

# When Tinnitus Loudness and Annoyance Are Discrepant: Audiological Characteristics and Psychological Profile

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## Key Words

Tinnitus · Tinnitus loudness · Annoyance rating · Psychological profile · Hyperacusis

## Abstract

This study evaluates sociodemographic and clinical characteristics of patients reporting discrepant levels of tinnitus loudness and annoyance. 4958 subjects recruited from a national tinnitus association completed a comprehensive screening questionnaire including Klockhoff and Lindblom's loudness grading system and the psychometric Mini-TQ (Tinnitus Questionnaire). There was a moderate correlation of 0.45 between loudness and annoyance. Of the subjects reporting very loud tinnitus, about one third had only mild or moderate annoyance scores. They were not different from those with high annoyance regarding age, gender and tinnitus duration, but annoyance was increased when subjects had additional hearing loss (OR = 1.71), vertigo/dizziness (OR = 1.94) or hyperacusis (OR = 4.96). Another significant predictor was history of neurological disease (OR = 3.16). Subjects reported low annoyance despite high loudness more often if not feeling low/depressed and not considering themselves as victims of their noises. A specific psychological profile was found to characterize annoyed tinnitus sufferers. Permanent awareness of the noises, decreased ability to ignore them and concentration difficulties were reported frequently even when overall annoyance scores were com-

paratively low. It is concluded that the coexistence of tinnitus with hearing loss, vertigo/dizziness and hyperacusis as complicating otological conditions seems to be of clinical relevance for the prediction of high annoyance levels. Tinnitus loudness and annoyance are not necessarily congruent and should be assessed separately.

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## Introduction

Tinnitus is a physical symptom with high prevalence rates in Western societies. Epidemiological studies showed that about one third of the population experiences tinnitus at least once in their life and about 1–5% develop serious psychosocial complications [Davis, 1995; Pilgramm et al., 1999]. The tinnitus prevalence increases to 70–85% of the hearing-impaired population. The causes of tinnitus are multiple. Tinnitus can be due to inner ear dysfunction, such as associated with sudden hearing loss or acoustic trauma, or part of otological and neurological diseases such as Ménière's disease, conductive hearing loss, acoustic neuroma or severe head injury. In addition, there are idiopathic forms of tinnitus with no identifiable etiological factors despite appropriate medical examination. Jastreboff [1990] developed a neurophysiological model postulating that the tinnitus signal is processed from low levels of the auditory system (gen-

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eration) to subcortical centers (detection) and the auditory cortex (perception and evaluation). The limbic and autonomic nervous system may be involved in negative emotional reactions, in which case attention towards the tinnitus signal is increased and habituation is hindered. A psychological formulation proposed by Hallam et al. [1984] assumes that habituation to tinnitus is normal, but habituation is slowed if the tinnitus is strong, changes or is unpredictable, if the person is very tense, or if an emotional significance or meaning is attached to the tinnitus. This model also linked habituation to the activity of the autonomic nervous system.

There has been growing interest in psychological factors associated with tinnitus. A recent study by Marciano et al. [2003] found that 77% of consecutively screened tinnitus patients fulfilled the criteria of at least one DSM-IV mental disorder and had elevated scores on the Minnesota Multiphasic Personality Inventory depression, hysteria and hypochondria scales. Anxious and depressive symptomatology seem to be the most common complications of tinnitus [Halford and Anderson, 1991; Folmer et al., 2001; Zöger et al., 2001; Reynolds et al., 2004; Andersson et al., 2004; Stobik et al., 2005]. Holgers et al. [2000] found that depression and physical immobility were the strongest predictors of incapacitating tinnitus. A study by Newman et al. [1997] demonstrated that tinnitus patients with high levels of self-attention and somatic attention had greater emotional distress, depression and perceived tinnitus handicap. Hallam et al. [2004] observed that patients with tinnitus also reported an increase in failure to perform everyday cognitive tasks and were slower in laboratory tasks involving cognition. Other research has demonstrated that quality of life and quality of family life seem to be reduced in at least a subgroup [Erlandsson and Holgers, 2001; El Refaie et al., 2004]. Folmer et al. [1999] showed that tinnitus patients with current depression reported the same level of tinnitus loudness as patients without a history of depression, but had higher ratings of tinnitus severity. It is likely, therefore, that the treatment of depression and associated psychological symptoms has beneficial effects also on tinnitus severity, which indeed has been confirmed by some recent studies [Folmer and Shi, 2004; Kaldo-Sandstrom et al., 2004; Zachriat and Kröner-Herwig, 2004; Hiller and Haerkötter, 2005].

