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# Psychometric Adequacy of the Tinnitus Handicap Inventory (THI) for Evaluating Treatment Outcome

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**Abstract**

This study assessed the test–retest reliability/repeatability and 95 percent confidence intervals (CIs) of the Tinnitus Handicap Inventory (THI) and developed categories for classifying self-perceived tinnitus handicap severity. Twenty-nine adults with tinnitus as their primary auditory complaint served as subjects. The THI was administered on two occasions (mean interval 20 days) using a paper-pencil format. Results support the contention that the THI is psychometrically robust. Specifically, the test–retest reliability/repeatability was high. Additionally, the 95 percent CI for the THI was 20-points, indicating that a 20-point or greater change had to occur from test to retest for a change to be considered statistically significant at the 5 percent confidence level. Quartiles calculated from raw scores were used to create a matrix of values representing tinnitus severity. We conclude that the THI is a brief, easily administered, and psychometrically robust measure that evaluates the impact of tinnitus on daily living.

**Key Words:** Efficacy, handicap, outcome, reliability, repeatability, tinnitus

**Abbreviations:** CI = confidence interval; DHI = Dizziness Handicap Inventory; HHIE/A = Hearing Handicap Inventory for the Elderly/Adults; $s_e$ = standard error of measurement; THI = Tinnitus Handicap Inventory; THQ = Tinnitus Handicap Questionnaire

Several self-report measures and open-ended problem questionnaires (Tyler, 1993) have been developed to assess an individual's reaction to tinnitus. In general, these tools were created to supplement the evaluation of tinnitus impairment (e.g., tinnitus pitch and loudness matching), as well as quantify the disabling consequences (e.g., sleep disturbance due to the tinnitus sensation[s]) and handicapping psychosocial impact of tinnitus (e.g., helplessness/frustration). Although a number of tinnitus instruments are available, many (1) lack internal consistency, (2) lack reliability and validity data, (3) measure a limited number of constructs, or (4) are difficult to score and interpret. Moreover, the application of tinnitus self-report measures for evaluating outcome following medical (e.g., Hulshof and Vermeij, 1985; Johnson et al, 1993), surgical (e.g., Souliere et al, 1992; Moller et al, 1993), and/or rehabilitative (e.g., Roeser and Price, 1980; Stouffer et al, 1991; Jastreboff and Hazell, 1993) intervention is further limited by the lack of available test–retest reliability data (Tyler, 1993). The need to demonstrate adequate retest reliability is important because clinicians must be assured that changes in perceived tinnitus handicap scores truly reflect management efforts, rather than a lack of reliability of the instrument itself.

One of the few measures for which test–retest data have been gathered is the Tinnitus Handicap Questionnaire (THQ; Kuk et al, 1990). Items on the THQ reflect an individual's physical, emotional, and social response to tinnitus (factor 1), the interfering effects of tinnitus on hearing ability (factor 2), and the patient's view of tinnitus (factor 3). In the

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standardization study, Kuk et al (1990) reported adequate internal consistency reliability for the total scale as well as construct validity of the questionnaire. In a subsequent study, Newman et al (1995) evaluated the retest stability of the THQ over a 6-week period. The latter investigators found high test–retest stability for factors 1 and 2, whereas factor 3 yielded inadequate retest stability. The authors suggested that only factors 1 and 2 be used for documenting changes in self-perceived tinnitus following intervention. Further, the patient response format employed for the THQ (choosing a number between 0 and 100 corresponding to subjective strength of belief for individual items) may be unwieldy or confusing to some patients (Steiner and Norman, 1994). Taken together, these observations suggest that this outcome measure may have limited usefulness.

