear whether the information conditions can be considered equivalent to directive counselling. Since no significant outcome difference was found between treatment including a noise generator (information and noise generator) and treatment excluding one (information alone), the study offers no good argument for employing noise generators in order to foster habituation.

McKinney et al. (1998) presented a poster on a study with 129 TRT-treated patients referred to a tinnitus clinic and an untreated control group, which was recruited by advertisements in a journal. The authors present data on tinnitus annoyance, quality of life and tinnitus awareness at 1 year after start of treatment. They summarize their findings by stating that in all three outcome variables the treated group improved significantly more than the untreated group. Using the criterion of 20% change in at least two variables they find an improvement rate of 78% in the TRT group and a rate of 18.8% in the control group. A positive appreciation of these results is made difficult by the various differences between both groups at baseline (see different selection procedures). A direct comparison of results of other treatments is not possible because of different evaluative procedures. The same research group (McKinney et al., 1999) describes an evaluation of the TRT method following a dismantling strategy. Different treatment sub-groups are compared: counselling alone/counselling plus just audible noise generators/counselling plus noise generators set at, or just below mixing point with tinnitus/counselling plus hearing aids/counselling plus high-frequency emphasis hearing aids

and counselling plus combination of instruments. 186 patients were sequentially assigned to the sub-groups. Individuals were treated and assessed at an initial clinic appointment and 1, 2, 6, 12 and 24 months later. The criteria for response to TRT was set at a 40% improvement after 12 months in at least two of the variables: annoyance, life quality, percent of awareness and loudness. No psychometrically validated tests were used as outcome measures. Regarding the whole treatment group the greatest improvement occurs after 3–6 months. After 6 months only slight improvement is found, which makes Jastreboff's demand for extended therapy duration questionable. After 24 months all changes are significant. 69.8% of the treatment group responds to TRT, using the criteria mentioned above. Looking at the sub-groups it is shown that neither the mean change in the questionnaire scales, nor the percentage of individuals in the treatment sub-groups (12 months) are significantly different from one another or the total group. Differences in the amount of minimal masking level and loudness discomfort level after 12 months are not significantly different between the sub-treatment groups either. The results of this study point out that directive counselling appears to be the most important element of TRT, whereas the gain by wearing any form of instrument is minimal.

Sheldrake et al. (1996) report on the data of 149 patients treated by TRT in a clinical trial lacking a control group. They state an improvement rate of 96%, mainly derived from interview data on tinnitus 'awareness'. Wilson et al. (1998) criticize the design of the study and its large deficits regarding information about measurement procedures and the definition of improvement. Therefore the extremely positive results reported in the study cannot be considered reliable.

Biesinger et al. (1998) defined the TRT they employed by the following objectives: Decoupling perception from tinnitus, reducing the stress response due to tinnitus, and treating emotional and psychological disorders as sequelae of tinnitus. The treatment interventions employed to attain these goals are, in accordance with Jastreboff's recommendations, counselling and the wearing of a noise generator. Patients are additionally advised to enrich their auditory environment. The second goal is, according to Biesinger et al., attained by the application of

relaxation techniques, whereas the third objective is attained by psychological therapy. The authors explicitly demand the involvement of psychologists in TRT. They report a study on 42 patients in the context of the described concept. All patients received noise generators and were counselled in accordance with the mentioned objectives. In addition some patients received a psychological therapy. What kind of psychological therapy was offered and how many patients attended it is not reported. Patients were evaluated at 2, 4 and 6 months after the first counselling session. Counselling was continued once every 6 weeks for the duration of about 2 years. The authors report a high degree of compliance regarding the use of the noise devices. After 6 months 78.8% of the patients still used the equipment for at least 6 hours a day. The score of the Tinnitus Questionnaire (Goebel & Hiller, 1992; Hiller & Goebel, 1992) declined by 9.1 points during the first half-year of evaluation, then decreased slightly more and stabilized between years 1 and 2. Only one patient dropped out of the program. After 2 years only 6 patients reported no progress. One can conclude that this group of patients profited markedly from therapy under the condition of high treatment adherence and supplementary psychological therapy. The course of the outcome data points to the fact that the biggest gain in therapy is made within the first half year, again making the demand for extended therapy duration questionable. The degree of improvement made is of a similar size as that attained in cognitive-behavioural trainings (see Table I). The outcome measure used in this study makes a direct comparison to Jastreboff's data impossible.

Goebel et al. (1999) report on an ongoing study on tinnitus therapy including various treatment conditions. One group of patients was provided with noise generators and instructed to use the instruments according to Jastreboff's guidelines. This group received no counselling.