The relationship between tinnitus loudness and annoyance is not yet sufficiently understood. Although there is a general correlation between both variables, clinicians are sometimes confronted with the puzzling phenomenon that some patients report loud tinnitus without

a marked impact on well-being and psychosocial functioning, while others are severely disabled despite relatively low tinnitus intensity. Tyler and Conrad-Arnes [1983a] noted patients with high levels of annoyance despite very low loudness matches and recommended special attention for the counseling of them (for the definition of loudness matches, see Henry and Meikle [2000]). Dauman and Tyler [1992] pointed out the importance of distinguishing between the physical properties of tinnitus and the annoyance attributed to it. Stouffer and Tyler [1990] and Stouffer et al. [1991] distinguished loudness and annoyance ratings over time. One of the first sensitive discussions about the importance of emotional and other psychological factors in managing the tinnitus patient had been provided by Fowler [e.g. Fowler, 1948; Fowler and Fowler, 1955]. More recent research has emphasized the role of dysfunctional cognitions related to the perception and interpretation of the tinnitus [Erlandsson et al., 1992; Hallam et al., 1984, 1988]. However, it is not known until today whether or not characteristics of tinnitus history, clinical presentation and etiology are related to discrepant developments of tinnitus loudness and annoyance. Other unanswered questions refer to the type and pattern of psychological symptoms typical for subjects having either congruent or discrepant levels of loudness and annoyance.

One reason for our lack of knowledge is that many studies are conducted in clinical settings where patients with only low tinnitus severity are relatively rare. The study presented here aimed to investigate the relationship between tinnitus loudness and annoyance in a large sample not drawn from typical clinical settings. We performed a mail survey among members of a national tinnitus association for which a broad spectrum of tinnitus manifestations can be expected. The Klockhoff and Lindblom [1967] grading system was used to obtain a measure of tinnitus loudness as subjectively experienced by the subjects. We decided to use this method instead of subjective loudness ratings because 'loudness' is an ambiguous term for many patients and frequently intermingled with aspects of tinnitus-related distress. Tinnitus-related annoyance was quantified with the psychometrically well-validated abridged version of the Tinnitus Questionnaire (Mini-TQ) [Hiller and Goebel, 2004]. We intended to contrast groups reporting similar levels of loudness/annoyance with those where loudness and annoyance were apparently discrepant. Dependent variables were characteristics of tinnitus manifestation and history, the presence of major etiological factors and the profile of psychological complaints.

Although our analyses were primarily exploratory, we hypothesized that more complicated forms of clinical presentation (e.g. binaural tinnitus, long duration, comorbidity with other otological conditions, severe medical disease as etiological factors) contribute to an increase in annoyance independent of loudness. We also expected to find different psychological profiles between subjects with congruent and discrepant levels of loudness and annoyance.

## Materials and Methods

### *Data Collection and Sample*

The mail survey was conducted among the members of the German Tinnitus League. The League is a registered charity providing information, support and advice about tinnitus, thereby aiming to raise awareness about the condition and funding research. The study was performed conjointly by the Psychological Institute of the University of Mainz and the Roseneck Center of Behavioral Medicine in Prien, Germany. The German Tinnitus League members were asked to support the organization's work by providing information about typical characteristics of their tinnitus and associated problems. About 18000 questionnaires were mailed out and 4995 of them were returned. 4958 questionnaires had complete and valid data on the Klockhoff and Lindblom grading and the Mini-TQ (see below). The mean age of this final sample was 56.4 years (SD 12.2), ranging from 16 to 95 years, and the female proportion was 42.1%.

### *Assessment of Tinnitus Loudness and Annoyance*

The Klockhoff and Lindblom [1967] system is a reliable standard measure indicative of subjective tinnitus loudness. It was recommended by the British Association of Otolaryngologists, Head and Neck Surgeons [McCombe et al., 2001]. Three grades of tinnitus loudness were defined: grade I: tinnitus audible only in silent environments; grade II: tinnitus audible in ordinary acoustic environments, but masked by loud environmental sounds; grade III: tinnitus audible in all acoustic environments, i.e., louder than all external sounds. To avoid confounding with tinnitus annoyance, we followed Scott et al. [1990] and omitted aspects of sleep and quality of life from the definitions of grades II and III.

