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The "Emotional Side" of Subjective Tinnitus

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1. Introduction

Tinnitus has been defined as the perception of a sound which cannot be attributed to an external source. Objective tinnitus refers to a rare number of patients in whom sound can be audible to others; for example, a pulsatile sound may be generated by a blood vessel adjacent to the middle ear, or tinnitus may be provoked by a palatal myoclonus. On the other hand, the term "subjective tinnitus" refers to the most common form, in which the source cannot be identified. It is a relatively common symptom and the prevalence is estimated at between 6% and 30% of the total population (Quaranta et al., 1996; Leske et al., 1991).

The underlying physiological mechanisms are largely unknown. A "hearing damage", possibly recovered, is thought to be the causal event. Some authors have pointed out that, after cochlear damage, a cascade of changes occurs in the central auditory pathways and some of these may serve as "neural code" for tinnitus (Eggermont & Roberts, 2004).

Recent papers have demonstrated changes in patients having tinnitus with enhanced spontaneous firing rates in central acoustic pathways (Kaltenbach et al., 2005) and tonotopic reorganization of the auditory cortex with altered synchronous cortical activity (Seki & Eggermont, 2003; Weisz et al., 2007). As a possible demonstration of this theory, repetitive Transcranial Magnetic Stimulation has been demonstrated to be useful in tinnitus treatment (De Ridder et al., 2011).

In clinical practice, the pitch and loudness of tinnitus can be assessed using "psychoacoustic measures"; moreover, in some patients, tinnitus may disappear for a short period after exposure to other sounds (Tyler, 2000).

However, according to the theory of Jastreboff, the tinnitus signal does not always extend beyond the auditory system and in these patients, tinnitus can be perceived only when the subject focuses on it; chronic and disabling tinnitus, on the other hand, is related to inappropriate activation of the limbic system. It has been stated that "perception and reaction to tinnitus are not the same thing" (Hallam et al., 1988).

2. Neurological correlates of tinnitus

2.1 The acoustic pathways

According to most authors, cochlear damage is supposed to be the initiating factor of tinnitus, leading to altered patterns of neural activity along the central auditory pathways. Studies on both animals and humans have been carried out in recent years to assess central areas involved in tinnitus perception. The pathophysiology of tinnitus may be compared with phantom pain felt in subjects with amputated limbs; in both cases, the brain continues to convey perceptual experiences even after the loss of function of peripheral sensory cells (Rauschenecker, 1999). Thus, tinnitus is thought to originate from plastic reorganization (remapping) of auditory pathways and the cortex.

Studies on both animals and humans have been carried out to demonstrate this theory.

In mammals, after a noise or drug-induced hearing loss, an increased spontaneous neural firing rate has been reported in the inferior colliculus, medial geniculate body and auditory cortex (Salvi et al., 2000). It may be of some interest to emphasize that, within the inferior colliculus, spontaneous activity changes are most prominent in neurons tuned to the frequencies of hearing loss, most frequently high frequencies (Chen & Jastreboff, 1995); moreover, in the primary auditory cortex, a drug-induced hearing loss provoked an increased spontaneous firing rate in neurons tuned to high pitched sounds and a decreased firing rate has been demonstrated in neurons tuned to low frequencies (Eggermont & Komiya, 2000). As a result of this remapping, frequency regions adjacent to the deafferented area "invade" the vacated space and become overrepresented in the cortical area.

Not unlike animals, recent studies with EEG, magnetoencephalography (MEG), high resolution MRI and fMRI on humans have demonstrated that tinnitus is associated with changes in cortical and subcortical brain activity (Muhlnickel et al., 2003). Studies with MEG in humans with tinnitus demonstrated a shift of the auditory cortical frequency map at the position of tinnitus frequency, and the entity of the finding was correlated with the strength of tinnitus. Moreover, tinnitus is not only related to reorganization of the omolateral auditory cortex but also to increased gamma-band activity in the controlateral auditory cortex; the entity of this reorganization showed a positive correlation with the severity of tinnitus (Van der Loo, 2009). Further MEG data indicated the possibility that tinnitus may be linked to abnormal spontaneous gamma band activity generated as a consequence of a cochlear disorder in thalamic nuclei, particularly in the medial geniculate body. According to this model, in these deafferented regions, oscillatory alpha activity decreases to theta band activity; as a result, lateral inhibition is reduced, inducing a surrounding gamma band activity, which is known as "the edge effect" (Llinas et al., 2005).

It should be concluded that tinnitus arises from a long-term reorganization of the auditory pathways, particularly at the thalamic and cortical level. Nonetheless, tinnitus has been reported to occur in individuals with normal hearing. "Normal hearing" is determined with pure tone audiometry only at frequencies below 8 kHz; when testing is performed at finer intervals (half octave) and on frequencies above 8 kHz, cases of individuals with tinnitus without hearing loss become rarer (Salvi et al., 2009).

It may be stated that the great majority of tinnitus cases involve hearing loss, although not permanent; nonetheless, the reverse is not true, since not everyone with a permanent sensorineural hearing loss develops tinnitus.

2.2 The role of the limbic system

Patients with chronic tinnitus often present anxiety and depressive disorders, indicating the possibility of an involvement of brain areas related to emotions. Moreover, the loudness of tinnitus seldom correlates with the distress.

In a Voxel Based Morphometry (VBM) study, Muhlau et al. (2006) demonstrated a significant volume loss in the subcallosal area of tinnitus sufferers; results have been replicated in other works, and other limbic structures have been found to be involved in the phenomenon (Landgrebe et al., 2009; Vanneste et al., 2010).

