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Els Ooms, June 2012
PREFACE

In chapter 1 of this dissertation we sketch out the historical and contemporary views on the tinnitus symptom. The starting point for this study is the observation that not all individuals experiencing tinnitus actually suffer with this symptom and that the differences in experienced severity are not determined by the psychoacoustic characteristics of tinnitus (pitch and loudness) (e.g., Meikle et al. 1984; Meikle 2003; Jastreboff 2011). The main factors held responsible for the differences in the experienced severity of tinnitus are depression and anxiety (e.g., Halford & Andersson 1991; Zöger et al. 2006; Belli et al. 2008; Landgrebe & Langguth 2011a, 2011b). However, we also found that there is a dearth of systematic research on the relationship between these variables. Therefore, in this doctoral dissertation we investigate the relationship between tinnitus severity and depressive symptoms and between tinnitus severity anxiety-related symptoms in more depth. A review of existing research on the relationship between these variables indicates that most studies are performed by means of self-report questionnaires (e.g., Folmer et al. 1999; Belli et al. 2008; Crocetti et al. 2009). We believe that this method may be biased via shared method variance and content overlap (see also Meyer et al. 2001) and may distort results found. Moreover although clinical practice, theory and research give an indication of a close relationship between anxiety-related problems and the experienced severity of tinnitus (e.g., Erlandsson & Archer 1994; Jastreboff 2011), studies on this relationship tend to neglect the complexity of the anxiety concept, which may be a result of the prevailing use of self-report questionnaires in investigating this relationship. Self-report questionnaires only address the cognitive component of anxiety, but, as theory and research indicate, the anxiety construct consists of different dimensions, different levels of processing and different disorders. In order to understand the relationship between tinnitus severity and anxiety, we believe that an investigation that incorporates the complexity of the anxiety construct in relation to the perceived severity of tinnitus is necessary and requires a multi-method approach.

Therefore, the aim of this dissertation is to investigate the relation between tinnitus severity, depression, and anxiety as measured via self-report questionnaires on the one hand, and the complexity of the anxiety concept via multi-method approach on the other hand. By following this approach we take into account the possible influence of shared method variance and content overlap.

In Chapter 2, we investigate whether the relationship between tinnitus severity and depressive symptoms found in research using self-report questionnaires can be interpreted as a function of content overlap and shared method variance. Our first research question is as follows: Is tinnitus severity a problem related to depressive symptoms? This chapter consists of two parts. In the first part, we present a study which takes into account content overlap and shared method variance of the two most widely used questionnaires to measure depressive symptoms and tinnitus severity. Relations between
tinnitus severity, depressive symptoms and audiological characteristics (pitch and loudness) of tinnitus are also explored. In the second part, we present an article in the form of ‘a letter to the editor,’ which is a response to a reaction of Langguth et al. (2011) to the study presented in the first part of Chapter 2.

The problems of content overlap and shared method variance also apply to the observed relationship between tinnitus severity and anxiety-related problems. Therefore, in Chapter 3, we start by examining the possible influence of content overlap and shared method variance in the relation between self-reported anxiety and tinnitus severity. Apart from the possible influence of these confounding factors, anxiety itself is not a single construct and consists of different dimensions, namely a cognitive, somatic and behavioural dimension. However, these dimensions are asymmetrically related to each other, in that patients may complain of anxiety without any increase of vegetative parameters, or conversely, may show an increase of autonomic arousal which is not experienced mentally as anxiety. A multidimensional study of anxiety is therefore important and could prevent false negative results. Such an approach is all the more important since a multidimensional approach is rarely employed in existing literature on the relation between tinnitus severity and anxiety related problems. Consequently, in addition to studying the possible influence of shared method variance and content overlap in the relationship between tinnitus severity and anxiety-related symptoms, a measure of the somatic dimension of anxiety is included. Our second research question is as follows: Is tinnitus severity a problem related to cognitive and somatic anxiety-related symptoms? Relations between tinnitus severity, anxiety-related symptoms and audiological characteristics (pitch and loudness) of tinnitus are explored.

The complexity of the anxiety construct is further taken into account in the following chapters, where multi-method designs are used. Next to assessing conscious appraisals of anxiety, we aim at mapping underlying anxiety-related processing mechanisms via the application of the Affective Priming Paradigm of Fazio et al. (1986). Such underlying processing mechanisms may be considered as important, since they modulate emotional experience and behaviour (Robinson et al. 2003). Studies have demonstrated that high levels of anxiety have an influence on the direction and the strength of affective priming effects (Dannlowski et al. 2005; Li et al. 2008) and that stronger priming effects are specifically provoked by threat-related primes (Li et al. 2008). Therefore, chapter 4 studies the question as to whether severely distressed tinnitus patients automatically process affective information in a manner as observed in highly anxious individuals. If tinnitus severity is related to underlying processing mechanisms as observed in highly anxious patients, a stronger basis and a first step in the understanding of the presence of anxiety-related problems in the tinnitus severity complaint may be accomplished. Moreover, making use of a multi-method design overcomes the often reported
problems of direct measurement methods, i.e., content overlap and shared method variance. Relationships with tinnitus severity, audiological characteristics (pitch and loudness) and hearing loss are examined and possible differences between tinnitus severity groups are explored.

As previously indicated, anxiety consists of different disorders as well. Anxiety disorders are often divided into fear-related disorders (e.g., phobia) and anxiety-related disorders (e.g., Generalized Anxiety Disorder) (e.g., American Psychiatric Association 2000). Whereas the emotional reaction in fear-related disorders are connected to a specific object, such an object is absent in anxiety-related disorders. Anxiety-related disorders are considered as a more general tendency to react with anxiety in many different situations. The difference between fear and anxiety has been demonstrated by psychophysiological research, a research domain employing autonomic responses (e.g., Heart Rate (HR) and Skin Conductance (SC)). When confronted with general threatening stimuli (e.g., fearful and/or angry faces), fear subjects tend to show autonomic responses consistent with the orienting response seen in normal control subjects, namely greater Skin Conductance Responses (SCR) and greater HR deceleration (e.g., Vrana & Gross 2004; Öhman 2008). This defensive reaction may be compromised in anxiety related disorders, since studies have indicated that anxiety disorders are primarily associated with high resting autonomic activity and less acute reactivity to general stressful, negative and threatening stimuli (e.g., Cuthbert et al. 2003; Öhman 2008). Moreover, research has indicated that the elevated autonomic responses during rest are not observed in normal controls or in subjects with specific phobia (e.g., Hoehn-Saric & McLeod 2000). Therefore, in addition to taking into account the cognitive dimension of anxiety, the physiological dimension (HR and SC) related to anxiety is also examined in chapter 5. This chapter investigates the following research question: *Is the tinnitus severity complaint associated with fear- and/or anxiety-related problems?* Along this way, we attempt to shed light on the direction of the relationship between tinnitus severity and anxiety. Relationships with tinnitus severity and audiological characteristics (pitch and loudness) are examined and possible differences in autonomic responding between tinnitus severity groups are explored.

Our general discussion is presented in Chapter 6, whereby the main results of the different studies are summarised. Here we also present a theoretical frame on the differences observed in the tinnitus severity complaint and its implications for the treatment of patients suffering from this symptom. Limitations and directions for future research are outlined.
REFERENCES


General introduction

Tinnitus: a twenty-eight-century-old symptom

In this introductory chapter we present an overview of the most important theoretical and empirical assumptions and findings on tinnitus throughout history. Different theoretical assumptions and empirical findings have been postulated, dismissed and postulated again throughout the centuries. Some of these assumptions are still or are again in use in present-day theories and treatments of the condition. In this chapter we introduce contemporary perspectives on the condition, formulate our own critical concerns, and highlight the gaps in existing research. We conclude with a presentation of the research questions explored in this doctoral dissertation.
Lying in bed after a night out in a loud environment, such as a party, most people have experienced a ringing sensation in their ear(s) and / or in their head. Yet, after a good night’s sleep, such sensations dissipate. Now, imagine that these sensations are not gone after a night’s sleep, but (almost) constantly present during the day and / or night. Such a ringing in the ear(s) and / or head is referred to as (subjective) tinnitus.

Tinnitus is not a ‘new’ symptom. The first writings on the condition date back to centuries before our common era (BCE). Different theoretical assumptions and empirical findings have been postulated, dismissed and again postulated throughout the centuries. Some of these assumptions are still or are again in use in present-day theories and treatments of the condition. Being aware of this historical trajectory is important, as it can help prevent us from making theoretical assumptions that have been previously dismissed. Tinnitus is also not a univocal symptom: patients’ descriptions of tinnitus have revealed hundreds of different types of tinnitus sounds. While there are some common factors in these sounds (e.g., a hissing, ringing, roaring sound), each sound experienced by an individual patient is unique. Apart from this, there are also different types of tinnitus (e.g., objective versus subjective tinnitus), and each type of tinnitus has different assumed forms and several possible causes. Moreover, not all individuals experiencing tinnitus are bothered by these sounds and the characteristics of the sound (e.g., pitch and loudness) don’t seem to determine the level of burden experienced by patients. Some patients’ daily life, for instance, is affected by tinnitus (e.g., not being able to sleep, work, or relax), while others’ daily life remains unimpaired. Until this day there are no objective tests to determine the presence of tinnitus, nor are there tests to distinguish between different forms of tinnitus. Thus, clinical practitioners can only rely on the patient’s own assessment of the tinnitus.

The aim of this introductory chapter is to present an overview of the most important theoretical and empirical assumptions and findings on tinnitus. Creating this context enables us to have a better understanding of the complexity of the tinnitus symptom. As it is impossible to study all types, forms and aspects of tinnitus, the object of our investigation is narrowed down. Based on the definition of tinnitus, we specify, in a first step, the type of tinnitus studied. We subsequently discuss the theoretical assumptions and empirical findings on tinnitus throughout history. More contemporary perspectives on the condition are then introduced and finally we formulate our own critical concerns, and highlight the gaps in existing research. We conclude with a presentation of the research questions explored in this doctoral dissertation.
1. GENERAL INTRODUCTION

TINNITUS: WHAT IS IT?

Tinnitus is not considered as a disease, but as a symptom (Hiller & Goebel 2006; Láinez et al. 2011). It’s most common definition is ‘the perception of [meaningless]¹ sound in the head and/or in the ear(s), despite the absence of an external sound source’ (Langguth 2011; Holmes & Padgham 2011). The first part of the definition, ‘the perception of meaningless sound,’ is important since it distinguishes tinnitus from auditory hallucinations. There is consensus that auditory hallucinations consist of meaningful sounds such as speech, which can occur in, for instance, schizophrenia (Møller 2011a). This doctoral dissertation will not cover auditory hallucinations. The latter part of the definition, ‘despite the absence of an external sound source,’ is also relevant since it differentiates different types of tinnitus, namely objective versus subjective tinnitus (Heller 2003; Møller 2011a; Láinez et al. 2011). The difference between objective and subjective tinnitus lies in the presence or absence of a sound source. Whereas objective tinnitus has an identifiable acoustic source, such a source is absent in subjective tinnitus. This difference implies that objective tinnitus can (often) be heard by both the patient and the examiner, while subjective tinnitus can only be heard by the patient.

The source of the sound in objective tinnitus is thought to be generated by the individual’s own body and transmitted to the ear. For example, this source can be the turbulent flow of blood in an artery, where there is a constriction, or it can be caused by muscle contractions (Meyer et al. 2001a; Láinez et al. 2011). ‘Subjective’ tinnitus should not be confused with something that doesn’t exist or something that is imagined by the person experiencing it. ‘Subjective’ thus merely refers to the absence of a sound source and the fact that the sound(s) can only be heard by the person who experiences it. Subjective tinnitus refers to phantom sounds, not dissimilar to the phenomenon of phantom limb symptoms and central neuropathic pain (Møller 2011b; Møller 2011f). Other names used for subjective tinnitus in the past include “tinnitus aurium” and “nonauditory tinnitus” (Heller 2003). In this doctoral dissertation, we only study subjective tinnitus. Thus, whenever the term ‘tinnitus’ is used, we refer to its subjective type, except when explicitly indicated.

A SHORT SKETCH OF A LONG HISTORY.

The term ‘tinnitus,’ which comes from the Latin word ‘tinnire’ and literally means ‘to ring / to tinkle,’ was first introduced by Gaius Plinius Secundus (or Pliny the Elder), an author from the 1st century (Meyer et al. 2001a). However, the history of this phenomenon is believed to date back to the 16th century BCE (Before Common Era). More specifically, item number 768 of the papyrus Ebers (Figure 1), which are Egyptian papyrus with medical information, is assumed to be the first reference to tinnitus (e.g., Stephens 1987; Heller 2003). Ebbell (1937) translated the first part of this section as ‘the bewitched ear,’ the second part of item 768 was translated as ‘pus in the ear.’ Therefore, some

¹ Added by the author.
authors believe that ‘the bewitched ear’ is the first reference to tinnitus (e.g., Stephens 1987; Heller 2003). However, based on translations of other authors, specialists in the domain of the papyrus Ebers question the correctness of the interpretation of the bewitched ear as a reference to tinnitus. Ghalioungui (1987), for example, translated this item as “ear that is strange looking, having collected pus”; and Stuhr (2011) translated this section to German as “fremdartige Ohr, es ist gekrümmt durch Eiter.” The two latter translations, which contest Ebbell’s translation to some extent, are considered to be more correct, whereby we postulate that the interpretation of ‘the bewitched ear’ as a historical starting point of tinnitus to be unlikely.²

The first writings explicitly referring to the tinnitus phenomenon come centuries later. On the Assyrian medical clay tablets (7th century BCE), which describe ‘the treatment for sick men suffering from ear trouble’ (Thompson 1931, p. 1), 22 references to tinnitus were found (Thompson 1931). These 22 references could be reduced to three types of ear diseases (situated in the right and/or left ear), namely the singing, the whispering and the speaking ear (Thompson 1931; Stephens 2000; Heller 2003). In this description, one can find an indirect distinction between the phenomenon – which we call tinnitus - and the auditory hallucination. Moreover, on several occasions the next sentence can be found: “when the ear is dull (of hearing)…” (Thompson, 1931, p. 16). Although it is not clear what is meant by this sentence, it was considered to be a sickness of the ear, since several remedies (oils, herbs, etc.) were proposed. The question is whether this could be a first reference to hyperacousis. Hyperacousis, or hypersensitivity to sounds, is often found to accompany tinnitus (Møller 2011b). However, authors discussing the history of tinnitus refer to the work of Galien (130-200 CE; Common Era) as the first possible reference to this specific hypersensitivity. Galien described the origin of tinnitus as ‘steam coming form the stomach which makes the hearing excessively sensible.’ As possible causes for this steam he described a cold, the heat, a disease or the excessive intake of wine (Meyer et al. 2001a).

² Figure 1 and all information concerning the papyrus Ebers were obtained via personal communication with Prof. Dr. R. Scholl, who works at the university of Leipzig and is head of the ‘papyrus project’. Prof. Scholl wrote that Ebbell’s translation of the first part of item 768 is probably interpreted wrongly, since the second part of the item is translated as ‘pus in the ear.’ Moreover, Prof. Scholl pointed to the other translations of the same item.
After the Assyrian clay tablets there is a time gap of several centuries in the historical writings on tinnitus. The next references to tinnitus are assumed to be found in the book of medicine by *Fayum medical papyrus of Crocodilopolis* (+/- 3rd century BCE). The papyrus mentions the presence of a sound in the ear which resembles the sound of a storm. But references to humming and ringing sounds in the ear can also be found in texts from The East, India, and China. In the Greek antiquity, *Hippocrates* (460-377 BCE) mentions a phenomenon which resembles the description of tinnitus, however this was associated with deafness and headaches (Meyer et al. 2001a).

These early recovered documents indicate that tinnitus has always fascinated doctors, researchers, philosophers, etc. Yet they don’t reveal anything on assumed mechanisms of tinnitus. Such a reference can be found in one of *Aristotle’s* (384-322 BCE) books on physiology, where he posed the following question: ‘Why does the sound which one can hear in the ear stop after exposure of a loud external sound?’ This observation was again made years later, in the Middle Ages, by *Guy De Chauliac* (+/- 1300) who proposed that the situation of people experiencing tinnitus gets better when they are plunged in a loud environment. However, the translation of Aristotle’s observation of a practical treatment for tinnitus was only made 2000 years later, when Itard (1774 – 1838) recommended the use of external sounds (masking sounds) to treat tinnitus (Meyer et al. 2001a). The application of external sounds to mask tinnitus is still (or again) a keystone in tinnitus treatment (see e.g., Jastreboff 2011; Biesinger & Mazzoli 2011).

Before returning to Itard’s theory in more depth, we will continue our chronological discussion of important contributions to the understanding of tinnitus. Although much has been written on tinnitus during the period between Greek antiquity and the Renaissance, the causes of tinnitus all involved an excess of air in the ear(s) or in the brain. This assumption changed with the contribution of *Paracelsus* (+/- 16th century) who postulated that excessive environmental sounds lie at the origin of the tinnitus symptom (Stephens 2000). Five hundred years later excessive environmental sounds are (again) an important aspect in theories on the development of tinnitus (e.g. Henderson et al. 2011; Møller 2011b). The importance of excessive environmental sounds is nowadays, for instance, reflected in the recent Belgian governmental decision to impose a sound limit of 100dB (decibels) in pubs, concerts and festivals. While it may seem that Paracelsus’s discovery remained relevant over the last 500 years, this is, however, not the case. As will be seen, its assumed relevance disappears and reappears in theory on tinnitus throughout history.

In the 17th century, for example, one of the most important and comprehensive theses on tinnitus is the publication of *Hartmann* (1669) and although he presented tinnitus as a disorder of the ear for the first time, he also accepted a view dating back to Greek times. Hartmann argued that tinnitus was also caused by air trapped within the ear. The causes of this entrapment were divided into four categories,
1. GENERAL INTRODUCTION

namely supernatural (e.g., the divine), natural (e.g., temperament, hereditary disposition), non-natural (e.g., abnormal activity in the trapped air, stemming from cerebral, psychological and systematic causes), and preternatural (e.g., depression\(^3\), hypochondrias, and venereal diseases) causes (Stephens 2000). During that time period the influence of excessive environmental sounds on the development of tinnitus disappeared. A couple of years later, entrapment of air in the ear(s) as a possible cause of tinnitus was again disregarded by Guichard Joseph Du Verney (1683). Du Verney, who is often referred to as the founder of the modern period, was the first to publish an entire book on the study of diseases of the ear (Figure 2) (Stephens 2000; Meyer et al. 2001a). He refused to accept old concepts and stated that tinnitus is an example of ‘depravation of hearing’ (Du Verney 1731, p. 158). According to Du Verney ‘it renders the ear sensible of noises which are not in reality, or which are not external’ (Du Verney 1731, p. 158). He did not accept that tinnitus arose from implanted air, but instead argued that tinnitus arose from vascular pulsation (a true sound), from disease of the ear (false sounds) and from disorders of the brain. Moreover, he stated that in tinnitus the ear doesn’t have to be affected directly, but that disorders can exert a direct influence on the nerves in the auditory pathway. Du Verney’s work led to the rejection of an approach regarding tinnitus merely as a manifestation of ear disease. His orientation to treatment dealt with the underlying lesion or the assumed cause of tinnitus (vascular, aural, or in the brain).

\(^3\) Depression should not be confused with the concept of depression as we know it nowadays. Depression was mainly used in a medical context and more specifically as an indication of a loss in cardiovascular functioning. Later on it obtained a psychological meaning. The medical encyclopaedia from 1860 described depression as: “lowness of spirits of people suffering under disease” (Dehue 2008, p. 37). Although a psychological meaning in this description can be found, depression was not seen as a separate psychological disorder. The view of depression as a separate mental disorder, started when the ‘entity model’ of sickness gained success, which was the end of the 19\(^{th}\) and the beginning of the 20\(^{th}\) century (Dehue 2008).
At this point we must stress the importance of Du Verney’s work. Not only can we find a primary differentiation between objective (a true sound) and subjective (false sounds) tinnitus, Du Verney also states that the ear doesn’t have to be affected in tinnitus and refers to the influence of the brain. These ideas can be roughly found in present-day theories on tinnitus. As discussed below, it is increasingly accepted that tinnitus may start with a pathology involving the ear, but most forms of persistent tinnitus are assumed to be caused by pathologies in the brain (Jastreboff 1990, 1995, 2011; Møller 2011e, Robert 2011; Schlee et al. 2011; De Ridder 2011).

Du Verney’s orientation to treatment, which focused upon the removal of the cause, was the only orientation in use until the beginning of the 19th century. Progress in technology in the 18th century let to the use of static electricity as a therapeutic approach to tinnitus. Wibel (1768) and Grappengiesser (1801) in particular made recommendations for this approach. According to Grappengiesser, stimulation via a constant current could make tinnitus disappear. Although this specific approach seemed promising, other researchers and medical doctors reported that the use of static electricity worsened or even created tinnitus (Stephens 2000; Meyer et al. 2001a). As a result of such reports the use of static electricity as a therapeutic approach faded away. However, technology evolved and new promising techniques by means of electricity were created. George Purdey Field (1875), for example, described the success of faradisation (electrical treatment by the galvanic current) in tinnitus. Although the object of faradisation was the removal of tinnitus, the success was limited to a certain amount of subjective improvement. Negative reports, such as great pain and haemorrhage (Field 1875), again arose and caused its disappearance. In spite of the loss of popularity in the use of electrical stimulation
as a therapeutic technique during certain periods of past centuries, it continued to exist. Today this
technique to treat tinnitus regained interest under the form of cochlear implants (e.g., Punte et al.
2011).

By the beginning of the 19th century, criticism emerged towards the commonly used orientation of
treatment towards the cause of tinnitus, in general, and the use of electrical stimulation, in particular.
Jean Marie Gaspard Itard (1774 - 1838), for example, argued that treatments directed towards the
cause were for most patients ineffective (Meyer et al. 2001a). In 1821, Itard published the book Traité
des maladies de l'oreille et de l'audition where he proposed his insight into tinnitus based on his
experience with 172 patients. Itard classified tinnitus into three groups: 1) tinnitus related to real
sounds (i.e., objective tinnitus or somatosounds), which he called ‘true tinnitus’; 2) tinnitus without
any acoustical basis (i.e., subjective tinnitus), which he called ‘false tinnitus’; and 3) fantastic tinnitus
(i.e., auditory hallucinations), which he considered to have a psychological basis. He established that
false tinnitus was much more frequently observed and could be further sub-divided into: idiopathic
tinnitus (as a consequence of exposure to loud sounds such as sounds of a canon or a water mill); and
symptomatic tinnitus (in relation to hysteria and hypochondria) (Itard 1821; Stephens 2000).
Moreover, Itard described that in case of stubbornness of tinnitus, treatment should focus on making
the tinnitus less intolerable for patients. According to Itard, this can be done by making use of a
variety of masking noises. The choice of the environmental masker (e.g., a water mill) was always
matched to the nature of the tinnitus. As such, Itard was the first to orient treatment towards managing
the consequences (especially sleeping problems) of the tinnitus rather than the perception of tinnitus
itself (Itard 1821; Stephens 2000; Meyer et al. 2001a).

Itard’s perspective on tinnitus is of major importance. First, Itard made a clear differentiation between
objective and subjective tinnitus, which were also differentiated from auditory hallucinations.
Moreover, he differentiated two kinds of subjective tinnitus, namely tinnitus as a consequence of
excessive environmental sounds and tinnitus in relation to other diseases4. His most important
contribution is, however, the orientation of treatment towards the consequences of tinnitus by making
use of masking sounds. Nowadays this view can still be recognised in Tinnitus Retraining Therapy
(TRT). TRT aims at removing the consequences of tinnitus rather than the cause. The object of TRT is
retraining (the brain of) patients suffering from tinnitus in such a way that patients are habituated to
the sound (or to not experience the sound as unpleasant or dangerous). Methods used in TRT are the
use of sounds (transmitted to the ear via ear devices) and learning to understand the mechanisms of

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4 Until the end of the 19th century, hysteria and hypochondria were both considered to be medical conditions.
Despite of Itard’s criticism, recommendations for treatment remained focused upon the cause. The main reason for this was the conviction that the cause of tinnitus was known (e.g., a disease of the nose and throat, the central nervous system, the different sections of the ear). Nevertheless, the effect of such a treatment was mostly described as temporary or even nil (Meyer et al. 2001a). A possible reason why Itard’s point of view did not receive great acceptance could lie, on the one hand, in the belief that a unitary (physiological) explanation for tinnitus could be found and, on the other hand, in the lack of an established psychological science. The possible influence of psychological factors in tinnitus was slow to be accepted and still debated in 1950. Nevertheless, without explicit reference to the influence of such factors, different interesting observations were made in the 19th and early 20th century.

In Great Britain, William Wilde (1815 – 1876), for example, believed that the description of the sound heard by the patient depends upon the social status and the imagination of the patient. In his book, *Practical observations on aural surgery and the nature and treatment of diseases of the ear* (1853), Wilde wrote the following: “The peculiar characters of the tinnitus, and the noises to which it is likened, are as variable as sound itself. Do these characters depend upon the cause of deafness, or the portions of the organs affected? I have taken some pains to investigate the subject, and I believe not. [...] I think the descriptions which patients give of the noise which they experience depend, to a certain degree, upon their fancy, their graphic powers of explanation, and not unfrequently upon their rank of life, or the position in which they have been placed, and the sounds with which they are most familiar: thus, persons from the country or rural districts draw their similitudes from the objects and noises by which they have been surrounded, as the falling and rushing of water, the singing of birds, buzzing of bees, and the waving or rustling of trees; while, on the other hand, persons living in towns, or in the vicinity of machinery or manufactures, say that they hear the rolling of carriages, hammerings, and the various noises caused by steam-engines. Servants almost invariably add to their other complaints, that they suffer from “the ringing of bells” in their ears; while in the country, old women much given to tea-drinking sum up the category of their ailments by saying, that “all the kettles in Ireland are boiling in their ears.” (Wilde 1853, p. 91). Wilde touched upon the subjective meaning of sounds in tinnitus patients and although this view has vanished, it could be a possible explanation for the abundant variety of sounds reported by patients. As outlined above, hundreds of types of sounds have been reported by patients and despite certain common factors (e.g., a hissing, ringing, roaring sound), each sound experienced by an individual patient is unique.

Other remarkable observations and findings with regard to the possible influence of psychological factors were described in the late 19th century by Victor Urbantschitsch and Politzer. Urbantschitsch reported that the subjective sensations made up a much bigger handicap than did the hearing disability, because such sensation prevented patients from working, thinking, and sleeping and they could even
lead to suicide. Politzer reported the appearance of hardly perceived tinnitus in normal hearing, which became worse if the individual experienced a loss of temper, tiredness or an additional disease. He considered variations in temperature, humid heat or extreme dry heat, a stay in a very warm room, an abundant meal, alcohol, and extreme physical weariness, as aggravating factors. Thus, although mental factors can be recognized to some degree, the focus was limited to objectively identifiable factors. In addition, Urbantschitsch noticed that in some tinnitus patients the ear and auditory nervous system are not affected and concluded that tinnitus can be a product of injuries of the central nervous system. He even found that syphilis, anaemia, certain circulatory problems (syncope), greensickness, quinine, aspirin, morphine, tobacco, and other manifestations under the name of weakness or over-stimulation of the nerves (nervousness) could all cause tinnitus (Meyer et al. 2001a).

As time progressed, technology progressed and as a result of the technological progression the number of causes proposed for tinnitus increased as well. Causes ranged from injuries of the ear, the auditory and central nervous system, to the causal effect of other medical diseases and even the causal effect of medication. All these and other contradictory facts made a unitary explanation for tinnitus difficult. Despite the progression in science during the 20th century and the increasing number of contradictory facts, the belief in and the quest for a unitary physiological explanation for tinnitus remained unsuccessful. Instead of a progression, a regression to older physiopathological assumptions (e.g., entrapment of air in the ear) emerged during the first part of the 20th century (Meyer et al. 2001a). The acceptance of the possible involvement of psychological factors remained difficult during the first (and to some degree the second) part of the 20th century, although psychology as a separate science came into existence by the end of the 19th century. It was only after World War II, when pure-tone audiometry became commonly used (Mester & Stephens 1984), that psychological factors became of interest in the theory and research on tinnitus. The observation that the intensity of tinnitus, as measured by pure-tone audiometry, was relatively faint even for patients who reported very loud levels of tinnitus (Meyer et al. 2001a) contributed to the acknowledgment of a possible influence of psychological factors in tinnitus.

It is argued that the modern approach to tinnitus began with the work of father and son, Earl Prince Fowler (1873 – 1966) and Earl Prince Fowler Junior. Both were otologists, but whereas the father was a great pioneer of audiometry, the son was more interested in the psychological aspects of audiovestibular disorders (Stephens 2000). In 1955 father and son both wrote down their approaches to the management of tinnitus in a patient-centred way. Together they listed nine points on how to examine patients suffering from tinnitus. These nine points are:

“1. Listen attentively to their story and obtain a complete personal history, particularly concerning the symptoms of the present and past episodes possibly related to emotional strains at home and in the business world.
2. Obtain a real family history not only concerning disease but also the personality of siblings and immediate ancestors.
3. Examine carefully, not only otolaryngologically, but as a physician.
4. Measure the hearing capacity.
5. Measure the loudness and pitch of the tinnitus.
6. Estimate related aural symptoms – vertigo, nausea, and so on.
7. Examine carefully for nystagmus.
8. Tell the patient the results of your examination in a clear, confident, reassuring manner and outline what treatment and management is indicated and not indicated.
9. Explain simply and briefly the basic types of tinnitus and their pathophysiology…Impress on him that it is not a delusion, and that unless he was crazy before he saw you he probably will not be crazy afterwards.” (Stephens 2000, pp. 447 – 448).

These points reveal relevant aspects with regard to the mechanism and management of tinnitus. Fowler and Fowler acknowledge the importance of medical, audiological and psychological factors in the mechanism and management of tinnitus. Secondly, these authors indicate that information on the personal history of an individual patient (medical and psychological) is necessary in the management of tinnitus. In other words, the broader context (e.g., personal relationships at home and at work) in the management of the tinnitus symptom was also being taken into account. As will be argued in the discussion of this dissertation, we believe that the personal (psychological) history of an individual patient and the necessary shift from the symptom to a broader personal context is often disregarded in present-day theories on the management of tinnitus.

To conclude this short overview of the historical contributions on tinnitus, we wish to add a noteworthy observation. Until approximately 1950, mechanisms of tinnitus were thought to be situated on a physiological level. Entrapment of air in the ear, excessive environmental noise, diseases of the ear, the auditory nervous system and the central nervous system were the most frequently reported causes of tinnitus. However, with regard to ideas on the dominant cause of tinnitus, history seems to repeat itself on several occasions. As will be seen in the next section, some of the basic historical ideas on these mechanisms, causes and treatments can, in some degree (again), be found in present-day theory and findings on tinnitus.

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5 A condition of involuntary eye movement.
1. GENERAL INTRODUCTION

CONTEMPORARY VIEWS: FORMS AND CAUSES

Tinnitus is still not considered to be a single phenomenon, because it is found to have many forms and different possible causes (Møller 2011a, 2011b). The complexity of the tinnitus symptom is reflected in several reported clinical observations. Such observations have indicated that tinnitus may be temporary or longstanding (Meikle et al. 1984; Henry et al. 2005; Holmes & Padgham 2011) and although often described as a “ringing in the ears,” patients also refer to whistling, hissing, buzzing, or roaring sounds of varying intensity, loudness, and pitch (Meikle et al. 1984; Henry et al. 2005; Holmes & Padgham 2011). In others it has a ticking, clicking, or roaring tune. It has also been described as a “whooshing” sound, like the sound of wind or waves (Heller 2003; Belli et al. 2008). Tinnitus sounds may be simple (e.g., whistling) or complex (e.g., music) (Meikle et al. 1984; Henry et al. 2005; McKenna 2008) and patients may hear single or multiple sounds (Meikle et al. 1984; Henry et al. 2005; Baldo et al. 2008). Tinnitus can be experienced in one ear, both ears, and/or perceived as being inside the head (Møller 2011b). It has been reported that an individual’s tinnitus can vary widely from time to time, that many forms of tinnitus change from day to day and may even change over the course of one day (Meikle et al. 1984; Møller 2011b; Holmes & Padgham 2011). Some tinnitus patients can modulate their tinnitus by signals from the somatosensory system, such as from eye movements, manipulations of their jaw, and applying various pressure on specific neck regions (Møller 2011b), and associations between tinnitus and hyperacusis – lowered tolerance or hypersensitivity to sounds (Baguley 2003; Møller 2011c), misophonia – a dislike of specific sounds (Møller 2006, 2011c), phonophobia – fear of sounds (Henry et al. 2005; Møller 2011c), and psychiatric disorders (Langgrebe & Langguth 2011a; Møller 2011b) have been reported. Moreover, not all individuals experiencing tinnitus are found to be bothered by the perception of the tinnitus sound. In some patients, for instance, daily life is affected by tinnitus (e.g., not being able to sleep, to work, to relax), while in others daily life remains unimpaired (Meikle et al. 1984; Meikle 2003; Jastreboff 2011; Landgrebe & Langguth 2011a; Møller 2011a, 2011b, 2011d).

It is thus not surprising that different classification systems of the tinnitus symptom have been proposed, yet not all systems have gained acceptance (Heller 2003). The two most widespread systems used are 1) a system based upon core characteristics of tinnitus and 2) a system based upon the perceived severity of tinnitus. In clinical practice, however, both systems are mostly used simultaneously. In terms of system 1, core characteristics of tinnitus are: a) The intensity: using a visual analogue scale or loudness matching; b) The character: high frequency (e.g., like crickets), low frequency (e.g., rumbling noises), tonal, pulsatile, constant, or intermittent; c) The presence of features such as the ability to modulate tinnitus by manipulating the jaw, moving the eyes, or applying pressure on neck regions; and d) The referred place, namely one ear, both ears, or perceived as being inside the head (Heller 2003; Møller 2011b). In the second system, where tinnitus is classified according to its
perceived severity, three broad groups are distinguished: 1) Mild tinnitus, defined as tinnitus that does not interfere noticeably with everyday life; 2) Moderate tinnitus, which causes some annoyance and may be perceived as unpleasant; and 3) Severe tinnitus which affects a person’s entire life (Reed 1960; Heller 2003; Møller 2011b). Although such subjective descriptive systems may help clinical practitioners in classifying the tinnitus symptom, it doesn’t reveal anything about its cause(s).

In contrast to the conviction of former centuries, nowadays most researchers are convinced that a single cause of tinnitus is unlikely (Baldo et al. 2008; Holmes & Padgham 2011; Møller 2011a, 2011b). The main reason for this conviction is that different anatomical locations of physiological abnormalities have been found and, although the most common causes of tinnitus are assumed to be related to damage and diseases affecting the conductive apparatus of the ear, its receptor organs/the inner ear, the auditory nerve, and nerve cells in the nuclei of the auditory system (including the cerebral auditory cortex), not all persons with aural pathology experience tinnitus (Møller 2011d) and not all tinnitus patients have an aural pathology (Baldo et al. 2008; Kleinjung & De Ridder 2011; Jastreboff 2011). Below we list the most commonly reported causes of tinnitus. Some researchers (Henry et al. 2005) argue, however, that these factors may be associated with tinnitus and that some may even cause the onset of tinnitus, but that the mechanism responsible for sustained tinnitus remains generally unknown (Henry et al. 2005).

