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Auditive Stimulation Therapy as an Intervention in Subacute and Chronic Tinnitus: A Prospective Observational Study

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Abstract: Tinnitus is a noise, a ringing, or a roaring sound in the affected ear and is becoming an increasingly serious problem for health care systems. Integrative treatment concepts are currently regarded as promising therapeutic approaches for managing tinnitus. The aim of this study was to present the results of auditive stimulation therapy, a program of music therapy developed specifically for tinnitus treatment. We collected data on outpatient treatment results from 155 tinnitus patients and evaluated them in a prospective observational study with three defined times of measurement (start, end, and 6 months after the end of treatment). Apart from anamnestic data and subjective evaluation of treatment, the major outcome parameter was the score of the tinnitus questionnaire. To evaluate effectiveness of the therapy, we calculated effect sizes (according to Cohen). Fifty-one percent of the patients were male, and the mean patient age was 49 years. Of the 155 patients, 137 (88%) were capable of gainful employment, which means that they fell in the age range between 18 and 65 years. The duration of tinnitus was more than 6 months for 80% of patients, and 43% had been suffering from tinnitus for more than 3 years. In general, all subscales of the tinnitus questionnaire showed highly significant changes (t-test, $p < .01$) between the measurement points "start of therapy" and "end of therapy," whereas no significant difference was found between the measurement points "end of therapy" and "follow-up." At follow-up, the values of the subscales were stabilized at a level recorded at the end of the therapy; we did not observe a reduction to the level prior to treatment. The values for the effect sizes mostly ranged between medium (> 0.5) and high (> 0.8). Closer investigations indicated that a combination of music therapy and psychological training rendered the best effect sizes. This study demonstrated that music therapy is an effective integrated treatment approach and offers a way to make progress in tinnitus treatment.

Key Words: effectiveness; music therapy; outcome research; tinnitus

The term *tinnitus* is derived from the Latin *tinnire* ("ringing") and is defined as the perception of sound in the absence of any appropriate external stimulation. A basic difference separates objective and subjective tinnitus. The term *objective tinnitus* is used for ear sounds based on genuine physical vibrations-oscillations that may be perceived by others or even measured [1]. This type of tinnitus is rather rare, whereas subjective tinnitus is far more frequent. In such cases, only the person afflicted perceives the sounds. These may occur as rustling, whistling, whirring, ringing, or droning sounds. High-frequency sounds are perceived far more often than are low-frequency sounds [2], and a hearing impairment is detectable in more than 50% of all cases.

The incidence of patients experiencing tinnitus in Germany and the Western world is approximately 10%. Some 1–2% of the population is severely disturbed by tinnitus, which may disrupt everyday activities and sleep [3]. If the symptoms continue for 6 months, we consider the condition to be chronic, the degree of which differs considerably from person to person and

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affects patients in different ways [4]. A decompensated tinnitus is accompanied in most cases by other complaints (e.g., depression, anxiety, impaired sleep and concentration, sensitivity to noises, and the like) [5–7]; consequently, intervention is required. Several treatments of chronic tinnitus have been proposed and implemented [8]. Among complementary therapies, homeopathy and acupuncture are proposed [9–11]. Although several case studies reported efficacy of these treatments, the empirical support in well-controlled studies is still weak [12,13].

Today, such integrative therapy concepts as cognitive-behavioral treatment compiled from counseling, relaxation therapy, music therapy, and pharmacological preparations (lidocaine, neurotransmitters) are regarded as promising therapeutic approaches for managing tinnitus [7]. In particular, music therapy offers the chance of a global treatment approach for tinnitus patients [14]. Harmony, for instance, as a connecting link between rhythm and melody also has a social function. Rhythm may also influence biological parameters via tempo accentuation and meter [15]. These components form the theoretical background for auditive stimulation therapy (AST), the music therapy (MT) program evaluated in this study.