According to the authors, the volume loss may be implicated in characteristic functional consequences. The subcallosal area is a poorly delineated area of the brain and constitutes a major hub linking limbic affective areas and the thalamo-cortical system involved in perception.

Activation of the subcallosal area, for example, correlates with the unpleasant effects of dissonant music (Blood et al., 1999); patients with depressive disorders often present abnormal activity levels in this area (Mayberg et al., 2005). Moreover, the subcallosal area overlaps with the Nucleus Accumbens (NA), the major component of the ventral striatum (Gruber et al., 2009). The NA contains both dopaminergic and serotoninergic fibres. The dopaminergic system has been demonstrated to play an important role in reward behaviour and avoidance learning (McCullogh et al., 1993), while serotoninergic fibres modulate emotional responses to external stimuli. Finally, the NA receives glutamatergic fibres from the Amygdala, Hippocampus and Raphe Nuclei, and the latter are responsible for the regulation of sleep (Ambroggi et al., 2008).

Anatomical studies have tried to demonstrate the connections between the Thalamic Reticular Nucleus (TRN), Medial Geniculate Nucleus (MGN) and the limbic system. The thalamic system without doubt plays an important role in transmission of sensorial information to cortical areas.

It has recently been demonstrated that TRN GABAergic afferent fibres strongly inhibit the neural activity of the MGN in animals, and its activity is highly frequency-specific (Yu et al., 2009). On the other hand, the TRN receives serotoninergic afferents from the limbic system (particularly the Dorsal Raphe, NA) with excitatory function on TRN neurons (McCormick & Wang, 1991). The network has been defined as "the noise cancellation system" (Rauschecker, 2010).

According to Rauschecker (2010), the maintenance of tinnitus may be linked to two possibilities:

It may be a consequence of overload from chronic firing of limbic system neurons, trying to compensate for the tinnitus signal.

It is possible that tinnitus patients have an independent, systemic vulnerability in one or more limbic transmitter system, particularly serotonin, making these individuals more susceptible to tinnitus as well as other disorders such as chronic pain or depression; in these subjects, the level of transmitters may decline more rapidly than in unaffected persons.

The first possibility is in accordance with previous theories which assigned a central role to auditory dysfunction and a reactive role to the limbic system. The second possibility underlines a possible more central role of the limbic system in preventing perception and chronicization of tinnitus.

3. The "emotional side" of tinnitus

Many studies have focused on the emotional aspect of tinnitus. Tinnitus has been demonstrated to be an important stressor and is often associated with anxiety and, in particular, depression.

Individuals unable to eliminate tinnitus with medical therapies may perceive the problem as permanent; if the tinnitus persists, patients tend to exhaust their coping resources and experience negative emotions. Similarities have been found with the experience of living with chronic pain, since both disorders are intractable, subjective and unpleasant and both significantly modify the life of sufferers.

Several studies have focused on the link between tinnitus and emotional distress. The onset of tinnitus often constitutes a change in a person's life and leads to significant psychological disturbance. According to McKenna et al. (1991), 45% of patients with tinnitus were in need of psychological help, and 86% of these subjects accepted it. Moreover, the onset of tinnitus is often associated with stress, and tinnitus annoyance may increase during stressful periods (Schmitt et al., 2000). Other stresses may aggravate tinnitus annoyance; in a sample of air traffic controllers suffering from tinnitus, a period of workload contributed to an increased perception of tinnitus. Moreover, other health problems can have additive effects as stressors and increase the probability of developing disability, social isolation and low levels of enjoyment of life (Vogt & Kastner, 2002). Anyway, the relationship between stress and tinnitus is still under debate; if tinnitus can be exacerbated by stress and fatigue, some stress-tolerant people might tolerate higher degrees of tinnitus and even when stress increases, subjective tinnitus does not (Hebert & Lupien, 2009).

3.1 Tinnitus, anxiety and depressive disorders

Without doubt, there is an association between tinnitus annoyance and a poor psychological state. Anxiety and depression play an important role in the tinnitus process and often the characteristics of tinnitus do not predict the distress provoked by it.

The relationship between tinnitus distress and psychological disorders has been widely investigated. Sullivan et al. (1988) studied the association between disabling tinnitus and affective disorders. Tinnitus sufferers presented a greater lifetime prevalence of major depression and current major depression than a control group of subjects with hearing loss without tinnitus. Moreover, patients with tinnitus and depressive disorders presented a higher psychosocial disability than non-depressive tinnitus sufferers, while no difference was established between patients with tinnitus without depression and controls with hearing loss. The authors concluded that the results are in accordance with the hypothesis that disability is strongly associated with depression.

Scott & Lindberg (2000) studied the psychological profiles and somatic complaints in two groups of tinnitus sufferers, respectively, help-seeking and non-help-seeking for tinnitus. They tried to address the question whether the two groups presented differences in psychological and somatic profiles. The groups differed both on the trait and state scales for anxiety, depression and reaction to stress even when hearing impairment was controlled. Help-seeking patients also showed a pattern of increased vulnerability. The authors concluded that the link between anxiety, depression, reactions to stress and chronic tinnitus is confirmed. Subjects with disabling tinnitus are more burdened with more severe somatization problems which might result in a less adaptive repertoire of coping strategies.

Results somehow confirm the data in an earlier paper (Halford & Anderson, 1991) in which the authors found that tinnitus was associated with a high anxiety trait and depression. The severity of tinnitus was correlated with both anxiety and depression but coefficients were of low magnitude. As a result, it may be argued that more anxious subjects with a negative outlook more probably will be unable to realize helpful coping strategies; anxiety and depression may predispose subjects to pay greater attention to tinnitus and related negative effects. Significantly, Andersson (1996) found that the predisposition toward optimism assessed by the Life Orientation Scale was negatively correlated with tinnitus complaints.