Most recently, the Tinnitus Handicap Inventory (THI) was developed by Newman et al (1996). This investigation demonstrated that the THI was brief, easily administered and interpreted, broad in scope, and psychometrically robust. In this regard, the 25-item final version of the THI contained items relating to the functional, emotional, and catastrophic reactions to tinnitus. Analyses suggested that the THI had excellent internal consistency reliability (Cronbach's alpha = 0.93) and adequate convergent and construct validity. Retest reliability, however, was not evaluated in this initial report, thus limiting its applicability for measuring treatment outcome. Therefore, the present study was undertaken to expand the clinical usefulness of the THI by (1) assessing test–retest reliability/repeatability, (2) determining the 95 percent confidence intervals (CIs; critical difference scores) used for quantifying clinically significant test–retest differences for individual patients, and (3) developing handicap categories for classifying perceived tinnitus handicap severity.

## METHOD

### Subjects

Twenty-nine adults (13 men and 16 women) ranging in age from 23 to 87 years old participated (mean = 55.3; SD = 17.4). The subject sample was drawn from audiology outpatient clinics at The Cleveland Clinic Foundation and Henry Ford Hospital. Tinnitus was the primary complaint of each patient and the reason for scheduling audiology and otolaryngology appointments at each institution.

Table 1 summarizes the means and standard deviations (SDs) for the left and right ear air-conduction thresholds for the sample. Inspection of individual audiograms revealed that the majority of the subjects had a high-frequency, gradually sloping sensorineural hearing loss. All subjects had a normal otoscopic examination as determined by an otolaryngologist.

### Materials and Procedures

The THI is a 25-item self-report instrument grouped into three subscales (see Appendix for individual items and associated subscale labeling). The functional subscale (11 items) reflects role limitations in the areas of mental, social/occupational, and physical functioning. The emotional subscale (9 items) includes a broad range of affective reactions to tinnitus. The third subset of items (5 items) probes catastrophic responses to the symptoms of tinnitus. A *yes* response to an item is awarded 4 points, *sometimes,* 2 points, and *no,* 0 points. Accordingly, scores for the total scale range from 0 to 100, with

**Table 1 Means and SDs for Right and Left Ear Air-Conduction Thresholds (dB HL) for Subject Sample (N = 29)**

| | *Frequency (Hz)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Ear* | *250* | *500* | *1000* | *2000* | *3000* | *4000* | *6000* | *8000* |
| Right | | | | | | | | |
| Mean | 22.3 | 20.8 | 20.5 | 20.5 | 26.1 | 24.5 | 40.0 | 50.3 |
| SD | 16.4 | 16.2 | 12.0 | 14.7 | 16.9 | 19.6 | 21.2 | 24.3 |
| Left | | | | | | | | |
| Mean | 18.8 | 19.0 | 16.8 | 19.3 | 25.6 | 26.0 | 38.0 | 47.2 |
| SD | 13.4 | 12.0 | 11.2 | 11.7 | 17.2 | 19.7 | 16.0 | 18.9 |

higher scores representing greater perceived handicap.

All subjects were mailed the THI, along with a tinnitus case history questionnaire (modified from Stouffer and Tyler, 1990), following the scheduling of the initial appointment. Each subject was requested to complete both forms and return them in a self-addressed, stamped envelope prior to his or her clinical visit. The second administration of the THI (pencil-pencil format) was completed on the day of the scheduled appointment. It is worth noting that the second administration (retest) of the THI was completed prior to any audiologic testing, medical examination, or counseling by either the audiologist or otolaryngologist The mean length of time between the first and second administrations of the THI was 20 days (SD = 19).

## RESULTS

### Subject Characteristics

Eleven patients (38%) reported predominantly unilateral tinnitus and 18 (62%) reported bilateral tinnitus (including one patient reporting the tinnitus sensation "in the head"). The mean length of time that the patients reported having tinnitus was 6.0 years (SD = 8.1), whereas the average time that the patient had been "bothered" by tinnitus was 3.0 years (SD = 4.5). On average, the patients indicated that the tinnitus was present 90 percent of the time during waking hours. Table 2 shows the means, SDs, and ranges associated with responses to a 10-point tinnitus pitch and loudness rating scale. Also displayed in Table 2 are responses to a 100-point Symptom Rating Scale (Tyler, 1993) quantifying tinnitus annoyance, sleep disturbance, depression, concentration disturbance, and interference with speech understanding.