THERAPY

AST is a complex program of MT originally employed in the treatment of chronic pain and developed specifically for tinnitus treatment. It consists of a total of 10 therapy sessions and employs specifically developed receptive music programs in combination with an education program. Musical self-control (MSC) training is a music program designed on the basis of music psychology and MT, the effectiveness of which was demonstrated in a clinical study [16]. The objective of MSC training is to improve patients' control of ear sounds and to relieve their feelings of helplessness. Ringing in the ear or strange sounds bring about alterations in perception. If we encourage the ability of selective hearing, we can promote some sounds in the hierarchy of perception and ignore other sounds or regulate them until they become hardly perceptible. Such training improves (i.e., lowers) the level of sensitivity to sounds.

Finally, the objective of AST is to bring about a change in sound perception that induces relaxation, reduces anxiety, and stimulates changes in unfavorable behavior patterns, thus improving the emotional state. The education program is aimed at alterations on a cognitive level.

The outpatient therapy (duration, 2 weeks) with AST consisted of a total of 38 hours of therapy (20-hr psychological training, 10-hr MT [AST], 8-hr kinesitherapy) and also included counseling by ear, nose, and throat experts, orthopedists, and dentists. Figure 1 shows the complete 2-week program of AST with its different modules.

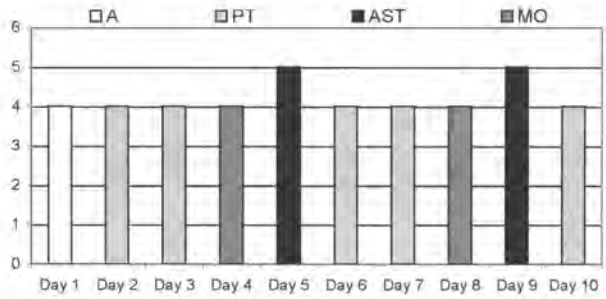

Figure 1. Complete 2-week program of auditive stimulation therapy (*AST*) as a function of hours of therapy per day. (*A* = admission; *PT* = psychological therapy; *MO* = motor therapy.)

METHODS

At the Tinnitus Therapie Zentrum Krefeld (Germany), we performed an observational study on a multimodal treatment concept (Krefelder-Modell) being applied on an outpatient basis for subacute and chronic tinnitus over a projected period of 2 years. Data on treatment were collected and evaluated in a prospective observational study using several standardized questionnaires immediately before and after therapy and at follow-up after 6 months. Apart from anamnestic data, the questionnaires asked for a subjective evaluation of treatment results. The tinnitus questionnaire designed by Goebel and Hiller [17], now the recommended standard tool throughout Germany, was used at all times for measurement. Included in the evaluation were only those questionnaires in which more than 90% of the questions were answered properly.

We included a total of 155 patients in this evaluation. Sufficient follow-up documentation for assessment was available for 111 patients (71.6%). Figure 2 shows the questionnaire instruments used and the patient flow in this study.

For an evaluation of the efficiency and sustained success of the therapy, we applied the *t*-test to show significant differences of tinnitus questionnaire scales after therapy. We carried out subgroup analysis of outcome measures according to the degree of tinnitus severity. Therefore, the tinnitus questionnaire results were grouped in the following clinically relevant groups: minor tinnitus (0–30 points); medium tinnitus (31–46 points); serious tinnitus (47–59 points); and very serious tinnitus (60–84 points).

As the treatment concept presented in this study (Krefelder-Modell) is a multimodal concept, the differ-