The Mini-TQ [Hiller and Goebel, 2004] is a psychometrically validated, one-dimensional scale with scores ranging from 0 (no annoyance) to 24 (maximum annoyance). According to normative data provided by the authors, subjects were classified into four categories: group I: no to mild distress (scores 0–7); group II: moderate distress (scores 8–12); group III: severe distress (scores 13–18); group IV: very severe distress (scores 19–24).

### *Assessment of Further Tinnitus-Related Variables*

The entire screening questionnaire comprised a total of 34 items covering major areas of tinnitus history, associated clinical conditions, etiology and tinnitus-related psychological complaints. We intended to keep the questionnaire as short as possible to reach good cooperativeness. Items were taken from the Structured Tinnitus Interview (STI) and the TQ, both well-established psychometric instruments [Goebel and Hiller, 2001; Hallam et al., 1988; Hiller and Goebel, 1992, 1999; Hiller et al., 1994]. Almost

all items were of multiple-choice format. The following data were assessed:

(1) Tinnitus manifestation and history: tinnitus localization (right, left, binaural, within head), subjective description of the type of sound, time since onset, type of onset (suddenly vs. slowly developed over time), development of tinnitus loudness since onset, maskability, effects of loud external noise on the tinnitus, constancy of the tinnitus (continuously, interruptions <1 h, interruptions >1 h, sometimes entire day without tinnitus).

(2) Tinnitus-related otological conditions: coexisting hearing loss, dizziness/vertigo and hyperacusis. Hyperacusis (oversensitivity towards external noise) was operationalized through the following three questions: (a) Do you experience slight or everyday noises (e.g. turning newspaper pages, hearing a computer ventilator, own laughter, buzzing of refrigerator) as uncomfortable or painful?; (b) Is it true that your oversensitivity to noise does not only pertain to certain noises (e.g. a child crying, music) but is generalized to different types of noises and multiple situations?; (c) Did the oversensitivity to noise lead to considerable impairment in your daily routines?. Each item could be answered with 'yes', 'sometimes' or 'no'. We categorized a subject as having full hyperacusis if all three questions had been rated with 'yes'. If all three questions were affirmed but at least one item was only rated as 'sometimes' instead of 'yes', hyperacusis was considered as subclinical.

(3) Tinnitus etiology: the most common tinnitus-related etiological conditions were presented as predefined categories. They included: inner ear dysfunction, conductive hearing loss (e.g. otosclerosis), sudden hearing loss, vascular dysfunction, cervical spine dysfunction, craniomandibular dysfunction, acoustic trauma or noise exposure, Ménière's disease, severe head injury, acoustic neuroma, neurological disease, ototoxic substance intake, and known family history of hearing disorder. All items were taken from the STI where their assessment had been successfully evaluated. Since the individual etiological factors do not exclude each other, multiple choices could be made.

(4) Psychological complaints: the 12 items of the Mini-TQ were included to yield a quantitative measure of annoyance. All items had been selected as highly relevant to represent central aspects of tinnitus-related distress. The Mini-TQ was developed as a short version of the TQ [Hallam, 1996; Hiller and Goebel, 1992]. It defines a general dimension of distress that correlates >0.90 with the full TQ. The Mini-TQ has a high test-retest reliability of 0.89 [Hiller and Goebel, 2004].

### *Statistical Methods*

Group differences were tested by  $\chi^2$  and t tests, depending on data type. Because of the large sample sizes in our study, significant results must be expected even if differences are not sufficiently large in magnitude. We therefore used odds ratios (ORs) as the major source of data interpretation. ORs provide an estimate for the relationship between two binary ('yes or no') variables. The odds is the ratio of the probability that an event of interest (e.g. binaural tinnitus) occurs to the probability that it does not. An OR is calculated by dividing the odds obtained in a group of interest by the odds of a comparison group. Unlike  $\chi^2$ , ORs are independent of overall sample size. An OR of 3, for example, indicates that a specific characteristic was three times as frequent in group A as in the comparison group B; 95% confidence intervals (CI) are additionally reported for each OR. The statistics software SPSS 4.0 was used for data analysis.