3.2 Coping style

Coping has been defined as the efforts to reduce the negative impacts of stress on individual well-being. Coping efforts are triggered by the appraisal of situations or symptoms as threatening, harmful or anxiety producing.

Studies concerning coping strategies in patients with tinnitus arise from the practical consideration that tinnitus is a relatively common symptom and it only becomes a disabling problem in a small number of subjects. That is to say, most sufferers adjust to tinnitus on their own and this adjustment does not appear to be closely related to the severity of the condition.

Budd & Pugh (1996), in their exhaustive work, assessed coping strategies using the 40-item Tinnitus Coping Style Questionnaire (TCSQ). They identified two different coping styles. The first one, termed "maladaptative", was characterized by the failure to avoid tinnitus. Sufferers reported that they often dream about life without tinnitus and pray that their tinnitus would go away. The coping style was characterized by catastrophic thinking about the consequences of tinnitus and these patients worry that tinnitus may cause a nervous breakdown. These subjects are often unable to cope with the noises and they attempt to get away from tinnitus by avoiding social situations. This coping style was associated with increased levels of tinnitus severity, anxiety and depression.

The second coping strategy was defined as "effective coping" and was characterized by sufferers' acceptance of tinnitus and using a broad range of adaptive coping strategies including positive self-talk, distraction and attention switching. These patients often reported increasing daily activities and taking up new hobbies and interests. According to the authors, this coping style was not correlated with decreased tinnitus severity; nonetheless, this coping style was not correlated with anxiety and depression.

3.3 Impact of tinnitus on life

It may be said that, in some cases, tinnitus has a considerable impact on work, sleep, family relationships and, more generally, on way of life.

Several studies have investigated the effects of tinnitus on people's ability to work. Surprisingly, in only a few cases did tinnitus sufferers refer to having difficulties in their jobs and only a few subjects were unable to work. Above all, people performing jobs requiring precision or working with music (music performers, sound technicians) were most disabled in their working life (Andersson, 2000a; Vallianatou et al., 2001).

On the other hand, sleep is without doubt the most important problem in everyday life for patients with tinnitus. Questionnaire-based studies (Sanchez & Stephens, 1997) concluded that sleep disturbance is probably the most common problem, since 71% of patients reported it. Davis et al. (1995) found that, in a normal population sample, 5% had sleep disorders and tinnitus was the causal factor.

Since patients with tinnitus often display a range of behaviours to communicate their distress to other people, marital support may play a significant role in coping style. In a questionnaire-based study on 91 tinnitus sufferers and 74 spouses, Pugh et al. (2004) reported that solicitous responses, that is to say, sympathetic responses to complaints about tinnitus, were directly and positively related to a maladaptive coping style; on the other hand, punitive responses were directly and positively related to anxiety and depression, both of which in turn mediated a relationship between punishing and maladaptive coping and tinnitus severity. Overlapping results have been found by Sullivan et al. (2004). Both papers underlined the role of familiar relationships in coping styles and the central role of depression in tinnitus distress.

3.4 Tinnitus and cognitive impairment

Tinnitus sufferers often complain of difficulties in cognitive functioning, particularly poor attention and concentration in everyday activities. In a recent paper, Hallam et al. (2004) investigated cognitive tasks with a self-administered questionnaire; the questionnaire measured performance under single and dual task conditions and results were compared with those of a group of patients with hearing impairment and a group of non-clinical subjects. Tinnitus patients responded significantly more slowly than the other groups; in general, comparisons on the other tasks demonstrated equivalent performance, even though tinnitus and hearing loss groups performed more poorly than non-clinical group on verbal fluency. The authors concluded that cognitive inefficiency in tinnitus subjects may be related to the control of attentional processes, similar to published findings on the effects of chronic pain on cognitive processes.

Considering the often present comorbid of hearing loss, this may be a possible bias in the evaluation of cognitive processes in tinnitus sufferers.

Andersson et al. (2000b) assessed the performances of tinnitus patients and healthy controls with normal hearing on three versions of the Stroop test. Patients scored significantly higher than controls on the Beck Depression Inventory(BDI) and the Spielberger Trait State Anxiety Inventory (STAI-S), but these measures did not correlate with the Stroop results. The authors concluded that the results indicate that tinnitus patients have impaired cognitive performance overall, but hearing impairment cannot be excluded as a possible confounder.

As a final consideration, recent papers have demonstrated inefficiencies in cognitive processes in tinnitus patients, but the real "weight" of mood disorders and of more practical problems (i.e. hearing loss) in it is still unclear. Moreover, it seems possible that tinnitus interferes more with mundane tasks than with high priority tasks in everyday life.

3.5 Tinnitus and personality trait

As previously described, the association between tinnitus and psychological state has been widely investigated, but at present, the results are unclear; tinnitus sufferers are often comorbid for anxiety and depression and the more depressed patients experience a higher distress with tinnitus. On the other hand, the association between tinnitus and personality trait is still under debate. That is to say, will tinnitus provoke distress, particularly in predisposed subjects, with a peculiar personality profile? After all, Jastreboff & Hazel (1993) found no differences in psychoacoustic measures of tinnitus (intensity, frequency and minimum suppression level) among patients with high and low annoyance.

