

Tinnitus School: An Educational Approach to Tinnitus Management Based on a Stress-Reaction Tinnitus Model

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Abstract: Stress is a significant factor influencing the clinical course of tinnitus. The auditory system is particularly sensitive to the effects of various stress factors (chemical, oxidative, emotional, etc.). Different stages of reaction (alarm, resistance, exhaustion) lead to different characteristics of tinnitus and to different therapeutic approaches. Individual characteristics of stress reaction may explain different aspects of tinnitus in various patients with different responses to treatment, despite similar audiological and etiological factors. A model based on individual reactions to stress factors (stress-reaction tinnitus model, or SRTM) could explain tinnitus as an alarm signal. In each patient, stressors have to be identified during the alarm phase to prevent an evolution toward the resistance and exhaustion phases. In the exhaustion phase, chronic tinnitus is due to the organization of a paradoxical auditory memory and a pathologically shifted attention to tinnitus. The aim of our study is to describe a therapeutic proposal based on the SRTM by taking an educational approach to management of chronic tinnitus. The educational aspect is emphasized; thus, we named our approach *tinnitus school*. Selection of appropriate patients and follow-up is based on psychometrics of tinnitus and stress questionnaires, including a tinnitus reaction questionnaire, a tinnitus cognitive questionnaire, and a 20-item perceived stress questionnaire. Tinnitus school is a three-phase program: counseling, training, and home training. Training is based on a tinnitus-fitted physiotherapeutic protocol.

Key Words: perceived stress questionnaire; physiotherapy; rehabilitation; stress reaction; tinnitus cognitive questionnaire; tinnitus reaction questionnaire

Stress is known to be a significant factor influencing the clinical course of tinnitus. The auditory system is, in fact, particularly sensitive to the effects of various stress factors (chemical, oxidative, emotional, etc.). Horner [1] described different stages of auditory pathway reaction to stress: alarm, resistance, and exhaustion. For severe, disabling chronic tinnitus, Shul-

man [2] demonstrated that a final common pathway exists in the medial temporal lobe system, the basic process of which is the establishment of a “paradoxical auditory memory.” He proposed for tinnitus a stress model in which the final common pathway involves the hippocampus and the cerebellum, providing the neurochemical basis (hippocampus) and the cognitive and motor basis (cerebellum) of abnormal behavioral aspects observed in tinnitus patients. Furthermore, Zenner and Zalaman [3] showed that in patients with chronic tinnitus, attention is pathologically shifted toward tinnitus and, in this way, cognitive functions are disturbed.

The aim of our study was to describe a therapeutic proposal based on a stress-reaction tinnitus model (SRTM) by taking an educational approach to management of

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patients suffering with chronic tinnitus. The educational aspect is emphasized, so we named our approach *tinnitus school*.

STRESS-REACTION TINNITUS MODEL

In a model based on reactions induced by exposure to stress factors—the SRTM—tinnitus is an alarm signal, just like an alarm bell, at least at its onset [4]. It informs an affected patient (and consequently, the physician) that something potentially dangerous for the subject's homeostasis is happening. In the SRTM model, aspects concerning the danger alarm (biochemical, sensory, motor, or affective) also explain epidemiological differences between the incidence of referred tinnitus (10–15%) and that of disabling tinnitus (2%). In other words, tinnitus could become a disabling symptom only in subjects chronically exposed to stress factors, when unable to switch off the alarm signal and to counteract the effect of the stressors. In other individuals, the same factors or diseases could provoke tinnitus without inducing disability because these subjects are skilled to cope with tinnitus and have a real capacity to restore homeostasis. Individual capacity to counteract stress factors is, in fact, strictly specific for each subject: This means that the evolution from alarm to exhaustion is specific for each patient [5]. Therefore, the definition of tinnitus as acute or chronic cannot refer merely to a standardized period but must be fitted to each subject.