**Table 1.** Association between tinnitus loudness and annoyance

	Degree of tinnitus loudness		
	low (grade I)	medium (grade II)	high (grade III)
Degree of annoyance (from Mini-TQ)			
Mild (scores 0–7)	334 (6.7)	1378 (27.8)	233 (4.7)
Moderate (scores 8–12)	43 (0.9)	788 (15.9)	354 (7.1)
Severe (scores 13–18)	20 (0.4)	613 (12.4)	561 (11.3)
Very severe (scores 19–24)	8 (0.2)	180 (3.6)	446 (9.0)

Figures in parentheses indicate percentages.

## Results

### *Distribution of Tinnitus Loudness and Annoyance*

Loudness ratings on the Klockhoff and Lindblom system were 8.2% grade I, 59.7% grade II and 32.2% grade III. Annoyance scores on the Mini-TQ showed that 39.2% of the sample belonged to group I, 23.9% to group II, 24.1% to group III and 12.8% to group IV. Cross-tabulation of both measures is shown in table 1. The Spearman rank correlation between both categorized variables was 0.45 and the Pearson correlation between the three loudness gradings on the one hand and the Mini-TQ raw scores on the other hand was 0.48.

### *Definition of Subgroups*

Although the majority of subjects rated loudness and annoyance of their tinnitus as congruent, there was a considerable proportion of subjects with high loudness but low annoyance and a smaller group with low loudness but high annoyance. To study these interesting constellations, we defined the following subgroups to be compared in all further analyses:

*Low Loudness/Low Annoyance Group.* There were 377 subjects with loudness grade I and either mild or moderate annoyance. This group is usually characterized by no or only little clinical complication.

*High Loudness/High Annoyance Group.* One thousand and seven subjects had loudness grade III plus either severe or very severe annoyance. This is the typical group of highly distressed tinnitus sufferers who are in need of intense medical and psychological management.

*High Loudness/Low Annoyance Group.* The group with loudness grade III but only mild or moderate annoyance was relatively large with 587 cases. These subjects are able, or have learned to limit the degree of psychological distress despite perceiving a relatively strong tinnitus signal.

*Low Loudness/High Annoyance Group.* Twenty-eight subjects reported loudness grade I in combination with severe or very severe annoyance. This seems to be a rather rare group where tinnitus distress is inappropriately greater than the intensity of the perceived sound.

The distribution of tinnitus characteristics, tinnitus history and etiologies is presented in tables 2 and 3 for all four study groups. We will first compare the two groups with congruently high or low levels of loudness/annoyance (LL vs. HH) and then the high loudness groups with either low or high annoyance (HH vs. HL). The relatively small group with high annoyance despite low loudness (LH) will be contrasted against the three other groups.

### *Comparison of LL and HH*

Subjects with low loudness/annoyance and high loudness/annoyance represent the most oppositional subgroups. We found marked differences for a number of variables (all  $p < 0.01$ ). There was a larger proportion of males among HH (OR = 1.65; 95% CI = 1.29–2.10), more of this group were above 50 years (OR = 3.31; 95% CI = 2.55–4.28), tinnitus was more frequently localized binaurally (OR = 2.03; 95% CI = 1.58–2.60) or within the head (OR = 2.98; 95% CI = 2.20–4.04), a larger proportion had tinnitus lasting >5 years (OR = 1.96; 95% CI = 1.47–2.60), tinnitus had more frequently increased in the past (OR = 16.15; 95% CI = 11.06–23.59), loud external noise led in more cases to tinnitus deterioration (OR = 1.97; 95% CI = 1.55–2.51), the percentage of subjects experiencing permanent tinnitus was greater (OR = 10.47; 95% CI = 7.60–14.43) and tinnitus was clearly more often associated with hearing loss (OR = 5.64; 95% CI = 4.16–7.65), dizziness/vertigo (OR = 3.76; 95% CI = 2.88–4.91) and hyperacusis (OR = 23.15 for full and 8.74 for subclinical hyperacusis; 95% CIs = 8.54–62.77 and 6.14–12.44, respectively). All etiological factors except cranioman-