Meric et al. (1998) and Vallianatou et al. (2001), found no peculiar personality profile in their subjects with chronic tinnitus assessed with the Minnesota Multiphasic Personality

Inventory (MMPI), even though the first authors found a correlation between MMPI depression scale and the Tinnitus Handicap Questionnaire.
On the other hand, Erlandsson et al. (2000) reported a rate of 50% of personality disorders in tinnitus sufferers, which is significantly higher than the 10–13% that the author estimated in the normal population.
Recent papers have focused on the relationship between tinnitus distress and type D personality. The definition "type D" (D stands for Distressed) has been introduced in psychology to describe a joint personality trait between negative affectivity and social inhibition. Type D personality can be assessed with a 14-item questionnaire, the Type D Scale (DS14).
Negative affectivity (NA) refers to the tendency to experience negative emotions across time/situations. High-NA individuals experience more feelings of dysphoria, anxiety, and irritability, have a negative view of self and scan the world for signs of impending trouble.
Social Inhibition (SI) refers to the tendency to inhibit the expression of emotions/behaviours in social interactions to avoid disapproval by others. High-SI individuals tend to feel inhibited, tense, and insecure when with others. Individuals with type D personality show a high vulnerability to chronic distress. Finally, Type D patients are at risk for clustering of psychological risk factors, including depression, anxiety, and irritability, and low levels of self-esteem, well-being, and positive affect.
Type D personality has been associated with post-traumatic stress disorders, hypertension, sudden cardiac arrest, development of cancer, and more widely with all-cause mortality (Denollet, 2005).
Bartels et al. (2010) studied personality trait in 265 patients with chronic tinnitus and the results were compared with a group of ENT patients without tinnitus. Patients demonstrated a higher level of neuroticism, negative affectivity and social inhibition and a lower level of extraversion and emotional stability than controls. According to the authors, the type D personality is independently associated with tinnitus and the prediction of developing chronic tinnitus is improved with the addition of type D personality to the single personality traits.

3.6 Therapies for tinnitus and psychiatric disorders

Over the last decade, repetitive Transcranial Magnetic Stimulation (rTMS) has received increasing attention as a potential therapeutic tool for tinnitus. Therapy is based on the application of a magnetic field on the scalp, inducing an electrical modification in specific areas of the brain. It has been demonstrated that rTMS directly modulates electrical activity in superficial areas of the brain but induces indirect modifications in remote areas which are connected to the stimulated zone. Low frequency rTMS on the left temporo-parietal cortex has been demonstrated to be useful in the treatment of tinnitus, nonetheless, some doubts arise about maintenance of therapeutic results (Langguth et al., 2008).
Recently, encouraging results have been obtained with the application of low frequency rTMS on prefrontal areas (Vanneste et al., 2011); the authors reported a significant reduction in both tinnitus intensity and distress. They hypothesized that results may be linked to modulation of the Anterior Cingulate Cortex (ACC), which plays an important role in the integration of motivationally important information with bodily responses related to the survival of individuals. The authors propose that a possible function of the ACC in tinnitus could be related to the fact that the generated phantom sound is considered as

motivationally important and the ACC responds with the maintenance of tinnitus in the focus of attention.
It may be of some importance that prefrontal cortex rTMS has been demonstrated to be useful in the therapy of psychiatric diseases including depression, panic and posttraumatic stress disorders (George et al., 2009).
A review of drug therapy for tinnitus is beyond the goals of this chapter; nonetheless, it must be underlined that among antidepressants, Selective Serotonin Reuptake Inhibitors (SSRIs) have been demonstrated to have probably the best efficacy in the treatment of tinnitus distress (Folmer & Shi, 2004).

4. Preliminary data from our research study on patients with chronic tinnitus. The role of psychological and clinical variables in tinnitus-related handicap and distress

As previously described, peculiar personality profiles, such as type D personality, pessimism and impulsiveness traits, inefficient coping abilities and anxiety and depressive symptoms have been associated with high intrusiveness of tinnitus and high tinnitus-related distress. Several personality profiles and cognitive constructs have been implicated in other medically unexplained somatic symptoms or in medical condition-related distress (Russo et al., 1994) and may also be involved in modulating the impact of tinnitus on quality of life. Thus, in a sample of patients with chronic tinnitus, we investigated the relationship between tinnitus-related distress and temperamental and character dimensions, according to Cloninger's theory of personality (Cloninger et al., 1993), cognitive constructs of worry and fear associated with common physical sensations. Moreover, we investigated the role of anxiety and depressive symptoms in mediating the influence of personality dimensions and cognitive constructs on the impact of tinnitus in everyday life.

4.1 Subjects

Forty-eight subjects suffering from unilateral tinnitus were recruited, out of those participating in an randomized double-blind study performed to assess the efficacy of low-level laser treatment for tinnitus (Teggi et al., 2009) and who also agreed to take part in this section of the study. They were all outpatients at the ENT Department of San Raffaele Hospital, Milan, Italy. Twenty-five were males and 23 were females and their mean age was 52.2 ± 11.9 years; the mean duration of illness was 61.2 ± 72.7 months. They all had sensorineural hearing loss, stable during the previous 3 months, from causes such as presbycusis, Ménière's disease, or idiopathic sudden sensorineural hearing loss. The day the patients received the laser treatment devices and instructions, they were further assessed with a self-administered battery of psychological tests; detailed explanations for test compilation were provided by expert psychologists.