According to the SRTM model, stress signals of a specific patient have to be identified during the *alarm* phase to prevent an evolution toward a *resistance* phase and, especially, an *exhaustion* phase. These phases lead to chronic disabling tinnitus in which emotional-affective activation is dominant. In the resistance and exhaustion phases, identification of primary stressors is still necessary but insufficient owing to the organization of a paradoxical auditory memory and a pathologically shifted attention to tinnitus.

In chronic tinnitus, attention must be paid to behavioral and emotional reaction strategies of affected patients rather than to identifying the audiological documentation and stressors. In the acute phase, an accurate audiological evaluation is important because treatment or auditory stimulation of hearing disorders (or both) can potentially interfere directly with eventual auditory tinnitus generators; furthermore, in the acute phase, early identification (where “early” does not attain to a predetermined period) of stress factors is important, too, to allow treatment of auditory or systemic disorders as soon as possible.

In the resistance phase, accurate evaluation of auditory function is useful but not primarily necessary because treatment of hearing disorders rarely produces,

per se, tinnitus relief; furthermore, in the resistance phase, auditory stimulation is usually more difficult and less effective. Stressor identification is necessary, as in the acute phase, because stressor removal may still interrupt prolonged stress reaction and avoid exhaustion. Attention has to be paid to eventual modification of behavior as secondary adaptation to the alarm signal. Such adaptation frequently evolves as a second-order stress factor per se, with a potential risk of developing a chronic disorder.

In the exhaustion phase, identifying both audiological and stress factors is useful but not necessary. The final common pathway is activated, a paradoxical auditory memory is maintained, attention is pathologically shifted toward tinnitus, behavioral modifications are evident, and emotional-affective aspects are predominant. In these cases, removal of stress factors is necessary for the general health condition but useless for the course of the tinnitus, the so-called severe, disabling-type tinnitus.

TINNITUS SCHOOL

Chronic disabling tinnitus is correlated to the combination of two main phenomena: paradoxical auditory memory in common final pathway structures [2] and pathological attention to tinnitus [6]. The combination of both phenomena, and mainly the second [7], leads to significant everyday cognitive failures.

Tinnitus school is aimed at promoting behavioral reorganization, helping affected patients to cope with tinnitus, decreasing paradoxical memory, and improving diversion and distraction of auditory attention. Tinnitus school is particularly directed at physical exercises to lead to a consciousness of one's own body, respiration control, and neck tension control and, in this way, to the shifting of a patient's attention away from tinnitus. These are the same principles as in kinesthetic competitive treatment as proposed by Dehler et al. [8]. In tinnitus school, physical exercises are integrated in an educational program, as in back school [9] and neck school [10]. Treatment is based on three stages: counseling, training, and home training.

Counseling

Counseling is carried out by the physician who visited with an affected patient and prepared treatment planning. The physician explains the main aspects of the auditory system, stressing the patient's attention to the phenomena involved in chronic tinnitus (paradoxical auditory memory and pathological attention to tinnitus). Lifestyle and drug use are investigated to identify specific stressor factors, and the possibilities of change are discussed with the patient.

Particular attention should be paid to diseases, disorders, or activities likely to stress an affected patient. In our experience, a CAPPE questionnaire [11] and an accurate evaluation of the patient's general medical documentation form a useful guide. The CAPPE questionnaire investigates the presence of different kinds of stressors: chemical (prolonged exposure to solvents, use of ototoxic drugs); acoustic (noise exposure, acoustic neuroma, otosclerosis, hearing loss); pathological (diabetes, thyroiditis, autoimmune diseases); physical (professional stress, worsening of tinnitus during physical exercises); and emotional (sleep disorders, job change, depression).