**Table 2.** Characteristics of tinnitus manifestation and history

	LL (n = 377)	HH (n = 1007)	HL (n = 587)	LH (n = 28)
Male, %	50.0	62.2	58.3	48.0
Age				
Mean $\pm$ SD, years	53.2 $\pm$ 15.2	58.2 $\pm$ 10.0	57.7 $\pm$ 10.7	53.5 $\pm$ 17.4
>50 years, %	54.1	79.6	76.0	53.8
Familial status, %				
Married	64.1	76.8	71.9	64.3
Divorced	4.0	5.4	5.1	0
Localization of tinnitus, % <sup>1</sup>				
Right	24.4	16.3	18.6	0
Left	35.5	26.1	25.6	39.3
Binaural	33.2	50.1	49.4	60.7
Within head	15.9	36.0	25.0	14.3
Time since onset of tinnitus, %				
$\leq$ 12 months	4.2	2.4	1.4	8.3
>5 years	71.7	83.2	84.7	62.5
Type of tinnitus onset, %				
Suddenly	56.2	47.5	46.3	50.0
Slowly progressive	34.7	35.5	41.6	42.9
Development of tinnitus loudness, %				
Has increased	8.8	60.8	39.7	25.0
Has decreased	44.6	1.6	5.6	28.6
Effects of loud external noise, %				
Tinnitus increases	39.5	56.3	51.0	35.7
Tinnitus decreases	8.9	3.4	3.1	17.9
Constancy of tinnitus, %				
Permanent	56.9	93.2	86.0	63.0
Tinnitus-free intervals of <1 h	3.5	4.2	4.6	3.7
Tinnitus-free intervals of >1 h	14.0	1.1	3.9	14.8
Sometime entire days without tinnitus	25.6	1.5	5.5	18.5
Associated otological conditions, %				
Subjective hearing loss	62.8	90.5	84.8	59.3
Dizziness/vertigo	24.2	54.5	38.2	46.4
Hyperacusis	1.1	20.1	4.8	11.1
Subclinical	11.0	41.7	30.8	37.0

<sup>1</sup> The column sum exceeds 100% because it was possible to code multiple categories.

dibular dysfunction were more common in the HH sample. We calculated ORs >3.00 for conductive hearing loss (5.63; 95% CI = 2.44–13.00), severe head injury (4.09; 95% CI = 1.25–3.44) and inner ear dysfunction (3.24; 95% CI = 2.35–4.48).

#### Comparison of HH and HL

These subgroups are equal in their loudness ratings but discrepant with regard to associated annoyance. The

data in tables 2 and 3 show that HL had greater similarity with HH than with LL. Both high loudness groups were predominantly male and had larger proportions of subjects above 50 years, with binaural tinnitus, tinnitus duration >5 years, sound-induced deterioration and permanently present tinnitus. There were only a few variables that could be used to discriminate between HH and HL on the  $p < 0.05$  level. The proportion of tinnitus localized within the head was somewhat larger in HH (OR =

**Table 3.** Tinnitus etiologies

	LL	HH	HL	LH
Inner ear dysfunction	13.5	33.7	31.0	25.0
Conductive hearing loss (e.g. otosclerosis)	1.6	8.3	5.5	0
Sudden hearing loss	30.5	40.3	37.8	10.7
Disturbance of blood circulation	24.7	32.1	23.2	35.7
Cervical spine dysfunction	30.8	38.8	28.6	28.6
Craniomandibular dysfunction	14.9	14.4	12.9	17.9
Acoustic trauma or noise exposure	10.9	23.6	18.7	21.4
Ménière's disease	6.1	13.5	11.2	17.9
Severe head injury	0.8	3.2	3.2	0
Acoustic neuroma	0.8	1.6	1.0	0
Neurological disease	3.7	10.0	3.4	7.1
Ototoxic substance intake	3.7	7.4	4.6	0
Family history of hearing disorder	15.1	18.7	22.7	14.3

All values are percentages.