4.2 Clinical and psychological measures

All subjects underwent pure tone audiometry and a complete psychoacoustic assessment, including pitch, loudness, minimum masking level and loudness discomfort level. In this section of the study, we focused on loudness and minimum masking level (MML) as the main measures of tinnitus intensity experienced by the subjects. Loudness match was determined by balancing the loudness of the tinnitus with the loudness of a tone at pitch

frequency in the contralateral ear and was expressed in decibel sensation level. The minimum masking level was established using broadband noise; first, the monaural hearing threshold was obtained, and then raised until the patient reported that the tinnitus was inaudible. Both loudness and minimum masking level were determined using 1-dB steps.
Tinnitus distress was assessed with the Tinnitus Handicap Inventory (THI) (Newman et al., 1996). This is a 25-item self-administered questionnaire for the measurement of tinnitus handicap and the impact of tinnitus on everyday functioning (total score ranging from 0 to 100, with a higher score indicating greater handicap). Depression and anxiety levels were assessed with the 31-item Self-Evaluation Depression Scale (SAD) and the 20-item State-Trait Anxiety Inventory, State Form (STAI-Y-1), respectively. Different psychological constructs were assessed with the following self-rating tests: the 17-item Body Sensation Questionnaire (BSQ), measuring fear associated with common physical sensations, such as heart palpitations, dizziness, nausea; the 16-item Penn State Worry Questionnaire (PSWQ), assessing the trait dimension of the worry process and its excessiveness, duration and uncontrollability, regardless of the contents of worry; the 5-item Physical Treat domain of the Worry Domains Questionnaire (WDQ), assessing worry specifically with regard to health-related content; the 240-item Temperament and Character Inventory-Revised (TCI-R), assessing the four temperamental dimensions (Novelty Seeking, NS; Harm Avoidance, HA; Reward Dependence, RD; Persistence, P) and three character dimensions (Self-Directedness, SD; Cooperativeness, C; Self-Transcendence, ST) of the 7-factor psychobiological model of personality proposed by Cloninger et al. (1993).

4.3 Statistical analyses and results

Pearson zero-order and partial correlation were performed to evaluate the association between the psychological constructs and the level of tinnitus-related distress as measured by the THI. Zero-order correlation measures the raw observed linear association between two variables, while partial correlation allows us to study the degree of association between two variables removing the effect of a set of controlling variables. Preliminary analyses were performed to evaluate whether sociodemographic (gender, age, years of education), duration of illness, psychoacoustic variables (loudness, MML), level of anxiety (STAI-Y-1, mean value) and level of depression (SAD) were significantly associated with the psychological variables considered (BSQ, WDQ-PT, PSWQ, TCI-R) or with THI. Zero-order correlation was performed to evaluate the association among continuous variables while an independent sample *t*-test was performed for the association between a continuous and a dichotomous variable (gender). If significant associations were found, these variables were inserted as controlling variables in the partial correlation analyses evaluating the association between psychological constructs and level of tinnitus-related distress.
Preliminary analyses showed that age, gender and years of education (mean value 11.7±13.8 years) did not significantly correlate with any psychological dimensions or with THI scores (mean value 45.3± 28.0). Similarly, neither duration of illness nor loudness (mean value 6.7±5.5) and MML (mean value 8.7±5.7) were significantly correlated with THI or with any of the psychological constructs evaluated. On the other hand, anxiety level (STAI-Y-1, mean value 44.6±12.2) and depression level (SAD, mean value 49.08±12.07) were significantly correlated with several of the psychological dimensions considered. Furthermore, they were strongly correlated with tinnitus-related distress as measured by THI scores. Thus, we inserted anxiety and depression levels as controlling variables in the partial correlation

analyses, whereas we excluded sociodemographic and psychoacoustic variables due to the lack of association found in preliminary analyses.
Correlations between tinnitus-related distress and psychological variables revealed THI to be significantly and positively related to the Penn State Worry Questionnaire scores, the Physical Treat domain of the Worry Domains Questionnaire scores and the Harm Avoidance temperamental dimension, whereas it was negatively related to the Self-Directedness and Cooperativeness character dimensions. When SAD was inserted as controlling variable, no partial correlations between THI and the considered psychological constructs remained significant. With the insertion of STAI-Y-1 as controlling variable, only the partial correlations between THI and the Penn State Worry Questionnaire scores and between THI and the Physical Treat domain of the Worry Domains Questionnaire scores remained significant, whereas all of the other correlations were not significant.

4.4 Conclusions

Our results showed that the levels of handicap and distress related to tinnitus were not related either to the psychoacoustic measures of tinnitus (perceived loudness or minimum masking level) or to the duration of illness or individual variables such as age, gender, or year of education. On the other hand, patients with high levels of tinnitus-related distress showed a temperamental and character profile with high Harm Avoidance temperamental dimension (i.e. subjects characterized by pessimism, anticipatory anxiety and fear of uncertainty, shyness, insecurity of the unknown, fatigue and lack of energy) and low Self-Directedness (i.e. subjects characterized by immaturity, poor accountability, weak capacity to focus on personal objectives) and Cooperativeness (i.e. subjects characterized by a tendency to isolation, lack of empathy, poor ability to collaborate with others) character dimensions. Similarly, the cognitive profile with high proneness to worry, including worry on health-related content, and high sensitivity and fear towards somatic sensations, was associated with high THI scores. Finally, high tinnitus-related distress was related to severity of anxiety and depressive symptoms. However, the impact of personality and cognitive profiles on tinnitus-related distress appeared to be strongly influenced by anxiety and depressive symptoms; indeed, only the proneness to worry seemed to have a direct association with high THI scores even when anxiety levels were taken into account.
Overall, our results support the idea that individual differences in personality and cognitive profiles may play a relevant role in modulating the impact of tinnitus on the quality of life, over and above the perceived loudness of the tinnitus itself, but underscore the importance of anxiety and depressive symptoms in mediating this association. Thus, in clinical settings, the specific assessment of severity of anxiety and depressive symptoms in patients with tinnitus and high THI scores is highly recommended; specific treatments directed toward the reduction of these symptoms may be an important therapeutic resource and may, in turn, improve the efficacy of psychological treatments focusing on the personality and cognitive traits that worsen the impact of tinnitus on the quality of life.
As a final consideration, the previous approach to the problem of the relationship between tinnitus and psychiatric disorders was univocal; tinnitus may provoke in some individual a strong emotional response. Recent studies focused on the possibility that annoyance, which is the "real problem", is the result of the action of tinnitus on subjects with a predisposing personality trait. Moreover, future goal should be to assess the role of serotoninergic system in the maintenance and distress provoked by tinnitus. Since SSRIs demonstrated to be useful

in the treatment of tinnitus, it may be hypothesized that the action is strictly related to its activity on "mood system" in the brain or a direct action on acoustic pathways may be supposed (the "noise cancellation system").