The CAPPE questionnaire is useful to identify "objective" stress factors, but it is not sufficient to clarify patient's perceptions of their personal "value" of stressors. Thus, we adopted the perceived stress questionnaire (PSQ), which is based on the perceived stress and is already used in stress evaluation in tinnitus sufferers [12]. It is designed to represent the subjective perspective of an affected individual ("You feel . . ."). Stress is a result of a patient's experience of overload, with further emphasis on the experience of unpredictability and uncontrollability of events. This implies that the existence of stress in a subject is partly inferred from information about the person's experience of lack of control. The stress experiences presented in the PSQ were intended to be abstract enough to be applicable to adults of any age, stage of life, gender, or occupation, but at the same time interpretable as specific to a variety of real-life situations. For example, "You feel under pressure from deadlines" could refer to anything from a bill due, to an oncoming birthday party, to a grant proposal. This questionnaire asks the respondent how often certain experiences of stress occurred in the last month. The content of the items does not refer to tinnitus but focuses on a more cognitive appraisal of stress. The 20-PSQ is a 20-item questionnaire of four scales with five items each:

Scale 1. *Worries*: covers worries, anxious concern for the future, and feelings of desperation and frustration (e.g., "You have many worries.")

Scale 2. *Tension*: explores tense disquietude, exhaustion, and the lack of relaxation (e.g., "You feel mentally exhausted.")

Scale 3. *Joy*: concerns positive feelings of challenge, joy, energy, and security (e.g., "You are full of energy.")

Scale 4. *Demands*: covers perceived environmental demands, such as pressure, overload, and lack of time (e.g., "You feel you are in a hurry.")

Each positive (yes) answer to scales 1, 2, and 4 is scored as 1. The joy scale is scored as 1 for each nega-

tive (no) answer because all items of this scale are positively worded. Thus, a maximum possible score (i.e., the most unbearable stress perception) is 20, and the higher the total score, the higher the perceived stress.

Training

Training is performed by a physiotherapist with a small class of patients (three subjects) in a gymnasium. Class treatment provides comparison and cooperation between patients and improves positive enforcement. In Table 1, the gymnasium protocol is shown.

The first step is to prepare patients to cooperate in a complex program involving movement, thinking, and learning. Musculoskeletal impairments are often provoked by or associated with tension and anxiety. Thus, beginning treatment with simple relaxation exercises is very important.

The physical exercises are aimed at postural control. In fact, in patients suffering from chronic tinnitus, the usual procedure is to observe musculoskeletal impairments that result from increased muscle tension, fatigue, and pain in the cervical and (sometimes) the thoracolumbar region. Changes in patients' internal perception of their own sensations (pathological attention to tinnitus) can also lead to abnormal alignment of body parts with respect to one another and to the base of support. Simple exercises have to be planned, and they are generally aimed at mobilizing the pelvis, the cervical rachis, and the thoracolumbar spine. In some cases, massages can be useful either to relax an affected patient or to mobilize joints. Tinnitus school consists of three sessions per week for 2 weeks followed by two sessions per week for another 2 weeks (total, 10 sessions).

Home Training

As in every school, home training is as important as class training. A part of the gymnasium session is dedicated to instructing patients in how to perform home exercises correctly. The home protocol is shown in Table 2. Exercises must be performed twice daily.

SELECTION OF PATIENTS

After a complete audiological and stress balance test, when the 20-PSQ score totaled more than 15 despite the subscale score, tinnitus school was proposed to patients suffering from chronic disabling tinnitus. To determine individual-specific tinnitus reactions, we adopted two psychometric questionnaires: the tinnitus reaction questionnaire (TRQ) [13] and the tinnitus cognitive questionnaire (TCQ) [14].