1.69; 95% CI = 1.34–2.12) and a slightly greater proportion of HL subjects had a slowly progressive type of tinnitus onset (OR = 1.30; 95% CI = 1.05–1.60). There were more HL subjects who reported that their tinnitus had decreased during the course of time (OR = 3.69; 95% CI = 2.01–6.76). Interesting results were found for the associated otological conditions: HH subjects had more subjective hearing loss (OR = 1.71; 95% CI = 1.25–2.34), more dizziness/vertigo (OR = 1.94; 95% CI = 1.58–2.39) and more hyperacusis (ORs = 4.96 for full and 2.28 for subclinical hyperacusis; 95% CIs = 3.29–7.47 and 1.82–2.86). The only etiological condition that was more frequent in the HH group with an OR >3.00 was neurological disease (3.16; 95% CI = 1.93–5.16).

#### *Characteristics of the LH Group*

This puzzling group with high annoyance despite low loudness does not, as a whole, resemble any of the other groups. The proportion of males was marginally smaller than in LL (OR = 0.92; 95% CI = 0.41–2.08) and clearly smaller than in HH (OR = 0.56; 95% CI = 0.25–1.24). LH was comparable with LL (and different from HH) concerning age, tinnitus within the head, tinnitus increase following external noise and pattern of tinnitus constancy. In contrast, LH was comparable with HH (and different from LL) concerning the proportions of binaural tinnitus and tinnitus onset (sudden type). Two variables that distinguished LH subjects from all other groups were a higher proportion of tinnitus duration ≤12 months (ORs = 2.07–6.24; 95% CIs = 0.45–31.12) and a lower rate of associated hearing loss (ORs = 0.15–0.86; 95% CIs = 0.07–1.91). The proportions of associated dizziness/ver-

tigo and full hyperacusis were larger than in the LL group (ORs = 2.71 and 11.53, respectively; 95% CIs = 1.25–5.92 and 2.44–54.49) but smaller than in the HH group (ORs = 0.72 and 0.50; 95% CIs = 0.34–1.53 and 0.15–1.67). With respect to the etiological conditions, the LH group had no cases or only relatively low rates of conductive hearing loss, sudden hearing loss, severe head injury, acoustic neuroma and ototoxic substance intake.

#### *Psychological Profiles*

The mean scores of the Mini-TQ were 3.55 (SD 3.11) for LL, 18.08 (3.39) for HH, 7.94 (3.07) for HL and 16.19 (2.98) for LH. The differences were statistically significant between LL and HH ( $t = 72.6$ ,  $p < 0.01$ ) and between HH and HL ( $t = 59.6$ ,  $p < 0.01$ ). The scores of the LH and HH groups were similar. Items discriminating best between LL and HH were items 7 (can't ignore noises; correlation between group membership and item score,  $r = 0.87$ ), 1 (all day aware of noises;  $r = 0.82$ ), 6 (harder to relax;  $r = 0.78$ ), 12 (concentration affected;  $r = 0.78$ ) and 9 (feeling low;  $r = 0.77$ ). Items discriminating best between HH and HL were items 11 (victim of noises;  $r = 0.67$ ) and 9 (feeling low;  $r = 0.66$ ).

We compared the four groups on all 12 psychological items of the Mini-TQ. Figure 1 shows the group profiles with mean scores for each item. Scoring was 2 for present, 1 for partly/sometimes, and 0 for not present. Subjects with high annoyance had a very similar profile irrespective of whether their loudness level was low or high. In contrast, subjects with low annoyance were less homogenous. HL scored clearly higher than LL on items 1, 4, 6, 7, 8, 9 and 12 (fig. 1). HL had scores that were even in the

same range as for the high annoyance groups on items 1 (all day aware of noises), 7 (can't ignore noises) and 12 (concentration affected).

## Discussion

The present study attempted to identify some of the factors that are related to the phenomenon that tinnitus loudness and annoyance are not necessarily congruent. The existence of this discrepancy is probably the major reason why tinnitus is considered a disorder with psychological complaints of clinical relevance in a subgroup of patients. Thorough somatic investigation is absolutely essential when patients present with an acute tinnitus, for example to rule out treatable diseases such as acoustic neuroma or consider audiological options such as the prescription of hearing aids. However, medical treatment as available today is limited and even ineffective in many cases, although patients usually expect that modern medicine should be capable of achieving complete cure. Serious psychological complaints may develop when the tinnitus becomes chronic and patients become aware that the noises will most probably continue until the end of their life. While most patients succeed in accepting this situation without further complications, others develop severe and enduring psychological symptoms and impairments.