Treatment components for a second group of patients comprise counselling, noise generator use, and an out-patient cognitive training (4 × 3 h). The third treatment condition is identical except that noise generators were not provided for. Additionally, a waiting list control is installed. There is no randomized assignment to the various treatment conditions. Beside the

Tinnitus Questionnaire various outcome measures are used. Preliminary results point to a low effectiveness of noise generator use alone, a result that is in line with Jastreboff's assumptions. In both other treatment conditions a marked reduction of annoyance and disability was observed. Since both conditions include psychological interventions the study does not really test TRT as conceived by Jastreboff. The authors preliminary conclusions are that a tinnitus treatment comprising counselling and cognitive interventions to improve coping constitutes a successful therapy of chronic tinnitus.

## Discussion

It has been shown that Jastreboff's neurophysiological theory of tinnitus, and its assumptions regarding treatment characteristics in particular, focus on psychological processes, especially attention direction and emotional responding to tinnitus. These factors, however, have previously been addressed in more detail by other authors, especially by R. Hallam (Hallam et al., 1984; Hallam & Jakes, 1987; Hallam et al., 1988). Thus it is rather regrettable that Jastreboff in his noteworthy and important article of 1990 fails to refer to Hallam's work. One strong point in Jastreboff's model, however, is the integration of peripheral as well as central auditory processes, and psychological processes into a neurophysiological concept of tinnitus; this makes his theory appealing to otologists. Thus Jastreboff offers a rationale for the treatment of chronic tinnitus patients that is plausible, straightforward and simple, and relies heavily on giving the right information to patients. He thereby can most probably relieve otologists from the feeling of helplessness they often face in the presence of chronic tinnitus sufferers.

We believe that TRT (especially counselling) effectively helps many tinnitus patients, though not all. We also emphasize that the educational approach should be the first step in treatment. As clinically experienced practitioners we are, however, convinced that a considerable proportion of patients is in need of additional psychologically well-elaborated interventions. In our opinion, it must be questioned whether the noise generator is an obligatory factor warranting treatment success rather than a technical placebo. All in all Jastreboff offers a good framework

demanding an interdisciplinary setting including otological and psychological experts in the treatment of chronic tinnitus.

The authors of this paper (the majority being psychologists) wonder why Jastreboff renounces the expertise of psychologists, e.g. in specifying goals and techniques of counselling and improving efficacy of treatment by including specific cognitive-emotional intervention techniques. It is also peculiar that Jastreboff does not include interventions to reduce stress and tension, in spite of the importance ascribed to stress in his model as a prerequisite or a consequence of tinnitus. Though Jastreboff's theoretical propositions are useful for conceiving and explaining tinnitus therapy, the main concepts regarding cognitive and emotional processes are not new and could be more elaborate.

Regarding the use of the term TRT as a denomination for a specific therapy, caution is warranted. A look into TRT literature (see also Clinical Guidelines Working Group of the British Tinnitus Association, 1999) and especially our interviews with otologists or psychologists in Tinnitus Retraining Centers made it very clear that TRT is not carried out in a standardized manner. Thus different procedures hide behind a common label. Since it makes no sense to strictly demand TRT to follow Jastreboff's recommendations, it is evident that every practitioner and every researcher conducting TRT or any variation of so-called neurophysiologically-based management, as the British Tinnitus Association names interventions based on the same principles, must describe the specific treatment format he employs very carefully.

Regarding the state of empirical support it must be concluded that the evaluation approaches so far used in TRT generally lack methodological quality. This is especially true for the evaluation procedure Jastreboff recommends. There are only a few studies that make use of psychometrically validated tests as outcome measures (e.g. Biesinger et al., 1998). Their model should be followed in the future. There is to our knowledge as yet no published study, evaluating TRT using a randomized group design, though this is the only design able to give valid information on the empirical status of a therapy. Thus the conclusion must be drawn that a control group design study at least with a waiting-list control group is required. Further-

more, it is interesting to follow a 'dismantling' strategy, as attempted in the study from McKinney et al. (1999), in which counselling turned out to be the most effective component of TRT. It also is necessary to compare TRT to other therapeutic techniques, e.g. cognitive-behavioural trainings (with randomized assignment to treatment conditions), to determine their comparative efficacy and their efficiency (cost-effectiveness). It must be underlined that in any study whatsoever the TRT protocol must be carefully described as must the assessment instruments and last but not least the results. Furthermore, we need studies using process measures to investigate the course of improvement and the underlying therapeutic mechanisms.

The public praise of TRT as the most promising therapy for chronic tinnitus can only be regarded as premature, we still await scientific corroboration. There are no grounds for discrediting TRT, neither is there reason to claim its superior efficacy. At the given time we must instead conclude that more empirical support exists for the efficacy of cognitive-behavioural therapies, since numerous randomized control group studies on these treatments have been conducted. But again, direct comparison of treatments using the same evaluation methods in the same setting are needed. Thus the conclusion Jastreboff (1998) reaches regarding TRT: '... but I strongly believe that it is the best method available at this time', is nothing but a personal conviction.

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