Common causes of tinnitus are:

a) **Otologic:** Noise-induced hearing loss, presbycusis (hearing loss due to aging), otosclerosis (a disorder of the bony labyrinth and the stapes), otitis, impacted cerumen, sudden deafness, Ménière disease, autoimmune hearing loss and other causes of hearing loss (Andersson 2002; Lockwood et al. 2002; Crummer & Hassan 2004; Folmer & Martin 2008; Del Bo et al. 2011; Biesinger & Mazzoli 2011).

b) **Neurologic:** Head injury, whiplash, multiple sclerosis, vestibular schwannoma (acoustic neuroma) or other cerebellar-pontine-angle tumors (Lockwood et al. 2002; Folmer & Griest 2003; Henry et al. 2005; Folmer & Martin 2008).

c) **Infectious:** Otitis media and sequelae, labyrinthitis, meningitis, syphilis, and other infectious or inflammatory processes that affect hearing (Lockwood et al. 2002).

d) **Ototoxic substances:** common side effect of many drugs, such as salicylates (e.g., aspirin), nonsteroidal anti-inflammatory drugs, aminoglycoside antibiotics, loop diuretics, and chemotherapy agents (e.g., platins and vincristine) (Folmer & Martin 2008; Bagai et al. 2006; Møller 2011b; Holmes & Padgham 2011) and heavy metals (e.g., lead) (Folmer & Martin 2008). In fact, Yorgason et al. (2006) found that more than 130 drugs are ototoxic.
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e) **Non-ototoxic substances**: lidocaine, anticonvulsants, antidepressants, cannabinoids, antihypertensives, beta-adrenergic blocking agents, opioids (buprenorphine), caffeine, and anti-histamines (Meyer et al. 2001a; Enrico & Goodey 2011).

f) **Vascular**: hypertension, arteriosclerosis, cerebral aneurysm, cerebrovascular accident (Folmer & Martin 2008).

g) **Metabolic**: hypo- or hyperthyroidism, lipidemias, anemia (Kazmierczak & Doroszewka 2001; Folmer & Martin 2008), or diabetes mellitus (Kraft 1998, Folmer & Martin 2008).

h) **Other**: Temporomandibular-joint dysfunction, other dental disorders (Folmer & Griest 2000; Lockwood et al. 2002; Henry et al. 2005; Møller 2011b), and migraine headaches (Møller 2011b).

This list may indeed reflect the impossibility of a unitary explanation for the etiology of tinnitus, yet some researchers (partly) disagree. As such, they assume that most forms of tinnitus are phantom sounds caused by abnormal function of neural circuits in the brain (Jastreboff 1990, 1995, 2011; Møller 2011e; Robert 2011; Schlee et al. 2011; De Ridder 2011). They argue that while the pathology that causes tinnitus may start with an event involving the ear, the pathology that causes most forms of persistent tinnitus is in the central nervous system where some abnormal neural activity is generated and interpreted in a similar way as activity generated when an external sound reaches the ear (Møller 2011e). This abnormal activity is assumed to be caused by **neural plasticity** (Møller 2011e; Robert 2011). Neural plasticity in turn can be activated through overstimulation or deprivation of the signals to the auditory nervous system (Møller 2011e). The deprivation of sensory input has been found to turn on neural plasticity, a conclusion that is based upon the finding that restoring the input to the auditory nervous system via, for example, a sound generator can alleviate tinnitus in some patients (Del Bo et al. 2011; Biesinger & Mazzoli 2011). In this view tinnitus has been regarded to as a ‘plasticity disorder’ (Møller 2011b; Møller 2011e; Roberts 2011), similar to phantom limb symptoms and central neuropathic pain (Møller 2011b, 2011f).

In terms of the historical assumptions and findings outlined above, diseases and / or injuries in the ear, the auditory and central nervous system have gained alternated support as being the dominant cause of tinnitus. Although there appears to be a wide variety of possible causes of tinnitus, similar to earlier centuries, some researchers continue to be convinced that a unitary explanation (or at least to some degree) can be found.

Nevertheless, regarding tinnitus as a problem of the central nervous system is complicated, as it is not easy to locate the region of the brain where the pathology is situated. Moreover, the abnormal function is not necessarily restricted to regions that are normally activated by sound stimulation, and some assume that tinnitus does not manifest as a result of a single event or damage to a single structure. As
such, it is believed that tinnitus is caused by a cascade of events in the brain that occur at the same time, while it may not have developed if such events had occurred alone or one at a time. There is considerable evidence that activation of neural plasticity is involved in many forms of tinnitus (Møller 2011e, 2011g), however the nature of the abnormalities that cause these forms of tinnitus, and how it is brought about, is still being investigated. As such, hypotheses regarding the pathology of tinnitus are constantly created and abandoned (Møller 2011e, 2011g).

It is not surprising that diverse and conflicting results of pathological brain regions emerge, as it has been found that neural plasticity is not a pathological, but a normal process in each living being. Pascual-Leone et al. (2005, 2011), for instance, found that plasticity represents an intrinsic property of the nervous system, which is retained throughout life and which enables modification of function and structure in response to the environmental demands via the strengthening, weakening, pruning, or adding of synaptic connections and by promoting neurogenesis. These researchers argue that the brain does not remain static but, instead, continues to change as the obligatory consequence of each sensory input, motor act, association, reward signal, action plan, and awareness (Pascual-Leone et al. 2005; Pascual-Leone et al. 2011). It thus seems that each internal and external cue can trigger neural plasticity and thus that neural plasticity is a natural conditionality of life.

Although this dissertation doesn’t focus on the cause(s) of tinnitus, the discussion above indicates that the manifestation of the tinnitus symptom has diverse physiological causes which may differ from individual to individual.

**THE PREVALENCE OF TINNITUS**

Due to the numerous differentiations in terms of forms and causes of tinnitus, an estimation of its prevalence is difficult to ascertain (Henry et al. 2005; Møller 2011d). This is further complicated by the fact that prevalence varies with age and, to some extent, with gender (Henry et al. 2005; Møller 2011d). Nevertheless, most studies indicate that tinnitus can occur at a young age, but that its prevalence steadily increases with the degree of age-related hearing loss and may reach 12-15% for people aged 65 and over (Møller 2011d). The prevalence of tinnitus is higher for men than for women up to the age of 75. Above the age of 75, however, the prevalence in men and women is approximately the same (Hoffmann & Reed 2004; Møller 2011d). However, different prevalence studies have defined tinnitus differently (e.g., Have you experienced tinnitus for more than 5 minutes and not exclusively after loud sounds? (Davis 1995); Do you experience tinnitus often or always? (Axelsson & Ringdahl 1989); Have you been bothered by ringing in the ears or other funny noises in the head in the past 12 months? (Ries 1994)), forcing some authors to conclude that an estimation of the actual prevalence in a single number is virtually impossible (Møller 2011d). This impossibility is reinforced
by the observation that not all individuals experiencing tinnitus seek (medical) help (Davis & Rafaie 2000; Møller 2011d). The UK National Study of Hearing (1984-1995), for instance, found that of the 10% prevalence in their study, approximately 7.1% visited a doctor of which 2.5% went to a hospital for treatment (Davis & Rafaie 2000). Such findings also suggest that the experienced severity of the tinnitus symptom varies strongly among individuals with tinnitus. Indeed, next to the many forms and causes of tinnitus, the subjectively experienced severity of tinnitus ranges widely from being a slight nuisance to affecting a person’s daily life. As was observed halfway through the 20th century, audiological studies still find that the measured loudness of tinnitus does not directly relate to the amount of distress experienced. Thus, even when the sound is at levels very close to the hearing threshold, tinnitus can be experienced as a disabling symptom that amounts to a major burden (Meikle et al. 1984; Meikle 2003; Jastreboff 2011; Landgrebe & Langguth 2011a; Møller 2011a, b, d). These results have lead researchers to differentiate the physical tinnitus symptom from the perceived severity of this symptom.

In this dissertation, we focus on the perceived severity of the tinnitus symptom, which is independent of the causes discussed above.

**TINNITUS: THE SYMPTOM AND ITS PERCEIVED SEVERITY**

It was Meikle (2003) who defined two aspects of tinnitus, namely the physical symptom and its subjectively experienced severity. Whereas the physical symptom refers to ‘the perception of the sound itself,’ the perceived severity is defined as ‘the nature and the extent of patients’ tinnitus-related problems’ (Meikle 2003, p. 59). The relationship between the tinnitus symptom and its perceived severity is, however, found to be asymmetrical. One study of Meikle et al. (1984) reports that the sounds heard by patients who are bothered by their tinnitus are not louder or different in pitch or quality from those heard by people who are not bothered by their tinnitus, implying that it is not the physical symptom, but the subjectively experienced severity of the symptom that varies among tinnitus patients (Meikle et al. 1984; Jastreboff 1990, 1995, 2011). Other studies have also reported minimal or even absent relationships between audiological characteristics of tinnitus (e.g., loudness and pitch) and the subjectively experienced severity of tinnitus as measured by different tinnitus severity questionnaires (Meikle et al. 1984; Meikle & Walsh 1984; Erlandsson et al. 1992; Newman et al. 1994; Henry & Wilson 1995; Holgers et al. 2003; Monzani et al. 2008; Landgrebe & Langguth 2011a). Research attempting to explain the differences in the subjective experience of tinnitus found that it correlates closer to psychological factors than to audiometric parameters. From this it is concluded that psychological factors, rather than audiological characteristics (pitch and loudness), are important in explaining the differences in the perceived severity of tinnitus among patients (Erlandsson et al. 1992; Erlandsson & Archer 1994; Jastreboff 1990, 1995, 2011; Zöger et al. 2006;
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Hiller & Goebel 2006; Puel & Guitton 2007). The two most reported psychological problems associated with the perceived severity of tinnitus are depression and anxiety (Halford & Andersson 1991; Zöger et al. 2006; Belli et al. 2008; Crocetti et al. 2009; Landgrebe & Langguth 2011a, 2011b). Yet, as will be discussed throughout the next sections, research on these relationships is somewhat lacking. This thesis examines the relationship between the perceived severity of tinnitus and depression and between the perceived severity of tinnitus and anxiety in more depth.

DEPRESSION AND ITS RELATION TO TINNITUS SEVERITY

There is abundant evidence for the presence of depressive symptoms in individuals suffering from tinnitus (Halford & Andersson 1991; Henry & Wilson 1995; Folmer et al. 1999; Rutter & Stein 1999; Dobie 2003; Andersson et al. 2003; Andersson et al. 2004; Zöger et al. 2006; Salonen et al. 2007; Andersson et al. 2009; Crocetti et al. 2009; Oishi et al. 2010; Langguth & Landgrebe 2011; Landgrebe & Langguth 2011a; Møller 2011a, 2011b). This seems to be especially true for those with disabling or severely experienced tinnitus (Halford & Andersson 1991; Henry & Wilson 1995; Folmer et al. 1999; Rutter & Stein 1999; Dobie 2003; Salonen et al. 2007; Oishi et al. 2010; Langguth & Landgrebe 2011).

However, since virtually all research on the relation between depression and tinnitus severity is carried out using self-report questionnaires, some researchers recommend that caution be taken when drawing conclusions on this matter (Langguth & Landgrebe 2011). In other words, while one can consider the presence of depressive symptoms in this context, whether there is an actual ‘clinical depression’ remains unclear (Langguth & Landgrebe 2011). Despite this warning, most researchers rather hastily conclude that tinnitus is a problem related to depression (e.g., Folmer et al. 1999; Dobie 2003; Oishi 2010; Langguth & Landgrebe 2011; Landgrebe & Langguth 2011a) and moreover that depression is one of the most reported disorders in tinnitus patients (Landgrebe & Langguth 2011a; Langguth & Landgrebe 2011; Møller 2011a, 2011b).

Some researchers even try to formulate a conclusion on the relationship between depression and tinnitus severity, although not all agree on the exact direction of this relationship. Some authors (Dobie 2003; Langguth & Landgrebe 2011), for example, consider the relationship between depressive symptoms and tinnitus (severity) in terms of vulnerability, meaning that tinnitus triggers depression in depression-prone individuals. The alternative view, i.e., that depression causes tinnitus, is considered unlikely. Because depressed people often focus on bodily functions and symptoms, it’s possible that tinnitus that was previously unnoticeable and ignored becomes more intrusive when depressed patients begin to pay attention to it (Dobie 2003; Langguth & Landgrebe 2011). Other authors, however, consider depressive symptoms as a reaction to tinnitus or consider tinnitus and depressive symptoms to be consequences of a third condition (e.g., a traumatic event) (Langguth & Landgrebe 2011).
Alternatively, Halford and Anderson (1991) consider the causal relationship between psychological variables (like depression) and tinnitus severity to be bi-directional.

These assumed possibilities concerning the direction of the relationship between depressive symptoms and tinnitus severity have led researchers to conclude that the exact relationship varies from patient to patient, and will depend on their order of onset (Langguth & Landgrebe 2011).

**Critical concerns**

Although findings concerning the relationship between depressive symptoms and tinnitus severity are compelling, we aim to re-examine this relationship. The observation that almost all results for the presence of depressive symptoms are based on data obtained from self-report questionnaires is concerning. Firstly, the presence of depressive ‘symptoms’ does not automatically mean that a patient suffers from a ‘clinical depression,’ as defined in the Diagnostic And Statistical Manual for Mental Disorders (DSM-IV-TR, American Psychiatric Association 2000; Langguth & Landgrebe 2011). Secondly, we believe that even the presence of ‘real’ depressive symptoms can be questioned. We discuss these critical concerns in more detail below.

As indicated by the DSM-IV-TR, before a diagnosis of any kind of mood disorder can be given, an individual should meet the criteria for a certain episode (a depressive, manic, mixed or hypomanic episode). Since a depressive episode is assumed to be relevant in tinnitus, the fulfilment of all criteria (A to E) of this episode is necessary (Table 1). Moreover, an episode is not a disorder. Thus, if an individual doesn’t meet the criteria of one of these episodes, a mood ‘disorder’ cannot be diagnosed (American Psychiatric Association 2000). Despite the warning of some authors concerning results based upon self-report questionnaires (Langguth & Landgrebe 2011), Major Depressive Disorder (MDD) (for criteria see Table 2) is assumed to play a role in severely distressed tinnitus patients (Halford & Andersson 1991; Dobie 2003; Landgrebe & Langguth 2011a; Langguth & Landgrebe 2011).

We believe that research that is solely based upon self-report questionnaires cannot provide the certainty that all required criteria, from A to E for the presence of a depressive episode, are met. Self-report questionnaires are merely based upon the symptoms listed under criteria A of a depressive episode. Given the observation that almost all results on the relationship between depression and tinnitus severity are based upon self-report questionnaires, the presence of ‘clinical depression’ in tinnitus populations lacks substantial evidence.
A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning: at least one of the symptoms is either 1) depressed mood or 2) loss of interest or pleasure. Note: symptoms may not be symptoms that are clearly due to a general medical condition, or mood-incongruent delusions or hallucinations.

1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful). Note: In children and adolescents, this can be an irritable mood;
2. Markedly diminished interest or pleasure in all (or almost all) activities most of the day, nearly every day (as indicated by either a subjective account or observation made by others);
3. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or change in appetite nearly every day. Note: In children, consider failure to make expected weight gains;
4. Insomnia or hypersomnia nearly every day;
5. Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down);
6. Fatigue or loss of energy nearly every day;
7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick);
8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others);
9. Recurrent thought of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.

B. The symptoms do not meet criteria for a Mixed Episode.

C. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

D. The symptoms are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism).

E. The symptoms are not better accounted for by bereavement (i.e., after loss of a loved one), the symptoms persist for longer than 2 months, or are characterized by marked functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.

Table 1 DSM-IV-TR criteria of a depressive episode (American Psychiatric Association, 2000).
Table 2 DSM-IV-TR criteria of Major Depressive Disorder (single episode) (American Psychiatric Association, 2000).

A. Presence of a single Major Depressive Episode.
B. The Major Depressive Episode is not better accounted for by schizoaffective disorder and is not superimposed on schizophrenia, schizophreniform disorder, delusional disorder or psychotic disorder not otherwise specified.
C. There has never been a manic episode, a mixed episode, or a hypomanic episode. Note: This exclusion does not apply if all manic-like, mixed-like, or hypomanic-like episode are substance or treatment induced or are due to the direct physiological effects of a general medical condition.

The second consequence of the sole use of self-report questionnaires is that the presence of ‘real’ depressive symptoms is doubtful. The following reasons may clarify this statement:

- Based on previous research on depression in a tinnitus population the presence of ‘clinically relevant’ depressive symptoms is questionable. Studies on depression in tinnitus populations often don’t report the (mean) scores on self-reported measures for depression. If they do, the (mean) scores mostly do not reach the required cut-off point even for mild depressive symptoms (e.g., Andersson et al. 2003, Andersson et al. 2004; Andersson et al. 2009). The same observation holds for studies comparing depression scores between groups (e.g., Andersson et al. 2003). Finding a statistically significant difference in depression scores between, for example, a tinnitus group and a control group, does not mean that the difference is clinically relevant. If the mean scores do not reach the required cut-off point, conclusions on the presence of clinical depression cannot be drawn.

- There is a marked resemblance between depressive symptoms and the reported difficulties by severely distressed tinnitus patients. Reports of severely distressed tinnitus patients contain descriptions of interference in daily life, such as difficulties with sleeping, reading, concentrating on (complex) tasks, social interaction, as well as effects on their emotional state (e.g., feeling upset, confused, irritable, etc.) (Dobie 2003; Møller 2011a). These reported difficulties as a consequence of tinnitus resemble the depressive symptoms as described in criteria A of a depressive episode in the DSM-IV-TR. Furthermore, this resemblance is reflected in questionnaires used for measuring depressive symptoms and questionnaires measuring the subjective severity of tinnitus. The latter implies that results obtained could be distorted due to content overlap and shared method variance (see also Meyer et al. 2001b).

- As mentioned in the list of criteria for a depressive episode, there is a necessary condition to regard listed symptoms as ‘depressive’ symptoms. This necessary condition, namely that listed symptoms may not be a consequence of a medical condition, should not be neglected.
This has implications concerning the relation between depressive symptoms and tinnitus. If symptoms are indeed a consequence of tinnitus, they should not be seen as depressive symptoms.

- For the fulfilment of the criteria for a depressive episode, the presence of 1) a depressed mood or 2) a loss of interest or pleasure is necessary. The presence of one of the two core symptoms is important, since it also determines whether the other listed symptoms under criteria A of a depressive episode can indeed be seen as symptoms of depression. This is not taken into account in research using self-report questionnaires.

- Next to a possible overlap between depressive symptoms and symptoms described by severely distressed tinnitus patients, there is also a possibility of content overlap with anxiety-related symptoms. The symptoms of depression and the difficulties reported by severely distressed tinnitus patients (e.g., fatigue, irritability, insomnia, exhaustion, and concentration difficulties) are symptoms that are also associated with several anxiety related disorders (e.g., Post Traumatic Stress Disorder (PTSD); Acute Stress Disorder (ASD); Generalized Anxiety Disorder (GAD)) as noted in the DSM-IV-TR. Thus, there is a reasonable chance that research findings that are solely based self-report questionnaire data in relation to tinnitus severity, depression and anxiety, are distorted by content overlap.

Overall, we believe that the considerations outlined above must be taken into account before any conclusion on the relation between depressive symptoms (and ultimately depression) and tinnitus severity can be drawn. Such studies have never been carried out with a tinnitus population and are of major importance given that distorted results might lead to inappropriate treatment of tinnitus. In Chapter 2, we take a first step in this direction and investigate whether results on self-reported depressive symptoms can be considered as clinically relevant and whether the often found relationship between tinnitus severity and depressive symptoms can be explained by shared method variance and content overlap.

ANXIETY AND ITS RELATION TO TINNITUS SEVERITY

In clinical practice patients often report being afraid that their tinnitus is becoming worse (Jastreboff 2011; Landgrebe & Langguth 2011b). Moreover, phonophobia, fear of specific sounds, often occurs together with tinnitus (Møller 2011b, 2011c; Landgrebe & Langguth 2011b) and it has been found that hyperacusis, hypersensitivity to sounds, occurs in 40% of tinnitus patients attending a tinnitus clinic (Baguley 2003; Henry et al. 2005; Landgrebe & Langguth 2011b). Although little is known about the phenomenon of hyperacusis, research has found direct neurological connections between the central auditory system and the amygdale (Jastreboff & Hazell 1993; Jastreboff 2011;
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Landgrebe & Langguth 2011b). As such, connections link emotions of fear and anxiety to specific or more general sounds and this mechanism has been hypothesised to underlie hyperacusis (Jastreboff & Hazell 1993; Landgrebe & Langguth 2011b). Based on these clinical observations, the presence of anxiety-related problems in a tinnitus population seems to be less uncertain than the presence of depressive symptoms. Moreover, theoretical models on tinnitus refer to the importance of anxiety in tinnitus. The neurophysiological model of tinnitus, for example, which is an internationally accepted model, states that tinnitus becomes a significant problem if the first experience of tinnitus induces a high level of annoyance or anxiety because it is associated with something unpleasant or it occurs during a period of stress and anxiety. If this is the case, higher levels of annoyance or anxiety link to the meaning of the new tinnitus sound which results in an enhancement of activity in the autonomic and / or limbic system, whereby emotional reactions are more enhanced (Jastreboff 1990, 1995, 2004, 2011).

Other researchers have focused on the role of anxiety in the experienced severity of tinnitus. For example, Erlandsson and Archer (1994) consider anxiety as one of the key factors in the psychological model of tinnitus tolerance or threat. They point to the role of anxiety as being part of a causal factor in the experienced tinnitus severity rather than an effect of the symptom itself. In a review study these authors report findings to suggest that anxiety-related symptoms, such as irritability, inability to relax, and stress/tension, do not change significantly as a function of tinnitus duration and conclude that anxiety is a causal factor in tinnitus severity. Puel and Guitton (2007) also conclude that there is a strong relationship between anxiety and the perception of tinnitus: ‘Anxiety does not per se produce tinnitus, but it strongly exacerbates its perception’ (p. 145).

Not all researchers agree on the causal role of anxiety in experienced tinnitus severity and consider anxiety to be a direct consequence of tinnitus. They describe the presence of anxiety as a reaction to a potentially threatening stimulus, which is considered to be the perception of tinnitus itself (Crocetti et al. 2009). Moreover, in early literature, tinnitus was not considered an anxiety-related problem but a (sensory) somatic expression of anxiety itself (Hamilton 1959). Hamilton, who developed the Hamilton Anxiety Rating Scale, an anxiety rating scale for clinicians which is still widely used in both clinical and research settings (Shear et al. 2001), placed tinnitus itself under the examples of (sensory) somatic expressions of anxiety. The exact reason why Hamilton viewed tinnitus as a somatic expression of anxiety remains unclear. In an article concerning the development of his rating scale, he merely states: “A series of symptoms were assembled which were considered to cover the condition adequately” (Hamilton 1959, p. 50).

Overall, it seems that anxiety-related symptoms and tinnitus are connected in some way, which is again supported by a substantial amount of research (Stephens & Hallam 1985; Halford & Andersson...
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1991; Erlandsson & Archer 1994; Rutter & Stein 1999; Folmer et al. 2001; Andersson et al. 2003; Reynold et al. 2004; Zöger et al. 2004; Zöger et al. 2006; Puel & Guittion 2007; Belli et al. 2008; Andersson et al. 2009; Crocetti et al. 2009; Hesser & Andersson 2009; Landgrebe & Langguth 2011a, 2011b; Jastreboff 2011). However, similar to research concerning the relation between depressive symptoms and tinnitus severity, some critical considerations emerged while reviewing existing research.

Critical concerns

Although to lesser extent as compared to research on tinnitus and depressive symptoms, studies focusing on tinnitus severity and anxiety are also largely based on self-report questionnaires (Stephens & Hallam 1985; Halford & Andersson 1991; Rutter & Stein 1999; Folmer et al. 2001; Andersson et al. 2003; Reynold et al. 2004; Zöger et al. 2004; Andersson et al. 2009; Crocetti et al. 2009; Hesser & Andersson 2009). As such, the consequences described with regard to the relation between depression and tinnitus severity also hold for the relationship between anxiety and tinnitus severity, and thus a differentiation between anxiety-related ‘symptoms’ and anxiety-related ‘disorders’ should be made. Research using self-report questionnaires alone cannot draw conclusions on the presence of an anxiety-related ‘disorder’ (see infra). Moreover, anxiety is one of the most basic emotional experiences in human beings and does not necessarily represent a pathological symptom. A certain level of anxiety is assumed to be essential for survival (LeDoux & Phelps 2010; Landgrebe & Langguth 2011b). An indication of clinically relevant results is thus of major importance. However, similar to research concerning the relation between depression and tinnitus severity, here too researchers generally neglect to report ‘clinically relevant’ proportions of anxiety-related symptoms. Conclusions built upon clinically irrelevant results may be problematic for the development of appropriate treatment strategies. Moreover, as discussed above, the problem of content overlap between the symptoms of tinnitus severity and anxiety (and depression) should be taken into account when performing research with self-report questionnaires. Here too problems of shared method variance and content overlap (Meyer et al. 2001b) may influence results, however these problems are not touched upon in research on the relationship between anxiety and the severity of the tinnitus complaint. In Chapter 3, we will examine whether self-reported anxiety symptoms are clinical relevant in a tinnitus population and whether the relationship between tinnitus severity and anxiety-related symptoms as measured by self-report questionnaires can be explained by shared method variance and content overlap.

Next to these critical considerations, we believe that the complexity of anxiety in relation to tinnitus severity is neglected in existing research, which may be partly the result of the sole use of self-report questionnaires. However, in order to obtain a better understanding of the relationship between anxiety
and tinnitus severity, acknowledgement of the complexity of anxiety is necessary and requires research methods other than the sole use of self-report questionnaires. As such, self-report questionnaires merely highlight the cognitive component of anxiety. As will be discussed in the next sections, anxiety is a broad concept and consists of different dimensions, different levels of processing, and different disorders. We believe that studying all components of anxiety in relation to tinnitus severity is relevant for the understanding of the relationship between anxiety and tinnitus severity.

**Different dimensions of anxiety**

According to some researchers, anxiety consists of different dimensions, namely the cognitive dimension (i.e., the mental component of anxiety), the somatic dimension (i.e., physiological component of anxiety) and the behavioural dimension (i.e., fight, flight or freeze behaviour). These dimensions are assumed to be important in the understanding of anxiety (Lang 1978; Cuthbert & Lang 1989; Lang et al. 1998; Rachman 1998; Larsen et al. 2008; Landgrebe & Langguth 2011b). However, research on anxiety indicates that these three dimensions are only loosely coupled, meaning that the different dimensions may not be concordant within a subject for many situations (Freud 1975 [1894], 1975 [1925]; Heimann & Giedke 1981; Cuthbert & Lang 1989; Rachman 1998). This implies that research should include more than one dimension of anxiety, as it is possible, for example, that patients who complain of anxiety do not necessarily show an increase of vegetative parameters, or do not show any overt behavioural reaction to their anxiety. Conversely, an increase of automatic arousal can be found which is not experienced mentally as anxiety at all (Heimann & Giedke 1981; Cuthbert & Lang 1989). Not including more than one dimension of anxiety could thus lead to false negative results, e.g., individuals experiencing an increase of activation which is not realized as anxiety, thus leading to an underestimation of the presence of anxiety. Studies including more than one dimension of anxiety in the tinnitus research domain are, however, rare. In Chapters 3 and 5, we will include the cognitive and physiological dimension of anxiety.

**Different levels of processing of anxiety**

Apart from the conscious appraisals of the cognitive, somatic and behavioural components, researchers within the domain of experimental psychology have found that underlying processing mechanisms also play a major role in emotional experience (e.g., anxiety). Such underlying mechanisms, like the automatic processing of affective information, are assumed to be important as they modulate emotional experience and emotion-related behaviour (Robinson et al. 2003; Wittenbrink 2007). Research has indicated that highly anxious subjects process affective information differently from low anxious subjects (Dannlowski et al. 2006; Li et al. 2008). Thus, if tinnitus severity is found to be related to underlying processing mechanisms as observed in highly anxious
individuals, not only could this offer a stronger basis for the relevance of anxiety-related problems in a tinnitus population, it could ultimately help us further understand the relationship between anxiety and tinnitus severity. Moreover, studying underlying processing mechanisms requires measurement methods other than the often used direct measurement methods (e.g., self-report questionnaires and interviews). An example of such a method of investigating such underlying processing mechanisms is the Affective Priming Paradigm of Fazio et al. (1986). This method is regarded as an indirect measurement method, as it excludes direct self-report of feelings or attitudes. This is an advantage, as certain people are not willing to report certain feelings or attitudes (Wittenbrink 2007), people do not always analyse their emotions and attitudes consciously, and not all people are aware of them (De Houwer 2003; Wittenbrink 2007). Thus next to problems of content overlap and shared method variance, indirect measurement methods may by-pass the reported problems of direct measurement methods as well. The use of such multi-method approaches have been recommended in research on emotion (Lang 1978; Cuthbert & Lang 1989; Lang et al. 1998; Larsen et al. 2008), but are nevertheless rarely used in the context of anxiety-related problems in tinnitus patients. In Chapter 4, we investigate the relation between tinnitus severity and the underlying processing mechanism via the affective priming paradigm (Fazio et al. 1986).

Different disorders of anxiety

Next to the different dimensions and levels of processing, anxiety itself is not a single phenomenon. Following the DSM-IV-TR, anxiety-related disorders have been classified into several categories (American Psychiatric Association 2000). In general, anxiety is divided into two main groups, namely ‘phobic disorders’ (e.g., specific phobias) and ‘anxiety-related disorders’ (e.g., panic disorder, generalized anxiety disorder, anxiety disorder due to [general medical condition]) (Freud 1959 [1926], 1962 [1895]; Rachman 1998; Öhman 2008; Landgrebe & Langguth 2011b). The difference between phobic and anxiety-related disorders mainly lies in the presence or absence of a phobic object (Freud 1959 [1926], 1962 [1895]; Rachman 1998). As such, the sensation felt in phobic disorders has been referred to as a ‘fear’ reaction, which is a reaction to a specific threatening or phobic object (e.g., a dog may be threatening for those who are afraid of dogs). The sensations felt in anxiety-related disorders on the other hand, are referred to as ‘anxiety’ and are considered to be vague, diffuse, more long lasting, a general state of distress, and not linked to specific objects. This difference between fear and anxiety implies that a fear reaction is easier to manage (e.g., when afraid of dogs, one can avoid, fight against or flee from dogs), whereas in the case of anxiety the accompanied sensations are uncontrollable, unmanageable and manifest as a general tendency in diverse situations (Freud 1959 [1926]; Spielberger 1966; Rachman 1998; Verhaeghe et al. 2007). Applied to the study of the relationship between anxiety-related symptoms and tinnitus severity, the difference between ‘fear’ and ‘anxiety’ could be important and, to some extent, shed light upon the direction of the relationship
between anxiety-related symptoms and the severity of the tinnitus complaint. Although some researchers have made direct and indirect statements about this difference in their conclusions concerning the relationship between tinnitus severity and anxiety (e.g., Erlandsson & Archer (1994) and Puel & Guitton (2007) regard tinnitus severity to be an anxiety-related problem; Crocetti et al. (2009) regard it to be a fear-related problem) this difference has never explicitly been tested in a tinnitus population. One domain that has found differences between fear and anxiety is psychophysiological research, which makes use of autonomic reactions, such as Heart Rate (HR) and Skin Conductance (SC). In Chapter 5, we use HR and SC reaction measures and investigate whether the tinnitus severity complaint is related to fear- and/or anxiety-related problems. Next to the exclusion of content overlap, shared method variance and other problems related to direct measurement methods, the physiological dimension of anxiety is also taken into account.

Overall, this dissertation attempts to critically investigate the results obtained in previous research that solely makes use of self-report questionnaires to measure the relationship between tinnitus severity, depression and anxiety. We argue that the complexity of the anxiety concept itself is often neglected, which may be a consequence of the dominant use of self-report questionnaires in studies of the relationship between tinnitus severity and anxiety. To obtain a better understanding of the complex relationship between tinnitus severity and anxiety-related symptoms, we believe that the complexity of the anxiety construct should be taken into account, which can only be done via a multi-method approach. Such an approach can resolve the problems typically observed in direct measurement methods, including shared method variance and content overlap (Meyer et al. 2001a). In this way, both the clinical reality and the proper treatment of patients who are severely distressed by the perception of tinnitus may be safeguarded.

To conclude this chapter, we briefly summarize the critical concerns and the gaps we have observed in existing research, and within this context present our research questions.

**RESEARCH QUESTIONS**

In this dissertation we start from the observation that not all individuals experiencing tinnitus suffer with this symptom and that the differences in experienced severity are not determined by the psychoacoustic characteristics of tinnitus (pitch and loudness) (Meikle et al. 1984; Meikle 2003; Jastreboff 2011). The main factors held responsible for the differences in the experienced severity of tinnitus are depression and anxiety. However, research on the relationship between these variables appears to be lacking. Therefore, in this doctoral dissertation we investigate the relationship between tinnitus severity and depressive symptoms and between tinnitus severity anxiety-related symptoms in more depth. A review of existing research on the relationship between these variables indicates that
most studies are conducted via the sole use of self-report questionnaires. We believe that this method is biased by shared method variance and content overlap (see also Meyer et al. 2001a) and may distort results found.

In Chapter 2, we investigate whether the relationship between tinnitus severity and depressive symptoms found in research using self-report questionnaires can be interpreted as a function of content overlap and shared method variance. Our first research question is as follows: Is tinnitus severity a problem related to depressive symptoms? This chapter consists of two parts. In the first part, we present a study which takes into account content overlap and shared method variance of the two most widely used questionnaires to measure depressive symptoms and tinnitus severity. Relations between tinnitus severity, depressive symptoms and audiological characteristics (pitch and loudness) of tinnitus are also explored. In the second part, we present an article in the form of ‘a letter to the editor,’ which is a response to a reaction of some researchers to the study presented in the first part of Chapter 2.