**Table 2 Means, SDs, and Ranges Associated with Responses to the Tinnitus (Pitch and Loudness) and Symptom Rating Scales**

| *Scale* | *Mean ± SD* | *Range of Scores* |
|---|---|---|
| Tinnitus ratings* | | |
| Pitch | 6.9 ± 2.8 | 1–10 |
| Loudness | 6.7 ± 2.8 | 1–10 |
| Symptom ratings† | | |
| Annoyance | 70.4 ± 31.6 | 0–100 |
| Sleep | 34.3 ± 39.6 | 0–100 |
| Depression | 36.1 ± 38.4 | 0–100 |
| Concentration | 43.2 ± 38.4 | 0–100 |
| Speech interference | 36.5 ± 33.0 | 0–100 |

*For pitch, 1 represented a very low-pitched foghorn and 10 represented a very high-pitched whistle; for loudness, 1 indicated very faint tinnitus and 10 represented very loud tinnitus; †for the Symptom Rating Scales, higher values were associated with greater tinnitus-related disturbance.
*Maximum score = 10; †maximum score = 100.

**Table 3 Mean, SD, and Range Values Associated with the Test–Retest Administrations of the Tinnitus Handicap Inventory (THI) Subscales and Total Scores (N = 29)**

| *THI* | *Test* | *Retest* |
|---|---|---|
| Functional* | | |
| Mean | 15.9 | 16.0 |
| SD | 11.8 | 12.4 |
| Range | 0–38 | 0–38 |
| Emotional† | | |
| Mean | 13.0 | 12.1 |
| SD | 10.1 | 10.2 |
| Range | 0–34 | 0–32 |
| Catastrophic response‡ | | |
| Mean | 8.2 | 8.9 |
| SD | 4.5 | 5.2 |
| Range | 0–16 | 0–20 |
| Total# | | |
| Mean | 37.1 | 37.1 |
| SD | 24.7 | 26.1 |
| Range | 0–88 | 4–90 |

*Maximum score = 44; †maximum score = 36; ‡maximum score = 20; #maximum score = 100.

### THI Scores

Table 3 summarizes the mean, standard deviation, and range values associated with the test and retest administrations of the THI. As is evident, the mean scores for the total and subscales were comparable between administrations ($p > .05$). The variability, as reflected by the standard deviations, was similar as well.

### Correlational Analysis

Pearson product-moment correlations were calculated between the first and second administrations in order to determine the extent to which patients maintained relative standing on total and subscale scores from test to retest. As shown in Table 4, the correlations between the test and retest values ranged from 0.84 to 0.94.

### Repeatability Plots

A graphical procedure for estimating test repeatability was performed. The coefficient of repeatability was determined for the total and

**Table 4 Correlation Coefficients, Standard Error ($s_e$) of Measurement, and 95% Confidence Intervals (CIs) Associated with the Test–Retest Administrations of the Tinnitus Handicap Inventory (THI) (N = 29)**

| | THI | | | |
|---|---|---|---|---|
| | *Functional* | *Emotional* | *Catastrophic* | *Total* |
| Test–retest correlation | 0.94 | 0.88 | 0.84 | 0.92 |
| $s_e$ | 2.9 | 3.5 | 1.8 | 7.0 |
| 95% CI | 8.2 | 9.9 | 5.1 | 19.8 |

subscales scores based on a statistical method described by Bland and Altman (Altman and Bland, 1983; Bland and Altman, 1986). Using this approach, the difference values between test and retest are plotted as a function of the mean test and retest scores for each subject. The underlying assumption is that the difference scores should be zero because the same measurement instrument was employed at both administrations without any intervening treatment. The mean of the test and retest scores provides the best estimate of the patient's true score (Bland and Altman, 1986). The derived plots, therefore, provide information about the relationships between measurement error and the true score for individual subjects. For an instrument to be considered repeatable, it is expected that 95 percent of the individual difference scores for the total sample should be within ±2 standard deviations of the zero difference score (British Standards Institution, 1981). Based on the assumption that the mean difference is zero, ±2 standard deviations of the difference scores (coefficient of repeatability) is calculated as follows:

$$\pm 2\sqrt{Di^2/n}$$

In this equation, $Di^2$ is the sum of the squared individual difference score (between test and retest) and n equals the total number of subjects in the sample. Using this equation, the repeatability coefficients for the THI were ±8.1, ±9.8, ±5.8, and ±19.5 for the functional, emotional, catastrophic response, and total scores, respectively. For the present data set (based on 95% of the sample size), no more than two test–retest differences scores should exceed the coefficient of repeatability. Figure 1 displays the scatterplots of the test—retest difference scores and means for the three subscales and total THI scores. As shown, less than two subjects' test–retest difference scores fell outside the coefficient of repeatability values (designated by the dashed ±2 SD bars) for the three subscales and total THI scores.

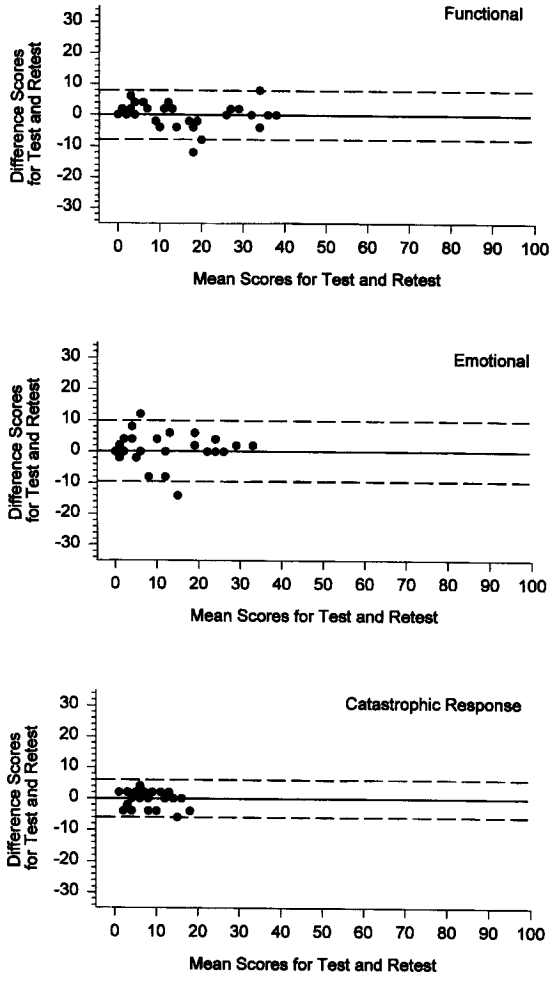


**Figure 1** Tinnitus Handicap Inventory test–retest difference scores plotted against mean test–retest scores for individual subjects for the functional, emotional, and catastrophic response subscales and total scale. The dashed lines represent ±2 SD of the difference values (coefficient of repeatability).

### Confidence Intervals

The standard error of measurement ($s_e$) for assessing differences between scores on two occasions and 95 percent CIs were computed as described by Demorest and Walden (1984). Table 4 displays the $s_e$ and 95 percent CI (or critical difference) values associated with the THI subscale and total scores. The CI value provides the clinician with an estimate as to whether a true change occurred between test and retest for a given patient. The $s_e$ values ranged from 1.8 to 7.0. Based on the CI estimates, pre- and postintervention total scores would have to differ by at least 20 points in order for clinical efforts to be considered effective.

### Handicap Severity Categories

Quartiles were calculated for the total THI score (mean test–retest) and were assigned handicap category designations in the following manner: first quartile = no handicap; second quartile = mild handicap; third quartile = moderate handicap; and fourth quartile = severe handicap. Table 5 shows the ranges of total scores associated with each handicap category. On the basis of these categories, seven subjects (24%) displayed no handicap, seven (24%) mild handicap, seven (24%%) moderate handicap, and eight (28%) severe handicap.