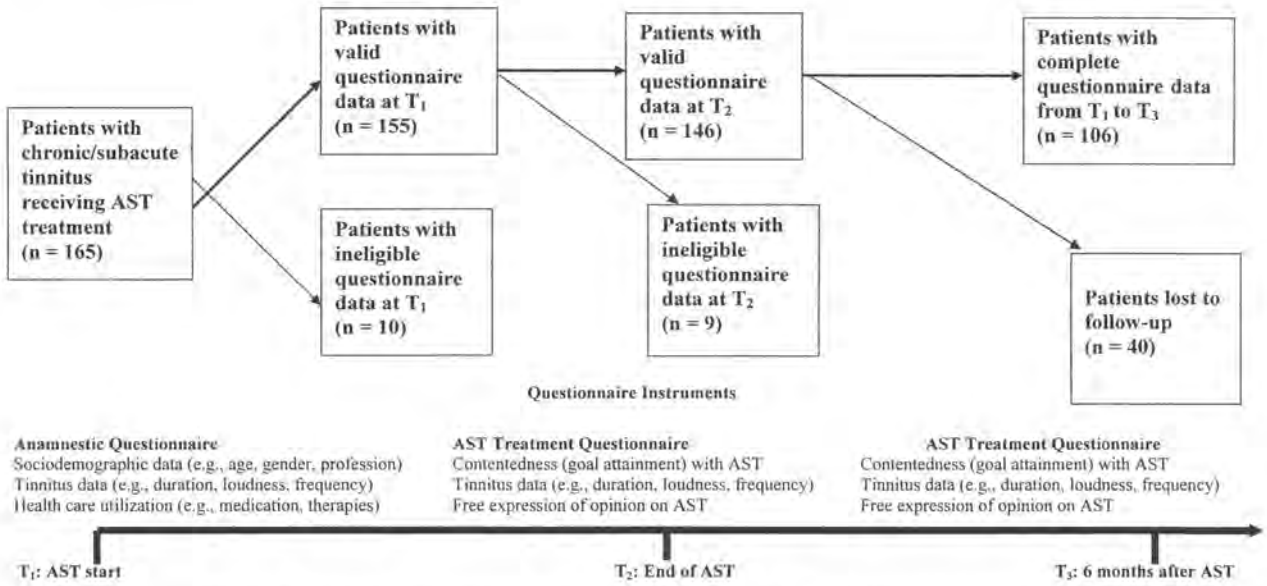

Figure 2. Patients and questionnaire instruments. (*AST* = auditive stimulation therapy.)

ent elements of treatment can be compared to achieve more detailed results on the efficiency of the MT training program (AST). Kinesitherapy having received a distinctly lower rating by patients, only the two treatment elements rated as most successful were compared with respect to their effectiveness: psychological training (PT) and music therapy (MT).

To evaluate effectiveness of the therapy and to render the results comparable with each other and also with other treatment facilities in the health care sector, we calculated effect sizes according to Cohen [18] and corrected according to McGaw and Glass [19].

PATIENTS

One hundred thirty-seven patients (88.38%) were of wage-earning age (i.e., between 18 and 65 years). Table 1 shows that the duration of tinnitus was longer than 6 months for 80% of patients. A total of 43.3% had been suffering from tinnitus for more than 3 years; 33.5% of those interviewed reported that tinnitus developed gradually. Every second patient (50.3%) said tinnitus set in suddenly; 16.1% did not answer this question; 76.8% said tinnitus occurred continuously; and 21.3% reported that tinnitus occurred with interruption. Three patients (1.9%) had no comment. Almost all patients (94.8%) reported times at which tinnitus was particularly intense. In contrast, only 75.5% said that at times tinnitus was barely perceptible.

Patients were also asked how often they resorted to seeking assistance through the health care system over 6 months before treatment, and they had the option of several possible answers. Seventy-four patients answering this question (47.74%) reported 111 individual consultations (main consultation with ear, nose, and throat specialists), which means an average of 1.5 consultations per patient approximately. Before treatment, patients were also asked about previous treatment; 137 patients reported a total of 304 instances (i.e., an average of 2.2 treatments per patient). The major treatments were infusions (78.8%).

RESULTS

The total score of the tinnitus questionnaire (Tinnitus Fragebogen [TF]) at the different measurement points is shown in Figure 2. The follow-up sample with regard to the TF total score did not differ significantly from that of the general population, which has been demonstrated [16]. Therefore, Figure 3 shows the mean scale values of the tinnitus questionnaire before and after outpatient tinnitus therapy (n = 146) and also at follow-up after 6 months (n = 106).