The problems of content overlap and shared method variance also apply to the observed relationship between tinnitus severity and anxiety-related problems. Moreover, we stated that anxiety itself is a broad concept and consists of different dimensions, different levels of processing and different disorders. However, this complexity is largely ignored in research on the relationship between tinnitus severity and anxiety. We believe that taking into account the complexity of anxiety, which requires a multi-method design, is important, since it may further our understanding of the relationship between anxiety and tinnitus severity. Therefore, the following chapters will focus on the relation between anxiety and tinnitus severity taking these critical considerations into account. In Chapter 3, we start by examining the possible influence of content overlap and shared method variance in the relation between self-reported anxiety and tinnitus severity. Next to the cognitive dimension, we also include the somatic dimension of anxiety. Our second research question is as follows: Is tinnitus severity a problem related to cognitive and somatic anxiety-related symptoms? Relations between tinnitus severity, anxiety-related symptoms and audiological characteristics (pitch and loudness) of tinnitus are explored.

Chapter 4 studies the question as to whether severely distressed tinnitus patients automatically process affective information in a manner as observed in highly anxious individuals. As indicated above, next to the conscious appraisals of anxiety, underlying processing mechanisms of anxiety may be considered as important as well, since they modulate emotional experience and behaviour. If tinnitus severity is related to underlying processing mechanisms as observed in highly anxious patients, a stronger basis and a first step in the understanding of the presence of anxiety-related problems in the tinnitus severity complaint may be accomplished. Moreover, making use of a multi-method design overcomes the often reported problems of direct measurement methods, i.e., content overlap and
shared method variance. The underlying processing mechanism is investigated by means of the Affective Priming Paradigm (Fazio et al. 1986). Relationships with tinnitus severity and audiological characteristics (pitch and loudness) are examined and possible differences between tinnitus severity groups are explored.

Chapter 5 investigates the following research question: *Is the tinnitus severity complaint associated with fear- and/or anxiety-related problems?* Since psychophysiological research has demonstrated differences in autonomic reactions between fear and anxiety, HR and SC reaction measures are used to address this research question. Along this way, we attempt to shed light on the direction of the relationship between tinnitus severity and anxiety. Next to a multi-method design, this study also includes different dimensions of anxiety, namely the cognitive and the physiological dimension. Relationships with tinnitus severity and audiological characteristics (pitch and loudness) are examined and possible differences in autonomic responding between tinnitus severity groups are explored.

Our general discussion is presented in Chapter 6, whereby the main results of the different studies are summarised. Here we also present a theoretical frame on the differences observed in the tinnitus severity complaint and its implications for the treatment of patients suffering from this symptom. Limitations and directions for future research are outlined.
REFERENCES


1. GENERAL INTRODUCTION


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1. GENERAL INTRODUCTION


In this study we investigate whether tinnitus severity is a problem related to depression. We argue that if it is, the following two conditions should be fulfilled: First, there should be evidence for the presence of moderate to severe depressive symptomatology in a substantial group of tinnitus patients; second, there should be evidence of a substantial relationship between depressive symptoms and tinnitus severity. One hundred and thirty-six consecutive help-seeking tinnitus patients\(^2\) filled in the Beck Depression Inventory (BDI-II), the Tinnitus Handicap Inventory (THI), and underwent psychoacoustic measurement. The results indicate that the mean depressive scores do not reflect clinically relevant depressive symptoms. Linear regression analysis was performed to examine the predictive role of the three components of depression (cognitive, somatic and affective) in tinnitus severity. The results show that only the somatic depression subscale of the BDI-II significantly predicted tinnitus severity, which can be explained due to content overlap between the BDI-II and the THI. We conclude that tinnitus does not appear to be a problem related to depression.


\(^2\) This sample consists of our original sample (N=81) used to study the research questions throughout this dissertation and a sample used in a pilot study (N=55). The pilot study screened for the presence of depressive and (cognitive) anxiety-related symptoms. However, no additional measures where employed in this sample. Therefore, this sample could only be used in this study.
INTRODUCTION

The symptom of tinnitus is described as a phantom auditory perception\textsuperscript{1,2} and its prevalence, which lies between 10\% and 15\%, appears to be much higher than the number of patients seeking treatment\textsuperscript{3,4}. The National Study of Hearing (1984-1995) indicates that, of the 10\% prevalence, approximately 7.1\% visit a doctor of which 2.5\% go to a hospital for treatment\textsuperscript{4}. This suggests that the experienced severity of tinnitus varies among patients. Meikle\textsuperscript{5} defines the severity of tinnitus as the ‘nature and extent of patients’ tinnitus-related problems’ (p. 59) and describes two aspects of tinnitus, namely the physical symptom and the subjective experience of the symptom. The relation between these two variables seems to be inconsistent. Meikle et al.\textsuperscript{6} report that the sounds heard by patients who are bothered by their tinnitus are not louder or different in pitch or quality from those heard by people who are not bothered by their tinnitus. The latter indicates that it is not the physical symptom, but the subjective experience of the symptom that varies among tinnitus patients. This minimal or even absent relationship between psychoacoustic measures and measures of subjectively experienced severity was shown in several studies\textsuperscript{7-9}. Research attempting to explain the differences in subjective experience of tinnitus found that it correlates closer to psychological factors than to audiometric parameters. From this it is concluded that psychological factors are important in explaining the differences in the perceived severity of tinnitus\textsuperscript{10-12}. One variable considered important for understanding differences in the experienced severity of tinnitus is depression. This relationship will be the focus of our study.

Some authors\textsuperscript{13,14} consider the relation between depression and tinnitus in terms of vulnerability, meaning that tinnitus triggers depression in depression-prone individuals. The alternative view, i.e., that depression causes tinnitus, is considered unlikely. Because depressed people often focus on bodily functions and symptoms, it’s possible that tinnitus that was previously unnoticeable and ignored becomes more intrusive when depressed patients begin to pay attention to it\textsuperscript{13}. However, Halford and Anderson\textsuperscript{8} consider the causal relationship between psychological variables (like depression) and tinnitus severity to be bi-directional.

Although the exact relation between depression and tinnitus remains unclear, numerous studies conclude that tinnitus is a problem related to depression\textsuperscript{13-15}. However, before coming to this conclusion, we believe two conditions must be fulfilled. First, there should be evidence for the presence of moderate to severe depressive symptomatology in a substantial group of tinnitus patients, and second, there should be evidence for a substantial relationship between depressive symptoms and tinnitus.
Considering the first condition, we found little support in the existing studies, although the information provided on depression scores is often insufficient to come to clear conclusions on this matter. When such information is provided, often only mean scores are reported\(^{16,17}\) which never reach the necessary cut-off scores for even mild depression\(^{16-18}\). The percentage of tinnitus patients that do reach the necessary cut-off score for mild depressive symptoms lies between 4% and 18.6%\(^{16-19}\). However, the proportion of patients experiencing severe depressive symptoms remains unclear. In the first step of this study we investigate the different levels of depressive symptomatology and the severity of tinnitus symptoms in a clinical tinnitus sample.

As a second condition, the existence of a substantial or ‘real’ relationship between depression and tinnitus is indispensable. At first sight, the empirical literature on depression and tinnitus seems to provide sound evidence for such a relationship: all studies find rather strong significant correlations between these variables that – if reported – range from .42\(^{20}\) to .69\(^{19}\). However, the studies investigating the relationship between depression and subjectively experienced severity of tinnitus mostly make use of self-report questionnaires to measure both variables. While this could give rise to artificially inflated correlations due to method and content overlap\(^{21}\), this possible bias is never considered. A close examination of both variables and their measurement instruments clearly shows that the problem of content overlap is not negligible. In tinnitus severity questionnaires, patients are asked to indicate the extent to which tinnitus interferes with the activities of daily living, such as sleeping, reading, concentrating on complex tasks, and social interaction, as well as the effects of tinnitus on their emotional state (feeling depressed, upset, confused, etc.). It is clear however that many of these complaints closely resemble depressive symptoms (i.e., concentration problems, sleeping problems and feeling depressed). The most widely used measure for depression is the Beck Depression Inventory (BDI-II). This self-report questionnaire is based on the DSM-IV criteria for major depressive disorder and reflects symptoms in all three domains of depression, namely the somatic, affective and cognitive components. With respect to the somatic component, and to a lesser extent the affective component, there is an overlap with aspects operationalizing tinnitus severity. The overlapping items of the BDI-II and the Tinnitus Handicap Inventory (THI), one of the most widely used self-report measures for tinnitus severity, are presented in Table 1.
In order to confirm the role of depression in the explanation of tinnitus severity, there should be a relationship between the two variables that cannot be solely explained by overlapping items. The question as to whether there is a substantial relationship between depression and tinnitus severity or whether this relationship should be interpreted as a method artefact will be the focus of the second part of this study. We therefore start by examining the general relationship between depression and tinnitus severity and subsequently examine the different subscales of the BDI-II. In order to confirm this relationship, this relationship should be present for all depression components and not just for those overlapping with the THI. To our knowledge, no previous studies have examined the relationship between tinnitus severity and the subscales of the BDI-II. Correlations between depression and the physical aspects of tinnitus will be examined in order to compare the results with previous studies and because the use of psychoacoustic measures excludes the possibility of method bias.

### Table 1: Overlapping items of the Tinnitus Handicap Inventory (THI) and of the Beck Depression Inventory II (BDI-II)

<table>
<thead>
<tr>
<th>THI</th>
<th>BDI-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Because of your tinnitus is it difficult for you to concentrate?</td>
<td>19. Concentration difficulty (S)</td>
</tr>
<tr>
<td>3. Does your tinnitus make you angry?</td>
<td>11. Agitation (S)</td>
</tr>
<tr>
<td>4. Does your tinnitus make you confused?</td>
<td>13. Indecisiveness (C)</td>
</tr>
<tr>
<td>5. Because of your Tinnitus are you desperate?</td>
<td>2. Pessimism (A)</td>
</tr>
<tr>
<td>7. Because of your tinnitus do you have trouble falling asleep at night?</td>
<td>16. Changes in sleeping pattern (S)</td>
</tr>
<tr>
<td>9. Does your tinnitus interfere with your ability to enjoy social activities (such as going out to dinner, to the cinema)?</td>
<td>4. Loss of pleasure (A)</td>
</tr>
<tr>
<td>10. Because of your tinnitus do you feel frustrated?</td>
<td>11. Agitation (S)</td>
</tr>
<tr>
<td>12. Does your tinnitus make it difficult to enjoy life?</td>
<td>4. Loss of pleasure (A)</td>
</tr>
<tr>
<td>14. Because of your tinnitus do you find that you are often irritable?</td>
<td>17. Irritability (S)</td>
</tr>
<tr>
<td>15. Because of your tinnitus is it difficult for you to read?</td>
<td>19. Concentration difficulty (S)</td>
</tr>
<tr>
<td>18. Do you find it difficult to focus your attention away from your tinnitus and on to other things?</td>
<td>19. Concentration difficulty (S)</td>
</tr>
<tr>
<td>20. Because of your tinnitus do you often feel tired?</td>
<td>15. Loss of Energy (S)</td>
</tr>
<tr>
<td>21. Because of your tinnitus do you feel depressed?</td>
<td>** is being measured by BDI-II</td>
</tr>
<tr>
<td>25. Does your tinnitus make you feel insecure?</td>
<td>13. Indecisiveness (C)</td>
</tr>
</tbody>
</table>

Note: (A) Affective component of depression; (C) Cognitive Component of depression; (S) Somatic component of depression
METHOD

Participants

The sample consisted of 136 consecutive tinnitus patients that were recruited from the ENT department of the Ghent University Hospital. Mean age was 49.11 years old (SD = 13.89); 35.29% were women; average duration of tinnitus was 26.32 months (SD = 46.27). All patients were seen by a psychologist, an audiologist and an ENT specialist. Psychoacoustic measures succeeded in 64% of the total sample (n=87). There were no significant differences with the subsample where psychoacoustic measures failed with respect to sex, mean age or mean duration (p > .05). Of all participants, 1.4% (n=2) were taking antidepressant medication and 8.9% (n=12) had received psychological counselling for tinnitus-related problems.

Measures

The Dutch version of the Beck Depression Inventory-II (BDI-II)\(^22\) was used to measure depression. This 21-item self-report questionnaire measures the severity of depressive symptoms. For each symptom, statements are listed in ascending order, from 0 (non-depressed) to 3 (severely depressed). Next to a total score, three subscale scores can be computed, namely the cognitive, the affective and the somatic subscale. The psychometric properties of the Dutch translation are acceptable and comparable to those of the original BDI-II\(^{23,24}\). Internal consistency in this sample was very good with Cronbach’s alpha = .92. The following cut-off scores are provided\(^25\): 0-13: no or minimal depressive symptoms; 14-19: mild depressive symptoms; 20-28: moderate depressive symptoms; and 29-63: severe depressive symptoms.

To evaluate the impact of tinnitus on daily life, the Dutch version of the Tinnitus Handicap Inventory (THI)\(^26\) was administered. This scale is composed of 25 questions and the scores can vary between 0 and 100. Next to an index score the THI specifies different ranges of the index score, namely light (0-16), mild (18-36), moderate (38-56), severe (58-76) and catastrophic (78-100) handicap. Cronbach’s alpha was .93 in this sample indicating a very good internal consistency of the scale which is comparable to the original version and the Danish version of the THI\(^{26,27}\).

The two psychoacoustic measures used in this study were pitch and loudness matching. Pitch matching attempts to quantify tinnitus in terms of its possible frequency. The procedure is a two-alternative forced choice. Two tones are presented to the patient and the patient is asked to choose which one most closely matches the tinnitus that they hear. This is continued until the match is made. An octave confusion test is performed next. This is the phenomenon where the patient has identified one tone as matching the tinnitus, when, with further testing, the match is actually one octave above or
below the tone. The loudness matching is the psychoacoustical equivalent of sound intensity. Therefore, this test attempts the tinnitus in decibels. The procedure for loudness matching starts at a level just below threshold and intensity is increased until the patient signals a match. The frequency that was matched to the patient’s tinnitus is used. Matching stimuli were presented using an Interacoustics Clinical Audiometer AC 40 in a sound proof booth.

The study protocol was approved by the ethical committee of Ghent University Hospital and was in accordance with the Helsinki Declaration.

RESULTS

Descriptives

Mean scores on depression (N=136), subjective tinnitus severity (N=136) and psychoacoustic measures (pitch and loudness) (n=87) are presented in Table 2.

Table 2. Mean Scores on the Beck Depression Inventory II (BDI-II), the Tinnitus Handicap Inventory (THI), and Psychoacoustic Measures (pitch and loudness).

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDI-II</td>
<td>11.27</td>
<td>9.45</td>
</tr>
<tr>
<td>THI</td>
<td>44.12</td>
<td>22.72</td>
</tr>
<tr>
<td>Pitch (kHz)</td>
<td>4.52</td>
<td>3.02</td>
</tr>
<tr>
<td>Loudness (dB SL)</td>
<td>7.98</td>
<td>5.57</td>
</tr>
</tbody>
</table>

Note: *total sample (N=136); b sub-sample (n=87); kHz = Kilohertz; dB SL = Decibel Sensation Level

Depressive symptomatology and experienced tinnitus severity in tinnitus patients

Following the BDI-II manual, 66.9% (n=91) of the sample reported no or minimal depressive symptoms; 16.9% (n=23) reported mild depressive symptoms; 10.3% (n=14) reported moderate depressive symptoms; and 5.9% (n=8) reported severe depressive symptoms. For the THI 14% (n=19) of the sample reported a light handicap; 27.2% (n=37) reported a mild handicap; 29.4% (n=40) reported a moderate handicap; 21.3% (n=29) reported a severe handicap; and 8.1% (n=11) reported a catastrophic handicap. While these percentages are comparable to results from other studies\(^{17}\), the number of patients reporting a severe or catastrophic handicap is fairly high. In terms of depression, of the patients with a severe tinnitus handicap (n=29) 17.2% (n=5) also reported severe depressive symptoms and no patients with a catastrophic tinnitus handicap (n=11) reported severe depressive symptoms.
The sub-sample \((n=87)\) where psychoacoustic measures succeeded did not differ statistically from the group where psychoacoustic measures failed on mean depressive symptoms scores \((t(134)=1.02, p > .05)\) and mean tinnitus severity scores \((t(134)=1.74, p > .05)\).

The relationship between depressive symptoms and tinnitus severity

Table 3 gives an overview of the correlations between all self-report measures and psychoacoustic measures. No correlations were found between subjective severity and psychoacoustic measures, or between depressive symptoms and psychoacoustic measures. Only the THI and the BDI-II correlated significantly \((r=.38)\), which corresponds with a large effect\(^2\)

<table>
<thead>
<tr>
<th></th>
<th>THI</th>
<th>Pitch</th>
<th>Loudness</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDI-II</td>
<td>.38(^<em>)</em></td>
<td>.08(^b)</td>
<td>-.01(^b)</td>
</tr>
<tr>
<td>THI</td>
<td></td>
<td>-.05(^b)</td>
<td>.03(^b)</td>
</tr>
<tr>
<td>Pitch</td>
<td></td>
<td></td>
<td>-.08(^b)</td>
</tr>
</tbody>
</table>

Note: \(^*\) \(p<.01\); \(^a\) total sample \((N=136)\); \(^b\) sub-sample \((n=87)\)

To check whether this correlation can be explained by content overlap, a linear regression analysis was performed with the THI as dependent variable and the three subscales (cognitive, somatic and affective) of the BDI-II as independent variables. A significant proportion of the variance in subjective severity was explained by the model with the three BDI subscales (Adjusted \(R^2 = .16, F(3, 132)= 9.78, p < .00\)). However, at the univariate level only the somatic depression subscale of the BDI-II significantly predicted subjective tinnitus severity (Table 4). Controlling for the use of antidepressants (Adjusted \(R^2 = .16, F(4, 135)= 7.29, p < .00\)) or psychological counselling (Adjusted \(R^2 = .16, F= 7.31, p < .00\)), didn’t significantly change these results. In both regression models the somatic depressive subscale remained the only significant predictor at the univariate level. The explanatory power of antidepressants \((B=.02, t(135)=.22, p > .05)\) and psychological counselling \((B=-.03, t(135)=-.31, p > .05)\) was not significant.
Table 4. Standardized coefficients and t-statistics for the subscales of the BDI-II as predictors of the THI (N=136).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Beta</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDIcogn</td>
<td>-.03</td>
<td>-.26</td>
<td>&gt; .05</td>
</tr>
<tr>
<td>BDIsom</td>
<td>.48</td>
<td>3.89</td>
<td>&lt; .00</td>
</tr>
<tr>
<td>BDIaff</td>
<td>-.05</td>
<td>-.39</td>
<td>&gt; .05</td>
</tr>
</tbody>
</table>

Note: BDIcogn=cognitive component of the BDI-II; BDIsom=somatic component of the BDI-II; BDIaff=affective component of the BDI-II

DISCUSSION

In this study, we investigated the relationship between tinnitus and depression. We stated that two conditions need to be fulfilled in order to conclude that tinnitus is a depression-related problem.

The first condition was the presence of a substantial group of tinnitus patients reporting moderate to severe depressive symptomatology. However, comparable to previous studies\textsuperscript{16-18,20}, we found that tinnitus patients in our sample reported on average no or minimal depressive symptoms and that only a small proportion of the sample reported moderate or severe symptoms. Nevertheless, 29.4\% reported a severe or catastrophic handicap by their tinnitus. Dobie\textsuperscript{13} suggests that only those people who are most severely bothered by their tinnitus may suffer from MDD. In our study none of the patients experiencing a catastrophic handicap and only 17.2\% (n=5) of patients experiencing a severe handicap also reported severe depressive symptoms. These results indicate that depression is not as widespread in tinnitus populations as is generally assumed. This has implications for treatment since antidepressants are often prescribed in clinical practice. In their review study on antidepressant use in tinnitus patients, Baldo et al.\textsuperscript{29} indicate that no or only slight improvements are reported. This might be explained by the apparent absence of substantial depressive symptoms in tinnitus patients.

As a second condition, we stated that there should be a substantial or ‘real’ relationship between tinnitus and depressive symptoms. Like other studies\textsuperscript{7-9}, we found no relationship between psychoacoustic measures of tinnitus symptoms and experienced tinnitus severity, indicating that the audiological characteristics do not determine the handicap that is experienced because of tinnitus. As Meikle\textsuperscript{6} concluded, it seems that the sounds reported by patients who are bothered by their tinnitus are not different from those who are not. Consequently, even though psychoacoustic measures provide a method that is less liable to bias, these measures do not provide an alternative for subjective tinnitus measures. Factors apart from the physical characteristics could explain differences in this subjectively experienced handicap. Not surprisingly, we found no relationship between psychoacoustic measures of tinnitus symptoms and depression.
TINNITUS SEVERITY AND DEPRESSIVE SYMPTOMS

For subjectively experienced tinnitus severity as measured with the THI, our results show a significant correlation with depressive symptoms as reported in the BDI-II. The more people are bothered by their tinnitus, the more depressive symptoms they seem to report. Although this relationship has been found in a number of other studies\textsuperscript{17,18,20,30}, it cannot be taken for granted since the possibility of method bias cannot be excluded. For items referring to somatic symptoms, there appears to be a substantial amount of content overlap between the THI and the BDI-II. Although items of the BDI-II refer to general states, while items of the THI refer to the effect of tinnitus on psychological states, such as mood, concentration and sleeping problems, we believe that the intermingling between both types of questions is such that depressive states and the effects of tinnitus on psychological states cannot be distinguished. To our knowledge this problem has never been investigated. We believe that mood and the effect of tinnitus on mood should be studied as two independent variables if future longitudinal or experimental research can demonstrate that they are indeed independent. On the other hand, if tinnitus is a depression-related problem, a relation with the three BDI-II subscales should be present. Therefore, we examined the predictive role of these three components of depression in experienced tinnitus severity. Our results indicate that in a model with the THI as dependent variable and the three subscales (cognitive, affective and somatic) of the BDI-II as independent variable, only the somatic subscale of the BDI-II predicts the experienced tinnitus severity scores, even after controlling for the use of antidepressants and psychological counselling. This indicates that the relationship often found between depression and tinnitus severity is due to the similarity of the items used to measure both constructs rather than an actual relationship between them. We conclude that people answer consistently to similar items in two questionnaires, yet because of this content overlap it is not possible to draw any further conclusions on the relationship between depression and tinnitus severity. These results indicate that caution is warranted in interpreting reported symptoms; for example, poor sleep and concentration due to tinnitus are not necessarily somatic indicators of depression. Alternatively, poor sleep or concentration due to depression may have an aggravating effect on patients’ experience of tinnitus. Longitudinal or prospective research may be useful to further investigate this issue. We advise against drawing strong conclusions on the relation between depression and tinnitus related severity based on cross-sectional data.

Given the fact that the somatic subscale of the BDI-II explained a substantial amount of variance in the THI data, it’s possible that a third variable ‘somatisation’ should be taken into account when investigating the relationship between depression and tinnitus severity. Our study didn’t include specific measures for somatisation. We recommend using such instruments in future studies. Future research should also use measures for anxiety, which may have less content overlap with tinnitus instruments such as the THI. In so doing stronger conclusions on the association between tinnitus severity and anxiety can be drawn.
A limitation of this study is that only one self-report measure was used to measure depression and one for tinnitus severity. However, it’s likely that similar conclusions regarding the problem of content overlap would be reached for other self-report questionnaires. Another limitation is the failure of psychoacoustic measurements in 36% of the sample. The sound(s) people hear can be variable not only across but also within patients. The latter makes it sometimes impossible for patients to choose the most resembling frequency and/or loudness. This phenomenon is not uncommon, yet most researchers do not mention this limitation.

We conclude that the relationship between depression and tinnitus is far less obvious than is currently assumed. More in-depth research is needed, taking into account some of the issues raised here. It is important to make a distinction between somatic symptoms that are a consequence of tinnitus and somatic symptoms as indicators of depression, and this also holds for other measurement methods like interviews. Of course the question remains why the subjectively experienced severity of tinnitus varies so much, independently of its physical characteristics. This remains a key question for future clinical and empirical research.
REFERENCES


Response to: Severe tinnitus and depressive symptoms: A complex interaction

Critical concerns on the conclusion of the study presented in Chapter 2a were expressed by Langguth Berthold, Kleinjung Tobias, and Landgrebe Michael in the form of a letter to the editor. These authors argue that the similarity between depression and tinnitus-assessment instruments may be a direct consequence of the symptomatic similarity of stressful tinnitus and depression. They emphasize that the co-occurrence of depressive symptoms plays a role and that it is rather a semantic question as to whether these co-occurring depressive symptoms can be called depression, since neurobiological research indicates the coactivation of unspecific distress networks in subjectively perceived tinnitus severity. In this second part of Chapter 2, we present our answer in to form of a ‘response to a letter to the editor’.

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We thank Berthold Langguth and his colleagues for their comments on our article “Tinnitus Severity and The Relation to Depressive Symptoms: A Critical Study,” but don’t fully agree with their analysis.

We disagree with the comment that the question whether tinnitus is a depression-related problem or not, is merely a semantic question. Theoretically spoken, a number of conditions need to be fulfilled before a problem can be qualified as depression. According to the DSM-IV-TR\(^1\), at least one of the two core symptoms, depressed mood or loss of interest, need to be present before depression can be diagnosed. These core symptoms determine whether associated somatic symptoms, such as fatigue, irritability, insomnia, exhaustion and concentration difficulties, – symptoms tinnitus patients also frequently complain about – can indeed be interpreted as signs of depression. Somatic depressive symptoms alone don’t suffice to make a diagnosis of depression; cognitive and affective problems should be present as well. Hence the observation that same symptoms like fatigue, irritability, insomnia, exhaustion and concentration difficulties are not specific to depression, and can also be found in Post-Traumatic Stress Disorder, Acute Stress Disorder, and Generalized Anxiety Disorder, as described in the DSM-IV-TR. Note that the only significant correlation found in our study was due to overlap between the somatic items of the BDI and items of the THI. Associations with cognitive and affective items were not significant. Furthermore, only 5.9% of our sample reported severe depressive symptoms, which is far more less than the prevalence of 13% in a general European population\(^2\) and unexpected if tinnitus were a depression-related problem. Also, none of the patients with the severest tinnitus complaints reported severe depressive symptoms. A further argument for our idea can be found in the evidence that anti-depressants typically have no effect on tinnitus\(^3\).

On the other hand, we agree that neurobiological research may contribute to a deeper understanding of tinnitus. However, what the study of Rauschecker et al.\(^4\) indicates is the co-activation of ‘unspecific’ distress networks, which are by no means exclusively related to depression.

As indicated by Langguth et al. a key question we left unanswered, is why some people suffer more than others from tinnitus. We believe that this question should be studied via multiple case psychological studies in which patients with depression and patients with tinnitus are compared, and via qualitative research into tinnitus patients’ depressive experiences\(^5\). Furthermore, these methods will permit a judgement about the directionality between psychological factors and tinnitus complaints.
REFERENCES


Tinnitus severity and its association with cognitive and somatic anxiety: A critical study

Tinnitus has been defined as a phantom auditory perception. Research indicates the importance of making a distinction between the physical symptom of tinnitus and the subjective severity of the tinnitus symptom, since the latter seems to vary among patients. The relationship between tinnitus severity and psychological variables has been well established. Anxiety is considered to be an important variable for understanding the differences in the subjective tinnitus severity. Although many studies confirm the relationship between anxiety and tinnitus severity, most studies do not take the possibility of shared method variance and content overlap between questionnaires into account. Furthermore, anxiety is a broad concept and contains both a cognitive and a somatic dimension. Research examining both dimensions of anxiety in relation to a tinnitus population is scarce. According to us, two conditions must be fulfilled before a theoretical framework on this relation can be formulated: 1) the presence of clinically relevant cognitive and/or somatic anxiety, and 2) evidence of a substantial or ‘real’ relationship. In our sample almost 60% reported more than average cognitive anxiety and 40.8% reported clinically relevant somatic anxiety. After controlling for content overlap between the questionnaires used, the relation between tinnitus severity and cognitive and somatic anxiety remains significant. Two hypothetical models concerning this relationship that deserve future research attention are described.

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INTRODUCTION

Tinnitus has been defined as a phantom auditory perception [1]. While clinical investigations have described help-seeking tinnitus patients as generally distressed by their tinnitus, epidemiological studies have shown that a large proportion of individuals with tinnitus do not seek medical or other professional help and appear not to be severely distressed by their affliction [2]. Meikle [3] defines the severity of tinnitus as the ‘nature and extent of patients’ tinnitus-related problems’ (p.59) and describes two aspects of tinnitus, namely the physical symptom and the subjective experience of the symptom. However, the relation between these two variables is inconsistent. Meikle et al. [4] report that the sounds heard by patients who are bothered by their tinnitus are not louder or different in pitch or quality from those heard by people who are not bothered by their tinnitus. This indicates that it is not the physical symptom, but the subjective experience of the symptom that varies among tinnitus patients. Indeed, several studies have demonstrated a small or even absent relationship between the subjectively experienced severity of tinnitus and psychoacoustic measures of tinnitus [5, 6]. Research on the differences in the subjective experience of tinnitus found closer correlations with psychological factors than with audiometric parameters. As a result, psychological factors have been put forward as important in explaining the differences in the perceived severity of tinnitus [7, 8]. Next to depression [9], anxiety is considered to be a particularly important variable for understanding these differences. The relationship between anxiety and tinnitus severity will be the focus of the present study.

Few researchers make specific statements about the exact relation between anxiety and tinnitus, but consider anxiety as one of the several features associated with it [10, 11]. Some authors consider symptoms of anxiety as a consequence of tinnitus [5, 12], while others focus on the role of anxiety in the experienced severity of tinnitus. For example, Erlandsson and Archer [13] consider anxiety as one of the key factors in the psychological model of tinnitus tolerance or threat. They point to the role of anxiety as being part of a causal factor in the experienced tinnitus severity rather than an effect of the symptom. In a review study these authors report findings to suggest that anxiety-related symptoms, such as irritability, inability to relax, and stress/tension, do not change significantly as a function of tinnitus duration and conclude that anxiety is a causal factor in the tinnitus severity. Puel and Guitton [14] also conclude that there is a strong relationship between anxiety and the perception of tinnitus: ‘Anxiety does not per se produce tinnitus, but it strongly exacerbates its perception’ (p.145). Jastreboff [1] combines these different views in his neurophysiological model. According to this model tinnitus becomes a significant problem if the first experience of tinnitus induces a high level of annoyance or anxiety because it is associated with something unpleasant or it occurs during a period of stress and anxiety. If this is the case, higher levels of annoyance or anxiety link to the meaning of the new tinnitus sound which results in an enhancement of activity in the autonomic and / or limbic system whereby a vicious circle is created. Finally, in early literature on tinnitus, this symptom is not only
considered an anxiety related problem but a somatic expression of anxiety [15]. Hamilton [15] developed an anxiety rating scale, namely the Hamilton Anxiety Rating Scale, which is still widely used in both clinical and research settings [16]. In this rating scale tinnitus itself is considered to be one of the (sensory) somatic anxiety symptoms.

So although the exact relation between anxiety and tinnitus remains unclear, numerous studies conclude that tinnitus is in some way related to anxiety. However, we believe that before further conclusions on the nature of the relationship between tinnitus (severity) and anxiety can be drawn, two primary conditions must be fulfilled. First, clinically relevant degrees of anxiety should be present in a substantial portion of tinnitus patients. Second, there should be evidence of a substantial relationship between anxiety and tinnitus severity. If one of these conditions is not met, theorisation on the exact relation between anxiety and tinnitus (severity) would be useless.

We note here that anxiety is a broad concept and contains both a cognitive and somatic dimension [15, 17, 18]. The cognitive dimension or the mental component is characterized by worry, negative self-talk, and unpleasant visual imagery [17]. Somatic anxiety is the physiological or affective component of anxiety [18] and is reflected in responses such as rapid heart rate, shortness of breath, sweating, etc. These symptoms indicate an increase in autonomic arousal and these are especially typical for Panic and Generalized Anxiety Disorder [17, 19]. The relation between cognitive and somatic anxiety is found to be asymmetric [20], meaning that it is relative: it is possible that patients complain of anxiety but do not show any increase of vegetative parameters. On the contrary, an increase of autonomic arousal can be found which is not experienced mentally as anxiety [20]. Given this, it is important that research concerning anxiety includes both aspects of anxiety, namely the cognitive and somatic component. Leaving out one of the aspects of anxiety could give rise to false negative results; e.g. people experiencing an increase of activation which is not realized as anxiety. Studies examining both aspects (cognitive and somatic) of anxiety in a tinnitus population are however exceptional [12, 19]. In this study we included measures for both aspects of anxiety.

Considering the first condition, namely the presence of clinically relevant or high levels of cognitive and somatic anxiety, existing studies showed mixed results. When scores are provided, often only mean cognitive anxiety scores are reported and these do not reach the required cut-off scores for clinically relevant or high anxiety [21, 22]. Studies that include the percentage of tinnitus patients that do reach the required cut-off score for mild (or borderline) cognitive anxiety indicate prevalences between 12% and 44.6% [23, 24]. The reported prevalence range is rather broad and this could be partly due to the different cut-off scores used in different studies even when using the same instrument [23, 24]. As a result, the proportion of patients experiencing clinically relevant or high cognitive anxiety remains unclear.
3. TINNITUS SEVERITY AND ANXIETY-RELATED SYMPTOMS

To our knowledge, only two studies investigated the somatic component of anxiety in addition to the cognitive component [12, 19]. Stephens and Hallam [12] measured somatic anxiety with a subscale of The Crown-Crisp Experiential Index (CCEI). Results show elevated somatic anxiety scores for tinnitus patients as compared to controls. However the authors mention that the magnitude of difference in significance tests was small. It remains unclear whether these results indicated clinically relevant somatic anxiety. Hiller et al. [19] measured somatic anxiety indirectly via the Screener for Somatoform Disorders (SSD), whereby the researchers looked at the association between tinnitus and single items of the SSD referring to states of anxiety (e.g., difficulty keeping balance, hot or cold sweats, shortness of breath, tingling sensations, blurred vision, and dry mouth). Yet also here the proportion of patients experiencing clinically relevant somatic anxiety symptoms remains unclear. We conclude that the information provided on cognitive and especially somatic anxiety in tinnitus is insufficient to come to clear conclusions on this matter. In this study we will explicitly examine the presence of both cognitive and somatic anxiety symptoms in a tinnitus sample.

The second condition outlined above concerns the existence of a substantial or ‘real’ relationship between (cognitive and somatic) anxiety and tinnitus. Previous research on the relation between cognitive anxiety and tinnitus severity provided mixed results, with correlation coefficients ranging from .15 [22] to .72 [23]. For somatic anxiety and tinnitus severity the observed correlation coefficients range from .16 [19] to .46 [12]. These differences could be due to sample specific characteristics and due to different measurement methods used. For example, whereas Stephens and Hallam [12] made use of a self-report questionnaire to measure somatic anxiety and correlated it with a single tinnitus severity question, Hiller et al. [19] correlated single somatic (anxiety) symptoms with the presence or absence of tinnitus. Furthermore these studies using self-report questionnaires did not consider the possibility that this method could give rise to artificially inflated correlations due to shared method variance and content overlap in the questionnaires [25]. In tinnitus severity questionnaires, patients are asked to indicate the extent to which tinnitus interferes with their activities of daily living, such as sleeping, reading, concentrating on complex tasks, and social interaction as well as the effects tinnitus has on their emotional state (feeling anxious, frustrated, irritated, restless, insecure, confused etc.). However, many of these complaints closely resemble symptoms of cognitive and somatic anxiety, such as feeling confused, restless, insecure, tired, and anxious. In order to conclude on the relationship between anxiety and tinnitus, this content overlap should be taken into account which was never done in the existing studies.