5. References

Ambroggi, F.; Ishikawa, A.; Fields, H.L.; Nicola, SM. (2008) Basolateral amygdala neurons facilitate renard seeking behavior by exciting nucleus accumbens neurons. *Neuron*, Vol. 59, Issue 4, pp. 648-61, ISSN 0896-6273.

Andersson G. (1996) The role of optimism in patients with tinnitus and in patients with hearing impairment. *Psychol Health*, Vol. 11, Issue 5, pp. 697-707, ISSN 0887-0446.

Andersson G. (2000a) Longitudinal follow-up of occupational status in tinnitus patients. *Int Tinnitus J*, Vol. 6, Issue 2, Issue, pp. 127-9, ISSN 0946-5448.

Andersson, G.; Eriksson, J.; Lundth, L.G.; Lyttkens, L. (2000b) Tinnitus and cognitive interference: a Stroop paradigm study. *J Speech Lang Her Res*, Vol. 43, Issue 5, pp. 1168-73, ISSN 1092-4388.

Bartels, H.; Middel, B.; Pedersen, S.S.; Staal, M.J.; Albers, F.W.J. (2010) The distressed (Type D) personality is independently associated with tinnitus: a case-control study. *Psychosomatics*, Vol. 51, Issue 1, pp. 29-38, ISSN 0033-3182.

Blood, AJ.; Zatorre, RJ.; Bermudez, P.; Evans, AC. (1999) Emotional responses to pleasant and unpleasant music correlate with activity in paralimbic brain regions. *Nat Neurosci*, Vol. 2, Issue 4, pp. 382-7, ISSN 1097-6256.

Budd, RJ; Pugh R. (1996). Tinnitus coping style and its relationship to tinnitus severity and emotional distress. *J Psychosom Res*, Vol. 41, Issue 4, pp. 327-35, ISSN 0022-3999.

Chen, G. & Jastreboff, P.J. (1995) Salycilate induced abnormal activity in the inferior colliculus of rats. *Hear Res*., Vol 82, Issue 2, pp. 158-78, ISSN 0378-5955.

Cloninger, C.L.; Svrakic, D.M.; Przybeck, T.R. (1993) A psychobiological model of temperament and character. *Arch Gen Psychiatry*, Vol 50, Issue 12, pp. 975-90, ISSN 0003-990X.

Davis, A. (1995) *Hearing in adults*. Whurr Publisher, ISBN 1861564031 London.

Denollet J. (2000) DS14: standard assessment of negative affectivity, social inhibition, and Type D personality. *Psychosom Me,* Vol. 67 Issue 1, pp.89-97, ISSN 0033-3174.

De Ridder, D; Vanneste, S; Kovacs, S; Sunaert, S; Menovsky, T; Van de Heyning, P; Moller, A. (2011) Transcranial Magnetic stimulation and extradural electrodes. implanted on secondary auditory cortex for tinnitus suppression *J Neurosurg*. [epub ahead of print], ISSN 1933-0693.

Eggermont, J.J. & Komiya H. (2000) Moderate noise trauma in juvenile cats results in profound cortical topographic map changes in adulthood. *Hear Res*, Vol 142 Issue 1-2, pp. 89-101 ISSN 0378-5955.

Eggermont, J.J.; Roberts, L.E. (2004) The neuroscience of tinnitus. *Trends Neurosci*, Vol 27, Issue 11, pp. 676–82, ISSN 0166-2236.

Erlandsson S. (2000) Psychological profile of tinnitus patients. In *Tinnitus Handbook*., Thomson Learning, pp 25-57, ISBN 156-5939-22-0 San Diego, USA.

Folmer, R.L. & Shi, Y.B. (2004) SSRI use by tinnitus patients: interactions between depression and tinnitus severity. *Ear Nose Throat J*, Vol. 83 Issue 2 pp. 107-8, ISSN 0145-5613.

George, M.S.; Padberg, F.; Schlaepfer, T.E.; O'Reardon, J.P.; Fitzgerald, P.B.; Nahas, Z.H.; Marcolin, M.A. (2009) Controversy: repetitive transcranial magnetic stimulation or

transcranial direct current stimulation shows efficacy in treating psychiatric diseases (depression, manis, schizophrenia, obsessive-compulsive disorder, panic, posttraumatic stress disorder). *Brain Stimul*, vol 2, Issue 1, pp.14-21, ISSN 1935-861X..

Gruber, AJ; Hussain, RJ; O'Donnell, P. (2009) The Nucleus Accumbens: a switchboard for goal-directed behaviors. *PloS ONE*, Vol 4, Issue 4 pp e5062, ISSN 0005062.

Halford, J.B.; Anderson, S.D. (1991) Anxiety and depression in tinnitus sufferers. *J Psychosom Res*, Vol 35, Issue 4-5, pp. 383-90, ISSN 0022-3999.

Hallam, R.S.; Jakes, S.C.; Hinchcliffe, R. (1988) Cognitive variables in tinnitus annoyance. *Br J Clin Psychol*, Vol.27, Issue 3, pp. 213-22, ISSN 0144-6657.