## DISCUSSION

In this era of accountability for health care in general (Bloom and Fischer, 1982; Ellwood, 1988; Relman, 1988) and audiology in particular (Erdman, 1993), increased emphasis is being placed on our ability to demonstrate the effectiveness of audiologic rehabilitation efforts. For example, self-report hearing handicap/disability measures have been shown to be effective clinical tools for documenting hearing aid fitting outcome (McCarthy, 1996; Weinstein, 1996). That is, differences between pre-and postintervention scores on handicap/disability scales (Cox and Alexander, 1995; Newman et al, 1991) have been considered indices of hearing aid benefit. One of our goals for developing the THI and for conducting this study was to devise a self-report tinnitus instrument that could be used as a criterion measure for evaluating treatment outcome for the number of tinnitus management approaches available to clinicians (e.g., drug therapy [Dobie et al, 1992], masking [Vernon and Schleuning, 1978; Vernon et al, 1980], habituation training [Jastreboff and Hazell, 1993; Hazell, 1995], and cognitive therapy [Sweetow, 1986]). To meet this expressed goal, it became necessary to evaluate the test–retest reliability of the THI. We acknowledge that several endogenous and exogenous factors potentially exist that can influence test–retest studies including mood, general health, motivation, concentration of the respondent, and test administration mode; however, it remains critical to demonstrate acceptable test reliability if clinical judgments are to be made regarding treatment efficacy.

High correlations were obtained between test and retest administrations of the total and subscale THI scores over approximately a 3-week interval. Each correlation exceeded the statistical criteria ($r > 0.80$) considered acceptable for clinical purposes (Nunnally, 1978). Whereas Pearson product-moment correlations provided a measure of the *strength* of the relationship between two administrations, repeatability plots allowed us to measure the *agreement* between administrations. The latter graphical approach (see Fig. 1) represents the test–retest difference score plotted against the mean test–retest THI scores, thus providing information about the relationship between measurement error and the true value. In the present study, each of the subscales and total THI met the criterion (95% of the observed differences falling within ±2 SD) established by the British Standards Institution (1981) for a test to be considered an acceptably repeatable clinical measure.

Additionally, the 95 percent CIs (critical difference scores) derived from the data provide useful information regarding significant changes in perceived handicap for individual subjects. That is, it is possible to quantify a true change in global perceived tinnitus (total score) and/or individual domains (subscale scores—functional, emotional, catastrophic response) between the pre- and post-treatment administrations of the inventory (see Table 4). A patient, however,

**Table 5 Ranges Associated with Handicap Categories for the Tinnitus Handicap Inventory (THI)**

| *Quartile* | *Category* | *Total THI* |
|---|---|---|
| 1st | No handicap | 0–16 |
| 2nd | Mild handicap | 18–36 |
| 3rd | Moderate handicap | 38–56 |
| 4th | Severe handicap | 58–100 |

would have to obtain an initial total score of at least 20 on the baseline administration in order to use the THI as an index of change (i.e., a floor effect would exist). That is, for a subject with an initial score < 20 points, it would not be possible to determine whether a significant improvement in function had occurred because of a floor effect. In the present data set, nine (31%) subjects had total THI scores on the initial administration < 20 points, precluding the use of the critical difference criterion for subsequent decision making about treatment outcome. Incidently, most of these scores would have been within the first quartile, indicating no tinnitus handicap. Alternatively, the severity categories developed (no handicap, mild, moderate, severe) can provide a straightforward method for clinicians to quantify changes in perceived handicap (movement from one category to another) over time with or without intervention.

The present study evaluated retest reliability of the THI rather than retest stability. That is, retest *reliability* is concerned with the magnitude of agreement beween two scores when the measurement interval is short (e.g., days, weeks), whereas retest *stability* denotes the magnitude of agreement between two scores when the measurement interval is of a longer duration (e.g., months). The decision to evaluate retest reliability (mean of 20 days between test and retest in the present study) was based on three considerations. First, the distressing nature of tinnitus for many of the subjects required that they be clinically evaluated as soon as possible after calling for an initial appointment. Accordingly, the initiation of treatment (including intial counseling by the audiologist and otologist during the first visit) was not delayed, resulting in a shorter time interval. Second, due to the possible fluctuating nature of tinnitus, it was important to have each patient make his or her judgments within a limited time window. Third, the interval between initiation of treatment and the assessment of the effects of treatment is often less than 1 month. For example, evaluating the relief from tinnitus provided by hearing aids, tinnitus maskers, or tinnitus instruments may need to be evaluated during the patient's 30-day right-to-return period for the device. Future studies should include retest stability of the THI so that judgments about treatment outcome requiring longer time intervals (e.g., habitution therapy, cognitive therapy) may be assessed with greater precision.