To address this problem we will investigate the relationship between cognitive and somatic anxiety and tinnitus severity while deleting overlapping items from their respective measurement instruments. We believe that if there is a real relationship between these variables it should be present after deleting overlapping items.
The relationship between cognitive and somatic anxiety and the physical aspects of the tinnitus symptom is not a central focus of this study, but will be tested and compared to results of previous studies.

**METHOD**

*Participants*

The sample consisted of 71 consecutive tinnitus outpatients that were recruited from the Ear, Nose and Throat (ENT) Department of the Ghent University Hospital. All patients gave their informed consent prior to their inclusion in the study. Mean age was 49.0 years old ($SD = 13.03$); 36.6% were women; average duration between onset of tinnitus and inclusion in the study was 43.9 months ($SD = 58.27$). All patients underwent a thorough ENT examination and if necessary, imaging of the ear and central auditory system was performed. In a next step all patients were seen by a psychologist and an audiologist. Psychoacoustic measures succeeded in 78.8% of the total sample ($n = 56$). There were no significant differences with the subsample where psychoacoustic measures failed with respect to sex, mean age or mean duration ($p > .05$). Of all participants, 9.9% ($n = 7$) were taking anxiolytica and 7% ($n = 5$) received psychological counselling.

This study protocol was approved by the ethical committee of Ghent University Hospital and was in accordance with the Helsinki Declaration.

*Measures*

The Dutch version of the State and Trait Anxiety Inventory (STAI) [26] was used to measure cognitive anxiety. The scale consists of two 20-item self-report scales, one scale for state anxiety and one for trait anxiety. Spielberger [27] defined ‘state anxiety’ as a transitory anxious emotional response, while ‘trait anxiety’ was defined as relatively stable individual differences in anxiety proneness and refers to a general tendency to respond with anxiety. For each symptom, statements are listed in ascending order, from 1 (almost never) to 4 (almost always). There is a total score for both state and trait anxiety. The psychometric properties of the Dutch version of the questionnaire are very good [26]. Internal consistency in this sample was also very good with $\alpha = .97$ for state anxiety and $\alpha = .94$ for trait anxiety. For each patient scores on the two scales can be compared with a Dutch norm group (different for men and women). This means that raw scores can be converted into decile scores ranging from 1 to 10 whereby a score of 5 is considered average, a score of 10 is very high and a score of 1 is very low [26].

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1 The original sample consisted out of 81 consecutive tinnitus outpatients, yet 10 patients didn’t fill in the list of somatic anxiety symptoms and were therefore not included in this study.
Since somatic anxiety is considered to reflect the symptoms typically known for Panic Disorder [17, 19] we developed a list based on the somatic anxiety symptoms of the Diagnostic and Statistical Manual for Mental disorders (DSM-IV) [28], described under panic attack (p. 255-256). The list with somatic anxiety symptoms can be found in Table 1. The internal consistency of the somatic anxiety symptoms in this sample was acceptable with $\alpha = .76$. Although ‘panic attack’ is not a separate diagnostic entity in the DSM-IV, a cut-off of 4 (or more) symptoms is given. This cut-off score was used to give an indication of the severity of somatic anxiety symptoms.

<table>
<thead>
<tr>
<th>List of somatic anxiety symptoms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Abdominal spasms</td>
<td>10. dizziness</td>
</tr>
<tr>
<td>3. Feelings of sickness / nausea</td>
<td>11. Feeling to die</td>
</tr>
<tr>
<td>4. Tachycardia</td>
<td>12. Pricking sensations</td>
</tr>
<tr>
<td>5. Sweating</td>
<td>13. Hot and cold flushes</td>
</tr>
<tr>
<td>6. Trembling / shivering</td>
<td>14. Troubles with balance</td>
</tr>
<tr>
<td>7. Difficulties breathing</td>
<td>15. Stunned feelings</td>
</tr>
<tr>
<td>8. Feelings of suffocation</td>
<td></td>
</tr>
</tbody>
</table>

To evaluate the impact of tinnitus on daily life, the Dutch version of the Tinnitus Handicap Inventory (THI) [29] was administered. This measure is composed of 25 questions and the scores can vary between 0 and 100. Next to an index score the THI specifies different ranges of the index score, namely a light (0-16), mild (18-36), moderate (38-56), severe (58-76) and catastrophic (78-100) handicap. Cronbach’s $\alpha = .93$ in this sample indicating a very good internal consistency which is comparable to the original and the Danish version of the THI [29, 30].

The two psychoacoustic measures used in this study were pitch and loudness matching. Pitch matching attempts to quantify tinnitus in terms of its possible frequency. The procedure is a two-alternative forced choice. Two tones are presented to the patient and the patient is asked to choose which one most closely matches the tinnitus that they hear. This is continued until the match is made. Next, an octave confusion test is performed. This is the phenomenon where the patient has identified one tone as matching the tinnitus, when, with further testing, the match is actually one octave above or below the tone. The loudness matching is the psychoacoustic equivalent of sound intensity. Therefore, this test attempts to quantify the tinnitus in decibels. The procedure for loudness matching starts at a level just below threshold and intensity is increased until the patient signals a match. The frequency
that was matched to the patient’s tinnitus is used. Matching stimuli were presented using an Interacoustics Clinical Audiometer AC 40 (Interacoustics A/S, Denmark) in a sound proof booth.

RESULTS

Descriptive Statistics

The mean scores for state and trait anxiety, somatic anxiety symptoms, subjective tinnitus severity, and psychoacoustic measures (pitch and loudness) are presented in Table 2. No correlations were found between subjective severity of tinnitus and the psychoacoustic measures or between anxiety symptoms (cognitive and somatic) and psychoacoustic measures \( (p > .05)\).

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Anxiety*</td>
<td>40.63</td>
<td>13.95</td>
</tr>
<tr>
<td>Trait Anxiety*</td>
<td>41.83</td>
<td>12.30</td>
</tr>
<tr>
<td>Somatic Anxiety*</td>
<td>3.35</td>
<td>2.92</td>
</tr>
<tr>
<td>THI*</td>
<td>43.36</td>
<td>22.34</td>
</tr>
<tr>
<td>Pitch (kHz)*</td>
<td>4.38</td>
<td>2.79</td>
</tr>
<tr>
<td>Loudness (dB SL)*</td>
<td>7.73</td>
<td>5.57</td>
</tr>
</tbody>
</table>

Note: *total sample \( (N=71)\); \( ^{b} \) sub-sample \( (n=56)\); kHz=Kilohertz; dB SL=Decibel Sensation Level

The subsample \( (n = 56) \) where psychoacoustic measures succeeded did not differ from the group where psychoacoustic measures failed \( (n = 15) \) on mean state \( (t(69)= -.57, p > .05)\), mean trait \( (t(69)= -1.56, p > .05)\), mean somatic anxiety symptoms \( (t(69)= -1.85, p > .05)\), and mean tinnitus severity scores \( (t(69)= -.34, p > .05)\).

For the THI 15.5% \( (n = 11) \) of the sample reported a light handicap; 25.4% \( (n = 18) \) reported a mild handicap; 29.6% \( (n = 21) \) reported a moderate handicap; 22.5% \( (n = 16) \) reported a severe handicap; and 7% \( (n = 5) \) reported a catastrophic handicap. While the percentages for a light, mild and moderate handicap are comparable to results from other studies [24], the number of patients reporting a severe or catastrophic handicap is fairly high.

Is there a substantial portion of tinnitus patients with a high cognitive and somatic anxiety score?

Following the STAI-manual, 15.5% \( (n = 11) \) of the sample had a very low score on state anxiety; 12.7% \( (n = 9) \) had a low score; 15.5% \( (n = 11) \) had an average score; 22.5% \( (n = 16) \) had a high score; and 33.8% \( (n = 24) \) had a very high score as compared to the norm group.
3. TINNITUS SEVERITY AND ANXIETY-RELATED SYMPTOMS

statistic comparing the different groups indicates a significant difference between the scores ($\chi^2 (4) = 11.34, p < .05$). For trait anxiety, 9.9% ($n = 7$) had a very low score; 19.7% ($n = 14$) a low score; 11.3% ($n = 8$) an average score; 28.2% ($n = 20$) a high score; and 31% ($n = 22$) had a very high score. The Chi-Square statistic comparing the different groups indicates a significant difference between the scores ($\chi^2 (4) = 13.01, p < .01$). For the list of somatic anxiety symptoms, 15.5% ($n = 11$) reported to experience no somatic anxiety symptoms, 43.7% ($n = 31$) reported to experience 1 to 3 symptoms, and 40.8% ($n = 29$) of the sample reported 4 or more somatic anxiety symptoms (4 symptoms: 9.9%; 5 symptoms: 11.3%; 6 symptoms: 11.3%; 7 symptoms: 1.4%; 8 symptoms: 1.4%; 11 symptoms: 1.4%; 12 symptoms: 4.2%). The Chi-Square statistic comparing the different groups indicates a significant difference between the scores ($\chi^2 (10)= 32.03, p < .00$).

Is there a substantial relationship between cognitive and somatic anxiety and the subjective severity of tinnitus?

There was a positive correlation between the THI and the STAI-State ($r = .52$), the THI and the STAI-Trait ($r = .53$) and the THI and the somatic anxiety ($r = .29$). These correlations correspond with large ($r > .37$) and medium ($r = .24 - .36$) effect sizes [31].

To check whether the correlations between the THI and the STAI remained significant when controlling for content overlap, we deleted all overlapping items from the THI, resulting in a ‘pure’ THI score, and recalculated the correlations. Therefore three researchers familiar with the subject independently rated the items of the Tinnitus Handicap Inventory (THI) and the State and Trait Anxiety Inventory (STAI) for similarity, which resulted in the same group of items (see Table 3). The correlations between STAI-State and THI-pure slightly dropped from .52 to .47, and the correlation between STAI-Trait and THI-pure slightly dropped from .53 to .49. These correlations correspond with a large effect ($r > .37$) [31]. After controlling for taking anxiolytics and receiving psychological counselling, both correlations remained invariant and significant.
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Table 3: List of overlapping items of the Tinnitus Handicap Inventory (THI) with the State and Trait Anxiety Inventory (STAI) as rated by three independent researchers familiar with the subject.

<table>
<thead>
<tr>
<th>Overlapping Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Because of your tinnitus is it difficult for you to concentrate?</td>
</tr>
<tr>
<td>3. Does your tinnitus make you angry?</td>
</tr>
<tr>
<td>4. Does your tinnitus make you confused?</td>
</tr>
<tr>
<td>10. Because of your tinnitus do you feel frustrated?</td>
</tr>
<tr>
<td>12. Does your tinnitus make it difficult to enjoy life?</td>
</tr>
<tr>
<td>14. Because of your tinnitus do you find that you are often irritable?</td>
</tr>
<tr>
<td>16. Does your tinnitus make you upset?</td>
</tr>
<tr>
<td>20. Because of your tinnitus do you often feel tired?</td>
</tr>
<tr>
<td>22. Does your tinnitus makes you feel anxious?</td>
</tr>
<tr>
<td>25. Does your tinnitus make you feel insecure?</td>
</tr>
</tbody>
</table>

DISCUSSION

In this study, we investigated the relationship between tinnitus severity and (cognitive and somatic) anxiety symptoms. We stated that two primary conditions should be fulfilled before any formulation about the precise relationship between tinnitus severity and anxiety becomes conceivable.

The first condition was that there should be a substantial part of tinnitus patients reporting clinically relevant cognitive and somatic anxiety symptoms. Similar to previous findings [10, 11, 22-24], we found that on average tinnitus patients reported medium state and trait anxiety scores. Moreover, we found that about one third of the sample reported very high state and trait anxiety symptoms. To our knowledge this is the first study reporting the exact percentage of tinnitus patients experiencing clinically relevant cognitive anxiety symptoms. Other studies [e.g. 22-24] indicated the prevalence of cognitive anxiety symptoms above the cut-off score for mild (or borderline) cognitive anxiety symptoms, which do not make them necessary clinically relevant. We used the STAI, which distinguishes between state anxiety, i.e., anxiety that fluctuates and depends on the patient’s current situation, and trait anxiety, i.e. anxious tendency. The results, showing that almost 60% of the sample reported more than average state and trait anxiety, indicate that next to an anxious reaction to their current situation, (tinnitus), patients tend to react in an anxious manner in general. These findings support the work of Erlandsson and Archer [13] who argue that anxiety is one of the key factors in the psychological model of tinnitus tolerance or threat.

Also for somatic anxiety symptoms we found that a substantial part of the group (40.8%) reported clinically relevant (4 or more) symptoms. These results are in line with previous studies [12, 19],
which found that somatic anxiety symptoms are important in a tinnitus population. However, in former studies instruments used to measure somatic anxiety symptoms remained ambiguous. Therefore we developed a list of somatic anxiety symptoms based on the DSM-IV. Since the symptoms of somatic anxiety are generally considered to be typical for panic [17, 19], we based ourselves on the symptoms described under panic attack. Overall, our results indicate that cognitive and somatic anxiety are clinically important problems in the tinnitus population.

As a second condition we argued that there should be a positive and substantial correlation between cognitive and somatic anxiety on the one hand and the subjective severity of tinnitus on the other hand. Like other studies [5, 6], we found no relationship between psychoacoustic measures of tinnitus symptoms and experienced tinnitus severity, nor between psychoacoustic measures of tinnitus and anxiety symptoms. These findings support the observation that the audiological characteristics do not determine the handicap that is experienced because of the tinnitus and that the audiological characteristics are not associated with anxiety-related distress [see also 4]. Consequently, even though psychoacoustic measures provide a method that is less liable to bias, they do not provide an alternative for subjective tinnitus measures. Factors other than the physical characteristics of tinnitus may explain differences in the subjective experience of the handicap.

In terms of subjectively experienced tinnitus severity as measured with the THI, our results did show a significant correlation with anxiety symptoms as measured by the STAI and the list of somatic anxiety symptoms. The more people are bothered by their tinnitus, the more cognitive and somatic anxiety symptoms they report. Even though this relationship was found in a number of other studies [11, 12, 19, 21-24], the possibility that it is inflated because of the problem of content overlap between measures was never examined.

However, there appears to be a substantial amount of content overlap between items from the THI and items from the STAI, yet not with the items from the list of somatic anxiety symptoms. To investigate this further, we deleted all overlapping items from the THI and calculated a ‘pure’ THI-score. The overlapping items were independently rated by three researchers familiar with the subject. Even though the selection of the items was very strict, our results show that the magnitude of the correlation dropped only slightly, remained significant and within the same effect size range. This indicates that tinnitus and cognitive anxiety are indeed related. As there was no content overlap between the somatic anxiety measure and the items of the THI, we can also conclude that somatic anxiety is related to the subjective tinnitus complaint in a tinnitus population. These results thus reflect Hiller’s conclusion [19] that the mechanism of arousal and somatic anxiety are important in the tinnitus complaint.

We conclude that both primary conditions are met and that there is an important relationship between cognitive and somatic anxiety and tinnitus severity [12, 13, 19]. Since we only made use of self-report
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questionnaires in a cross-sectional design, we cannot make statements on the exact direction of this relation. However based on these results and in line with other authors, we think at least two hypothetical models concerning the relation between anxiety and tinnitus severity deserve future research attention. First, anxiety can be considered an amplifier of tinnitus severity. In line with Erlandsson and Archer [13], Puel and Guitton [14], and Jastreboff [1], anxiety could be the causal factor for the amount of experienced tinnitus severity. Former research results show that anxiety related (personality) disorders are very common among tinnitus patients [32]. Probably these patients also have a more anxious reaction towards the tinnitus signal [5, 12]. In this way a vicious circle is created whereby anxiety as causal factor and anxiety as reactive factor stimulate each other.

Secondly, tinnitus itself could be considered as a possible somatic anxiety symptom. In 1959 Hamilton developed the Hamilton Anxiety Rating Scale [15]. In this rating scale tinnitus itself is considered to be one of the somatic anxiety symptoms. This view on the tinnitus symptom seems to have vanished. However, research such as this of Hiller et al. [19] where it is shown that mechanisms of arousal, which are also common for states of anxiety [17, 19], are closely related to the tinnitus symptom. This indicates the possibility that tinnitus itself could be a somatic anxiety symptom. If this would be the case, close relations with cognitive and somatic anxiety and tinnitus are obvious. In this view some forms of tinnitus are part of anxiety problems and not the other way around.

We believe these two models do not exclude each other since tinnitus is not a homogeneous phenomenon. For some people the first model could hold, whereas for others the second model could have more explanatory power. Which model is most suited to describe a certain patient’s tinnitus can only be decided on an individual level.

As far as we know, this was the first study explicitly assessing both cognitive and somatic anxiety in relation to tinnitus severity while taking into account the possible methodological problem of content overlap. Our findings support the importance of anxiety in the understanding of the experience of tinnitus severity. Nevertheless there are some limitations to this study. First, only self-report questionnaires were used to measure both anxiety and tinnitus severity, whereby method bias could have an influence of results found. Yet, we excluded overlapping items whereby the specificity of the subjective measures used, is more guaranteed. However, future research should include non-self report methods to elaborate on and confirm these results. Second, for somatic anxiety a new list was developed since we think no self-report instruments exist providing good coverage of somatic anxiety symptoms. Even though this instrument is not extensively tested, we assume it adequately reflects somatic anxiety since it is based on the generally accepted symptoms of somatic anxiety described in the DSM-IV [17, 19]. Finally, the rather small sample size ($N = 71$) limits the generalizability of our results, however is comparable to other studies investigating clinical tinnitus samples [e.g 32].
REFERENCES


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Anxiety is found to play an important role in the severity complaint of tinnitus patients. However, when investigating anxiety in tinnitus patients, most studies make use of verbal reports of affect (e.g. self-report questionnaires and/or interviews). These methods reflect conscious appraisals of anxiety, but don’t map underlying processing mechanisms. Nonetheless, such mechanisms, like the automatic processing of affective information, are important as they modulate emotional experience and emotion-related behaviour. Research shows that highly anxious people process threatening information (e.g., fearful and angry faces) faster than non-anxious people. Therefore, this study investigates whether tinnitus patients process affective stimuli (happy, sad, fearful, and angry faces) in the same way as highly anxious people do. Our sample consisted of 67 consecutive tinnitus patients. Relationships between tinnitus severity, pitch, loudness, hearing loss, and the automatic processing of affective information were explored. The results indicate that especially in severely distressed tinnitus patients, the severity complaint is highly related to the automatic processing of fearful ($r = .37, p < .05$), angry ($r = .44, p < .00$), and happy ($r = -.44, p < .00$) faces and these relationships become even stronger when controlling for hearing loss. Furthermore, in contrast to findings on the relation between audiological characteristics (pitch and loudness) and the conscious report of anxiety, we found that the audiological characteristic, loudness, tends to be related to the automatic processing of fearful faces ($r = .25, p = .08$). We conclude that tinnitus is an anxiety-related problem on an automatic processing level. 

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INTRODUCTION

Tinnitus is often described as a ringing noise in the ear(s) or in the head, without the presence of external stimulation [1]. In some patients it takes the form of a buzzing, hissing, humming, or whistling sound, or as ticking, clicking, roaring, tunes, songs, etc. It has also been described as a “whooshing” sound, like wind or waves [2]. While clinical investigations have described help-seeking tinnitus patients as generally distressed by their tinnitus, epidemiological studies have shown that a large proportion of individuals with tinnitus do not seek medical or other professional help and appear not to be severely distressed by their affliction [3]. Several studies have indicated [4, 5] that at least two dimensions must be considered, namely the physical tinnitus symptom and its subjective experience or severity. However, the relationship between the tinnitus symptom and subjective severity seems to be asymmetric [5]: correlations between self-reported tinnitus severity and audiological characteristics (e.g. pitch and loudness) are usually nil. Conversely, strong correlations are often found between subjective tinnitus severity and psychological factors, such as anxiety. From this it is concluded that psychological factors, such as anxiety, are important in explaining the differences in the subjective severity complaint [6]. In a previous study [7] we indeed found that tinnitus severity ratings, but not audiological tinnitus characteristics (pitch and loudness), are anxiety-related.

Yet, when investigating anxiety in a tinnitus population, most studies exclusively make use of direct measurement methods, such as self-report questionnaires and/or (structured) interviews [2, 6, 7]. These methods reflect conscious appraisals of anxiety, but don’t map underlying processing mechanisms. Nonetheless, such mechanisms, like the automatic processing of affective information, are important as they modulate emotional experience and emotion-related behaviour [8]. Therefore, this study was designed to investigate the relation between tinnitus severity and anxiety on the level of automatic processing of affective information.

An influential method for measuring automatic processing of affective information is the affective priming paradigm of Fazio et al [9, 10]. This model [9, 11] proposes associative relations between representations of concepts and representations of their respective evaluation as having either a positive or a negative valence. It describes the process of automatic evaluation in terms of the spreading of activation between such representations. Central to this model is the difference between negative and positive evaluation of mental representations, and the idea that in a memory network concepts of the same valence are connected [12]. As a consequence, activation can spread between semantically unrelated but affectively congruent concept representations via the indirect links established in the form of the valence nodes. The idea that information is organized into associative networks in memory, is generally accepted within the broader domain of emotion research [13].
In an affective priming task, participants are first shown affectively polarized prime stimuli, like pictures of a smiling or sad face, for a very short period of time, typically \( \leq 200 \) milliseconds (ms). These are followed by positive or negative target stimuli, like pictures of human injury or pleasant images of children, after which participants must evaluate the valence of the target as quickly and accurately as possible. The time it takes to make this evaluation is measured. The typically observed effect is the congruency or affective priming effect, qualified by a prime-target interaction: i.e. compared with reaction time to a baseline neutral prime, responses are facilitated when the valence of prime and target is congruent (e.g. “happy face” – “picture of the sun”), but are slower when the valence is incongruent (e.g. “angry face” – “picture of the sun”) [9].

According to the network theory of mood and memory [12], the presence of any emotional state should trigger associated information in memory, leading to selective encoding of congruent stimuli. Studies have demonstrated that high levels of anxiety produce the expected affective priming effects, whereas low levels of anxiety result in reversed priming effects [14]. Furthermore, people with high trait anxiety proved to have stronger affective priming effects than people with low trait anxiety, which was specifically provoked by threat-related primes [15]. Studies concerning attentional processes also demonstrated the presence of a threat-related bias in anxious patients [16]. These findings are consistent with theories on anxiety, where biases in processing threat-related information have been assigned a prominent role in the aetiology and maintenance of anxiety related problems [16, 17].

Facial expressions are particularly effective in alerting others to impending threat, with fearful and angry facial expressions as ecologically valid and salient depictions of threat [18, 19]. Anxious people are typically described as constantly scanning the environment for possible threats [16, 17, 20]. In terms of the affective priming task, such a threat-related bias may imply that anxious subjects are faster in deciding that a threatening stimulus is unpleasant [15], which is in line with network theory of mood and memory [12, 21].

Applied to the current study, the affective priming paradigm brings us to the research question whether tinnitus severity is related to the automatic processing of threatening information, which might corroborate the thesis that tinnitus is an anxiety-related problem. Therefore, we hypothesize that the automatic processing of threatening information (fearful and angry facial expressions) will be positively related to tinnitus severity. Furthermore we explore whether the latter hypothesis holds for all tinnitus patients, or only for those with high tinnitus-severity complaints. Usually, research on the relation between audiological characteristics (pitch and loudness) and self-reported anxiety find no relationships [4-7]. However, it remains possible that audiological characteristics are related to the automatic processing of affective information. We will study these relationships, but since this is the
first study exploring this possibility, no specific assumptions are made. Additionally, we controlled for the possible influence of hearing loss in the severity complaint.

METHODS

Participants

The sample consisted of 81 consecutive tinnitus outpatients recruited from the Ear, Nose and Throat (ENT) Department of Ghent University Hospital. Five patients were unable to complete the experiment due to insufficient computer knowledge. Another nine patients were outliers and were excluded from analysis on the basis of mean reaction time (< 250 ms or > 1500 ms). The mean age of the 67 remaining patients was 48.63 years old (SD = 12.74); 37.3% were women; average duration between onset of tinnitus and inclusion in the study was 44.18 months (SD = 58.26). All patients underwent a thorough ENT examination and, if necessary, imaging of the ear and central auditory system. All patients were seen by a psychologist. In 15 patients psychoacoustic measures failed. The reason for this failure was the inability of patients to match their pitch and loudness. There were no significant differences between the subsample where psychoacoustic measures failed with respect to sex, mean age or mean duration (p > .05).

The study protocol was approved by the ethical committee of Ghent University Hospital and was in accordance with the Helsinki Declaration.

Measures

Tinnitus Handicap Inventory (THI) [22]: To evaluate the impact of tinnitus on daily life, the Dutch version of the THI was administered. This scale is composed of 25 questions and the scores can vary between 0 and 100. The THI specifies different ranges of an index score, namely light (0-16), mild (18-36), moderate (38-56), severe (58-76) and catastrophic (78-100) handicap. Cronbach’s alpha was .92 indicating very good internal consistency, comparable to the original version of the THI [22].

The anxiety trait scale of the Dutch version of the State and Trait Anxiety Inventory (STAI) [23] was used to measure anxiety. The scale consists of two 20-item self-report scales for trait anxiety. Spielberger [24] defined ‘trait anxiety’ as relatively stable individual differences in anxiety proneness and refers to a general tendency to respond with anxiety. For each symptom, statements are listed in ascending order, from 1 (almost never) to 4 (almost always). There is a total score for trait anxiety. The psychometric properties of the Dutch version of the questionnaire are very good [23]. Internal consistency in this sample was also very good with $\alpha = .96$ for trait anxiety. For each patient scores on the scale can be compared with a Dutch norm group (different for men and women). This means that
raw scores can be converted into decile scores ranging from 1 to 10 whereby a score of 5 is considered average, a score of 10 is very high and a score of 1 is very low [23].

The two psychoacoustic measures used in this study were pitch and loudness matching. Pitch matching attempts to quantify tinnitus in terms of its possible frequency (kilohertz; kHz). The procedure is a two-alternative forced choice. Two tones are presented to the patient and the patient is asked to choose which one most closely matches the tinnitus that they hear. This is continued until the match is made. Next, an octave confusion test is performed. This is the phenomenon where the patient has identified one tone as matching the tinnitus, when, with further testing, the match is actually one octave above or below the tone. The loudness matching is the psychoacoustic equivalent of sound intensity. Therefore, this test attempts to quantify the tinnitus in decibels (Decibels Sensation Level; dB SL). The procedure for loudness matching starts at a level just below threshold and intensity is increased until the patient signals a match. The frequency that was matched to the patient’s tinnitus is used. Matching stimuli were presented using an Interacoustics Clinical Audiometer AC 40 (Interacoustics A/S, Denmark) in a sound proof booth.

Hearing loss was measured with pure tone audiometry. The pure tone average (PTA) was calculated across the frequencies 0.5, 1.0, and 2.0 kHz. Since this method fails to account for hearing loss at higher frequencies, a second PTA across the frequencies 4.0, 6.0, and 8.0 kHz was calculated. Normal hearing was defined as PTA (0.5-1.0-2.0) < 15dB HL (Hearing Level) and for higher frequencies as PTA (4.0-6.0-8.0) < 30dB HL [25].

Affective priming task: Stimuli. Target stimuli were 7 positive and 7 negative pictures from the International Affective Picture System (IAPS) [26]. Selection was based on a Flemish validation study [27]. The 7 most positively and negatively rated pictures on valence were selected for this study. Prime facial stimuli were 6 fear, 6 angry, 6 sad, 18 happy and 6 neutral facial pictures from the Karolinska Directed Emotional Faces (KDEF) [28]. The KDEF-database shows pictures of 70 individuals (35 women and 35 men) displaying 7 different emotional expressions (Angry, Fearful, Disgusted, Sad, Happy, Surprised, and Neutral). Selection was based on a Flemish validation study [18], which used the frontal view pictures of the A series for their validation. To minimize fashion characteristics, the hairlines of all pictures were removed. For each emotion used in this study (fear, anger, sadness, happiness and neutral), we selected the best rated facial expressions for men and women. In this way the amount of men and women expressing each emotion was balanced.

Procedure. Subjects were informed that they would be presented with sets of positive and negative pictures. The instruction was to evaluate the pictures as quickly and accurately as possible. Response latencies were recorded by pressing one of two response buttons (left, right) on a control pad. Each
trial had the same routine: The prime was presented for 180 ms, preceded by a dot lasting 150 ms. The prime was erased lasting 20 ms, after which the target was immediately presented. This led to a stimulus onset asynchrony of 200 ms between prime and target presentation. The pre-trial pause was 600 ms. There were 3 exercise blocks and 4 experimental blocks. The first exercise block consisted of 20 trials of target stimuli only. If the target was incorrectly evaluated, an error message was given. The second exercise block consisted of 20 prime-target trials, again an error message appeared when the target was incorrectly evaluated. The last exercise block consisted of 60 prime – target trials. If the number of correct answers was < 75%, this exercise block would be repeated for a maximum of 5 times. The purpose of these exercise blocks was that patients could get used to the experiment and thus, these data were removed for data analyses. The 4 experimental blocks each consisted of 84 trials. In each block the amount of positive (happy faces) and negative (fearful, angry, sad faces) primes was balanced. For each emotion prime stimuli were randomly assigned to the 14 targets so that 18 affective congruent happy face (happy-pos), 18 affective incongruent happy face (happy-neg), 6 affective congruent fearful face (fear-neg), 6 affective incongruent fearful face (fear-pos), 6 affective congruent angry face (angry-neg), 6 affective incongruent angry face (angry-pos), 6 affective congruent sad face (sad-neg), 6 affective incongruent sad face (sad-pos), and 12 control trials (6 neutral face-pos, 6 neutral face-neg) were generated separately for each block. Pictures were presented full-screen on a computer (1280 x 1024 pixels). Subjects could take a break after each block.

RESULTS

Descriptives

Mean scores on subjective tinnitus severity, trait anxiety, and audiological characteristics are presented in table 1. For the THI 13.4% \( (n=9) \) of the sample reported a light handicap; 26.9% \( (n=18) \) reported a mild handicap; 29.9% \( (n=20) \) reported a moderate handicap; 22.4% \( (n=15) \) reported a severe handicap; and 7.5% \( (n=5) \) reported a catastrophic handicap.

Following the STAI-manual, 9% \( (n=6) \) had a very low score; 21% \( (n=14) \) a low score; 9 % \( (n=6) \) an average score; 29.8% \( (n=20) \) a high score; and 31.3% \( (n=21) \) had a very high score for trait anxiety. Furthermore, 50% of the sample \( (n=26) \) where audiological measures succeeded had normal hearing at the averaged frequency levels \( (0.5-1.0-2.0) \) and 36.5% \( (n=19) \) had normal hearing at averaged high frequency levels \( (4.0-6.0-8.0) \). In total 26.9% \( (n=14) \) had normal hearing on each frequency level.
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Table 1: Mean scores (M), standard deviations (SD), and range values for the Tinnitus Handicap Inventory (THI), Trait anxiety of the State and Trait Anxiety Inventory (STAI-trait), audiological characteristics (Pitch and Loudness), and hearing loss (PTA (0.5-1.0-2.0) and PTA (4.0-6.0-8.0))

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.88</td>
<td>21.86</td>
<td>4 – 96</td>
</tr>
<tr>
<td>STAI-trait&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.13</td>
<td>12.30</td>
<td>20 – 70</td>
</tr>
<tr>
<td>Pitch&lt;sup&gt;b&lt;/sup&gt; (kHz)</td>
<td>4.41</td>
<td>2.76</td>
<td>0.12 – 11.2</td>
</tr>
<tr>
<td>Loudness&lt;sup&gt;b&lt;/sup&gt; (dB SL)</td>
<td>7.75</td>
<td>5.66</td>
<td>0 – 30</td>
</tr>
<tr>
<td>PTA(0.5-1.0-2.0)&lt;sup&gt;b&lt;/sup&gt; (dB HL)</td>
<td>16.65</td>
<td>11.38</td>
<td>1.67 – 61.67</td>
</tr>
<tr>
<td>PTA(4.0-6.0-8.0)&lt;sup&gt;b&lt;/sup&gt; (dB HL)</td>
<td>39.15</td>
<td>19.81</td>
<td>5 – 90</td>
</tr>
</tbody>
</table>

Note: kHz = kilohertz; dB SL = decibel sensation level; PTA= Pure Tone Average; dB HL = decibel hearing level;<sup>a</sup> total sample (N= 67);<sup>b</sup> sub-sample (n=52)

Table 2 gives an overview of correlations found between the THI, STAI-trait, audiological characteristics (pitch and loudness), and hearing loss. Positive significant correlations were found between the THI and STAI-trait, and between the THI and hearing loss.

Table 2: Correlations between the Tinnitus Handicap Inventory (THI), Trait anxiety of the State and Trait Anxiety Inventory (STAI-trait), audiological characteristics (Pitch and Loudness), and hearing loss (PTA (0.5-1.0-2.0) and PTA (4.0-6.0-8.0))

<table>
<thead>
<tr>
<th></th>
<th>THI</th>
<th>STAI-trait</th>
<th>Pitch</th>
<th>Loudness</th>
<th>PTA (0.5-1.0-2.0)</th>
<th>PTA (4.0-6.0-8.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAI-trait</td>
<td>.51**&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitch</td>
<td>.17&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loudness</td>
<td>-.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.13&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.31&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTA(0.5-1.0-2.0)</td>
<td>.34&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.08&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.21&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PTA(4.0-6.0-8.0)</td>
<td>.41***&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.09&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.71***&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: PTA= Pure Tone Average; *= p < .05; **=* p < .00; <sup>a</sup> total sample (N= 67); <sup>b</sup> sub-sample (n=52)

Affective priming results and priming indices

Mean reaction times were subjected to a 4 (valence of prime: happy, sad, fearful, angry faces) x 2 (valence of target: positive vs. negative pictures) ANOVA with repeated measures on the two variables. ANOVA revealed a significant interaction effect between valence of the prime and valence of the target (prime x target), $F(3,63) = 6.89, p < .05, \eta_p^2 = .25$, meaning that the affective priming...
effect can be observed for the different valences of the prime. The main effects of prime valence and target valence did not reach significance (F < 1).