In general, all subscales showed highly significant changes (*t*-test, $p < .01$) between the measurement points "start of therapy" and "end of therapy," whereas we found no significant difference between the measurement points "end of therapy" and "follow-up." At follow-up, the values of the subscales were stabilized at a level recorded at the end of the therapy; we did not observe a reduction to the level before treatment. Approximately 80% of the patients with a disease severity of *medium* to *very serious* at least moved to a clinically improved stage (e.g., from *very serious* to *serious*). The

Table 1. Sociodemographic and Anamnestic Data

Characteristic	Male	Female	Total
Gender	51%	49%	100%
Age			
Mean	48.9 yr	48.7 yr	48.8 yr
Standard deviation	12.1 yr	15.5 yr	13.9 yr
Median	52 yr	50 yr	51.5 yr
Marital status			
Single	16%	17%	17%
Married or established partner	74%	64%	69%
Divorced or living separated	10%	9%	10%
Widowed	—	9%	5%
Graduation			
Secondary school	55%	43%	49%
Secondary modern school	25%	29%	27%
High school, A-levels	7%	18%	13%
University or college	13%	9%	11%
Profession			
Laborer	33%	13%	23%
Clerk	40%	48%	44%
Self-employed	4%	3%	3%
Unemployed	24%	37%	30%
Duration of tinnitus			
<6 mo	20%	20%	20%
6–12 mo	16%	16%	16%
1–3 yr	20%	22%	21%
3–5 yr	14%	10%	12%
>5 yr	30%	32%	31%
Loudness, ear-ringing: 0 (not at all) to 10 (maximum)			
Mean (95% CI)	6.5 (6.0–7.0)	5.5 (4.9–6.1)	6.1 (5.7–6.5)
Standard deviation	2.2	2.8	2.5
Median	6	5.5	6
Disruption, ear-ringing: 0 (not at all) to 10 (maximum)			
Mean (95% CI)	7.0 (6.4–7.6)	6.4 (5.7–7.1)	6.7 (6.3–7.1)
Standard deviation	2.6	3.0	2.8
Median	7	6	7
Restrictions, ear-ringing: 0 (not at all) to 10 (maximum)			
Mean (95% CI)	5.8 (5.1–6.5)	4.5 (3.8–5.2)	5.2 (4.7–5.7)
Standard deviation	3.0	3.2	3.2
Median	6	4	5

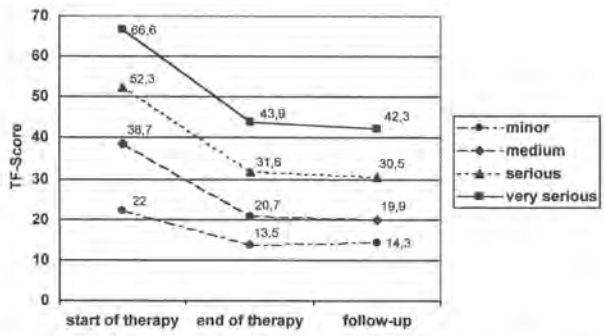

Figure 3. Total score on the tinnitus questionnaire (*TF*) at the different measurement points, according to degree of disease severity.

details of this transition process will, however, be the subject of a following evaluation using Marcov-chains methods.

We determined the values of effect sizes for individual subscales and for the total score. The values for the effect sizes were all in the range of medium (> 0.5) to high (> 0.8), with the exception of the scale *somatic disorders*, and are illustrated in Figure 4.