There exist different methods to assess tinnitus loudness [Andersson, 2003]. In the present study, we employed the Klockhoff and Lindblom method which assumes a linear relationship between tinnitus maskability and loudness. This method has the advantage of being less sensitive to linguistic uncertainties associated with the terms 'loudness', 'annoyance' and 'severity'. Other methods frequently used in tinnitus research are psychoacoustic loudness matching or masking procedures [Henry and Meikle, 2000]. However, psychoacoustic measures are far from representing 'true' values of loudness because results may strongly depend on the way the psycho-physical assessment is performed. For example, the signal to be matched can be presented ipsi- or contralaterally, at tinnitus frequency or normal-hearing frequency, or by applying different protocols concerning the order of signal occurrence and the type of choice provided to the patient [Tyler and Conrad-Arnes, 1983b; Henry and Meikle, 2000]. Andersson [2003] demonstrated that loudness expressed in dB HL (absolute loudness above hearing level) was more closely associated with tinnitus severity than loudness expressed in dB SL (absolute loud-

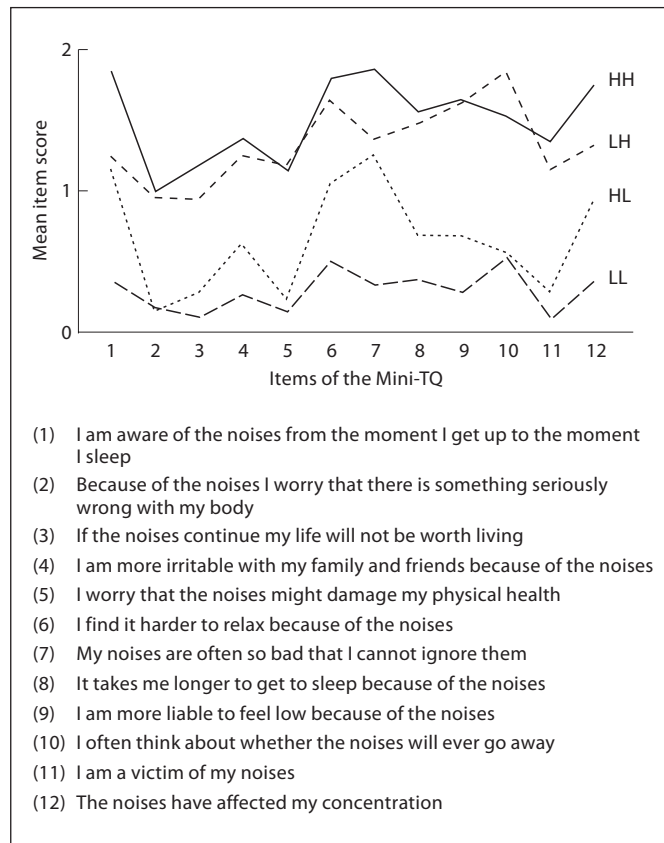


Fig. 1. Psychological profiles.

ness minus auditory threshold). Psychoacoustic measures are usually not collected in large samples because of high associated costs.

The results of our study show that some variables of sociodemographic status, tinnitus manifestation and tinnitus history are associated with the development of high annoyance and discrepant levels of loudness and annoyance. Men and elderly persons were more often affected by loud and annoying tinnitus. Other clear risk factors were binaural forms of tinnitus as well as manifestations that were long-lasting, increasing over time and continuously present. Of surprisingly great importance were co-existing otological conditions other than tinnitus. We found that subjects with additional hearing loss, dizziness/vertigo and hyperacusis reported both higher loudness and higher annoyance. ORs for these conditions were greater than 3 and up to about 23 when subjects with congruently high versus low loudness/annoyance were compared. Hyperacusis was identified as most relevant for the development of annoyance in subjects who rated

their tinnitus loudness as high. While about 20% of subjects with high loudness plus high annoyance were found to have full hyperacusis, this was the case in only 5% of those with low annoyance despite high loudness. The corresponding OR was almost 5, which emphasizes the practical relevance of this difference.