Four indices were computed to examine the influence of the prime types (happy, sad, fearful, and angry face) on patients’ evaluations. The indices were calculated in such a way that we controlled for the influence of the valence of the target. The following formula was used [29]:

1. Influence of positive (happy face) primes = [(positive prime-negative target) – (positive prime-positive target)] – [(neutral prime-negative target) – (neutral prime-positive target)]
2. Influence of negative (sad, fearful, and angry faces) primes = [(negative prime-positive target) – (negative prime-negative target)] + [(neutral prime-negative target) – (neutral prime-positive target)]

The relation between affective priming indices (happy, sad, fearful, angry faces) and tinnitus (severity complaint and audiological characteristics): overall results

Table 3 gives an overview of correlations found between the affective priming indices and tinnitus severity at the level of the total sample. A negative significant correlation was found between the THI and the happy face prime, meaning that the affective priming effect of happy faces becomes smaller as patients’ THI score increases. No correlations were observed between other prime types and tinnitus severity (p > .05). Since the THI was correlated with hearing loss, we repeated our analyses while controlling for hearing loss on the two average frequencies separately. Results of partial correlations (table 4) showed that the negative correlation between the THI and the happy face prime became stronger. Moreover, after controlling for hearing loss at normal frequencies (PTA (0.5-1.0-2.0)) the relation between the THI and anxious face became marginally significant, while after controlling for hearing loss at high frequencies (PTA (4.0-6.0-8.0)) the relation between the THI and anxious face became significant.

Furthermore, a marginal positive correlation was found between the psychoacoustic characteristic, loudness, and the anxious face prime (r=.25, p=.08), meaning that the affective priming effect of anxious faces becomes higher as patients’ experienced loudness increases. No correlations between other prime types and loudness, or pitch were observed (p>.05).
Table 3: Correlations between the Tinnitus Handicap Inventory (THI) and the affective priming indices for happy, sad, fearful, and angry faces (N=67).

<table>
<thead>
<tr>
<th></th>
<th>Happy face primes</th>
<th>Sad face primes</th>
<th>Fearful face primes</th>
<th>Angry face primes</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI</td>
<td>-.27*</td>
<td>-.03</td>
<td>.16</td>
<td>.11</td>
</tr>
</tbody>
</table>

Note: *p < .05

Table 4: Partial correlations between the Tinnitus Handicap Inventory (THI) and the affective priming indices for happy, sad, fearful, and angry faces controlled for PTA (0.5-1.0-2.0) and PTA (4.0-6.0-8.0) separately (n=52).

<table>
<thead>
<tr>
<th>Control variable</th>
<th>Happy face primes</th>
<th>Sad face primes</th>
<th>Fearful face primes</th>
<th>Angry face primes</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI PTA(0.5-1.0-2.0)</td>
<td>-.36**</td>
<td>.08</td>
<td>.25*</td>
<td>.22</td>
</tr>
<tr>
<td>THI PTA(4.0-6.0-8.0)</td>
<td>-.31*</td>
<td>.04</td>
<td>.29*</td>
<td>.17</td>
</tr>
</tbody>
</table>

Note: PTA = Pure Tone Average; *p < .05; **p < .01; *p = .07

The relation between affective priming indices (happy, sad, fearful, angry faces) and tinnitus severity: results for patients with low and high tinnitus severity complaints

In a next step, the total sample was divided into two subgroups: a group with slight/mild tinnitus severity (THI score < 38) and a group with moderate, severe or catastrophic tinnitus severity (THI score ≥ 38) [30]. Again the THI was correlated with the four indices for influence of prime types (happy, sad, fearful, angry face). The analyses were performed for each group (low / high tinnitus severity) separately. For the low tinnitus severity group no relationships between prime types and the THI were found. Table 5 depicts the results for the high tinnitus severity group. The THI score was positive related to fearful and angry faces, and negative related to happy faces. No relation with sad face was observed (p > .05). Since the THI was correlated with hearing loss, we repeated our analyses while controlling for hearing loss on the two average frequencies separately. Results of partial correlations are depicted in table 6. These results indicate that in patients with severe distress, tinnitus severity is accompanied by an increasing impact of fearful and angry face primes, and by an decreasing impact of happy face primes, and this impact became even stronger after controlling for hearing loss.

Table 5: Correlations between the Tinnitus Handicap Inventory (THI) and the affective priming indices for happy, sad, fearful, and angry faces for the high tinnitus severity group (THI ≥ 38).

<table>
<thead>
<tr>
<th></th>
<th>Happy face primes</th>
<th>Sad face primes</th>
<th>Fearful face primes</th>
<th>Angry face primes</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI</td>
<td>-.44***</td>
<td>.18</td>
<td>.37*</td>
<td>.44***</td>
</tr>
</tbody>
</table>

Note: *p < .05; ***p < .00
### 4. Tinnitus, Anxiety, and Automatic Processing

Table 6: Partial correlations between the Tinnitus Handicap Inventory (THI) and the affective priming indices for happy, sad, fearful, and angry faces controlled for PTA (0.5-1.0-2.0) and PTA (4.0-6.0-8.0) separately for the high tinnitus severity group (THI ≥ 38).

<table>
<thead>
<tr>
<th>Control variable</th>
<th>Happy face primes</th>
<th>Sad face primes</th>
<th>Fearful face primes</th>
<th>Angry face primes</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI PTA(0.5-1.0-2.0)</td>
<td>-.54***</td>
<td>.28</td>
<td>.45**</td>
<td>.53***</td>
</tr>
<tr>
<td>THI PTA(4.0-6.0-8.0)</td>
<td>-.50***</td>
<td>.19</td>
<td>.48***</td>
<td>.50***</td>
</tr>
</tbody>
</table>

*Note: PTA = Pure Tone Average; **p<.01; ***p<.00

**DISCUSSION**

In this study, we investigated the relationship between automatic processing of affective information and tinnitus severity. We hypothesized a positive relationship between automatic processing of threat-related information. Furthermore, we explored whether these predictions hold true for the total tinnitus sample or only for patients reporting severe tinnitus complaints. For audiological characteristics, pitch and loudness, we explored whether relations could be found with the automatic processing of affective information.

In line with former research, tinnitus severity and self-reported anxiety are highly related [6, 7], indicating that tinnitus severity is an anxiety-related problem. As expected, no relations were found between tinnitus severity and audiological characteristics (pitch and loudness), or between self-reported anxiety and audiological characteristics (pitch and loudness) [6, 7]. There were however positive correlations between tinnitus severity and hearing loss on each averaged frequency level, meaning that the more hearing loss patients have, the higher the severity complaint is.

Overall, our results indicate the presence of an affective priming effect: reaction times were shorter when the prime and the target had the same valence than when the valence of prime and target was opposite. This was indicated by a significant prime x target interaction and corroborates previous findings in affective priming tasks [10, 11]. This result confirms the validity of the material designed for the present study.

For the total sample our results suggest that subjectively rated tinnitus severity is related to disruptions in the automatic processing of positive affective information, but not to the processing of negative affective information. However, after controlling for hearing loss at normal frequencies (PTA (0.5-1.0-2.0)), the negative relation between the THI and happy faces became stronger and the correlation...
between the THI and anxious faces became marginal significant. Also after controlling for high frequency hearing loss (PTA (4.0-6.0-8.0)), the negative relation between the THI and happy faces became stronger and the relation between the THI and anxious faces became significant. The negative relation between priming effects of pleasant stimuli and tinnitus severity may give an indication of the impact of tinnitus on the quality of life. In clinical practice many patients report withdrawing from pleasant social activities as a result of tinnitus and often co-morbid hearing disability: like difficulty following conversations, irritation by surrounding noises etc., which possibly leads to perceiving such activities as unpleasant and to experiencing less positive emotion. This might explain why it takes longer for them to react to positive emotional stimuli as tinnitus severity increases. Alternatively priming effects to positive affective stimuli might indicate that distressed tinnitus patients feel more ambivalent about positive emotions, and thus take longer to process these. Some researchers have argued that smaller priming effects to positive stimuli are associated with anxiety [14, 21], while others have found that non-depressed (in comparison with depressed) subjects demonstrated a bias toward the positive stimuli [31]. However, a direct relationship between tinnitus severity and anxiety-related stimuli (fearful faces) for the total sample could only be established after controlling for hearing loss, which implicates that hearing loss obfuscates the relation between tinnitus severity and the processing of fearful faces. Moreover a remarkable trend could be observed between the audiological characteristic, loudness, and the automatic processing of fearful faces. The reason why this trend was not significant, could be our smaller sample size. As mentioned, not all patients were able to match pitch and loudness, and thus we lost some statistical power. However, the result indicates that as patients experience more loudness, a stronger priming effect of the threat-related cues (fearful faces) emerges. These findings suggests that tinnitus severity and loudness, cohere with the processing of fear-related stimuli on an automatic level. A possible explanation, why only fearful faces are related and not threat-related stimuli in general, could be that tinnitus severity and loudness are accompanied specifically with a fear reaction in memory. Although this interpretation should be tested for in future research, we believe it is consistent with verbal reports in clinical practice, where patients are afraid that the tinnitus and specifically the loudness gets worse.

In a next step we studied our hypothesis in the subgroup of patients with severe tinnitus complaints and the subgroup with mild tinnitus-severity complaints separately. In the high scoring group tinnitus severity was positively related to fear and anger stimuli and negatively to positive emotion stimuli, which was in line with our hypothesis. In this subgroup stronger tinnitus-severity complaints are accompanied by stronger affective priming of threat-related information and weaker affective priming for positive affective information and these relations became stronger after controlling for hearing loss at normal and high frequency levels. This result is in line with the study of Li et al [15], who found especially stronger affective priming driven by threatening stimuli for subjects with high trait anxiety as compared to those with low trait anxiety. Furthermore, we found normal priming effects and not
reversed ones, which is in line with former research findings [14] where affective priming was found in people with high trait anxiety, and reversed priming effects in people with low trait anxiety. Moreover, these results converge with research concerning threat-related biases in highly anxious subjects [16].

Overall, these findings show that especially in patients with severe tinnitus distress, symptom severity is an anxiety-related problem independent from the amount of hearing loss. For patients with mild tinnitus distress this did not prove to be true.

We believe that this result has important theoretical and clinical implications: the presence of a threat-related bias suggests that distress associated with tinnitus severity is an anxiety-related problem, and not a depression-related problem. If tinnitus severity was related to depression, one would expect a bias towards the sad faces. Indeed, in previous studies such bias towards sad faces proved to be typical for depressed patients, but not for anxious patients [20]. Likewise in previous studies depressed patients did not show the kind of threat-related bias that is typical of anxiety [14, 20]. The results of this study corroborate the suggestion of Ooms et al. [32] that the frequently observed relation between tinnitus severity and depression is an artefact of method bias and content overlap between questionnaires. However, results on mood congruency effects in depression are contradictory [21], and thus caution is still warranted in drawing conclusions in this respect.

Since this study is a correlation study, statements upon the directionality between tinnitus severity and the automatic processing of threatening information cannot be made. However, based on former research [33, 34], theory [35] and clinical practice, we believe that the automatic processing of threatening information may exist before the tinnitus becomes chronic. Support for this idea can be found in former research, which indicates that anxiety-related personality disorders are common in tinnitus patients [36]. Probably these patients also have a more anxious reaction to the tinnitus signal. In this way, a vicious circle is created whereby anxiety as causal factor and anxiety as reactive factor stimulate each other. Yet, we believe that the exact direction between tinnitus severity and anxiety can only be decided on an individual level.

Limitations of this study concern our interpretation of the affective priming effects via network theory and the idea of spreading activation. This theory is contested by some authors [10]. Another explanation for priming effects is the stroop mechanism, where automatic and strategic components reflect priming effects [10]. However, in our interpretation the notion of spreading activation and the stroop mechanism are not opposed to each other. As Fazio [11] argues, rather than opposing each other, these theories are complementary. Moreover, we did not make use of a masking procedure to overcome possible strategic responding [10] putting the ‘automaticity’ of our results into question.
However, this cannot explain the different priming patterns associated with tinnitus severity, since strategic responding can be considered to have the same impact for the whole sample. Furthermore, as we didn’t replicate our experiment, it remains possible that these results were obtained by chance. Yet, this is the first study on automatic processing of affective information with a tinnitus population, and our results fit the clinical observation that patients with severe tinnitus complaints typically suffer from anxiety related symptoms such as feeling more anxious, restless, irritable, having poor concentration and difficulty sleeping [37, 38].

This study principally points to the importance of processing of threatening information in tinnitus patients. Moreover, a different pattern in the processing of affective pictural stimuli between patients with low versus high tinnitus severity scores was found. In patients with severe distress, tinnitus severity scores are clearly connected with a bias towards threatening information and which is independent from the amount of hearing loss. This is consistent with findings in highly anxious subjects, and indicates that in severely distressed patients tinnitus severity is also an anxiety-related problem on an automatic level. Furthermore, the audiological characteristic, loudness, also tends to be in some degree an anxiety-related problem. Yet, future research needs to confirm the obtained results and should focus on the directionality between anxiety and tinnitus (severity).
REFERENCES


Is tinnitus a fear- or an anxiety-related problem? A multi-method study

In this study the nature of anxiety in relation to tinnitus is investigated via a multi-method assessment of anxiety. We examine whether the tinnitus severity complaint reflects an anxiety-related problem (predisposing factor) and/or a fear-related problem (consequence of tinnitus) and whether these relations are specific to severely distressed patients. The sample consists of 68 consecutive tinnitus outpatients from the Ear, Nose and Throat (ENT) Department of Ghent University Hospital. Patients filled in the trait anxiety scale of the State and Trait Anxiety Inventory (STAI) and the Tinnitus Handicap Inventory (THI). Heart rate (HR) and Skin Conductance (SC) were measured at base and while viewing emotional-laden pictures. After measurement pictures were rated and psychoacoustic measurement (pitch and loudness matching) was performed. The results indicate that especially in severely distressed patients, the severity complaint is related to autonomic responding patterns as observed in fear- as well as in anxiety-related problems. Loudness, on the other hand, reflects a fear-related problem.

In patients who suffer with their tinnitus, anxiety as a result and anxiety as a predisposing factor are important in understanding differences among tinnitus patients.

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2 The author thanks Roger Dow, the president of contact precision instruments, London, England, for his technical and methodological assistance.
INTRODUCTION

Tinnitus is often described as a ringing noise in the ear(s) or in the head, without the presence of external stimulation (Reynolds, Gardner, & Lee, 2004; Rutter & Stein, 1999). In some patients it takes the form of a buzzing, hissing, humming, or whistling sound, in others a ticking, clicking, roaring, tune or song. It has also been described as a “whooshing” sound, like the sound of wind or waves (Belli et al., 2008; Heller, 2003). While clinical investigations have described help-seeking tinnitus patients as generally distressed by their tinnitus, epidemiological studies have shown that a large proportion of individuals with tinnitus do not seek medical or other professional help and appear not to be severely distressed by their affliction (Coles, Davis, & Haggard, 1981; Davis & El Refaie, 2000). Several studies have indicated that at least two dimensions must be considered, namely the physical tinnitus symptom and its subjective experience or severity (Halford & Anderson, 1991; Holgers, Zöger, & Svedlund, 2005; Meikle, 2002; Meikle, Vernon, & Johnson, 1984; Meikle & Walsh, 1984). The relationship between the tinnitus symptom and subjective severity seems to be asymmetric (Erlandsson, Hallberg, & Axelsson, 1992; Meikle et al., 1984). This conclusion is based upon the lack of association often found between self-reported tinnitus severity and audiological characteristics (e.g. pitch and loudness). Medium to large correlations are found, however, between subjective severity and psychological factors, such as anxiety. From this it is concluded that psychological factors, such as anxiety, are important in explaining the differences in the subjective severity of the complaint (Erlandsson et al., 1992). Tinnitus severity can be considered an anxiety-related problem (Ooms et al., 2011). However the nature of this anxiety remains unclear.

Theoretical and clinical distinctions are often made between fear and anxiety. Whereas fear is held to be a reaction to a threatening or phobic object (e.g. a dog may be threatening for those who are afraid of dogs), anxiety is considered a more long lasting and general state of distress that is not necessarily linked to threatening or phobic objects, but manifests as a general tendency to respond anxiously in diverse situations (Rachman, 1998; Spielberger, 1966). Some authors consider elevated anxiety in tinnitus patients to be a consequence of the tinnitus symptom (Hiller & Goebel, 2006; Meikle, 2002), and thus consider it as a fear reaction. This is also what is mapped by tinnitus distress measures, like the Tinnitus Handicap Inventory (THI; Newman, Jacobson, & Spitzer, 1996) which specifically focuses on reactions towards the tinnitus symptom. Others consider anxiety to be a more general underlying factor in the experienced tinnitus severity (Erlandsson et al., 1992; Puel & Guittion, 2007); and still others combine both fear and broader anxiety perspectives, arguing that anxiety is an important cause of tinnitus severity as well as a consequence of the tinnitus symptom itself, whereby a vicious circle in experienced tinnitus severity is created (Jastreboff, 1995).
In this study we investigate the nature of anxiety in tinnitus in more depth using a multi-method approach to assess anxiety. Most studies investigate anxiety exclusively through verbal report of affect (Belli et al., 2008; Erlandsson et al., 1992; Ooms et al. 2011; Zöger, Svedlund, & Holgers, 2001). However, when studying emotion, a multi-method approach, in which the verbal report of affect (e.g., self-report questionnaires, interviews) is combined with a physiological measurement of affect (e.g., Heart Rate (HR), Skin Conductance Response (SCR)), and/or behavioural acts (e.g., motor behaviour such as fight or flight), has been recommended (Cuthbert & Lang, 1989; Lang, 1978; Lang, Bradley, & Cuthbert, 1998; Larsen, Berntson, Poehlmann, Ito, & Cacioppo, 2008).

Emotion is often conceptualized as an ‘action set’, that is, an active disposition to respond to a stimulus or situation. The latter typically involve contexts of marked personal and/or phylogenetic significance (e.g., situation of threat). The action set itself is considered to be an associative network of information that is stored in the brain. Information in this network is activated when a stimulus triggers a specific emotional disposition and produces both somatic and visceral consequences (Cuthbert & Lang, 1989; Lang, Davis, & Öhman, 2000). Moreover, neural networks underlying emotion include direct connections to two primary motivational systems in the brain: an appetitive system that governs approach behaviour and engagement with the environment, and a defensive system that promotes avoidance and protection against danger (Bradley, Codispoti, Cuthbert, & Lang, 2001; Lang et al., 2000; Smith & Ellsworth, 1985). Within this theory it is said that emotional arousal results from the activation of cognitive-perceptual representations that connect with the appetitive or defensive action system (Bradley et al., 2001; Lang, Bradley, & Cuthbert, 1997; Lang et al., 2000; Levenston, Patrick, Bradley, & Lang, 2000).

Such cognitive-perceptual representations can be studied via emotion-laden pictures, which elicit specific patterns of physiological and self-report responses (Bradley et al., 2001; Greenwald, Cook, & Lang, 1989; Lang et al., 1997; Lang, Greenwald, Bradley, & Hamm, 1993; Levenston et al., 2000; Stern, Ray, & Quigley, 2001). Facial expression is considered a core element of the perception and experience of emotions, therefore pictorial emotional facial expressions are often used in emotion research (Goeleven, De Raedt, Leyman, & Verschuere, 2008). Whereas fearful and angry facial expressions are ecologically valid and salient depictions of threatening stimuli (Ladouceur et al., 2006; Whalen et al., 2001), sad facial expressions are considered as generally unpleasant stimuli and happy facial expressions as generally pleasant stimuli (Goeleven et al., 2008; Vrana & Gross, 2004).

A picture viewing context is typically associated with skin conductance responses (SCRs) and heart rate deceleration (HR deceleration). The latter has been described as the orienting response to an interesting, meaningful, or novel visual stimulus (Lang et al., 1997; Öhman, 2008; Stern et al., 2001). Greater SCR indicates greater intensity, activation or arousal and greater HR deceleration indicates
greater attention devoted to an interesting, meaningful, or novel visual stimulus (Lang et al., 1997, Levenston et al., 2000; Vrana & Gross, 2004). Generally, SCRs are more pronounced for both pleasant and unpleasant pictures than for neutral pictures. HR deceleration is greater for aversive pictures than for neutral pictures and less for pleasant pictures. When the material is truly phobic to the viewer, then increased HR is generally observed (Lang et al., 1993; Stern et al., 2001; Vrana & Gross, 2004).

Extensive psychophysiological research has demonstrated that there is a difference between fear and anxiety. When fear subjects (e.g., subjects with a specific phobia) view pictures of their phobic object, their heart rate accelerates, probe reflexes show greater than normal potentiation (Hamm, Cuthbert, Globisch, & Vaitl, 1997), skin conductance responses are enhanced and blood pressure increases (Globisch, Hamm, Esteves, & Öhman, 1999). When confronted with general threatening stimuli (e.g. fearful and/or angry faces), fear subjects, similar to normal control subjects, tend to show autonomic responses consistent with the orienting response (greater SCRs and greater HR deceleration) (Lang & McTeague, 2009; Öhman, 2008; Vrana & Gross, 2004). The psychophysiological response to stress seen in anxiety related disorders, like panic disorder and generalized anxiety disorder, is different. Anxiety disorders are associated primarily with high resting autonomic activity and less acute reactivity to general stressful, negative and threatening stimuli. As such, it is argued that the defensive system is compromised in anxiety (Cuthbert et al., 2003; Lang, Bradley, & Cuthbert, 1998; Lang & McTeague, 2009; Lang, McTeague, & Cuthbert, 2005; Öhman, 2008). Furthermore, the elevated autonomic responses during rest are not observed in normal controls, or in subjects with specific phobia (Hoehn-Saric & McLeod, 2000; Lang et al., 1998; Öhman, 2008). Whereas self-reported anxiety tends to cohere with physiological responses in fear-related conditions, the opposite is found to be true for anxiety-related conditions (Hoehn-Saric & McLeod, 2000; Lang et al., 1998; Lang & McTeague, 2009; Öhman, 2008).

Research question

In this study we examine whether tinnitus severity, as measured by the Tinnitus Handicap Inventory, reflects a fear- and/or an anxiety-related problem. Therefore, next to assessing anxiety by means of a self-report measure, we also use psychophysiological measures. If tinnitus severity is in fact a fear-related problem, we expect to observe a relation between tinnitus severity and physiological responses (SCR and HR) towards threat-related cues, but no relation between tinnitus severity and autonomic activation at base. Conversely, if tinnitus is an anxiety-related problem, tinnitus patients have an anxious disposition and generally react with anxiety to many situations and not only in the context of the tinnitus symptom. In this case, we expect to observe a relationship between tinnitus severity and automatic activation at base and a relationship between tinnitus severity and diminished reactivity to negative and threatening stimuli. Furthermore, we explore whether the latter assumptions
hold for all tinnitus patients, or only for those with high tinnitus-severity complaints. The latter may be expected since daily life is affected for those patients. In general, research on the relation between audiological characteristics (pitch and loudness) and self-reported anxiety has found no relationship (Halford & Anderson, 1991; Holgers et al., 2005; Meikle, 2002; Meikle et al., 1984; Meikle & Walsh, 1984; Ooms et al., 2011). However, as it is possible that audiological characteristics are related to physiological responses which are observed in fear and/or anxiety subjects, we will explore this in more depth.

**MATERIALS AND METHODS**

**Participants**

Eighty-one consecutive tinnitus outpatients that were recruited from the Ear, Nose and Throat (ENT) Department of the Ghent University Hospital and gave informed consent. Thirteen patients were excluded from the analysis due to excessive movement during psychophysiological recordings. The mean age of the 68 remaining patients was 48.09 years old ($SD = 13.34$); 38.2% were women; average duration between the onset of tinnitus and participation in this study was 40.47 months ($SD = 57.47$). In 16 of the 68 remaining patients (23.5%) the HR measure failed due to technical problems. There were no significant differences with the subsample where the HR measure failed with respect to sex, mean age or mean duration ($p > .05$). All patients underwent a thorough ENT examination and if necessary, imaging of the ear and central auditory system was performed. In 17 of the remaining 68 patients (25%), psychoacoustic measures failed. The reason for this failure was the inability of patients to match their pitch and loudness. There were no significant differences with the subsample where psychoacoustic measures failed with respect to sex, mean age or mean duration ($p > .05$).

The study protocol was approved by the ethics committee of Ghent University Hospital and was in accordance with the Helsinki Declaration.

**Measures**

*Tinnitus Handicap Inventory (THI)* (Newman et al., 1996): To evaluate the impact of tinnitus on daily life, the Dutch version of the THI was administered. This scale is composed of 25 questions and the scores can vary between 0 and 100. The THI specifies different ranges of an index score, namely *light* (0-16), *mild* (18-36), *moderate* (38-56), *severe* (58-76) and *catastrophic* (78-100) handicap. Cronbach’s alpha was .93 indicating very good internal consistency, comparable to the original version of the THI (Newman et al., 1996).
5. TINNITUS: A FEAR- OR AN ANXIETY-RELATED PROBLEM?

The Dutch version of the *State and Trait Anxiety Inventory* (STAI) (Van der Ploeg, 2000) was used to measure trait anxiety. This scale consists of two 20-item self-report scales, one scale for state anxiety and one for trait anxiety. In this study only the trait-anxiety scale was used. Spielberger (1966) defined ‘trait anxiety’ as relatively stable individual differences in anxiety proneness. It refers to a general tendency to respond with anxiety. For each symptom, statements are listed in ascending order, from 1 (almost never) to 4 (almost always). There is a total score for trait anxiety. The psychometric properties of the Dutch STAI are very good (Van der Ploeg, 2000). Internal consistency in this sample was also very good with $\alpha = .96$ for trait anxiety. For each patient, scores on the scale can be compared with a Dutch norm group (different for men and women). This means that raw scores can be converted into decile scores ranging from 1 to 10 whereby a score of 5 is considered average, a score of 10 is very high and a score of 1 is very low (Van der Ploeg, 2000).

The two *audiological characteristics* used in this study are pitch and loudness matching. Pitch matching attempts to quantify tinnitus in terms of its possible frequency. The procedure is a two-alternative forced choice. Two tones are presented to the patient and the patient is asked to choose which one most closely matches the tinnitus that they hear. This is continued until the match is made. Next, an octave confusion test is performed. This is the phenomenon where the patient has identified one tone as matching the tinnitus, when, with further testing, the match is actually one octave above or below the tone. Loudness matching is the psychoacoustic equivalent of sound intensity, and attempts to quantify the tinnitus in decibels. The procedure for loudness matching starts at a level just below threshold and intensity is increased until the patient signals a match. Matching stimuli were presented using an Interacoustics Clinical Audiometer AC 40 (Interacoustics A/S, Denmark) in a sound proof booth.

*Emotional face stimuli.* Facial stimuli were 6 negative (2 fear, 2 angry, 2 sad), 6 happy and 6 neutral facial pictures from the Karolinska Directed Emotional Faces (KDEF) (Lundqvist, Flykt, & Öhman, 1998). The KDEF database shows pictures of 70 individuals (35 women and 35 men) displaying 7 different emotional expressions (angry, fearful, disgusted, sad, happy, surprised, and neutral). Selection was based on a Flemish validation study (Goeleven et al., 2008). For each emotion used in this study (fear, anger, sadness, happiness and neutral), we selected the best rated facial expressions for men and women. The amount of men and women expressing each emotion was balanced.

*Autonomic measures* used in this study were skin conductance (SC) and heart rate (HR). The PSYLAB SC5 (Contact Precision Instruments, London, UK) skin conductance coupler provides a 24-bit accuracy A-D converter built into the Amplifier. SC5 coupler provides a 0.5-V constant voltage across the two electrodes and measures the skin conductance directly. SC was recorded from the thenar and hypothenar eminences of the non-dominant hand using a pair of 8-mm² pre-wired Ag/AgCl electrodes.
5. TINNITUS: A FEAR- OR AN ANXIETY-RELATED PROBLEM?

(TD-22 EL1, Med Associates Inc. ST Albans, VT, USA) filled with Johnson and Johnson K-Y Jelly. The accuracy of skin conductance measurement was checked each time it was turned on by an automatic calibration circuit provided in the pre-amplifier. SC was measured in micro Siemens (µS). SC at base was calculated by counting any responses which exceed 0.02 µS in amplitude. An amplitude figure was used; this was obtained by adding together the amplitude of all such responses, which are identified using a wave shape detection algorithm. SCR to pictorial stimuli was calculated as the maximal skin conductance change (with a minimum of 0.02 µS), starting between 1 and 5s after picture onset. Raw scores were transformed (log[SCR+1]) to reduce skewness (Bradley, Cuthbert, & Lang, 1990; Levenston et al., 2000).

Electrocardiography (ECG) was recorded with a Bioamplifier with the high pass filter set at 10Hz and the low pass filter set at 40Hz. Gain was adjusted to 1mV with the Hum filter on. Acquisition sample rate was set at 1000Hz allowing off-line R-R calculation to 1mS accuracy using a peak detection algorithm. ECG was recorded using three disposable Ag/AgCl electrodes (3M Red dot monitoring electrodes with solid gel, 2239). Electrodes were placed on the chest in such a way that the heart is in between them, with the white lead on the Right Arm (RA) position just below the clavicle, the black lead on the Left Arm (LA) position just below the clavicle, and the green lead (the amplifier ground) on the Left Leg (LL) position on the lower edge of the ribcage. Inter Beat Interval (IBI) is calculated by timing the interval between R-waves. R-waves are detected using a wave shape recognition algorithm. Artefact is rejected on the basis of outliers which exceed a running average of 10 previous beats by 40% or more. Heart Rate (HR) was measured in beats per minute (bpm). For responses at base mean values of HR were used. HR change to pictorial stimuli was defined as average change during the 7-s picture viewing period from the last 3-s of the ITI immediately preceding picture onset.

Procedure

HR and SC were measured during base for three minutes without any stimulus presentation. Base measures were followed by two habituation picture viewing trials (pictures of coloured surfaces), each presented for 7s and an inter trial interval (ITI) of 30s. These trials were included to habituate initial large autonomic reactions (cfr. Levenston et al., 2000), and were excluded from analyses of the data. Habituation trials were followed by emotional picture viewing trials (2 fearful, 2 angry, 2 sad, 6 happy and 6 neutral faces) each presented for 7s with an ITI of 30s. Pictures were presented full-screen on a computer (1280 x 1024 pixels).

Four fixed random stimulus orders were used to balance the presentation of pictures. For reducing predictability, pictures of the same valence never occurred consecutively and the amount of men and women expressing the emotion no more than twice consecutively.
After autonomic recordings, participants rated each picture for pleasure (positive-negative), arousal (excited-calm), and dominance (controlled-in control) by using the pencil and paper version of the Self-Assessment Manikin (SAM) (Bradley & Lang, 1994; Lang, 1980), while pictures were fixed randomly presented full-screen on a computer (1280 x 1024 pixels) for 30s. Ratings of valence are indicated by five graphic figures with facial expressions ranging from a severe frown (most unpleasant) to a broad smile (most pleasant). Arousal and dominance were similarly indicated; for arousal, the manikin varies from a state of low agitation to that of high agitation and for dominance, the manikin itself varies from very small (low dominance) to very large (high dominance). All scores range from 1 to 9.

RESULTS

Descriptives

Mean scores on subjective tinnitus severity, trait anxiety, audiological characteristics (pitch and loudness), and physiological responses (SC and HR) at base are presented in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>THI^a</td>
<td>41.53</td>
<td>22.90</td>
</tr>
<tr>
<td>STAI-trait^a</td>
<td>41.15</td>
<td>12.60</td>
</tr>
<tr>
<td>Pitch^b (kHz)</td>
<td>4.65</td>
<td>2.80</td>
</tr>
<tr>
<td>Loudness^b (dB SL)</td>
<td>8.06</td>
<td>5.83</td>
</tr>
<tr>
<td>SC^a</td>
<td>2.02</td>
<td>2.99</td>
</tr>
<tr>
<td>HR (bpm)^c</td>
<td>71.89</td>
<td>9.86</td>
</tr>
</tbody>
</table>

Note: ^a total sample (N=68); ^b sub-sample (n=51); ^c sub-sample (n=52); kHz=Kilohertz; dB SL=Decibel Sensation Level; bpm= beats per minute.

For the THI 17.6% (n=12) of the sample reported a light handicap; 27.9% (n=19) reported a mild handicap; 26.5% (n=18) reported a moderate handicap; 20.6% (n=14) reported a severe handicap; and 7.4% (n=5) reported a catastrophic handicap.

Following the STAI-manual, 13.2% (n = 9) had a very low score; 20.6% (n = 14) a low score; 10.3% (n = 7) an average score; 26.5% (n = 18) a high score; and 29.4% (n = 20) had a very high score for trait anxiety.
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There was a positive correlation between the THI and the STAI-trait ($r=.55, \ p < .00$), which corresponds with a large ($>.37$) effect size (Cohen 1992). Audiological characteristics, pitch and loudness, were not significantly correlated to the THI, $r = .13, \ p = .36 \text{ and } r = .07, \ p = .65 \text{ respectively,}$ or to the STAI-trait, $r = -.01, \ p = .95 \text{ and } r = .16, \ p = .25 \text{ respectively.}$

Relationships between tinnitus and physiological responses: baseline results

Table 2 gives an overview of correlations found between tinnitus severity, audiological characteristic (pitch and loudness), and physiological response (HR and SC) at base. There was a marginally significant positive correlation between the THI and SC at base ($r=.23, \ p=.06$).

<table>
<thead>
<tr>
<th></th>
<th>THI</th>
<th>Loudness</th>
<th>Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>.23 (.06)$^a$</td>
<td>.19 (.18)$^b$</td>
<td>-.09 (.55)$^b$</td>
</tr>
<tr>
<td>HR</td>
<td>-.13 (.34)$^c$</td>
<td>.24 (.14)$^d$</td>
<td>-.13 (.41)$^d$</td>
</tr>
</tbody>
</table>

Note: $^a$total sample ($N=68$); $^b$sub-sample ($n=51$); $^c$sub-sample ($n=52$); $^d$sub-sample ($n=40$); $p$-values in parentheses

Physiological responses to facial emotion pictures

SCR and HR change for all emotional faces are presented in Table 3. Higher values for SCR reflect more reactivity, whereas for HR change, more reactivity is reflected in more negative values. An ANOVA with repeated measures on SCR with emotion as factor (fearful, angry, sad, happy, neutral) revealed a significant main effect of emotion, $F(4,64)= 3.87, \ \eta_p^2 = .20$. Specific effects showed that fearful faces prompted significantly greater SCR than neutral faces, $t(67)= 2.34, \ p<.05$, and sad faces prompted significantly less SCR than neutral faces, $t(67)= -2.09, \ p< .05$.

The repeated measures ANOVA on HR change with emotion as a factor (fearful, angry, sad, happy, neutral) revealed no significant main effect of emotion, $F(4,48)= 1.28, \ \eta_p^2 = .10$. 

Table 3. Correlations between physiological measures (SC and HR), The Tinnitus Handicap Inventory (THI), pitch and loudness at base.
Table 3. Mean values and standard deviations (SD) for physiological measures, Skin Conductance Response (SCR) and Heart Rate change (HR change) on facial emotion pictures (fearful, angry, sad, happy, and neutral faces).