In a comparison of the individual therapies, AST was responsible for a surprisingly high percentage of the positive total result and clearly was preferred by patients, despite the fact that psychological training was twice as long (20 therapy session hours as compared to 10 for MT). For further analysis of these findings, we

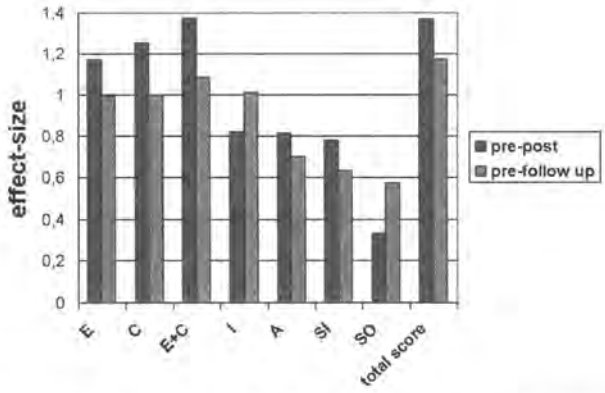

Figure 4. Changes (on the tinnitus questionnaire) of scale values in effect sizes. (*E* = emotional distress; *C* = cognitive distress; *I* = intrusiveness; *A* = hearing problems; *SI* = sleeping problems; *SO* = somatic complaints.)

calculated effect sizes at measurement times and related to the patients' subjective evaluation. Figure 5 illustrates the calculation of effect sizes.

A combination of MT and PT renders the best therapeutic effect. MT alone ranked in second place, and PT was third. The combination of MT-PT comprises the partial therapies MT and PT, and this suggests that the share of MT in this result is higher than that of PT. In addition, MT shows excellent effect sizes over longer periods, a clear indication of the quality of the concept of AST as to contents and didactic implementation. The results appear to confirm in particular the intention of enabling patients to continue independently with MT and to make autonomous use of receptive music programs. The most expressive results in this context certainly are those of the follow-up, as the data from these particular patients are available for all measurement times. In retrospect, they were able to come to a conclusive evaluation for themselves.

In answer to the question of whether the therapy

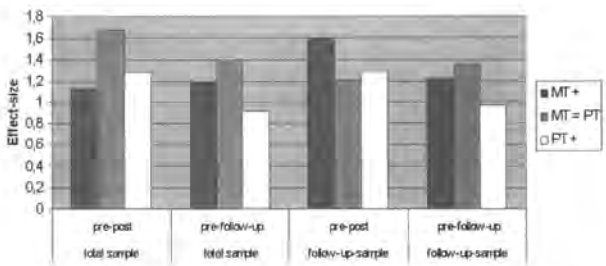

Figure 5. Changes in effect sizes (total, n = 143; follow-up, n = 105) depending on patients' preferred therapy. (*MT+* = subgroup of patients favoring music therapeutic elements; *MT=PT* = subgroup of patients who were indecisive between music therapy and psychotherapy; *PT+* = subgroup of patients favoring psychotherapeutic elements.)

helped them to cope better with ringing in the ear, 40% of patients described the success as excellent, 29% as good, and 16.8% as satisfactory. At a follow-up 6 months after the end of the therapy, the question was whether any ear ringing was still perceivable; 3.2% of patients reported none at all; 30.8% had a temporary absence of ear ringing; some two-thirds of patients continued to perceive noises during the 6 months after the therapy ended, but these had noise that had been clearly reduced. In summary, 52.3% indicated further positive changes after the therapy was concluded.

CONCLUSION

An analysis of the tinnitus problem, particularly from a traditional perspective, suggests a general confusion among most experts, although many scientists have explored the problem. A great variety of models and treatment approaches are available, the effectiveness of which is still inconclusive. The standard therapies in Germany include medication to improve blood circulation or, with increasing frequency, infusions as part of a hospitalization period, with disproportionate side effects as compared to the severity of the complaints [20].