Less impact was found for the presence or absence of etiological factors. Although the sample percentages of nearly all etiological factors were highest in the most severely affected group with both high loudness and annoyance, only few of these differences were sufficiently large. Conductive hearing loss and severe head injury were the clearest risk factors with ORs around 4 or greater. Our explanation is that these conditions lead to louder and more obtrusive forms of tinnitus, which in turn increases the probability of high annoyance. Acoustic neuroma and the presence of an underlying neurological disease were found to have a considerable but somewhat independent impact on both loudness and annoyance. It should be kept in mind, however, that these conditions are rare, especially if compared with more common etiological factors such as sudden hearing loss, inner ear dysfunction or affections of the cervical spine. If present, however, severe diseases are likely to cause relatively high levels of tinnitus severity.

Interesting conclusions can finally be drawn from the psychological profiles of the four study groups. We analyzed the presence and intensities of 12 complaints that may typically occur as reactions or consequences of tinnitus. Subjects with a high annoyance level had a consistent profile characterized by intense complaints and irrespective of loudness. In contrast, subjects with low annoyance had low scores on some of the psychological items only when loudness was also low. We observed that permanent awareness of the noises during the course of the day, difficulties to relax, problems to ignore the noises and impaired concentration were also present in subjects with high loudness but low overall annoyance. Therefore, these psychological symptoms are not as unequivocally linked to annoyance as expected. Items differentiating most clearly between severe and mild forms of tinnitus were worries about a more general damage of physical health because of the noises and the conviction to be a victim of the tinnitus.

Our findings seem to connect knowledge derived from various researches. The differentiation between loudness and annoyance has also been suggested by studies showing that only weak to moderate correlations exist between audiological matched loudness and subjective distress [Meikle et al., 1984; Hallam et al., 1985; Folmer et al.,

1999; Henry and Meikle, 2000]. Andersson et al. [1999] used the Klockhoff and Lindblom system and found that grades II and III were predictable from a cluster of variables including tinnitus pitch, minimal masking level, avoidance of situations because of tinnitus and tinnitus tolerance at present in relation to onset. There is strong evidence that coexisting otological conditions contribute considerably to the different aspects of tinnitus severity. For example, Newman et al. [1994] found that speech understanding in loud surroundings was decreased when tinnitus patients had additional hearing loss. Erlandsson et al. [1992] observed that mood was more negative and impairments were greater when tinnitus was accompanied by vertigo. Nelson and Chen [2004] provided a review about the triad of tinnitus, hyperacusis, and hearing loss. They suggested a common pathway but additive effects on auditory perceptual processes and behavioral reactions. However, empirical studies about psychological consequences of the coexistence of tinnitus and hyperacusis are still lacking.

When discussing the value of this study, it should be considered that a large and nonclinical sample was investigated. Since our subjects were recruited among members of a national tinnitus association, the sample is not representative of the general population. On the other hand, the spectrum of tinnitus characteristics is broader than in usual clinical populations, mainly because more subjects with relatively mild forms of tinnitus are included as well as subjects who are not in ongoing clinical care. It can be expected that the respondents of our study were willing to support their organization by providing exact and complete information. It is interesting that three of the four subgroups were large with several hundred cases, whereas the subgroup with low loudness and high annoyance was remarkably small with only 28 subjects. We believe that this combination is generally uncommon and not an artifact of the population studied here. One could argue that people with low tinnitus loudness would not consider this problem as very relevant, and thus would not be interested to join a tinnitus association. However, a considerably large number of subjects ( $n = 405$ ) had low tinnitus loudness, representing about 20% of all subjects analyzed here, but only 8.9% of them reported high annoyance. This small proportion suggests that low annoyance is by far the normal case in subjects reporting low loudness.

A general conclusion from the present study is that tinnitus loudness and annoyance should be assessed and considered separately. Both represent aspects of what sometimes is subsumed under the more general term of

'tinnitus severity' in the literature [McCombe et al., 2001; Meikle et al., 1984]. Our results demonstrate that at least three types of severity can be distinguished: one characterized by both high loudness and annoyance, one consisting of high loudness only, and one (of minor relevance) consisting of high annoyance only. Future research should address the question of how these types can be taken into account for counseling and treatment. Although the reduction of 'severity' is the global goal of virtually all treatments, most methods presently available

seem to have stronger effects on annoyance than on loudness. The search for effective treatments reducing tinnitus loudness is nevertheless a great task for the future.

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