Hallam, R.S.; McKenna, L.; Shurlock, L. (2004) Tinnitus impairs cognitive processes. *Int J Audiol*, Vol. 43, Issue 4, pp. 218-26, ISSN 1499-2027.

Hebert, S & Lupien, SJ. (2009) Salivary cortisol levels, subjective stress and tinnitus intensity in tinnitus sufferers during noise exposure in the laboratory. *Int J Hyg Environ Health*, Vol. 212, Issue 1, pp. 37-44, ISSN 1438-4639.

Jastreboff, P.J.; Hazell, J.W.P. (1993) A neurophysiological approach to tinnitus: clinical implications. *Br J Audiol*, Vol. 27, Issue 1, pp. 7-17, ISSN 0300-5364.

Kaltenbach, J.A.; Zhang, J.; Finlayson, P. (2005) Tinnitus as a plastic phenomenon and its possible neural underpinnings in the dorsal cochlear nucleus. *Hear Res*, vol.206, Issue 1-2, pp. 220-6, ISSN 0378-5955.

Landgrebe, M.; Langguth, B.; Rosengarth, K.; Braun, S.; Koch, A.; Kleinjung, T., May A.; de Ridder, D.; Hajak, G. (2009) Structural brain changes in tinnitus: grey matter decrease in auditory and non auditory brain areas. *Neuroimage*, Vol 46, Issue 1, pp. 213-8. ISSN 1053-8119.

Langguth, B.; de Ridder, D.; Dornhoffer, J.L.; Eichhammer, P.; Folmer, R.L.; Frank, E.; Fregni, L. et al. (2008) Controversy: Does repetitive transcranial magnetic stimulation/transcranial direct current stimulation show efficacy in treating tinnitus patients? *Brain Stimul*, Vol. 1, Issue 3, pp. 192-205, ISSN 1935-861X.

Leske, M.C. (1981) Prevalence estimates of communicative disorders in the US. Language, hearing and vestibular disorders. *American Speech and Hearing Association*, Vol. 23, Issue 3, pp. 229-37, ISSN 0001-2475.

Llinas, R.R.; Urbano, F.J.; Leznick, E.; Ramirez, R.R.; van Marle, H.J. (2005) Rhythmic and dysrhytmic talamocortical dynamics: GABA system and the edge effect. *Trends Neurosci*, Vol.28, Issue 6, pp. 325-33, ISSN 0166-2236.

Mayberg, H.S.; Lozano A.M.; Voon V.; McNeely H.E.; Seminowicz, D.; Hamani, C.; Schwalb, J.M.; Kennedy, S.H. (2005). Deep brain stimulation for treatment-resistant depression. *Neuron*, Vol. 45, Issue 5, pp. 651-60, ISSN 0896-6273.

Meric, C.; Gartner, M.; Collet, L.; Chery-Croze, S. (1998) Psychopathological profile of tinnitus sufferers: evidence concerning the relationship between tinnitus features and impact on life. *Audiol Neurotol*, Vol 3, Issue 4, pp. 240-52, ISSN 1420-3030.

McCormick, D.A. &Wang Z. (1991) Serotonin and noradrenaline excite GABAergic neurons of the guinea-pig and cat nucleus reticularis thalami. *J Physiol*, Vol. 442 Issue 10, pp. 235-55, ISSN 0022-3751.

McCullough, L.D.; Sokolowski, J.D.; Salamone, J.D. (1993). A neurochemical and behavioural investigation of the involvement of nucleus accumbensdopamine in instrumental avoidance. *Neuroscience,* Vol. 52, Issue 4, pp. 919-25, ISSN 0306-4522.

McKenna, L.; Hallam, R.S.; Hinchcliffe, R. (1991) The prevalence of psychological disturbance in neurotology outpatients. *Clin Otolaryngol Allied Sc,* Vol. 16, Issue 5, pp. 452-6, ISSN 0307-7772.

Muhlau, M.; Rauschecker, J.P.; Oestricher, E.; Gaser, C.; Rottinger, M.; Wohlschlager, A.M.; Simon, F.; Etgen, T.; Conrad, B.; Sanders, D. (2006). Structural brain changes in tinnitus. *Cereb Cortex*, Vol 16, Issue 9, pp. 1283-8, ISSN 1047-3211.

Muhlnickel, W.; Elbert, T.; Taub, E.; Flor, H. (1998) Reorganization of auditory cortex in tinnitus. *Proc Natl Acad Sci USA* Vol. 95, Issue 17, pp. 10340-3, ISSN 0027-8424.

Newman, C.R.; Jacobson, G.P.; Spitzer, J.B. (1996) Development of the Tinnitus Handicap Inventory. Arch Otolaryngol Head Neck Surg, Vol 122, Issue 2, pp. 143-8, ISSN 0886-4470.

Pugh, R.; Stephens, D.; Budd, R. (2004) The contribution of spouse responses and marital satisfaction to the experience of chronic tinnitus. *Audiol Med*, Vol 2, Issue 1, pp. 60-73, ISSN 1651-386X.

Quaranta, A.; Assennato, G.; Sallustio, V. (1996) Epidemiology of hearing problems among adults in Italy. *Scandinavian Audiology*, Vol 42, Suppl. , pp. 7-11, ISSN 0107-8593.

Rauschecker, J.P. (1999) Auditory cortical plasticity: a comparison with other sensory systems. *Trends Neurosci*, Vol. 22, Issue 2, pp. 74-80, ISSN 0166-2236.