Table 1. Tinnitus School Gymnasium Training Protocol**Supine**

- Relaxation exercises control breathing, improving consciousness of abdominal or thorax breathing: deep inhalation followed, after a few seconds, by a forced exhalation while pronouncing the word *one*. This exercise is repeated 8–10 times.
- Patients move the head—first slowly and then faster—in all directions, fixating on a target straight on the ceiling.
- Patients lift the right knee against the chest, then extend the leg and lift the left knee against the chest. Holding the knee against the chest with the hands, patients perform a gentle traction of the flexed leg.
- Patients lift both knees to the chest simultaneously, helping gently with the hands.
- Patients lift the pelvis while simultaneously extending the arms over the head. Then patients reposition the arms along the body while lowering the pelvis.
- Patients grasp a stick. Still holding the stick, they extend the arms over the head and then return to the primary position.
- In the quadrupedal position, patients inhale and arch the back, holding the head between the arms. Then they exhale, retroflexing the head and rotating the pelvis in hyperlordosis.
- In the quadrupedal position, patients extend the right arm and the left leg simultaneously. Then they reverse the procedure (the left arm and the right leg).
- In the prone position, patients lift the left arm and the right leg, maintaining the forehead over the bed. Then they reverse the procedure (the right arm and the left leg).

Sitting

- Patients move the head first slowly and then faster in all directions while fixating on a target straight in front.
- Patients look for three targets sited, respectively, in front, at their left, and at their right. They fixate on the front target, then they move the head, fixating on the right-sided target. At last, they rotate the head leftward, maintaining the fixation of the right-sided target.
- Patients fixate on the frontal target. Then they move the head leftward and fixate on the left-sided target. Finally, they rotate the head rightward, maintaining the fixation of the left-sided target.
- Patients turn the head rightward and fixate on a target on the lateral wall. Then they hold the head straight, maintaining visual fixation on the target through eyes counter-rotation, and count to 10.
- Patients turn the head leftward and fixate on a target on the lateral wall. Then they hold the head straight, maintaining visual fixation on the target through eyes counter-rotation, and count to 10.
- Patients extend the right arm and lift the thumb. Then patients move the arm slowly to and fro in a horizontal direction and then in a vertical direction. Patients pursue the thumb with eyes only, first slowly and then progressively increasing the velocity of thumb displacement.

Sitting (continued)

- Patients repeat the exercise as above but simultaneously move the head also, trying to hold the eyes still.
- Patients grasp a stick with both hands and position the stick behind the shoulder at the level of the cervicodorsal junction. In this position, they rotate the trunk to and fro, keeping the head still through fixation of a target directly in front. Rotation of the trunk must be harmonious with quiet breathing.
- Patients place the stick forward on the sternum at the level of the sternoclavicular joint. Then they perform a rhythmic backward displacement of the shoulders. In this position, they rotate the trunk to and fro, keeping the head still through fixation on a target directly in front. Rotation of the trunk must be harmonious with quiet breathing.
- Paying attention to quiet breathing, patients inhale. Then, exhaling, they bend forward and place the head on the right knee and wait 10 seconds. Then, inhaling, they return to the sitting position.
- Paying attention to quiet breathing, patients inhale. Then, exhaling, they bend forward and place the head on the left knee and wait 10 seconds. Then, inhaling, they return to the sitting position.
- Patients inhale. Exhaling, they bend forward to retrieve an object on the floor. Then they inhale, take the object up over the head, and fixate on it for 10 seconds. Patients inhale. Exhaling, they bend forward and return the object to the floor.

Standing

- Patients fixate on their image in a mirror and align their posture correctly. Thus, they maintain quiet equilibrium for 1 minute, paying attention to breathing and keeping the eyes open. They then close the eyes while imagining the correct body position in their mind. They remain in this position for at least 1 minute while still paying attention to breathing. Then they oscillate to and fro according to their breath rhythm, hearing the air that enters and then exits from the lungs.
- Patients in a quiet, upright position fixate on a target in a mirror. In this case, they have two planes of fixation: the target and their image. Thus, they must be able to extract the correct fixation information from visual inputs. Then they oscillate to and fro according to their breath rhythm, hearing the air that enters and then exits from the lungs.
- Patients hold a small object and lift it over the head while fixating on it. Then they deeply inhale. Exhaling, they bend forward and move the object to the floor. They wait 10 seconds and then, inhaling, again lift the object over the head.
- Patients move a small object over the head. Fixating on the object, they move it in small circles according to their breath rhythm, hearing the air that enters and then exits from their lungs.