<table>
<thead>
<tr>
<th>Facial Emotion</th>
<th>SCR^a</th>
<th>HR change^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fearful faces</td>
<td>.03 (.05)</td>
<td>-1.23 (2.20)</td>
</tr>
<tr>
<td>Angry faces</td>
<td>.03 (.06)</td>
<td>-.68 (1.97)</td>
</tr>
<tr>
<td>Sad faces</td>
<td>.01 (.03)</td>
<td>-.77 (1.80)</td>
</tr>
<tr>
<td>Happy faces</td>
<td>.02 (.04)</td>
<td>-.21 (2.13)</td>
</tr>
<tr>
<td>Neutral faces</td>
<td>.02 (.04)</td>
<td>-.59 (1.93)</td>
</tr>
</tbody>
</table>

Note: ^a total sample (N=68); ^b sub-sample (n=52); SD in parentheses.

Relationships between tinnitus and physiological responses to facial emotion pictures

To investigate individual differences in autonomic responding (SCR and HR change) to the different emotional facial expressions, autonomic responding to neutral faces was subtracted from automatic responding to emotional faces (fearful, angry, sad, happy).

Table 4 gives an overview of correlations found between tinnitus severity, audiological characteristics, and physiological responses (SCR and HR change) to the different facial emotion pictures as controlled to neutral pictures. Whenever significant correlations are observed, trends with all other measures are reported.

A significant negative correlation between the THI and SCR change to angry faces was observed ($r = -0.27, p < .05$), meaning that SCR change to angry faces becomes smaller when tinnitus severity rises. HR change to angry faces also showed a significant correlation with the THI, meaning that if patients are bothered more by tinnitus greater HR deceleration towards angry faces is observed ($r = -0.41, p < .05$). Furthermore, a marginally significant correlation was found between SCR change to sad faces and the THI ($r = -0.24, p = .05$), meaning that as patients experience more severity, the SCR prompted by sad faces becomes smaller.

For the audiological characteristic loudness, a positive correlation was found with SCR change for fearful faces ($r = 0.44, p < .05$), meaning that fearful faces prompt greater SCR when experienced loudness rises.
Table 4. Correlations between physiological measures (SCR and HR change) for emotional faces as controlled for neutral faces, The Tinnitus Handicap Inventory (THI), and audiological characteristics (Loudness and Pitch).

<table>
<thead>
<tr>
<th></th>
<th>THI</th>
<th>Loudness</th>
<th>Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR change angry faces</td>
<td>-.27a (.03)</td>
<td>.03b (.85)</td>
<td>.17b (.25)</td>
</tr>
<tr>
<td>SCR change fearful faces</td>
<td>.17a (.16)</td>
<td>.44b** (.00)</td>
<td>-.17b (.23)</td>
</tr>
<tr>
<td>SCR change sad face</td>
<td>-.24a (.05)</td>
<td>-.04b (.77)</td>
<td>-.05b (.73)</td>
</tr>
<tr>
<td>HR change angry faces</td>
<td>-.41c** (.00)</td>
<td>.26d (.11)</td>
<td>-.19d (.25)</td>
</tr>
<tr>
<td>HR change fearful faces</td>
<td>.07c (.61)</td>
<td>-.13d (.42)</td>
<td>.09d (.56)</td>
</tr>
<tr>
<td>HR change sad faces</td>
<td>-.15c (.29)</td>
<td>-.18d (.28)</td>
<td>.05d (.77)</td>
</tr>
</tbody>
</table>

Note: * total sample (N=68); b sub-sample (n=51); c sub-sample (n=52); d sub-sample (n=40); p-value in parentheses: *p<.05; **p<.00

Dividing our sample into a high and low tinnitus severity group revealed no correlations between physiological responses and the THI for the group with low tinnitus severity complaints. However, for the group with high severity complaints SCR change to angry faces and SCR change to sad faces were significantly correlated with the THI and these relations were stronger than the correlations found for the total sample (r=-.37, p< .05 and r=-.34, p< .05 respectively). The THI was significantly related to HR change for sad faces and marginally significant to HR change for angry faces, r=-.39, p< .05 and r=-.37, p = .05 respectively.

Picture ratings: overall results

The 3 ANOVAs with repeated measures on the mean valence, mean arousal and mean dominance ratings for all emotional faces (fearful, angry, sad, happy, neutral) revealed a significant main effect of emotion for the valence, arousal, and dominance ratings, F(4,64)= 61.85, p< .00, F(4,64)= 13.69, p< .00 and F(4,64)= 2.54, p< .05 respectively.

All emotional faces (fearful, angry, sad, happy) where significantly different from neutral faces in valence ratings. Fearful, angry and sad faces where significantly rated more negative than neutral faces, t(67)= -11.03, p< .00, t(67)= -9.88, p< .00, and t(67)= -9.77, p< .00 respectively. Happy faces where significantly rated more positive than neutral faces, t(67)= 11.57, p< .00. For arousal ratings, fearful, angry, sad, and happy faces where all significantly rated more exciting than neutral faces (p< .05). Only fearful and angry faces where significantly different from neutral faces in dominance ratings, t(67)= -2.16, p< .05, and t(67)= -2.63, p< .01 respectively.
Relationships between tinnitus and picture ratings

For the total sample, picture valence, arousal, and dominance ratings were unrelated to the THI. For the audiological characteristic, loudness, a positive significant correlation was found with valence of angry faces ($r=0.31$, $p<0.05$), meaning that as loudness increases, pictures of angry faces are rated as more pleasant. No other ratings were related to audiological characteristics.

For the group of tinnitus patients with high severity scores, the THI was positively related to the valence rating of angry and sad faces, $r=0.44$, $p<0.05$ and $r=0.35$, $p<0.05$ respectively, and marginally significant to the valence rating of fearful faces ($r=0.31$, $p=0.06$). A negative marginally significant correlation between the THI and valence rating of happy faces ($r=-0.29$, $p=0.09$) was found. This means that for the group with high tinnitus severity complaints all negative emotions (angry, sad, and fearful faces) were rated as more pleasant, while the positive emotion (happy faces) was rated as more unpleasant as the THI rises. Correlations between the THI, arousal and dominance ratings were not found to be significant.

DISCUSSION

In this study, we investigated whether tinnitus severity is a fear- and/or an anxiety-related problem. We hypothesized that if tinnitus severity is a fear-related problem, a positive relation between the THI and physiological responses to threat-related stimuli and no relation between the THI and physiological responses at base would be found. If, on the other hand, tinnitus severity is an anxiety-related problem, we would find a positive correlation between the THI and physiological responses at base, and a relationship with distorted physiological responses to negative and/or threatening stimuli. Furthermore, we explored whether these predictions hold true for the total sample or only for patients reporting severe tinnitus complaints. For audiological characteristics, pitch and loudness, we explored whether relations could be found with physiological responses.

In line with former research, tinnitus severity and self-reported anxiety are highly related (Erlandsson et al., 1992; Hiller & Goebel, 2006; Meikle, 2002; as previously reported upon in Ooms et al., 2011; Puel & Guitton, 2007), indicating that tinnitus severity is an anxiety-related problem on the subjective reported level. Furthermore, 54.9% of our total sample reported high and very high trait-anxiety, indicating that trait-anxiety is a significant clinical problem in tinnitus patients. As expected, no relations were found between tinnitus severity and audiological characteristics, or between self-reported anxiety and audiological characteristics (Erlandsson et al., 1992; Hiller & Goebel, 2006; Meikle, 2002; as reported upon in Ooms et al., 2011).
Although only marginally significant, our results for responses at baseline suggest that tinnitus severity is related with SCR prompted at base, meaning that as patients are more bothered by their tinnitus, arousal at base rises as well. Furthermore, this relation holds true for the total sample and not only for those patients with high-severity complaints. Although caution is warranted in interpreting these results, it appears that tinnitus severity may be an anxiety-related rather than fear-related problem; the result found resembles the pattern observed in populations with an anxiety-related condition, where high autonomic activity is observed during rest, which is not the case in normal control, or in fear-related conditions (Hoehn-Saric & McLeod, 2000; Öhman, 2008).

In a subsequent step we examined relationships between tinnitus and physiological responses to facial emotion pictures. For the total sample, the results showed that as tinnitus severity increases, less SCR and greater HR deceleration is prompted by angry faces. The latter means that angry faces attracted more attention, as indicated by greater HR deceleration, yet elicited less autonomic activation, indicated by diminished SCR. This finding is consistent with findings in anxiety-related conditions, where threatening stimuli seem to elicit diminished autonomic reactivity (Bradley et al., 2001; Cook, Melamed, Cuthbert, McNeil, & Lang, 1988; Hoehn-Saric & McLeod, 2000; Lang et al., 1998; Lang et al., 2000; Lang & McTeague, 2009; Öhman, 2008). Negative stimuli (sad faces) were also significantly related to tinnitus severity. Yet, as our general results indicate, sad faces prompted significantly less SCR than neutral faces, which is an odd finding. It is questionable as to whether sad stimuli failed to elicit the normally observed SCR or whether neutral stimuli elicited more than normal SCR. Considering the latter proposition, Vrana and Gross (2004) found that neutral faces are not significantly different from angry faces for SCR and HR, while subjects rated neutral expressions as affectively neutral. These researchers argued that neutral expressions are more difficult to decode and are sometimes rated negatively because they are ambiguous and uncommon, which elevates the potential for non-reward or punishment. Furthermore, Vrana and Gross (2004) found that these greater physiological responses to neutral and angry faces manifested for the high fear group, but not for the low fear group. This could mean that in our sample neutral faces, in spite of the affectively neutral ratings, prompted greater SCR, which points in the direction of a fear-reaction to neutral faces. However, it is possible that sad faces didn’t prompt the necessary SCR, or that the reactivity was diminished, reflecting a reaction pattern observed in anxiety-related conditions. It seems more likely, however, that both processes were at work and that this result could reflect a fear- as well as an anxiety-related response.

Our analyses on the different tinnitus severity groups revealed that relations found at the level of the total sample were specifically true for the high tinnitus severity group. Relationships became stronger and were only present in the high tinnitus severity group, indicating that the mix of physiological responses are specific for patients who are more bothered by their tinnitus.
It seems that tinnitus severity reflects a fear- as well as an anxiety-related problem. Diminished arousal is observed towards angry and sad faces, while HR deceleration indicates that attention is given to these stimuli. We assume that neutral faces prompted greater SCR, suggesting its negative and/or threatening value. Further support for this assumption may be reflected in the small differences in SCR for emotional versus neutral stimuli, as shown in Table 3. Although the result was not significant, the relation between tinnitus severity and SCR prompted by fearful faces may point in the same direction. This would indicate that greater SCR is prompted as tinnitus severity increases. However, future research should confirm whether this interpretation holds.

The audiological characteristic, loudness, was significantly related to SCR prompted by fearful faces, indicating that as patients experience more loudness, reactivity (arousal) towards fearful faces becomes higher. Although it is often found that audiological characteristics are not related to subjective severity complaints in tinnitus patients (Erlandsson et al., 1992; Ooms et al., 2011), or to self-reported psychological problems (Ooms et al., 2011), this finding suggests that loudness is specifically related to fear-related stimuli on a physiological level. A possible explanation as to why only fearful faces are related to loudness and not threat-related stimuli in general could be that loudness may be associated with a fear reaction in memory. Although this interpretation should be examined in future research, it is consistent with verbal reports in clinical practice, where patients report being afraid that loudness will get worse.

In this study we observed a dissociation between the covert (e.g. SCR) and the overt expression (e.g. arousal rating) of neutral and sad faces. Whereas sad faces were rated as more arousing than neutral faces, the SCR prompted by sad faces as compared to neutral faces showed the opposite direction. This result is hard to interpret; however, research has reported such a dissociated effect for neutral stimuli (Vrana & Gross, 2004). It is not clear whether the dissociation found between overt and covert expressions for neutral and sad faces is a specific effect, or whether it is an artefact due to socially desirable responses. Moreover, for the high tinnitus severity group, strange relations with valence ratings emerged. All negative stimuli were rated as more pleasant and the positive stimuli rated as more unpleasant when the tinnitus severity complaint was higher. Valence ratings tend to covary with HR, whereas arousal ratings covary with SCR (Bradley et al., 2001; Lang et al., 1997; Lang et al., 1998; Lang et al., 2000). The latter implies that for the high tinnitus severity group, HR response is dissociated from overt expression (ratings). For loudness, however, this dissociation was not found. Nevertheless, while such dissociations between ratings and physiological responses are often found in anxiety-related conditions (Cook et al., 1988; Öhman, 2008), they are also found in other conditions, such as psychopathy (Levenston et al., 2000). Although these relations were specifically true for the high tinnitus severity group, future research should examine whether this is a specific effect.
Conclusion

Overall our results indicate that: 1) Tinnitus severity and anxiety are highly related on the subjective level, and that 54.9% of our sample reported high and very high levels of trait anxiety, which indicates the clinical relevance of trait anxiety in a tinnitus population: 2) Tinnitus severity was marginally significant in its relation to greater SCR prompted at base: 3) In the high tinnitus severity group, tinnitus severity was significantly related to less SCR and more HR deceleration towards angry and sad faces, and greater SCR to neutral faces: 4) Audiological characteristics are indirectly relevant in relation to anxiety and thus the subjective tinnitus complaint. In particular, loudness emerged as an important variable, with greater reactivity towards fearful faces. 5) For the high tinnitus severity group dissociations between overt and covert expressions were found.

Taken together these results indicate that there is evidence that tinnitus severity reflects a complex interaction between a fear- and an anxiety-related problem, whereas the audiological characteristic ‘loudness’ reflects a fear-related problem. These observations are consistent with Jastreboff’s (1995) theoretical model, were it is argued that anxiety is important as a causal factor of tinnitus severity and as a consequence of the tinnitus symptom itself whereby a vicious circle in the experienced tinnitus severity is created.

Limitations of this study concern the substantial loss of data, which consequently led to a loss of statistical power. This may have caused the non-significant results found, particularly for the correlations with HR. Furthermore, the low amount of stimuli used (2 fearful faces, 2 angry faces, 2 sad faces, 6 happy faces, and 6 neutral faces) could have distorted our findings. It is possible that physiological responses were elicited by specific pictures and not by the specific emotions (Stern et al., 2001). Neutral faces elicited greater physiological responses, which could have distorted our results. It is questionable as to whether this is specific for tinnitus patients or whether it is a consequence of the choice of stimuli. However, research within the psychophysiological domain has made use of facial emotion pictures (Dimberg, 1997; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) and these pictures have been found to be ecologically valid representations of emotions (Goeleven et al., 2008; Ladouceur et al., 2006; Whalen et al., 2001). Another limitation of this study is that we only made use of a self-report scale for anxiety, but not for fear. While future research should include such a scale, the fear reaction is implicitly measured via the THI (e.g., item 22: Does your tinnitus make you feel anxious?).

Although physiological measures have been used in tinnitus research (e.g., Heinecke, Weise, & Rief, 2009), to our knowledge, this is the first study to explicitly examine the nature of the anxiety problem observed in tinnitus patients while making use of multiple methods. We believe a complex pattern of
fear- and anxiety-related problems is reflected in the tinnitus severity complaint, while audiological characteristics, such as loudness, reflects a fear-related problem on a physiological level.
REFERENCES


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5. TINNITUS: A FEAR- OR AN ANXIETY-RELATED PROBLEM?


General conclusion and discussion:
Towards an understanding of the relationship between tinnitus severity and anxiety-related problems

This dissertation started from the observation that not all individuals experiencing tinnitus actually suffer with this symptom. The main factors held responsible for differences in this experienced severity are depression and anxiety. However, we observed that most studies on the relationship between tinnitus severity, depression, and anxiety are performed via self-report questionnaires. This method may be biased via shared method variance and content overlap. Moreover, we observed that the complexity of the anxiety concept is neglected in existing research, which may also be a result of the dominant use of self-report questionnaires in investigating the relationship between tinnitus severity and anxiety. Therefore, the aim of this dissertation was to carry out a more in depth investigation of the relationship between tinnitus severity, depression, and anxiety. In this final chapter we start by summarizing our main findings. Moreover, we note the lack of a theoretical framework for understanding ‘why’ some patients are more severely distressed by the perception of tinnitus, while others are not. We believe that Freud’s psychoanalytical theory on the mechanism of binding may provide such a framework. We therefore outline some of the foundational aspects of Freud’s theory on the psychical apparatus and the dynamics of mental functioning. Following this we put forward an interpretation of our findings and clinical experience in the light of this theory and we formulate an answer to the question as to why some tinnitus patients experience more anxiety and annoyance than others. Implications for treatment, limitations and directions for future research are considered.
OVERVIEW OF MAIN FINDINGS

In Chapter 1 of this dissertation we sketched out the historical and contemporary views on the tinnitus symptom. The starting point for this study was the observation that not all individuals experiencing tinnitus actually suffer with this symptom (Meikle et al. 1984; Meikle 2003; Davis & Rafaie 2000; Möller 2011a, 2011b, 2011c; Jastreboff 1990, 1995, 2011; Landgrebe & Langguth 2011a) and that the differences in experienced severity are not determined by the psychoacoustic characteristics of tinnitus (i.e., pitch and loudness) (Meikle et al. 1984; Meikle 2003; Jastreboff 2011). The main factors held responsible for the differences in the experienced severity are depression and anxiety (Hållström & Andersson 1991; Zöger et al. 2006; Belli et al. 2008; Crocetti et al. 2009; Landgrebe & Langguth 2011a, 2011b). However, we also found that there is a dearth of systematic research on the relationship between tinnitus severity, depression, and anxiety. A review of the existing literature on the relationship between these variables indicated that most studies are performed by means of self-report questionnaires (e.g., Folmer et al. 1999; Rutter & Stein 1999; Andersson et al. 2003; Belli et al. 2008; Crocetti et al. 2009; Hesser & Andersson 2009). We believe that this method may be biased via shared method variance and content overlap (see also Meyer et al. 2001). Moreover, although clinical practice, theory and research give an indication of a close relationship between anxiety-related problems and the experienced severity of tinnitus (e.g., Erlandsson & Archer 1994; Jastreboff 1990, 1995, 2011), studies on this relationship tend to neglect the complexity of the anxiety concept, which may be a result of the prevailing use of self-report questionnaires in investigating this relationship. We stated that self-report questionnaires only address the cognitive component of anxiety, but that, as theory and research indicate, the anxiety construct consists of different dimensions, different levels of processing and different disorders. In order to understand the relationship between tinnitus severity and anxiety, we believe that an investigation that incorporates the complexity of the anxiety construct in relation to the perceived severity of tinnitus is necessary and requires a multi-method approach.

Therefore, the aim of this dissertation was to investigate the relation between tinnitus severity, depression, and anxiety as measured via self-report questionnaires on the one hand, and the complexity of the anxiety concept via a multi-method approach on the other hand. By following this approach we took into account the possible influence of shared method variance and content overlap.

In Chapter 2, we started our investigation by studying the possible influence of content overlap and shared method variance in the often found association between tinnitus severity and depressive symptoms. With this aim, we used the two most widely used self-report questionnaires, the Tinnitus Handicap Inventory (THI) and the Beck Depression Inventory-II (BDI-II), to measure both constructs. Moreover, since research suggests that the severity complaint and other psychological problems are unrelated to audiological characteristics (pitch and loudness) of the tinnitus symptom, we also
explored these relationships without formulating specific hypotheses. To our knowledge, this is the first study to investigate whether the association between tinnitus severity and depressive symptoms can be explained due to shared method variance and content overlap. There we stated that before one can conclude that tinnitus is a problem related to depression, two conditions must be fulfilled. First, there should be evidence for clinically relevant symptoms in a substantial group of tinnitus patients, and second, there should be evidence of a substantial or ‘real’ relationship between depressive symptoms and tinnitus severity. To investigate the first condition, we used the cut-off scores given by the manuals for the THI and the BDI-II. Comparable to previous research (Rutter & Stein 1999; Andersson et al. 2003; Andersson et al. 2009; Crocetti et al. 2009), our results indicated that the tinnitus patients in our sample reported, on average, no or minimal depressive symptoms. Only a small proportion of our sample (16.2%, n=22) reported moderate or severe depressive symptoms. While some researchers (e.g., Dobie 2003) argue that only severely distressed tinnitus patients suffer from depression, we found that, of the patients with a severe tinnitus handicap (n=29), only 17.2% (n=5) also reported severe depressive symptoms. Furthermore, no patients with a catastrophic tinnitus handicap (n=11) reported severe depressive symptoms. These results indicate that depressive symptoms are not as widespread in tinnitus populations as generally assumed. Concerning the second condition, we found a positive relationship between tinnitus severity and depressive symptoms. However, exploration of the items of both questionnaires revealed a substantial amount of content overlap between the somatic depressive symptoms of the BDI-II and the items of the THI. A model with the THI as dependent variable and the subscales of the BDI-II (cognitive, affective and somatic) as independent variables revealed that only the somatic subscale of the BDI-II was significantly related to the THI. The results of this second condition indicate that the relationship that is often found between depression and tinnitus severity is most probably caused by the similarity of the items used to measure both constructs, rather than an actual relationship between them. Moreover, in line with other studies (Meikle & Walsh 1984; Halford & Anderson 1991; Holgers et al. 2003) we found no relationship between psychoacoustic measures of tinnitus symptoms and experienced tinnitus severity, indicating that audiological characteristics do not determine the handicap that is experienced because of tinnitus. We concluded that people answer consistently to similar items in the two questionnaires used, but that the relationship between tinnitus severity and depression seems to primarily result from shared method variance and content overlap. Therefore, as both conditions were not fulfilled, we believe that tinnitus severity is not a problem related to depression. Moreover, as discussed in the second part of Chapter 2, an inspection of the somatic depressive symptoms (e.g., fatigue, irritability, insomnia, exhaustion and concentration difficulties) revealed that the same symptoms can be found in post-traumatic stress disorder, acute stress disorder and generalized anxiety disorder, as described in the DSM-IV-TR (American Psychiatric Association 2000). In a letter to the editor, Langguth et al. (2011) disagreed with our conclusion, stating that the relation between tinnitus severity and depression
was merely a semantic issue. The second part of Chapter 2 contains our response to this letter where we outline why we disagree with such a statement.

Given the fact that substantial content overlap can not only be observed between tinnitus severity complaints and depressive symptoms, but also anxiety-related symptoms, in Chapter 3 we investigated the influence of shared method variance and content overlap in the relation between tinnitus severity and anxiety-related symptoms.

Apart from the possible influence of the confounding factors mentioned above, we argued that anxiety itself is not a single construct and consists of different dimensions, namely a cognitive, somatic and behavioural dimension. However, these dimensions are asymmetrically related to each other, in that patients may complain of anxiety without any increase of vegetative parameters, or conversely, may show an increase of autonomic arousal which is not experienced mentally as anxiety. We therefore stated that a multidimensional study of anxiety is important and could prevent false negative results. Such an approach is all the more important since a multidimensional approach is rarely employed in existing literature on the relation between tinnitus severity and anxiety-related problems. Consequently, in addition to studying the possible influence of shared method variance and content overlap in the relationship between tinnitus severity and anxiety-related symptoms, a measure of the somatic dimension of anxiety was included. The measures used in Chapter 3 include the THI, which measures tinnitus severity complaints; the State and Trait Anxiety Inventory (STAI), which measures the cognitive dimension of anxiety, and a list of somatic anxiety symptoms, which was based on the somatic anxiety symptoms of Panic Disorder as described in the DSM-IV-TR (American Psychiatric Association 2000). Relationships between the severity complaint, cognitive and somatic anxiety, and audiological tinnitus characteristics (pitch and loudness) were explored without formulating a specific hypothesis. The same primary conditions outlined in Chapter 2 were applied, where we stated that before a conclusion on the relationship between tinnitus severity and anxiety-related problems can be drawn, a) there should be evidence of clinically relevant symptoms in a substantial group of tinnitus patients, and b) there should be evidence of a substantial or ‘real’ relationship between cognitive and somatic anxiety symptoms and tinnitus severity. Cut-off scores reported in the manuals of the THI and STAI, and the cut-off score given for panic attack in the DSM-IV-TR, were used to investigate our first condition. The results indicated that 56.3% \((n=40)\) of our sample reported high to very high state anxiety, and 59.2% \((n=44)\) high to very high trait anxiety. Thus, next to an anxious reaction to their current situation (i.e., state anxiety), patients tend to have an overall anxious disposition and attitude (i.e., trait anxiety). Moreover, 40.8% \((n=29)\) reported clinically relevant somatic anxiety symptoms. We concluded that our first condition is met, namely that cognitive and somatic anxiety must be clinically relevant. Concerning our second condition, we found positive correlations between the THI and the STAI and between the THI and somatic anxiety symptoms. However, content overlap between
items of the THI and items of the STAI was observed, which was not the case between the THI and somatic anxiety symptoms. To investigate whether the relationship found between the THI and the STAI would still exist after removing overlapping items, three researchers familiar with the subject independently rated overlapping items. After removal of the rated overlapping items of the THI, the results indicated that the magnitude of the correlation dropped slightly, but remained significant and within the same effect size range. Similar to the findings in Chapter 2, no relationships between tinnitus severity, cognitive and somatic anxiety and audiological characteristics were found. Audiological characteristics do not determine the handicap that is experienced because of tinnitus, nor are audiological characteristics associated with anxiety-related distress (see also Meikle et al. 1984). We concluded that both primary conditions are met and that both cognitive and somatic anxiety are relevant problems in a tinnitus population, which contribute to the experienced severity of the complaint.

The complexity of the anxiety construct was further taken into account in the following chapters, where multi-method designs were used. Next to assessing conscious appraisals of anxiety, we aimed at mapping underlying anxiety-related processing mechanisms via the application of the Affective Priming Paradigm of Fazio et al. (1986) in Chapter 4. Studies have demonstrated that high levels of anxiety have an influence on the direction and the strength of affective priming effects (Dannlowski et al. 2005; Li et al. 2008) and that stronger priming effects are specifically provoked by threat-related primes (Li et al. 2008). Therefore, we investigated whether tinnitus severity would be related to the automatic processing of threatening information. Furthermore, we explored whether such a relation could be found in the total sample, or whether it would be specific to those with high tinnitus-severity complaints. Additionally, relationships with audiological characteristics (pitch and loudness) were checked and we controlled for the possible influence of hearing loss in the severity complaint. In terms of the total sample, the results indicated that tinnitus severity was negatively related to the priming effects of pleasant stimuli (i.e., happy faces). Only after controlling for (normal and high frequency) hearing loss, a positive association could be observed between tinnitus severity and the priming effect of fearful stimuli (i.e., fearful faces). At the level of the total sample, our hypothesis could not be fully confirmed. Moreover, a marginal significant correlation was found between the audiological characteristic, loudness, and the priming effect of fearful stimuli (i.e., fearful faces). The negative relation between the priming effect of pleasant stimuli and tinnitus severity may give an indication of the impact of tinnitus on quality of life. Many patients often report a withdrawal from pleasant social activities as a result of tinnitus, as they experience difficulty following conversations and irritation by surrounding noise etc. This may lead to perceiving such activities as unpleasant and experiencing less positive emotion, which might explain why it takes longer for them to react to positive emotional stimuli as tinnitus severity increases. Alternatively priming effects to positive affective stimuli might indicate that distressed tinnitus patients feel more ambivalent about positive emotions, and thus take
longer to process them. We observed that only the priming effects of fearful stimuli, and not the priming effects of threat-related stimuli, where related to tinnitus severity (after controlling for hearing loss) and loudness. A possible explanation for this could be that tinnitus severity and loudness are accompanied specifically with a fear reaction in memory. The latter interpretation is consistent with what I learned in clinical practice, where patients typically indicate that they are afraid that the tinnitus and specifically the loudness might get worse. In a next step, we divided our sample into a high and low tinnitus severity group. The results revealed that in the high scoring group tinnitus severity was positively related to threatening information (i.e., fearful and angry faces) and negatively related to positive emotion stimuli (i.e., happy faces), while no relationships were found in the low scoring severity group. After controlling for (normal and high frequency) hearing loss, these correlations even turned out to be stronger. The results for the severely distressed tinnitus severity group are in line with our hypothesis and with previous studies on highly anxious individuals (Dannlowski et al. 2006; Li et al. 2008). We concluded that our findings suggest that, particularly in highly distressed tinnitus patients, symptom severity is an anxiety-related problem on an automatic processing level, which is independent of the amount of hearing loss. Moreover, we stated that the audiological characteristic “loudness” also tends to be in some degree an anxiety-related problem. However, we argued that future research needs to confirm the obtained results and should focus on the directionality between anxiety and tinnitus severity.

Therefore, in Chapter 5, we attempted to shed light on the direction of the relation between the tinnitus severity complaint and anxiety-related problems. As previously discussed, anxiety disorders are often divided into fear-related disorders (e.g., phobia) and anxiety-related disorders (e.g., Generalized Anxiety Disorder) (e.g., American Psychiatric Association 2000). Whereas the emotional reaction in fear-related disorders are connected to a specific object, such an object is absent in anxiety-related disorders. Anxiety-related disorders are considered as a more general tendency to react with anxiety in many different situations. The difference between fear and anxiety has been demonstrated by psychophysiological research, a research domain employing autonomic responses (e.g., Heart Rate (HR) and Skin Conductance (SC)). When confronted with general threatening stimuli (e.g., fearful and/or angry faces), fear subjects tend to show autonomic responses consistent with the orienting response seen in normal control subjects, namely greater Skin Conductance Responses (SCR) and greater HR deceleration (Vrana & Gross 2004; Öhman 2008; Lang & McTeague 2009). This defensive reaction may be compromised in anxiety related disorders, since studies have indicated that anxiety disorders are primarily associated with high resting autonomic activity and less acute reactivity to general stressful, negative and threatening stimuli (Lang et al. 1998; Cuthbert et al. 2003 Lang et al. 2005; Öhman 2008; Lang & McTeague 2009). Moreover, research has indicated that the elevated autonomic responses during rest are not observed in normal controls or in subjects with specific phobia (Lang et al. 1998; Hoehn-Sarie & McLeod 2000; Öhman 2008). Therefore, in addition
6. GENERAL DISCUSSION AND CONCLUSION

to taking into account the cognitive dimension of anxiety, the physiological dimension (HR and SC) related to anxiety was also examined in this study. More specifically, we investigated whether tinnitus severity would be related to the autonomic responses as observed in fear- and/or anxiety-related disorders. Furthermore, we explored whether such relations could be found in the total sample, or whether it would be specific to those with high tinnitus-severity complaints. Possible relationships with audiological characteristics (pitch and loudness) were also explored. The results indicated that tinnitus severity was marginally significantly related to greater SCR at base in the total sample, meaning that as patients are more strongly bothered by tinnitus, arousal at base rises as well. We carefully interpreted that tinnitus severity may be an anxiety-related rather than a fear-related problem, since this result resembles the pattern observed in populations with an anxiety-related condition (e.g., Hoehn-Saric & McLeod 2000; Öhman 2008). In a subsequent step we examined relationships between tinnitus and physiological responses to facial emotion pictures. For the total sample the results showed that as tinnitus severity increases, less SCR and greater HR deceleration was prompted by angry faces. Thus angry faces attract more attention as indicated by greater HR deceleration, but elicited less autonomic activation as indicated by diminished SCR. This finding is also consistent with findings in anxiety-related conditions, where threatening stimuli seem to elicit diminished autonomic reactivity (Cook et al. 1988; Lang et al. 1998; Hoehn-Saric & McLeod 2000; Lang et al. 2000; Bradley et al. 2001; Lang & McTeague 2009). Next to the relation with this threatening stimuli (angry faces), a relation between tinnitus severity and the autonomic reaction to negative stimuli (sad faces) was also found. This was, however, an unexpected finding, since our general results indicated that sad faces prompted significantly less SCR than neutral faces. This result is incongruent with normal findings in a picture viewing context. In general, greater SCRs are found towards pleasant and unpleasant stimuli as compared to neutral stimuli (Lang et al. 1993; Stern et al., 2001; Vrana & Gross 2004). However, it is questionable as to whether sad stimuli failed to elicit the normally observed SCR or whether neutral stimuli elicited more than normal SCR. Considering the latter proposition, Vrana and Gross (2004) found that neutral faces are not significantly different from angry faces for SCR and HR, even while subjects rated neutral expressions as affectively neutral. These researchers argued that neutral facial expressions are more difficult to decode and are sometimes rated negatively because they are ambiguous and uncommon, which may elevate the potential for non-reward or punishment. Moreover, Vrana and Gross (2004) found that these greater physiological responses to neutral and angry faces could only be found in a high fear group, but not in the low fear group. In terms of our own study, we stated that this could mean that in our sample neutral faces, in spite of the affectively neutral ratings, prompted greater SCR, which may point in the direction of a fear-reaction to neutral faces. However, it remains possible that sad faces didn’t prompt the necessary SCR, or that reactivity was diminished, which could reflect a reaction pattern observed in anxiety-related conditions. Nevertheless, we believe both processes were at work and that this result may reflect a fear- as well as an anxiety-related response. Moreover, we found that these relationships were specifically true for the high tinnitus
severity group, since no relationships were observed in the low tinnitus severity group. For the audiological characteristic loudness, a significant relation with SCR prompted by fearful faces was observed, indicating that as patients experience more loudness, reactivity towards fearful faces becomes higher. A possible explanation as to why only fearful faces are related to loudness and not threat-related stimuli in general could be that loudness may be associated with a fear reaction in memory, which, as indicated above, is consistent with verbal reports in clinical practice, where patients report being afraid that the loudness might get worse. We concluded that our results indicate that tinnitus severity reflects a complex interaction between fear- and anxiety-related reactions, whereas the audiological characteristic, loudness, reflects a fear-related reaction. Thus, anxiety may be an effect of the perception of tinnitus as well as a cause of the tinnitus severity complaint, which supports Jastreboff’s theoretical model (1990, 1995, 2004, 2011).

Overall, the results of our studies indicate that differences in the experienced severity of the tinnitus symptom are not related to depressive symptoms. Empirically observed relations between both variables may be regarded as an artefact due to the observed content overlap between the complaints of severely distressed tinnitus patients and depressive symptoms. We do not consider this just to be a semantic issue, since our sample lacked a substantial proportion of patients with clinically relevant depressive symptoms, thus supporting the idea that depression in tinnitus patients is not as widespread as generally assumed. However, future research should confirm our conclusion using other measurement and recruiting methods. Our results did indicate that tinnitus severity is related to cognitive and somatic anxiety-related symptoms, to conscious appraisal of anxiety, and to the automatic processing of threatening information, as observed in highly anxious subjects. Moreover, our results suggest that a complex pattern of anxiety as a cause and as an effect of the perception of tinnitus may be at work. The question as to how we can understand the complex relationship between tinnitus severity and anxiety-related problems urges itself upon us.