Rauschecker, J.P., Leaver, A.M.; Muhlau, M. (2010). Tuning out the noise: limbic-auditory interactions in tinnitus. *Neuron*, Vol. 66, Issue 6, pp. 819-26, ISSN 0896-6273.

Russo, J.; Katon, W.; Sullivan, M.; Clark, M.; Buchwald D. (1994) Severity of somatisation and its relationship to psychiatric disorders and personality. *Psychosomatics*, Vol.35, Issue 6, pp. 546-56, ISSN 0033-3182.

Salvi, R.J.; Wang, J.; Ding D. (2000) Auditory plasticity and hyperactivity following cochlear damage. *Hear Res*, Vol 147, Issue 1-2, pp. 261-74, ISSN 0378-5955.

Salvi, R.J.; Lobarinas, E.; Sun, W. (2009) Pharmacological treatments for tinnitus: new and old. *Drugs Future*, Vol. 34, Issue 5, pp. 381-400, ISSN 0377-8282.

Sanchez, L.; Stephens, D. (1997) A tinnitus problem questionnaire. *Ear Hearing,* Vol 18, Issue 3, pp. 210-7, ISSN 0196-0202.

Seki, S. & Eggermont J.J. (2003) Changes in spontaneous firing rate and neural synchrony in cat primary auditory cortex after localized tone-induced hearing loss. *Hearing Res*, Vol 180, Issue 1-2, pp. 28-38, ISSN 0378-5955.

Schmitt, C., Patak, M.; Kroner-Herwig B. (2000) Stress and the onset of sudden hearing loss and tinnitus. *Tinnitus Journal*, Vol. 6, Issue 1, pp. 41-9, ISSN 0946-5448.

Scott, B.; Lindberg, P. (2000) Psychological profile and somatic complaints between help-seeking and non help-seeking tinnitus subjects. *Psychosomatics*, Vol. 41, Issue 4, pp. 347-52, ISSN 0033-3182.

Sullivan, M.; Katon, W.; Russo, J.; Dobie, R.; Sakai, C. (1994) Coping and marital support as correlates of tinnitus disability *Gen H Psy*, Vol. 16, Issue 4, pp. 259-66, ISSN 0163-8343.

Teggi, R; Bellini, C.; Piccioni, L.O.; Palonta, F.; Bussi M. (2009) Transmeatal low-level laser therapy for chronic tinnitus with coclea dysfunction. *Audiol Neurotol*., Vol 14, Issue 2, pp. 115-20, ISSN 1420-3030.

Tyler, R.S. (2000) The psychoacoustical measurement of tinnitus. In *Tinnitus Handbook*, Thomson Learning, pp. 149-79, ISBN 156-5939-22-0 San Diego, USA.

Vallianatou, N.; Christodoulu, P.; Nestoros, J.; Helidonis, E. (2001) Audiologic and psychological profile of Greek patients with tinnitus – preliminary findings. *Am J Otolaryngol*, Vol. 22, Issue 2, pp. 33-7, ISSN 0196-0709.

Van der Loo, E.; Gais, S.; Congedo, M.; Vanneste, S.; Plazier, M.; Menovski, T.; et al. (2009) Tinnitus intensity dependent gamma oscillations of the controlateral auditory cortex. *PLoS ONE*, Vol 4, Issue 10, p. e7396, ISSN 1932-6203.

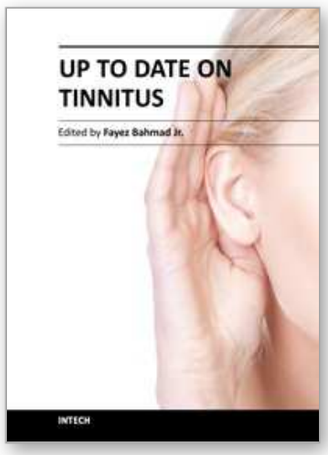
Vanneste S., Plazier M., van der Loo E., de Heyning P.V., Congedo M., De Ridder D. (2010) The neural correlates of tinnitus-related distress. *Neuroimage*, Vol 52, Issue 2, pp.470–480, ISSN 1053-8119.

Vanneste, S.; Plazier, M.; van de Heyning, P.; de Ridder, D. (2011) Repetitive transcranial magnetic stimulation frequency dependent tinnitus improvement by double cone coil prefrontal stimulation. *J Neurol Neurosurg Psychiatry*, Vol [Epub ahead of print], ISSN 0022-3050.

Vogt, J.; Kastner, M. (2002) Tinnituskrankungen be fluglotsen: eine klinisch arbeitpsychologische studie. *Zeitschrift fuer Arbeits und Organisationpsychologie*, Vol. 46, Issue 2, pp. 35-44, ISSN 0007-5868.

Weisz, N.; Muller, S.; Schlee, W.; Dohrmann, K.; Hartmann, T.; Elbert, T. (2007) The neural code of auditory phantom perception. *J Neurosci*, Vol 27, Issue 6, pp. 1479–84, ISSN 0270-6474.

Yu, X.J.; Xu, X.X.; He, S.; He, J. (2009) Change detection by thalamic reticular neurons. *Nat Neurosci*, Vol 12, Issue 9 pp. 1165-70, ISSN 1097-6256.



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Up to Date on Tinnitus encompasses both theoretical background on the different forms of tinnitus and a detailed knowledge on state-of-the-art treatment for tinnitus, written for clinicians by clinicians and researchers. Realizing the complexity of tinnitus has highlighted the importance of interdisciplinary research. Therefore, all the authors contributing to the this book were chosen from many specialties of medicine including surgery, psychology, and neuroscience, and came from diverse areas of expertise, such as Neurology, Otolaryngology, Psychiatry, Clinical and Experimental Psychology and Dentistry.

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