The TRQ is a self-reported scale designed to assess perceived distress associated with tinnitus. It consists of 26 items describing some of the potential effects of tinnitus on lifestyle, general well-being, and emotional state. Respondents are asked to rate, on a five-point scale (0 = not at all, 4 = almost all the time), the extent to which each of the potential effects have applied to them over the last week. Respondents are also asked to indicate (from *not at all* to *always*) how frequently tinnitus induces certain reactions, such as depression, anger, confusion. The total score ranges from 0 to 104.

A lower score represents a slight reaction to tinnitus (alarm), whereas higher scores indicate deeply negative reactions (exhaustion).

The TCQ investigates patients' approach to tinnitus, with 13 negative-thinking items (1–13) and 13 positive-thinking items (14–26), rated on a 0 to 4 scale. For each item, respondents are asked to “indicate how often they have been aware of thinking a particular thought on occasions when they have noticed the tinnitus.” The negative items are scored from 0 to 4, whereas the positive items are scored from 4 to 0. The total score is the sum

Table 2. Tinnitus School Home-Training Protocol**Supine**

- Relaxation exercises with control of breathing improve consciousness of abdominal or thoracic breathing: Inhale deeply and then, after a few seconds, exhale forcefully while pronouncing the word *one*. Repeat this exercise 8–10 times.
- Lift both knees to your chest simultaneously, helping gently with your hands.
- Lift your pelvis while simultaneously extending your arms over your head. Then reposition your arms along your body while lowering your pelvis.
- Grasp a stick. Lift your extended arms over your head while still grasping the stick and then return them to the primary position.
- In the prone position, lift your left arm and right leg while maintaining your forehead over the bed. Then reverse the procedure (the right arm and the left leg).

Sitting

- Move your head first slowly and then faster in all directions while fixating on a target directly in front of you.
- Grasp a stick with both hands and position the stick behind your shoulders at the level of the cervicodorsal junction. In this position, rotate your trunk to and fro while also keeping your head still through fixation on a target directly in front of you. Rotation of the trunk must be harmonious with quiet breathing.
- Repeat the exercise, placing the stick forward on your sternum at the level of the sternoclavicular joint. Then perform a rhythmic backward displacement of your shoulders.

Standing

- With your hands on a table, lift yourself on your tiptoes and maintain this position for 30 seconds. Pay attention to your breathing!
- With your hands on a table, lift yourself on your heels and maintain this position for 30 seconds. Pay attention to your breathing!
- Fixate on your image in a mirror. Then oscillate to and fro and right and left using your ankles as fulcrum, keeping your pelvis still and in accord with your breath rhythm, and hearing the air that enters and then exits from your lungs.
- Repeat this exercise with your eyes closed. Remember to recall correct body posture while eyes are closed.
- Grasp a small object, lift it over your head, and fixate on it. With your arms extended, move it in ever-wider circles while maintaining your fixation on the object and in accord with your breath rhythm, hearing the air that enters and then exits from your lungs.
- Repeat this exercise with your eyes closed, recalling correct body posture in relation to your prior fixation on the object. Pay attention to your breathing!
- Grasp a small object and lift it over your head. Fixate on it and inhale. Then exhale and bend yourself forward to position the object on the floor. Wait 10 seconds and then, while inhaling, lift the object again over your head. Pay attention to your breathing!

of the scores of each item and ranges from 0 to 104. A high score represents a greater tendency to engage in negative cognitions in response to tinnitus and low engagement in positive cognitions.

RESULTS

In four classes, we treated 12 patients (3 male, 9 female; mean age, 49.5 years; TRQ, 87 ± 7 ; TCQ, 77 ± 6).