In this study, we were able to demonstrate that the multimodal concept achieves highly significant changes. The calculation of effect size, according to the tinnitus questionnaire results, illustrates that the most significant effect sizes occurred in the area of psychological stress and total score changes. In comparison with effect sizes of other studies with hospitalized patients and outpatients summarized in a meta-analysis by Schilter [21], the advantages of this treatment concept become evident. With an overall effect size of 0.63 from pretherapy to follow-up, other multimodal therapeutic strategies range far behind the results of the therapeutic approach described in this study. Medical treatments (e.g., tocainide, lidocaine, carbamazepine) or other remedies have effect sizes in the same magnitude; however, these therapies have side effects, such as tremor, vertigo, giddiness, and nausea [21]. Therefore, our nonpharmacological intervention achieves the high effect sizes of the drug-based therapies without their concomitant side effects. The Krefelder-Modell treatment concept alone uses an MT training program embedded within a complex treatment approach, indicating that the advantage—compared to other treatment forms—is principally the influence of the specific MT intervention.

If we assume that tinnitus is not a disease but a symptom of an underlying process, singular symptom–oriented approaches will fail [2]. Sixty-one percent of patients state that professional medical help was not of much use—a shockingly high figure in view of the numerous medical interventions. Much suggests a holistic

treatment approach, in which ringing in the ear is viewed as a sign of particularly high stress. The question of whether the symptom is of a somatic or a psychosomatic nature seems to be of no importance in the treatment of subacute and chronic tinnitus. An analysis not only of the biological but of the psychological and social needs of patients [22] provides a more comprehensive insight into and understanding of their situation. MT AST is seen as salient to their problems among patients and as highly effective, perhaps because we are not making a direct, singular psychological intervention but an intervention in the same modality as that in which the symptom is experienced. By accommodating sound control within an ecology of other sounds, itself within a stress-reduction context, we are offering a form of self-control that is adapted to a personal environment [23–25]. On this extended basis of our knowledge about hearing, we should be able to develop for affected patients coping strategies that address the causes of the problem directly and thus render the symptom superfluous.

Our follow-up interview of patients after 6 months showed a high degree of sustained therapeutic success. Furthermore, these interviews provide important feedback for therapists and show longer-term positive treatment results, specifically in the areas of well-being and reintegration of patients in their family environment, as amply demonstrated in our study. We hear frequently that therapy success in most cases becomes evident over time. If a reorientation in terms of perception takes place, the consequences of this reorientation, as therapeutic effects, are best seen in follow-up assessments.

The subjective symptom of tinnitus is a phenomenon that the unaffected cannot easily understand, as defining a cause is difficult in most cases. Hearing of sounds that are normally located externally is suddenly directed internally and, therefore, is difficult for others to imagine. The affected individual suffers from a personal noise problem that is inaudible to others; consequently, others lack understanding. Musicians, however, understand this concept as part of their daily practice [26]. "Only inner anticipatory hearing makes musical interpretation possible. This phenomenon is most obvious in Ludwig van Beethoven who composed without being able to hear. Accordingly, listening must also be seen as an internal process of perception" [14]. Neugebauer reminded us that a sensory stimulation must not necessarily result in a conscious perception, nor must a sensory experience necessarily be caused by a physical stimulus. The specific way in which music therapists or musicians hear may indeed be helpful or suitable in understanding tinnitus patients and also in explaining—taking a composer as an example—how such experiences of internal hearing may also be observed in different settings in which they are absolutely normal and by no means pathological. Aldridge [25] suggested that the purpose of MT is that patients are enabled to generate expressive potentials that reveal new possibilities for becoming healthy. In the context of ear ringing, MT might help to create a context of meanings that integrates the sounds or noises into the music and thus removes them from conscious perception, which would clearly promote recovery. Sounds no longer perceived as disturbing, once brought under control, are perceived as musical.

This study demonstrates that MT is an effective treatment approach and offers a way to make progress in tinnitus treatment. Music has an esthetic aspect; it is part of our cultural heritage. How we integrate sounds into our daily life and how they become perceived as noise or music is a complex activity involving the physiological, the psychological, and the social. A therapeutic intervention that incorporates these understandings appears to offer considerable benefits, not as a cure but as a healthy adaptation.

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