**TOWARDS AN UNDERSTANDING OF THE RELATIONSHIP BETWEEN TINNITUS SEVERITY AND ANXIETY-RELATED PROBLEMS**

As discussed throughout this dissertation, researchers postulate different hypotheses concerning the directionality of the relationship between tinnitus severity and anxiety-related problems. Some authors consider symptoms of anxiety as a consequence of the tinnitus perception (Halford & Andersson 1991; Crocetti et al. 2009). They describe the presence of anxiety as a reaction to a potentially threatening stimulus, which is considered to be the perception of tinnitus itself (Crocetti et al. 2009). Others focus on the role of anxiety in the experienced severity of tinnitus. Erlandsson and Archer (1994), for example, consider anxiety as one of the key factors in the psychological model of tinnitus tolerance or threat. They point to the role of anxiety as being part of a causal factor in the experienced tinnitus severity rather than an effect of the symptom. In a review
study these authors report findings to suggest that anxiety-related symptoms, such as irritability, inability to relax, and stress/tension, do not change significantly as a function of tinnitus duration and conclude that anxiety is a causal factor in tinnitus severity. Puel and Guitton (2007) also conclude that there is a strong relationship between anxiety and the perception of tinnitus: ‘Anxiety does not per se produce tinnitus, but it strongly exacerbates its perception’ (p. 145). Jastreboff (1995) combines these views in his neurophysiological model. According to this model tinnitus becomes a significant problem if the first experience of tinnitus induces a high level of annoyance or anxiety because it is associated with something unpleasant, or because it occurs during a period of stress and anxiety. If this is the case, higher levels of annoyance or anxiety link to the meaning of the new tinnitus sound. This results in an increase of activity in the autonomic and/or limbic system, as a result of which emotional reactions are enhanced (Jastreboff 1995, 2004, 2011). Finally, in early literature, tinnitus is not only considered an anxiety related problem but a somatic expression of anxiety (Hamilton 1959). Hamilton (1959), who developed an anxiety rating scale, namely the Hamilton Anxiety Rating Scale, which is still widely used in both clinical and research settings (Shear et al. 2001), considered tinnitus itself to be one of the (sensory) somatic anxiety symptoms (Hamilton 1959). Yet the reason why Hamilton viewed tinnitus as a somatic expression of anxiety remains unclear. In an article concerning the development of his rating scale, he merely states: “A series of symptoms were assembled which were considered to cover the condition adequately” (Hamilton 1959, p. 50).

Except for Hamilton’s conception of tinnitus, many other researchers have formulated hypotheses on the directionality between tinnitus severity and anxiety. However, we believe that such hypotheses do not explain why some patients experience more anxiety in the first place and/or consider the perception of tinnitus as something unpleasant, annoying or anxiety provoking, while other patients do not. Although, Jastreboff’s neurophysiological model (1995, 2004, 2011) may be the only model providing a theoretical framework on the relationship between tinnitus severity and anxiety-related problems, we believe that it still leaves the question as to why some individuals are more distressed than others partly unanswered.

In his model, Jastreboff states that some individuals will be distressed or feel anxious as a result of the tinnitus perception, because the meaning of the tinnitus perception is linked with higher levels of annoyance or anxiety. This link occurs due to an association between the tinnitus perception and something unpleasant, or due to a period of stress and anxiety before the onset of tinnitus. If this association occurs, it will result in enhancement of the autonomic and/or limbic systems and this enhancement will trigger more emotional reactions. Jastreboff moves on and states that “the limbic and autonomic systems are the main systems responsible for negative tinnitus-evoked reactions” (Jastreboff 2011, p. 575). However, by regarding these systems as the main systems responsible for negative tinnitus-evoked reactions, he seems to neglect his own formulated starting point, namely that
tinnitus becomes distressing due to the association between the tinnitus perception and an unpleasant or anxious meaning. Therefore, I believe that the mechanism of association or ‘binding’ between the perception of tinnitus and its given (unpleasant and/or anxious) meaning, is essential for understanding the differences in the perceived tinnitus severity among patients. Although we do not want to disregard the importance of the limbic and autonomic systems in negative tinnitus-evoked reactions, we suggest considering neurological structures as correlates of emotional states, rather than as (pure) causes of experienced emotions (Noë 2009; Keizer 2012). Thus, by arguing that the association or binding between the tinnitus perception and an unpleasant or anxious meaning is relevant in differences in the perceived severity among tinnitus patients, a theory on such a binding mechanism is necessary. We believe that Freud’s psychoanalytical theory on the mechanism of binding provides a relevant theoretical framework for addressing the question as to why some tinnitus patients experience more anxiety and annoyance than others.

A FREUDIAN THEORETICAL FRAMEWORK

In this section we outline Freud’s theory on the mechanism of binding, since we believe it may be relevant for an understanding of the tinnitus symptom. We start with a general introduction of this mechanism and briefly outline its dynamic relation to anxiety and symptom formation. In a second step, these components (the binding mechanism, anxiety, and symptom formation) will be discussed in more depth. Following this, Freud’s theoretical frame will be used as a guideline for an interpretation of our findings and we attempt to formulate an answer as to why some tinnitus patients associate the perception of tinnitus with something unpleasant or anxiety provoking, while others do not. Finally, implications for theory and management of the tinnitus symptom and its severity complaint are given.

The mechanism of binding and its dynamic relationships: general introduction

Ideas on the mechanism of binding [“bindung”] can be found throughout Freud’s theory on the psychical apparatus and on the dynamics of mental functioning. Although his theory on the psychical apparatus evolved over time, from a topographic model (Freud 1966 [1895], 1957 [1915a]) to a structural model (Freud 1961 [1923]), Freud maintained his general idea on binding throughout his entire work. According to Freud binding is a general operating mechanism, which lies on the crossroad of the psyche and the soma; its primary function concerns the transition of unrepresented somatic functioning to representation-based mental functioning (Freud 1966 [1895]). Denoting it as a general mechanism implies that it transcends the structural basis of neurosis, psychosis and perversion. It is a necessary mechanism which is present in everyone, as it leads to the capacity for consciousness and reflectivity through its connection to language. In other words, through the mechanism of binding, an individual becomes mental or psychical in nature.
According to Freud, mental or psychical functioning requires the linking (or binding) of free floating, unbound or somatic excitation to representations (or ideas) (1966 [1895]). When this process of binding is successful, arousal-related excitation is no longer purely somatic, but psychical and thus memory traces are created, which makes the excitation in part controllable for the subject. Although there will always be a part of the excitation left unbound, more radical failure in this process leaves the excitation in a free floating or somatic state, whereby the subject may be overwhelmed by such excitations, unable to master them and which creates feelings of helplessness (Freud 1966 [1895], 1959 [1926]). This feeling of helplessness is seen by Freud as an endogenous situation of danger which cannot be escaped (Freud 1959 [1926]), leading to (unmediated automatic) anxiety. He therefore considered the process of binding to be responsible for the transition from (unmediated) automatic anxiety (nowadays known as anxiety-related problems) to (mediated) signal anxiety (nowadays known as fear-related problems) (Freud 1959 [1926]; Verhaeghe 2004; Verhaeghe et al. 2007). Moreover, this process is inherently related to any kind of symptom formation ranging from actual neuroses to psychoneuroses (or the neuropsychoses of defense) (Freud 1959 [1926]).

This short sketch indicates that the mechanism of binding, anxiety, and symptom formation are closely related to each other. Below we will describe these innate processes in more detail. We start by discussing the mechanism of binding, which is the process of linking free floating, unbound or somatic excitation to representations (or ideas).

**Bindung**

Freud describes free floating, unbound or somatic excitation as a 'quota of affect' (Freud 1962 [1894]), which he considers to be a quantitative amount of affective energy, also named the Q-factor (Freud 1957 [1915b]). The quota of affect or Q-factor is regarded as the central characteristic of the drive, it refers to an inner rise of tension, to a pressure or an excitation that arises from within the body and therefore cannot be escaped (Freud 1957 [1915b]; 1959 [1926]). Freud states “…in mental functions something is to be distinguished – a quota of affect or some of excitation – which possesses all the characteristics of a quantity (though we have no means of measuring it), which is capable of increase, diminution, displacement and discharge, and which is spread over the memory traces of ideas somewhat as an electric charge is spread over the surface of the body” (Freud 1962 [1894], p. 60). Since one cannot escape this endogenous excitation, it must be bound to representations (or ideas). According to Freud, representations (or ideas) are mental expressions of somatic excitations. Freud divides these representations (or ideas) into thing- and word-representations, which are compositions of several related elements. Thing-representations are essentially sensory in nature, and consists of heterogeneous visual, acoustic, tactile, kinaesthetic and other sensory impressions (Freud 1957 [1915b]). They are the ground layer of the psyche and are generally unconscious, although they are not limited to the unconscious as they may also link with word-representations. Word-
representations, on the other hand, are regarded as the unity of the speech function and are linguistic representations that connect to the sensory thing representations. Word-representations are, according to Freud, essential, since they bring about consciousness and enable thought and reflecting (Freud 1957 [1915b]). The process of binding free floating excitations to representations integrates them into an associative network and makes them manageable for the subject (Freud 1957 [1915b]; 1959 [1926]). However, Freud also considered the process of binding to be fragile, because it is inherently connected to the experience of anxiety, which may lead to any kind of symptom formation ranging from actual neuroses to psychoneuroses (or neuropsychoses of defense) (Freud 1959 [1926]; 1962 [1895]). This brings us to the question as to how Freud conceptualized anxiety.

Anxiety

In his later work Freud compares anxiety with externally triggered fear that arises as a reaction to a situation of harmful external danger. However, he notes that external dangers are rare in daily life and thus he assumes that personal history and deep unconscious layers from the psychic apparatus must play a role in the triggering of anxiety (Freud 1959 [1926]). As he makes a parallel with reactions to external threatening situations, Freud argues that anxiety should always be thought of as a reaction to danger. According to Freud ‘a situation of danger’ must be seen as a feeling of helplessness. The feeling of helplessness, which will be experienced in relation to harmful external danger, can, according to Freud, also be triggered by internal factors. The main internal factor is the failure of the binding process, as a consequence of which, the subject is overwhelmed with endogenous excitation. Given the fact that escaping endogenous excitation is not possible, such failure at the level of binding results in anxiety, which is dominantly expressed at the level of the body. In Freud’s view this situation of being overwhelmed by endogenous excitation where escape is impossible makes up a traumatic experience (Freud 1959 [1926]). Moreover, he indicates that such abrupt failure of the process of binding is most characteristic for a specific class of neuroses, namely the actual neuroses and more specifically for the subclass of anxiety neurosis (Freud 1962 [1895]), which is discussed below. If, on the contrary, binding succeeds, the excitation is bound to representations and thus becomes manageable for the subject. However, the process of binding will never succeed ‘completely,’ there will always be some material left on a previous non-linguistic level, which according to Freud makes up the heart of the unconscious. He therefore considers anxiety to be a ‘normal’ affect in life. In general, anxiety is manageable because large quanta of affect are tied to representations. Indeed, if a person is confronted with a situation that is experienced as dangerous, he or she will build representations around the dangerous situation, which functions as a defence against it. Henceforth, the representation will function as a signal that alerts the individual against the imminent danger, as a result of which the situation can be avoided or fled and feelings of helplessness no longer overwhelm the subject (Freud 1959 [1926]). For example, when an individual is afraid of a
certain noise, he or she can avoid such noise, and as a result the unpleasant feeling provoked by the noise no longer debilitates the subject. In this way, we can understand why Freud stated that signal anxiety, which is a consequence of successful binding, is typical for the neuropsychoses of ‘defense.’ Individuals create a defensive reaction against an otherwise uncontrollable endogenous excitation. A specific form of such a defensive reaction is repression (Freud 1957 [1915c], 1959 [1926]), which is discussed below. According to Freud, symptom formation functions as a form of signal anxiety, which is a defensive reaction that cancels out the precarious experience of helplessness (Freud 1959 [1926]). It is through the formation of symptoms that the otherwise overwhelming excitations become manageable. Freud finds confirmation for this hypothesis in the observation that if one takes the symptom away too quickly anxiety appears (e.g., if one prevents a compulsion, such as hand washing, the patient will experience heightened anxiety) (Freud 1959 [1926]).

In our further discussion of Freud’s theory, we will only discuss his ideas on symptom formation with regard to anxiety and somatic symptoms and, more specifically, the anxiety neurosis as a variant of actual neuroses and conversion symptoms as a variant of psychoneuroses. This part of his theory is relevant for the topic of this dissertation.

**Symptom formation**

Early in his career Freud worked with patients suffering from somatic symptoms. This experience prompted him to introduce a differential diagnosis between actual neuroses and psychoneuroses. According to Freud, the common denominator of all actual neurotic symptoms is that they are a direct expression or discharge of accumulating somatic excitation that cannot be worked over psychically. Freud stated that “...the source of excitation, the precipitating cause of the disturbance, lies in the somatic field instead of the psychical one, as is the case in hysteria and obsessional neurosis” (Freud 1962 [1895], p. 114]. In actual neuroses, the mechanism of symptom formation takes place at the somatic level and can be understood as the direct expression of the excitation at the level of the body, which can also be experienced as (unmediated automatic) anxiety (Freud 1959 [1926]). The term ‘actual’ denotes the absence of symbolic defensive mediation and thus of binding (Freud 1962 [1894], 1959 [1926]). This absence of symbolic mediation is the reason why Freud stated that these problems are inaccessible to psychoanalytic treatment (Freud 1962 [1895]). Whereas in the psychoneuroses physical or somatic tension is translated into the psychic sphere, this is not the case in actual neurotic symptoms, where the physical or somatic tension is expressed at the somatic level.
At first Freud distinguished two variants of the actual neuroses, namely neurasthenia and anxiety neurosis (Freud 1962 [1895]), later adding hypochondria \(^1\) (Freud 1957 [1914]). Although Freud considered actual neuroses as distinct from psychoneuroses, he did not approach it as a categorical entity, but instead understood it on the basis of a continuum, with the psychoneuroses at the one extreme (e.g., phobia, conversion symptoms) and the actual neuroses at the other (i.e., neurasthenia, anxiety neurosis and hypochondria). Moreover, Freud noted that actual neurotic and psychoneurotic symptoms frequently appear together and proposed that all psychoneurotic symptoms contain an actual neurotic kernel (Freud 1959 [1926]).

The mechanism that constitutes the continuum between actual neurotic and psychoneurotic symptoms is thus the mechanism of binding. Regarding actual neurotic and psychoneurotic symptoms as extremes of this continuum implies that most symptoms can be situated somewhere in the middle, where a mixture between actual and psychoneurotic symptoms can be found. In the sections below, both extremes will be discussed. We start with a specific variant of the actual neuroses, namely anxiety neurosis, which we consider to be most important for the interpretation of differences in the experienced severity of the tinnitus symptom and which will be discussed in more depth below.

**Anxiety neurosis**

In 1895 Freud detached anxiety neurosis from neurasthenia \(^2\). Instead of fatigue or exhaustion, which was denoted as the main symptom in neurasthenia, anxiety neurosis was characterized by a preponderance of anxiety. According to Freud, the clinical picture of anxiety neurosis comprises specific symptomatology. The first symptom he refers to is (1) ‘general irritability.’ In this context, Freud states that "Increased irritability always points to an accumulation of excitation or an inability to tolerate such an accumulation-that is, to an absolute or a relative accumulation of excitation" (Freud 1962 [1895] p. 92). One specific manifestation of this increased irritability was ‘auditory hyperaesthesia,’ which is nowadays known as ‘hyperacusis’ and refers to hypersensitivity to noise. According to Freud, auditory hyperaesthesia has an intimate relationship with fright. Anxiety neurosis was also characterized as (2) an anxious state which is mostly latent as regards to consciousness, but is

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\(^1\)As hypochondria was understood by Freud as a psychotic variant of actual neurosis we will not discuss it further here.

\(^2\)Characteristic symptoms of neurasthenia are fatigue, headaches, neuralgia, dizziness, and depression. It was a popular diagnosis in Europe at the end of the nineteenth and the beginning of the twentieth century (Wessely 1990; Schäfer 2002). The term was first used by George Miller Beard in 1869 and is still a recognised diagnosis in the World Health Organization’s International Classifications of Diseases (ICD) as well as in the Chinese Classification of Mental Disorders (CCMD), translated as ‘shenjing shuairuo’. It is, however, no longer included as a diagnosis in the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders (DSM). Instead neurasthenia appears within the classification of chronic fatigue syndrome or fibromyalgia (Wessely 1997; Schäfer 2002).
constantly lurking in the background. Freud describes this ‘general anxious expectation’ as “[a] quantum of anxiety in a freely floating state, which, where there is expectation, controls the choice of ideas and is always ready to link itself with any suitable ideational content” (Freud 1962 [1895] p. 93). Freud regarded this anxious expectation as a tendency to take a pessimistic view of things, which is frequently recognised by the patient as a kind of compulsion. While one form of anxious expectation concerns the subject’s own health, it must not be confused with hypochondria. Next to this ‘general anxious expectation,’ Freud refers to (3) the ‘anxiety attack,’ which concerns the sudden break through of anxiety into consciousness without being aroused by the train of ideas. An anxiety attack may consist of the feeling of anxiety with no associated idea, or may be accompanied by the interpretation that is nearest to hand, for example the extinction of life, ideas of a stroke, or the threat of madness. Such feelings may also be linked to a sense of disturbance in one or more bodily functions. In these cases, patients may complain of spasms of the heart, difficulty breathing, outbreaks of sweating, ravenous hunger, etc. Alternatively, the feeling of anxiety may recede into the background and is more vaguely referred to by the patient as ‘being unwell,’ ‘feeling uncomfortable,’ and so on. Freud does not give a fixed list of interpretations because any interpretation of these bodily sensations is possible and depends on the personal context of the subject himself. This is a line of reasoning that Freud worked out in his theory on the principle of binding, where a quota of affect has no clear cut relation with a representation. (4) Freud states that “[the] proportion in which these elements (from point 3) are mixed in an anxiety attack varies to a remarkable degree, and that almost every accompanying symptom alone can constitute the attack as well as can the anxiety itself” (Freud 1962 [1895] p. 94). Freud proposed a continuum of rudimentary anxiety attacks and the somatic equivalents of anxiety attacks, suggesting that they possibly all have “the same significance, which exhibit a great wealth of forms that has yet been little appreciated” (Freud 1962 [1895b] p. 94). In terms of the somatic equivalents of anxiety attacks, Freud includes disturbances of the heart action; disturbances of respiration; attacks of sweating, tremor, and shivering; attacks of ravenous hunger; diarrhoea; locomotor vertigo; congestions; and paraesthesias. (5) Waking up at night is another symptom, of which Freud describes two forms: a) subjects wake up at night in fright which is usually combined with anxiety, dyspnoea, sweating and so on, and which he considers as a variant of an anxiety attack, and b) sleeplessness can be caused by auditory hyperaesthesia because of its innate relation with fright, where vigilance is a dominant factor. (6) ‘Vertigo,’ which is a symptom that can be mild, in the form of giddiness, or severe, which is described as ‘attacks of vertigo’ (with or without anxiety). Freud makes a differentiation between vertigo of the anxiety neurosis and Ménière’s vertigo. Vertigo of the anxiety neurosis is not rotatory nor does it affect certain planes or directions. It belongs to the class of locomotor or co-ordinary vertigo. It is a specific state of discomfort, accompanied by sensations of the ground rocking, of the legs giving way and of it being impossible to stand any
longer; while the legs feel as heavy as lead and tremble or the knees bend. Nevertheless, this form of vertigo never causes the individual to fall. (7) On the basis of chronic anxiousness (anxious expectation) two groups of typical phobias are discerned. The first relates to general physiological dangers (e.g., fear of snakes, darkness, thunderstorms, etc.), moral over-scrupulousness, or forms of doubting mania. The second group is related to locomotion, and more specifically, agoraphobia. For both groups of phobias, Freud stresses their difference from the phobias in psychoneuroses, stating:

What they have in common is that in both an idea becomes obsessional as result of being attached to an available affect. The mechanism of transposition of affect\(^4\) thus hold good for both kinds of phobia. But in the phobias of anxiety neurosis (1) this affect always has the same colour, which is that of anxiety; and (2) the affect does not originate in a repressed idea, but turns out to be not further reducible by psychological analysis, nor amenable to psychotherapy. The mechanism of substitution\(^5\), therefore, does not hold good for phobias of anxiety neurosis. (Freud 1962 [1895] p. 97)

(8) In anxiety neurosis digestive activities undergo characteristic disturbances. Sensations such as an inclination to vomit and nausea, the symptom of ravenous hunger, by itself or in conjunction with other symptoms (such as congestions), which give rise to a rudimentary anxiety attack. Analogous to anxious expectation, there is a chronic change where an inclination of diarrhoea and the need to urinate can be found. (9) Freud notes that several of the symptoms mentioned can accompany or take the place of an anxiety attack, and can also appear in a chronic form. In this context, Freud states that “they are still less easy to recognise, since the anxious sensation which goes with them is less clear than in an anxiety attack” (Freud 1962 [1895] p. 98).

It is thus not surprising that anxiety neurosis is nowadays recognised in panic disorders and generalized anxiety disorders (Verhaeghe 2004; Verhaeghe et al. 2007), which are considered to be more or less objectless and thus less manageable than phobias (e.g., Rachman 1998). As indicated above, we believe that the anxiety neurosis, which is a consequence of a more radical failure of the binding mechanism, is relevant with regard to the disproportionate relationship between the perception of tinnitus and its experienced severity, which can be observed in some tinnitus patients. We will return to this point below. First, we discuss the other extreme of Freud’s continuum, namely symptom formation in the psychoneuroses or neuropsychoses of defense.

The concept of psychoneuroses appears very early in Freud’s work in his article on ‘The Neuro-Psychoses of Defense’ (Freud 1962 [1894]). As discussed above, this term must be understood as the

\(^4\) This transposition of affect is related to Freud’s theory on the principle of binding.

\(^5\) The mechanism of substitution is related to Freud’s theory on repression, which is discussed below.
opposite of ‘actual neuroses’ (Freud 1962 [1896], 1962 [1898], 1961 [1916-1917], 1959 [1926]). Symptoms of psychoneuroses are characterized by a symbolic expression of conflict, which is a result of a successful binding process and may function as a signal of anxiety. In this dissertation, we only discuss conversion symptoms for reasons clarified below.

The conversion symptom

The term ‘conversion,’ which originates from biology and anatomy, was used by Freud in his discussion of psychopathology to account for the “leap from a mental process to a somatic innervation” which he himself considered difficult to comprehend (Freud 1959 [1909], p. 232). He used this term for the first time in the case-history of Frau Emmy von N in Studies on Hysteria (Freud 1955 [1895a]), and in his article on The Neuro-Psychoses of Defense (Freud 1962 [1894]). In short, conversion is understood by Freud as a mechanism of symptom formation, which consists in a transposition, and attempted resolution, of a psychical conflict into somatic symptoms, which may be either of a motor (e.g., paralysis) or sensory nature (e.g., localised anaesthesia or pain). What differentiates conversion symptoms from actual neurotic phenomena is thus their symbolic basis: conversion symptoms are the expression of repressed ideas through the medium of the body.

Freud’s understanding of conversion is tied to his economic approach to psychopathology and the process of repression (Freud 1957 [1915c]), which he later formulates as a specific form of a defence reaction (Freud 1959 [1926]). In his article on ‘Repression’ (Freud 1957 [1915c]) Freud distinguished three phases: the return of the repressed, repression proper or after-pressure, and primal repression. The object of the repression proper consists of a quantity of affect which has already been attached to a representation, but for various reasons, has been rejected from consciousness. In other words, certain ideas come into contact with incompatible ideas and must be kept out of consciousness. The affective component of these representations shift to other – seemingly neutral – representations (e.g., sounds) and it is through this process that the return of what has been repressed can take place. The return of the repressed denotes the inherent failure of repression. The content which should be kept out of consciousness succeeds one way or the other to find its way back to consciousness.

The basis of repression is primal repression, which can be situated in the transition from not-linguistic to linguistic functioning, and which is equivalent to the process of binding. Freud hypothesized that during this transition some material is left behind at a previous level. The material that makes the transition is transposed to the level of mental representations and Freud calls the mechanism ‘conformation’ (‘Bejahung’). Henceforth, mental representations make up a defensive system against

\footnote{See the process of binding.}
that which is left behind. The quantity of affect\textsuperscript{7} which does not make the transition remains at a rudimentary level of expression, outside the field of mental representations. The nature of this leftover is not clear because of the lack of words. It concerns the drive\textsuperscript{8} and will never leave the subject unaffected. The latter implies that although the process of binding may succeed there will always be a failure to some degree, leaving the subject helpless. Symptom formation signals this helplessness, but is at the same time a defence against this helplessness, which is more manageable for the subject.

The place of the conversion symptom within Freud’s theory is as follows: the representative material which forms the anticathexis is what Freud calls the substitute representation. As mentioned above, repression is a mechanism which is doomed to fail. Because the anticathexis is made up of a substitute representation, nothing will be changed in the subject’s psychical economy and the conflict which formed the basis of the repression insists. In other words, the only change that has taken place is that the original representation has been changed into a substitute representation. Symptom and substitute representation overlap with each other. It is the substitute representation that continues to disturb the psychic economy in the form of a symptom. This symptom contains anxiety, but is due to its representative nature, at the same time a prevention against the feeling of helplessness. According to Freud conversion follows this process of repression, but instead of a representation, the body is affected via the process of conversion (Freud 1962 [1894], 1957 [1915c], 1955 [1895b]). In this way, we may understand that conversion symptoms are an expression of underlying anxiety (Freud 1959 [1926]).

**INTERPRETATION OF OUR RESULTS IN THE LIGHT OF THE BACKGROUND THEORY ON THE BINDING PROCESS**

In the previous section we discussed Freud’s theory on the mechanism of binding, and indicated how it is related to anxiety and symptom formation. We believe this theory provides a useful framework for the interpretation of our results, and more in particular for understanding why some patients associate the perception of tinnitus as something unpleasant or anxious generally. It is not our intention to ‘prove’ the correctness of this piece of Freudian theory, but we believe that the complexity of the anxiety concept, as used in our empirical studies (different dimensions, different levels of processing and different disorders), are consistent with Freud’s theory.

Freud’s theory helps us to understand why anxiety is often found in studies on (somatic and psychic) symptoms in general. According to Freud, anxiety and symptom formation are closely related. As discussed above, anxiety is a reaction to an internal and/or an external situation of danger. The

\begin{footnotesize}
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    \item[7] See our comments on the ‘quota of affect’, Q-factor or quantitative energetic factor.
    \item[8] See our comments on the binding mechanism.
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situation of danger always refers to the feeling of helplessness (Freud 1959 [1926]). As such, the appearance of a somatic symptom, for example, may provoke such feelings of helplessness, especially when there are no direct solutions or treatments available. On the other hand, most individuals are able to manage feelings of anxiety. According to Freud, the difference in anxiety management lies in the more abrupt failure of the mechanism of binding. In case of a more abrupt failure, the person may be confused, overwhelmed and in search for an answer that might take the intolerable feelings away. In this dissertation we found precisely this preponderance of anxiety. In Chapter 3, for example, we found that approximately 56% of the sample reported clinically relevant state anxiety, approximately 60% reported clinically relevant trait anxiety and approximately 40% reported clinically relevant somatic anxiety symptoms. Thus, next to a current state of anxiety (state anxiety), a substantial proportion of our sample reported high to very high levels of ‘trait’ anxiety, indicating that most patients generally react with anxiety throughout their lives. The high proportions of cognitive and somatic anxiety in our sample may give an indication that distressed tinnitus patients have a tendency towards what Freud denotes as anxiety neurosis, where anxiety is the main complaint. Patients may feel overwhelmed, helpless and experience somatic sensations which they cannot comprehend, represent, or control. The latter may indicate that as people are confronted with the perception of tinnitus, due to several possible underlying medical conditions, they react – as they generally do – with anxiety, the form of anxiety which is devoid of meaning, as seen in panic disorder and generalized anxiety disorder.

Moreover, one of the symptoms of anxiety neurosis is a ‘general anxious expectation,’ which Freud described as an anxious state which is mostly latent as regards consciousness, but is constantly lurking in the background and controls the choice of ideas. Freud didn’t reduce this expectation to the ‘unconscious,’ however, people will not always be aware of this tendency, which makes the application of an indirect measurement method relevant (see also De Houwer 2003; Wittenbrink 2007). In Chapter 4, we found that tinnitus severity is related to the automatic processing of threatening information, which is also found in highly anxious subjects (Dannlowski et al. 2005; Li et al. 2008). Moreover, we found that the relation between automatic processing of threatening information and tinnitus severity was especially true for severely distressed tinnitus patients. Nevertheless, we do not claim that this automatic processing is equivalent to Freud’s notion of ‘general anxious expectation.’ However, general anxious expectation may to some degree explain why the impact of automatic processing of threatening information increases in severely distressed tinnitus patients. Thus, this result might also indicate that severely distressed tinnitus patients have a tendency towards what Freud denoted as the anxiety neurotic position.

Freud’s theory clearly states that bodily symptoms may be interpreted in a specific threatening manner. Due to the lack in verbalization in affects (binding), patients try to understand bodily
6. GENERAL DISCUSSION AND CONCLUSION

sensations and interpret them with explanations nearest at hand (Freud 1962 [1895]). However, such fear-reactions must not be confused with the fear-reactions of the psychoneurotic position; the latter are full of ‘meaning.’ In this way we might better understand the results presented in Chapter 5, where we found that tinnitus severity is related to autonomic reactions as observed in anxious- and fear-related problems, which was again specifically true for highly distressed tinnitus patients. We do not consider this result as partly reflecting the phobic reaction as conceptualized in Freud’s theory, i.e., that the reaction would be full of ‘meaning.’ However, we do believe this result may reflect fear-reactions as described in the anxiety neurosis, which, according to Freud, are more or less meaningless.

The results of our studies seem to point in the direction of the importance of the anxiety neurotic position. We will supplement this hypothesis with some interesting observations. The first symptom Freud refers to in this context is ‘general irritability,’ where he notes one specific manifestation, namely the ‘auditory hyperaesthesia’ or hypersensitivity to noise. As indicated above, the contemporary concept for auditory hyperaesthesia is ‘hyperacusis.’ As discussed in our introductory chapter, hyperacusis occurs in 40% of tinnitus patients (Baguley 2003; Henry et al. 2005; Landgrebe & Langguth 2011b). Although little is known about the phenomenon of hyperacusis, research indicates that there are direct neurological connections between the central auditory system and the amygdale (Jastreboff & Hazell 1993; Jastreboff 2011; Landgrebe & Langguth 2011b). Such connections link emotions of fear and anxiety to specific or more general sounds, which is the mechanism that has been hypothesized to underlie hyperacusis (Jastreboff & Hazell 1993; Landgrebe & Langguth 2011b). Jastreboff (2011) argues that in case of accompanying hyperacusis, patients will be more distressed than when hyperacusis is absent. Moreover, he discusses that in case of hyperacusis, the unbearable sounds have no personal meaning. According to Jastreboff, such a personal meaning is present if patients have accompanying misophonia, which is a dislike of ‘certain’ sounds (Jastreboff 2011; Møller 2011d). We may interpret these phenomena with regard to Freud’s actual neurotic – psychoneurotic continuum. Patients with accompanying hyperacusis may be situated closer to the anxiety neurotic extreme, where the sensations are overwhelming and meaningless. According to Freud, hyperacusis is an expression of automatic anxiety itself, since it has an innate relationship to fright (Freud 1962 [1895]). Patients with accompanying misophonia, may be situated somewhere in the middle of the continuum, where there is, to some degree, a connection with the personal history of an individual patient. Following this line of reasoning, it may be possible to place accompanying phonophobia (e.g., fear of specific sounds) at the psychoneurotic extreme, where the phobia is full of personal meaning. In this case, the sounds refer to an underlying dangerous situation, but at the same time the phobia is a defence against it (e.g. Freud 1959 [1926]). Although, hyperacusis, misophonia and phonophobia are generally poorly understood, they all seem to be connected with
anxiety. We believe that Freud’s theory may offer a framework for an understanding of these phenomena.

Another interesting observation is the often reported sleeping difficulties by distressed tinnitus patients, who specifically report waking up at night. According to Freud, waking up at night is a symptom of anxiety neurosis, because of its innate relation with fright, where the dominant factor is vigilance (Freud 1962 [1895]). While sleeping difficulties should not be reduced to anxiety alone, we believe it might be a contributing factor in severely distressed tinnitus patients.

Overall, we believe that our results and observations may indicate that patients severely distressed by tinnitus reflect an anxious neurotic position. Yet, since Freud stated that actual neurotic and psychoneurotic symptoms are the extremes of a continuum, it is more correct to say that patients severely distressed tend towards an anxious neurotic position. According to Freud this position is a consequence of a more abrupt failure of the binding process. In other words, severely distressed patients may experience more difficulties with identifying and processing (or verbalizing) of affects (binding). Maybe here we can adapt Jastreboff’s statement, namely that ‘the perception of tinnitus is interpreted as unpleasant and/or anxious,’ to ‘the perception of tinnitus is “misinterpreted” by some patients. This adaptation then refers to the contemporary definition of panic disorder, where the latter is defined as ‘misinterpretations of bodily sensations’ (Clark 1986, 1997; Salkovskis 1996; Rachman 1998). As discussed above, panic disorder (and generalized anxiety disorder) may be a contemporary conception of the anxiety neurosis (Verhaeghe 2004; Verhaeghe et al. 2007).

While we believe that Freud’s theoretical framework may be useful for understanding the discrepancy between the perception of tinnitus and its experienced severity, we do not want to disregard the importance of biological and/or neurological factors. We therefore agree with Freud, who stated: “We never denied the significance of constitutional factors. We refuse a principle antithesis between both series of etiological factors, rather we assume a regular mutual manipulation in order to bring about the observed effect. The series, in which variable quantities of both factors appear combined, will have its extreme case” (Freud 1958 [1912], p. 98).

**GENERAL CONCLUSION AND IMPLICATIONS FOR TREATMENT**

Overall, this dissertation points at the importance of anxiety-related problems in patients suffering from the perception of tinnitus. While we do not suggest that depression is totally absent in a tinnitus population, we believe that depression may only be observed in extreme cases and that the tinnitus severity complaint will vary, mostly due to anxiety-related problems. Although other researchers have also indicated the importance of anxiety in the tinnitus severity complaint, they have
rarely taken the complexity of the anxiety construct into account. Moreover, while hypotheses on the relationship between tinnitus severity and anxiety have previously been formulated, no psychological theoretical framework has been put forward that would help us understand this relationship. While Jastreboff (1990, 1995, 2011) provides an overarching framework, it doesn’t sufficiently explain why some patients interpret the perception of tinnitus as something unpleasant and/or anxiety provoking, while others do not. We do not disregard the importance of neurological systems in the severity complaint; however, we believe that neurological signals are not the starting point. Moreover, if the association between the perception of tinnitus and the interpretation of the perceived sound is important, we stated that a psychological theory on this mechanism is necessary. Such a theory can be found in Freud’s work and until now his theory on the binding process is still regarded as important (Bucci 1997; Centonze et al. 2004, Verhaeghe et al. 2007; Green 2010; Aisenstein 2010).