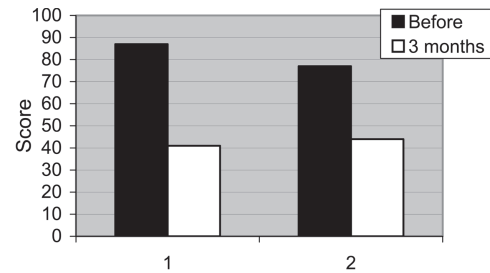


Figure 1. Tinnitus reaction questionnaire (TRQ, signified by 1) and tinnitus cognitive questionnaire (TCQ, signified by 2) modification after 3 months' follow-up, showing modification of mean values of a psychometric questionnaire 3 months after a tinnitus school session. Both TRQ and TCQ scores are reduced.

No specific drug was proposed. Follow-up was conducted each month for 3 months to modify home-training exercise planning and to re-motivate the patients to therapy. After 6 months, we reevaluated nine patients (three had dropped out). All patients reported that their tinnitus coping was good and that lifestyle modifications (sleep and diet regulation, regular physical exercise) induced a positive increase in quality of life as documented by a lowering of TRQ and TCQ scores to 41 ± 9 and 44 ± 4 , respectively (Fig. 1).

Follow-up PSQ rescoring showed significant improvements for two of the stress scales and the overall score: After 10 sessions of training and 3 months of home training, tinnitus patients registered a significant decline in general PSQ scores (i.e., generally perceived stress level). Even if amelioration regarding tension decreased (fewer positive answers) and joy increased (fewer negative answers), worries and demands remained unchanged (Fig. 2), as already described by Weber et al. [15].

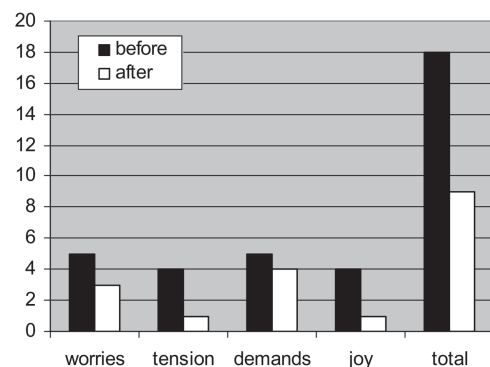


Figure 2. Perceived stress questionnaire mean subscales and total scores. Scores reflect pretreatment status and after 3-month follow-up. Worries and demands subscales were not modified, but tension and joy subscales were ameliorated. Thus, the total score is decreased after the tinnitus school program.

CONCLUSIONS

Tinnitus is a symptom that is impossible to resolve when it is chronic. Chronic disabling tinnitus is due to emotional-affective involvement induced by a pathological shift of affected patients' attention to their tinnitus. Coping with tinnitus thus requires a modification of such patients' approach to their perception of tinnitus through modification of lifestyle, stressor removal, and diversion of that pathological attention. The aim of a tinnitus cure, generally speaking, is to reach a golden point at which a patient is able to hear tinnitus but tinnitus does not disable the patient.

Tinnitus school is an educational approach aimed at helping affected patients to manage their symptom and thereby to restore a normal quality of life. Tinnitus school requires strict cooperation between an audiologist and a physiotherapist and could be integrated with pharmacological (e.g., benzodiazepine or gabapentin [16]) or instrumental rehabilitative (e.g. Ultraquiet [17] and sound therapy [18]) protocols.

Decreasing TCQ, TRQ, and 20-PSQ scores represented significant improvement in the quality of life of the participants, thus suggesting that an educational approach could have an effect on the qualitative aspects of tinnitus and can contribute positively to the management of tinnitus. Generally, in evaluating the adopted psychometrics questionnaires, the tinnitus school program resulted in a significant decrease of tinnitus disturbance (TRQ and TCQ) through a decreased perception of stress (20-PSQ).

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