In the light of this theory, our results may indicate that severely distressed tinnitus patients have a tendency towards an anxiety neurotic position. The latter implies that severely distressed tinnitus patients interpret tinnitus as an unpleasant or anxiety provoking experience, which is connected to general difficulties in verbalizing affects. Yet as Freud postulated a continuum, a more psychoneurotic position may also apply to tinnitus. Although we have no ‘empirical’ proof, our clinical experience suggests that this is the case, in that the perception of tinnitus itself can in some instances be a conversion symptom. I will illustrate this with a case from my own clinical practice. I will not give a detailed description of therapy sessions, but a general overview of a specific case example.

Patient x, we will call her “Jane”, who was referred to me by an ENT specialist, consulted me with a tinnitus complaint, which had appeared out of the blue three weeks prior to our first meeting. An ENT and audiological examination had not revealed any physical evidence of damage. An exploration of the patient’s personal situation revealed that her partner, who suffered from a terminal disease, had recently been informed that the treatment for this disease would be stopped, since it no longer had any effect. As no other treatments were available, the life of Jane’s partner would soon end. One day, after this message, Jane experienced tinnitus for the first time. When this coincidence was pointed out, she expressed surprise and stated that the tinnitus wasn’t constantly present; the tinnitus only appeared when being at home with her partner. Upon leaving the house, the tinnitus would stop, even in silent environments. Arriving at the front door of the house was enough for the tinnitus to re-appear. Jane tried several self-invented masking sounds that had helped to reduce her distress associated with the tinnitus. However, she had to change the masking sounds constantly, as they failed over and over again. In this context, tinnitus seems to have been an expression of an underlying conflict that concerned Jane’s way of dealing with the death of the partner.
This clinical vignette may indicate that, in some patients, tinnitus can be a conversion symptom, which is full of meaning and forms a defence reaction against an underlying unbearable conflict.

In general, we believe that tinnitus can take any position on Freud’s actual neurotic – psychoneurotic continuum, and in this respect, certain recommendations for the treatment of tinnitus can be formulated. Firstly, we believe that our analyses indicate the importance of psychological treatment in tinnitus patients. As found by Cima et al. (2012), including long term psychological treatment has proved to be better than the usual treatment protocol that does not include psychological treatment. However, in the study of Cima et al. (2012), the effect of various treatment techniques was not investigated. Therefore, a comparison of different psychological treatments and their respective effects would be a challenge for future research. Secondly, we believe that our analyses reflect the importance of the personal (medical and psychological) history of an individual patient, which should be taken into account in the treatment of tinnitus patients, as previously indicated by Fowler and Fowler (1955). In other words, treatment should not only focus on the symptom, but take the personal context of the individual patient into account. If, for example, the personal context of a patient indicates the possibility that the tinnitus is a conversion symptom, abruptly tackling the patient’s perception of tinnitus via sound therapy or cochlear implants, for instance, may in fact exacerbate the patient’s anxiety. In this respect, we refer to an observation of Prof. dr. Bart Vinck, mentioned in a personal communication. Audiological tests are usually performed to explore whether or not masking sounds would provide relief for certain patients, since such sounds may take the perception of tinnitus away. However, in some patients where the masking sound alleviates the tinnitus, anxiety emerges. Indeed, as Freud (1959 [1926]) remarked, symptom formation is useful for an individual, as it forms a defence against something unbearable. Taking this defence away will lead to anxiety (Freud 1959 [1926]). Moreover, taking Freud’s continuum and thus the importance of an individual history into consideration, standardized treatment protocols should be avoided. Jastreboff (1990, 1995, 2011), for example, states that the first advice that should be given to tinnitus patients is ‘to avoid silence,’ as it could trigger neuroplasticity and worsen tinnitus. Although this may indeed be true for some patients, it does not account for all tinnitus patients. Clinical practice suggests (e.g., Jane) that some patients don’t experience tinnitus at all in silent environments. We believe that such advice may even create a fear reaction itself, i.e., they will not be afraid of sounds, however they may become afraid of the absence of sounds.

Overall, we believe that Freud’s theory may be useful in understanding why some tinnitus patients interpret the perception of tinnitus as something unpleasant and/or anxiety provoking, which points to the underlying difficulties in identifying and processing (or verbalization) of affects and has to be situated on a continuum. In this way, we can also understand why Hamilton regarded tinnitus to be a somatic expression of anxiety itself (Hamilton 1959).
LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The studies presented in this dissertation have a number of shortcomings. First of all, there was a loss of data due to the numerous techniques used. Psychoacoustic measures failed in a substantial portion of our sample due to the difficulty certain patients experienced in matching the pitch and loudness of their tinnitus. Yet no differences were found between the group of patients where audiological measures succeeded with regard to age, sex and mean duration of the perception of tinnitus, and the group where these measures failed. Data was also lost in relation to the affective priming technique. Some patients were unable to complete the experiment due to inadequate computer knowledge. Others were excluded, as they were indentified as outliers. Autonomic measures, particularly Heart Rate (HR), used in Chapter 5 failed in a substantial part of our sample. In other instances data were excluded due to excessive movement during the psychophysiological recording. Thus, at certain instances, the small sample sizes may have limited the generalizability of our findings. That is, the samples may have been too small to be representative for the population they were drawn from. Small samples sizes also mean that detecting correlations is more difficult, since significant results are not easily reached, which may have been a particular limitation for Chapter 5. Despite this problem, we believe that meaningful relationships were detected in our studies and that given the observation that a number of findings were consistent with the results of previous studies, the possibility that our results were obtained by chance is less likely.

Secondly, the use of only one self-report scale for depressive symptoms, anxiety-related symptoms and the tinnitus severity complaint may be regarded as a limitation. Future research should investigate whether similar conclusions regarding the problem of content overlap would be reached for other self-report questionnaires. Moreover, in Chapter 3, a new list for somatic anxiety symptoms was developed since, to our knowledge, no self-report instruments exist that provide good coverage of somatic anxiety symptoms. While the instrument developed was not extensively tested, we believe that it adequately reflects the somatic dimension of anxiety, as it is based on the generally accepted symptoms of somatic anxiety described in the DSM-IV-TR (American Psychiatric Association 2000).

There were a number of limitations in the study presented in Chapter 4. Firstly, we interpreted the affective priming effects via network theory and the idea of spreading of activation. This theory is contested by some authors (Klauer & Musch 2003). Another explanation for priming effects is the stroop mechanism, where automatic and strategic components reflect priming effects (Klauer & Much 2003). However, in our interpretation the notion of spreading of activation and the stroop mechanism are not opposed to each other. As Fazio (2001) argues, rather than opposing each other, these theories are complementary. Moreover, we did not make use of a masking procedure to overcome the possibility of strategic responding (Klauer & Much 2003), which puts the ‘automaticity’ of our results...
into question. However, this cannot explain the different priming patterns associated with tinnitus severity, since strategic responding can be considered to have the same impact for the whole sample. As we did not replicate our experiment, it remains possible that the results were obtained by chance. On the other hand, it was the first study on automatic processing of affective information with a tinnitus population, and our results fit the clinical observation.

The low amount of stimuli used in the study presented in Chapter 5 may have distorted our findings. It is possible that physiological responses were elicited by specific pictures and not by the specific emotions (Stern et al. 2001). Neutral faces in this study elicited greater physiological responses, which may have distorted the results found. It is questionable as to whether this is specific for tinnitus patients or whether it is a consequence of the choice of stimuli. However, research within the psychophysiological domain has made use of facial emotion pictures (e.g. Dimberg 1997; Vrana & Gross 2004) and these pictures have been found to be ecologically valid representations of emotions (Whalen et al. 2001; Ladouceur et al. 2006; Goeleven et al. 2008). Moreover, in this study we did not use a self-report scale for fear, which may be another limitation of the study presented. Nevertheless, the fear reaction was implicitly measured via the THI (e.g., item 22: Does your tinnitus make you feel anxious?).

Finally, not all studies, with exception of the study presented in Chapter 4, included the possible influence of hearing loss and none of the studies included the possible influence of hyperacusis. However, since we lost a certain amount of data due to the inability of some patients to perform audiological tests, the resultant loss of statistical power could distort instead of reveal meaningful results.

Despite these limitations, we believe that the strength of this study is its multi-method design performed in a clinical population. Yet, as indicated in our discussion, we also believe that Freud’s theory indicates the need to acknowledge the personal history of each patient. Such context variables may influence the results of empirical research, as indicated by Markova and Berrios (2009). These authors argue that mental symptoms are unstable constructs and cannot be considered as stable ‘objects’ with clear definitions, structures, meanings, etc.. Mental symptoms will vary in the context of an individual patient, in interactions between the patient and the practitioner, in the time frame, the type of society, etc. Regarding mental symptoms as unstable constructs will inevitably have implications for both research and theory (Markova & Berrios 2009). We therefore believe that several pathways for future research concerning the tinnitus symptom are indicated. As discussed above, the outcome of various treatments could be examined and compared to one another. We believe that the best way to do this is via single case-process therapy studies, where personal context variables can be taken into account. Moreover, such a method could further explore whether the tinnitus symptom can,
in some cases, be classified as a conversion symptom. Another interesting approach would be the integration of qualitative research, in which tinnitus patients with varying severity complaints are compared to each other based on their personal stories concerning the onset of tinnitus, the complaints they experience and the experienced emotional problems. Such comparisons could be done by using thematic analysis, which could further investigate whether our hypothesis, that the severity of tinnitus reflects an anxiety neurotic position, can be confirmed. Moreover, since we centralize the continuum actual neuroses – psychoneuroses, future research should investigate the body-mind and the mind-body dialect in relation to the tinnitus symptom.
REFERENCES


6. GENERAL DISCUSSION AND CONCLUSION


TINNITUS EN DE SUBJECTIEVE KLACHT: EEN MULTIMETHODISCH ONDERZOEK

Het doel van deze doctoraatsverhandeling luidt dan ook het in rekening brengen van deze beïnvloeding van gedeelde methode-variantie en overlappende inhoud tussen meetinstrumenten. Dit doen we enerzijds door de relatie tussen de ervaren tinnitus ernst, depressie en angst zoals gemeten via zelfrapportage vragenlijsten te onderzoeken, en anderzijds door de complexiteit van angst aan de hand van een multimethodische aanpak in het onderzoek te betrekken.

**BELANGRIJKSTE RESULTATEN**

In hoofdstuk 2 starten we met een studie naar de vaak gevonden associatie tussen de ervaren tinnitus ernst en depressieve symptomen. Om de mogelijke invloed van gedeelde methode-variantie en overlappende inhoud tussen de gehanteerde meetinstrumenten na te gaan, maken we gebruik van twee zelfrapportage vragenlijsten voor het meten van beide constructen, namelijk de Tinnitus Handicap Inventaris (THI) en de Beck Depressie Inventaris-II (BDI-II). Indien tinnitus een depressie gerelateerd probleem is, moet er volgens ons aan twee voorwaarden voldaan worden. Ten eerste, moet er evidentie zijn voor de aanwezigheid van klinisch relevante depressieve symptomen in een substantiële groep tinnitus patiënten; en ten tweede moet er evidentie zijn voor een substantiële of ‘echte’ relatie tussen depressieve symptomen en de ervaren tinnitus ernst. Uit de resultaten van ons onderzoek blijkt dat er aan beide voorwaarden niet wordt voldaan. Er is geen substantiële groep tinnitus patiënten met klinisch relevante depressieve symptomen, en de gevonden relatie blijkt volledig gedetermineerd te zijn door overlappende items van de BDI-II en de THI. Mensen antwoorden wel consistent op de gelijkende items van de twee vragenlijsten, maar de relatie tussen depressieve symptomen en de ervaren ernst van tinnitus is, in de eerste instantie, een gevolg van gedeelde methode-variantie en inhoudelijke overlap tussen de vragenlijsten.

We concluderen dat depressie geen wijdverspreid probleem is in een tinnitus populatie. Volgens ons is tinnitus dus geen depressie gerelateerd probleem.

Op bovenstaande conclusie kwam er reactie van Langguth et al. (2011) in de vorm van een brief aan de editor. In deze brief gaven de auteurs aan dat ze het oneens waren met ons besluit. Volgens hen zijn depressieve symptomen wel degelijk aanwezig en is de relatie tussen de ernst van tinnitus en depressieve symptomen slechts een semantische kwestie. In een antwoord op deze brief (deel 2 van hoofdstuk 2) beargumenteren we waarom we het oneens zijn met hun stelling.

Omdat inhoudelijke overlap niet alleen geobserveerd kan worden tussen de ervaren ernst van tinnitus en depressieve symptomen, maar ook tussen de ervaren ernst van tinnitus en angst gerelateerde symptomen, onderzoeken we in hoofdstuk 3 de mogelijke invloed van gedeelde methode-variantie en inhoudelijke overlap in de relatie tussen de ervaren tinnitus ernst en angst gerelateerde symptomen. Onafhankelijk van deze mogelijke invloed van bovenstaande beschreven factoren, argumenteren we tevens dat angst geen enkelvoudig construct is, maar uit verschillende dimensies bestaat, namelijk een
cognitieve, somatische en gedragsdimensie. Daarenboven blijkt dat deze dimensies asymmetrisch met elkaar verbonden zijn (bv. sommige mensen ervaren angst, maar vertonen geen verhoogde vegetatieve parameters of mensen vertonen een verhoogd arousal niveau, maar ervaren geen angst). Ter preventie van mogelijke vals negatieve resultaten stellen we dus dat een multidimensionele studie van angst belangrijk kan zijn. Des te meer omdat deze aanpak zelden kan teruggevonden worden in de bestaande literatuur over de associatie tussen de ervaren tinnitus ernst en angst gerelateerde problemen. Daarom nemen we in hoofdstuk 3 de cognitieve en somatische dimensie van angst op. De cognitieve dimensie wordt gemeten aan de hand van de zelfbeoordelingsvragenlijst (ZBV). Voor de somatische dimensie van angst maken we gebruik van een lijst met somatische angstsymptomen, gebaseerd op de symptomen van ‘paniekstoornis’ zoals vermeld in de Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association 2000). Om na te gaan of de ernst van tinnitus een (cognitief en / of somatische) angst gerelateerd probleem is, formuleren we dezelfde twee voorwaarden uit hoofdstuk 2, namelijk a) er moet sprake zijn van klinisch relevante angst gerelateerde symptomen in een substantiële groep tinnitus patiënten, en b) er moet een substantiële of ‘echte’ relatie zijn tussen de ernst van tinnitus en angst gerelateerde problemen. Onze resultaten wijzen uit dat aan beide voorwaarde wordt voldaan. Zo rapporteert meer dan de helft van onze steekproef klinisch relevante (cognitieve) angst gerelateerde symptomen en bovenop een actuele angstige toestand is er ook sprake van een algemene angstige dispositie en attitude. Daarenboven rapporteert zo’n 41% van onze steekproef klinisch relevante somatische angstsymptomen. Na correctie voor de overlappende inhoud tussen de vragenlijsten, blijft deze relatie tussen de ernst van tinnitus en angst gerelateerde symptomen in dezelfde grootorde bestaan.

We concluderen dat zowel cognitieve als somatische angst gerelateerde symptomen belangrijk zijn in een tinnitus populatie en een invloed hebben op de ervaren ernst van tinnitus.

In de volgende hoofdstukken onderzoeken we de complexiteit van angst in relatie met de ervaren ernst van tinnitus en maken we gebruik van een multimethodisch design. Naast een bewuste verwerking, blijkt angst ook beïnvloed te worden door een automatische verwerking. In hoofdstuk 4 onderzoeken we de verschillende verwerkingsniveaus van het angstconcept in relatie tot de ervaren ernst van tinnitus. Studies hebben aangetoond dat angst een invoel heeft op het automatisch verwerken van affectieve en voornamelijk bedreigende informatie (Dannlowski et al. 2005; Li et al. 2008). Daarom gaan we in deze studie na of de ernst van tinnitus gerelateerd is aan het automatisch verwerken van bedreigende informatie. Voor het meten van de automatische verwerking van affectieve informatie maken we gebruik van het Affectieve Priming Paradigma van Fazio et al. (1986). Voorts exploeren we of deze vorm van verwerking voor alle tinnitus patiënten geldt, dan wel specifiek is voor mensen die ernstige hinder van tinnitus ervaren. Relaties met de audiologische karakteristieken van tinnitus en gehoorverlies worden gecontroleerd.
Onze resultaten geven aan dat vooral bij patiënten die ernstig gehinderd worden door tinnitus, de ernst van tinnitus gerelateerd is aan het automatisch verwerken van bedreigende informatie. Dit resultaat is in overeenstemming met onderzochtersresultaten bij hoog angstige mensen (Dannlowski et al. 2005; Li et al. 2008). Voorts vinden we dat de audiologische karakteristiek, luidheid, specifiek gerelateerd is aan het automatisch verwerken van angstige stimuli, maar niet aan bedreigende stimuli in het algemeen. Een mogelijke verklaring voor deze laatste bevinding zou een specifieke angstreactie in het geheugen voor de luidheid van tinnitus kunnen zijn, wat in overeenstemming is met de klinische ervaring dat patiënten schrik hebben dat tinnitus en voornamelijk de luidheid van tinnitus zou toenemen.

Onze conclusie luidt dat de ervaren ernst van tinnitus, bij erg gehinderde patiënten, geassocieerd is met een angst gerelateerd probleem op een automatisch verwerkingsniveau. Deze relatie blijkt bovendien onafhankelijk te zijn van de hoeveelheid gehoorverlies. Ook de audiologische karakteristiek luidheid, is tot op zekere hoogte een angst gerelateerd probleem. Toch achten we verder onderzoek dat zich bovendien zou moeten focussen op de richting van de relatie tussen angst en de ervaren ernst van tinnitus noodzakelijk.

Daarom proberen we in hoofdstuk 5 zicht te krijgen op de richting van de relatie tussen de tinnitus ernst en angst gerelateerde problemen. Angst wordt verondersteld uit verschillende stoornissen te bestaan, namelijk angst gerelateerde stoornissen (bv. gegeneraliseerde angststoornis, paniekstoornis) en vrees gerelateerde stoornissen (bv. fobie) (bv. Rachman 1998, American Psychiatric Association 2000). Het verschil tussen deze twee stoornissen is de aan- of afwezigheid van een ‘angstobject’. In vrees gerelateerde stoornissen is zulk een specifiek object aanwezig (bv. mensen met een fobie voor ‘honden’, waar honden als angstobject fungeren), terwijl zulk een object afwezig is in angst gerelateerde stoornissen. Deze laatste stoornissen worden gekenmerkt door algemene angstige reacties. Dit wil zeggen dat mensen in vele situaties met angst reageren. Met deze theorie in het achterhoofd, stellen we de vraag of tinnitus patiënten specifiek angst hebben als gevolg van de tinnitus perceptie (vrees gerelateerd) dan wel dat ze in het algemeen met meer angst reageren en hierdoor de perceptie van tinnitus als erger / angstiger ervaren. Het verschil tussen vrees en angst gerelateerde problemen werd reeds aangetoond in psychofysiologisch onderzoek (bv. Hoehn-Saric & McLeod 2000; Öhman 2008). In dit soort onderzoek wordt er gebruik gemaakt van autonome reacties, zoals hartslag en huidgeleiding. Deze autonome reacties blijken te verschillen tussen beide angstcondities. In deze studie maken we dan ook gebruik van de autonome reacties, hartslag en huidgeleiding, en proberen we na te gaan of de ernst van tinnitus gerelateerd is aan autonome reacties zoals geobserveerd in vrees en / of angst gerelateerde problemen. Opnieuw exploreren we of deze relatie bij alle tinnitus patiënten geobserveerd kan worden, dan wel enkel bij deze patiënten die ernstige tinnitus hinder ervaren. De relaties met audiologische karakteristieken, pitch en luidheid, worden opnieuw nagegaan.
Uit onze resultaten blijkt dat de ernst van tinnitus gerelateerd is aan autonome reacties zoals geobserveerd bij vrees en angst gerelateerde problemen en dit vooral bij mensen die veel hinder ondervinden van tinnitus. Voorts is de audiologische karakteristiek luidheid specifiek gerelateerd aan autonome reacties op angstige stimuli. Zoals reeds vermeld, kunnen we deze relatie interpreteren als een reflectie van een nauwe relatie tussen de tinnitus luidheid en een angstreactie in het geheugen, wat in overeenstemming is met klinische ervaringen dat mensen angst hebben dat tinnitus en voornamelijk de luidheid van tinnitus erger wordt.


Algemeen tonen onze resultaten dus aan dat de ervaren ernst van tinnitus niet gerelateerd is aan depressieve symptomen.

De ervaren ernst blijkt eerder verbonden te zijn met cognitieve en somatische angst gerelateerde symptomen, met een bewuste beoordeling van angst én met een automatische verwerking van bedreigende informatie zoals geobserveerd bij hoog angstige mensen. Onze resultaten suggereren dus een complex patroon van angst als oorzaak van de ervaren ernst van tinnitus én angst als effect van de perceptie van tinnitus.

NAAR EEN INZICHT VAN DE RELATIE TUSSEN DE ERVAREN ERNST VAN TINNITUS EN ANGST GERELATEERDE PROBLEMEN

In hoofdstuk 6 van deze doctoraatsverhandeling proberen we een antwoord te formuleren op de vraag waarom bepaalde tinnitus patiënten meer last ervaren dan anderen. Verschillende onderzoekers hebben hypothesisen met betrekking tot de richting van de relatie tussen de ervaren tinnitus hinder en angst geformuleerd, maar volgens ons is er geen theoretisch kader voor handen dat deze relatie verklaart. Jastreboff heeft wel een overkoepelende theorie geformuleerd, maar deze theorie geeft ons inziens geen antwoord op de vraag waarom sommige mensen meer gehinderd zijn door tinnitus dan anderen. In Jastreboff’s neurofysiologisch model zouden mensen die ernstig gehinderd worden door tinnitus, de perceptie van tinnitus associëren met iets onplezierigs of met iets angstigs. Toch gaat Jastreboff voorbij aan zijn geformuleerde beginpunt als hij zegt dat het verschil tussen mensen gevonden kan worden in de hersenen en meer specifiek in het limbisch en autonome systeem. Hoewel we de invloed van deze hersensystemen niet willen ontkennen, zijn wij van mening dat deze systemen als correlaten van emotionele toestanden moeten benaderd worden en niet als oorzaak van ervaren emoties (zie ook Noë 2009; Keizer 2012). Als met andere woorden de associatie tussen de perceptie van tinnitus en de onplezierige en / of angstige interpretatie van belang is voor het
begrijpen van het verschil in de ervaren ernst van tinnitus, dan is een psychologische theorie over zulk een associatie mechanisme noodzakelijk.

Wij denken dat Freud’s psychoanalytische theorie over het bindingsmechanisme een relevant theoretisch kader is om de vraag te beantwoorden waarom sommige tinnitus patiënten meer angst en last ervaren dan anderen.

**EEN FREUDIAANS THEORETISCH KADER**

Freud’s theoretisch kader toont een nauw verband tussen het bindingsmechanisme, angst en symptoomvorming. Kort geschetst is het bindingsmechanisme volgens Freud een algemeen mechanisme, dat op de grens ligt tussen het somatische en het psychische en van primair belang is bij de overgang van mentaal geregideerde somatisch functioneren naar het op representatie gebaseerd mentaal functioneren (Freud 1966 [1895]). Om mentaal of psychisch van aard te worden, dient volgens Freud vrij vlottende, ongebonden of somatische excitatie gebonden te worden aan representaties (of ideeën). Als dit proces succesvol is, dan is de arousal gerelateerde excitatie niet langer puur somatisch, maar psychisch en worden er tegelijkertijd geheugensporen gecreëerd.

Hierdoor wordt de excitatie gedeeltelijk controleerbaar. Ondanks het feit dat dit mechanisme nooit geheel slaagt, zal een meer radicaal falen van dit proces ervoor zorgen dat de excitatie in een vrij vlottende of somatische staat blijft, waardoor het individu overspoeld wordt door excitaties, die oncontroleerbaar zijn en een gevoel van hulpeloosheid creëren (Freud 1966 [1895], 1959 [1926]). Dit gevoel van hulpeloosheid wordt door Freud als een endogene situatie van gevaar gezien, waaraan ontsnappen onmogelijk is (Freud 1959 [1926]), wat meteen zijn conceptualisatie van het ‘angstconcept’ is. Het bindingsproces is dus volgens Freud verantwoordelijk voor de transitie van onbemiddelde automatische angst (vandaag bekend onder de gegeeneraliseerde angststoornis of de paniekstoornis) tot (bemiddelde) signaalangst (vandaag bekend als vrees gerelateerde problemen) (Freud 1959 [1926]); Verhaeghe 2004; Verhaeghe et al. 2007). Bovendien is dit proces inherent gerelateerd aan elke vorm van symptoomvorming. Deze symptoomvorming dient, aldus Freud, op een continuüm geplaatst te worden met aan het ene extreem de actuaalneurosen (bv. angstneurose) en aan het andere extreem de psychoneurosen (bv. conversiesymptomen) (Freud 1966 [1895], 1959 [1926]). Het verschil wordt gedetermineerd door het in meer of mindere mate slagen van het bindingsmechanisme. Indien dit mechanisme radicaler faalt, wat neerkomt op een algemene moeilijkheid met het identificeren en verwerken (of verbaliseren) van affecten, leidt dit volgens Freud tot een actuaalneurotische symptoomvorming, die bovenal betekenisloos is. Bij de andere kant van het extreem (psychoneurosen), getypeerd door het voldoende slagen van het bindingsmechanisme, is de symptoomvorming betekenisvol en staat het psychisch conflict centraal. We denken dat voornamelijk Freud’s angstneurotische positie relevant is voor het begrijpen van de disproportionele relatie tussen de perceptie van tinnitus en de ervaren hinder.
De angstneurose wordt volgens Freud gekenmerkt door een opsomming van opvallende symptomen. Een eerste symptoom is de ‘algemene toestand van geprikkeldheid’. Eén specifieke manifestatie hiervan is overgevoeligheid aan geluiden, wat tegenwoordig bekend staat onder de term ‘hyperacusie’. Een tweede symptoom is een ‘algemene angstige verwachting’. Deze angstige verwachting is volgens Freud altijd latent aanwezig, zonder dat mensen er zich noodzakelijk van bewust zijn.

Ten derde verwijst hij naar de ‘angstaanval’, wat een doorbraak van angst in het bewustzijn is. Deze gevoelens zijn niet verbonden aan bepaalde ideeën. Het gevolg is dat deze gevoelens geassocieerd zullen worden met de interpretatie die het dichtst voorhanden is. Zo kunnen deze gevoelens verbonden worden aan een verstoring van één of meer lichamelijke functies. Als lichamelijke symptomen noemt Freud onder meer hartkloppingen, ademhalingsmoeilijkheden, zweten, enz. Voorts kan het angstig gevoel op zich naar de achtergrond verdwijnen, waardoor er alleen gesproken wordt over vage klachten (bv. zich niet goed voelen).

De interpretatie van deze lichamelijk sensaties hangt voornamelijk af van de persoonlijke context van het individu, wat Freud specificere als vierde symptoom van de angstneurose.

Ten vijfde vernoemt hij ‘s nachts wakker worden’, omdat dit nauw verbonden is met vrees, waar waakzaamheid de dominante factor is.

Symptoom 6 is ‘duizeligheid’, wat duidelijk onderscheiden wordt van de duizeligheid eigen aan de ziekte van Ménière.

Onder punt 7, vermeldt Freud twee groepen van fobieën, maar deze worden als verschillend geacht van de fobische reacties typische voor de psychoneurosen. De fobische reacties behorende tot de angstneurose zijn volgens Freud, als gevolg van een meer radicaal falen van het bindingsmechanisme, betekenisloos.

Vervolgens (8) verwijst hij naar een reeks lichamelijke reacties, zoals de neiging te braken of aanvallen van extreme honger.

En als laatste (9) vermeldt Freud dat de symptomen van de angstaanval ook in een chronische vorm kunnen voorkomen, waardoor ze moeilijk te herkennen zijn (Freud 1962 [1895]).

Volgens verschillende auteurs dienen paniekstoornis en veralgemeende angststoornis als moderne conceptualiseringen gezien te worden van Freud’s angstneurose (Verhaeghe 2004; Verhaeghe et al. 2007). Zoals reeds vermeld, achten we deze klasse van de actuaalneurose als relevant voor het interpreteren van onze resultaten en voor het begrijpen van de disproportionele relatie tussen de perceptie van tinnitus en de ervaren ernst.
EEN INTERPRETATIE VAN ONZE RESULTATEN IN HET LICHT VAN DE ACHTERGRONDTHEORIE ROND HET BINDINGSMECHANISME

We vonden dat meer dan de helft van onze steekproef klinisch relevante cognitieve angstsymptomen en zo’n 40% klinisch relevante somatische angstsymptomen rapporteerden. Naast een actuele angstige toestand, gaf zo’n 60% van onze steekproef aan in het algemeen een angstige attitude te hebben. Angst lijkt dus de primaire klacht te zijn, wat consistent is met Freud’s angstneurose. Als tweede symptoom vermeldt Freud, een algemene angstige verwachting die constant op de achtergrond aanwezig is. Ondanks het feit dat we niet kunnen beweren dat dit hetzelfde is als het automatisch verwerken van bedreigende informatie, gaan we ervan uit dat de angstige verwachte houding wel een reden kan zijn waarom de tinnitus hinder gerelateerd is aan het automatisch verwerken van bedreigende informatie. Freud stelt bovendien dat bij de angstaanval lichamelijke sensaties op een specifieke en persoonlijke manier kunnen geïnterpreteerd worden en zelfs in een chronische vorm kunnen voorkomen. We denken dan ook dat onze resultaten uit hoofdstuk 5, waar we vonden dat de ernst van tinnitus zowel angst als vrees gerelateerd is, in deze context dienen geïnterpreteerd te worden.

In Freud’s definiëring van de angstneurose vinden we bovendien nog een aantal opmerkelijkheden terug. Zo is het eerste symptoom waar Freud naar verwijst de algemene prikkelbaarheid met één specifieke manifestatie, namelijk hyperacusie. Onderzoek toont aan dat hyperacusie bij 40% van de tinnitus patiënten voorkomt. Volgens Jastreboff zorgt dit bijkomend fenomeen voor een grotere tinnitus klacht. Neurologisch onderzoek toont een nauwe link tussen hyperacusie en de hersendelen die belangrijk worden geacht bij angst (Jastreboff 2011), wat consistent is met Freud’s theorie over de angstneurose.

Twee andere fenomenen die vaak voorkomen bij tinnitus zijn misofonie en fonofobie, die eveneens een verband met angst kennen (Møller 2011c). Daarenboven worden in tegenstelling tot hyperacusie, misofonie en fonofobie wel geacht gerelateerd te zijn aan de persoonlijke geschiedenis van een individu (Jastreboff 2011). We kunnen deze fenomenen misschien beter begrijpen op Freud’s continuüm actuaalneurose – psychoneurose, met hyperacusie langs de actuaalneurotische kant, fonofobie langs psychoneurotische kant en misofonie in het midden van het continuüm.

Een tweede opmerkelijk observatie heeft betrekking op Freud’s 5de symptoom van de angstneurose, namelijk het ’s nachts wakker worden, wat volgens Freud nauw verbonden is met een toestand van vrees en bijbehorende waakzaamheid. Mensen die ernstig lijden aan tinnitus, rapporteren vaak ’s nachts wakker te worden.
Algemene conclusie en implicaties voor de behandeling

Algemeen denken we dat onze resultaten en observaties aangeven dat patiënten die ernstig lijden onder tinnitus naar een angstneurotische positie neigen. Dit wil zeggen dat deze patiënten algemene moeilijkheden in het identificeren en verwerken (of verbaliseren) van affecten zouden ervaren. Misschien kunnen we Jastreboff’s stelling, namelijk ‘de perceptie van tinnitus wordt als onplezierig of angstig geïnterpreteerd’ herschrijven naar ‘de perceptie van tinnitus wordt misinterpreteerd’. Deze aanpassing verwijst dan naar de huidige definitie van paniekstoornis, die gekenmerkt wordt door ‘misinterpretaties van lichamelijke sensaties’ (bv. Rachman 1998). Zoals aangegeven wordt paniekstoornis als moderne conceptie van angstneurose beschouwd (Verhaeghe 2004; Verhaeghe et al. 2007).

Freud formuleerde echter een continuüm tussen een actueel- en psychoneurotische positie, wat zou willen zeggen dat tinnitus ook langs de kant van de psychoneurose, als conversiesymptoom, kan gesitueerd worden. Ondanks het gebrek aan ‘empirisch’ bewijs, lijkt de klinische praktijk hier wel een getuigenis van af te leggen. In dit geval, is tinnitus vol van betekenis en fungeert het symptoom als een beschermingsreactie tegen een ondraaglijk onderliggend conflict.

Volgens ons kan Freud’s theorie dus een antwoord bieden op de vraag waarom sommige patiënten de perceptie van tinnitus als iets onplezierigs of angstigs interpreteren. Op basis van deze theorie hebben mensen die meer gehinderd zijn door tinnitus moeilijkheden met het identificeren en verwerken (of verbaliseren) van affecten. Toch willen we, net als Freud, het belang van biologische en neurologische factoren niet veronachtzamen. We veronderstellen een complex samenspel tussen de verschillende factoren.

Op basis van Freud’s theorie kunnen we bovendien een aantal implicaties voor de behandeling van tinnitus formuleren. Ten eerste, denken we dat onze analyse het belang aantoont van een bijkomende psychologische behandeling. De studie van Cima et al. (2012) geeft dit belang aan en toont dat bijkomende langdurige psychologische begeleiding voor betere effecten zorgt dan het normaal gehanteerde behandelingsprotocol zonder psychologische begeleiding. Echter, zoals aangegeven door deze auteurs werd het effect van behandelingstechnieken niet onderzocht. Dit soort onderzoek zou dan ook meteen een uitdaging kunnen zijn voor toekomstig onderzoek. Ten tweede, toont onze analyse dat de persoonlijke geschiedenis van een individuele patiënt van belang is. Wij geloven dat deze geschiedenis steeds in de behandeling in rekening dient gebracht te worden. Dit houdt in dat de behandeling niet alleen op het symptoom gefocust mag zijn. Daarenboven impliceert het betrekken van de persoonlijke geschiedenis dat gestandaardiseerde behandelingen en adviezen moeten worden vermeden. Jastreboff’s behandelmensmodel geeft bijvoorbeeld aan dat het eerste advies wat gegeven moet worden, het vermijden van stilte is. Onze klinische ervaring geeft aan dat niet iedereen tinnitus
ervaart in een stille omgeving. We gaan er dan ook vanuit dat dit soort gestandaardiseerd advies bij sommige mensen een nieuwe angstreactie kan uitlokken. Dit maal gaat het niet over angst voor geluid, maar wel over angst voor de afwezigheid van geluid.

Wij denken dat de uitdaging voor toekomstig onderzoek gelegen is in het betrekken van de persoonlijke geschiedenis van een individu. Volgens ons kan dit het best gedaan worden via het bestuderen van psychotherapeutische vorderingen van single cases.
REFERENCES