The THI was developed, in part, as a companion inventory to the Hearing Handicap Inventory for the Elderly/Adults (HHIE—Ventry and Weinstein, 1982; HHIA—Newman et al, 1990) and the Dizziness Handicap Inventory (DHI—Jacobson and Newman, 1990). The HHIE/HHIA evaluates the emotional (12 items) and social/situational (13 items) consequences of hearing impairment for elderly and young adults, respectively. The DHI assesses the functional (9 items), emotional (9 items), and physical (7 items) ramifications of balance function disorders. When used together, the 25-item measures (i.e., HHIE/HHIA, DHI, THI) form an audiologic/otologic self-report handicap battery (profile) that can be used to evaluate the outcome of clinical intervention. For example, Kinney et al (1997) found these measures useful for evaluating, over time, patients with Meniere's disease who have been treated either medically (e.g., salt-restricted diet and diuretics) or surgically (e.g., sac decompression, shunt, vestibular nerve section). Each of the handicap measures corresponds to the symptomatology of Meniere's disease (HHIE/HHIA—hearing, DHI—dizziness, and THI—tinnitus). Taken together, the handicap scales provide insight into the impact that Meniere's disease has on a patient's ability to function in daily life—information unable to be derived from traditional diagnostic auditory (e.g., audiometry, electrocochleography) and vestibular (e.g., electronystagmography, rotational testing) tests.

In conclusion, the THI is a brief, easily administered, reliable measure that evaluates the impact of tinnitus on daily living and the outcome of medical, surgical, and/or rehabilitative intervention. In light of the adequate retest reliability/repeatability and small $s_e$ observed for the THI, we believe that this instrument has excellent clinical usefulness for detecting changes in self-perceived tinnitus handicap following intervention. Moreover, the critical difference scores derived from the pre- and postadministrations of the inventory serve as criterion measures for documenting the effects of tinnitus management efforts. Future investigations should be designed to assess the stability of the instrument over several months in order to assess the feasibility of evaluating long-term treatment outcomes.

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## APPENDIX

**Instructions:** The purpose of this questionnaire is to identify problems your tinnitus may be causing you. Check **Yes, Sometimes,** or **No** for each question. Do not skip a question.

| | | **Yes** (4) | **Sometimes** (2) | **No** (0) |
|---|---|---|---|---|
| 1F. | Because of your tinnitus is it difficult for you to concentrate? | ___ | ___ | ___ |
| 2F. | Does the loudness of your tinnitus make it difficult for you to hear people? | ___ | ___ | ___ |
| 3E. | Does your tinnitus make you angry? | ___ | ___ | ___ |
| 4F. | Does your tinnitus make you feel confused? | ___ | ___ | ___ |
| 5C. | Because of your tinnitus do you feel desperate? | ___ | ___ | ___ |
| 6E. | Do you complain a great deal about your tinnitus? | ___ | ___ | ___ |
| 7F. | Because of your tinnitus do you have trouble falling to sleep at night? | ___ | ___ | ___ |
| 8C. | Do you feel as though you cannot escape your tinnitus? | ___ | ___ | ___ |
| 9F. | Does your tinnitus interfere with your ability to enjoy social activities (such as going out to dinner, to the movies)? | ___ | ___ | ___ |
| 10E. | Because of your tinnitus do you feel frustrated? | ___ | ___ | ___ |
| 11C. | Because of your tinnitus do you feel that you have a terrible disease? | ___ | ___ | ___ |
| 12F. | Does your tinnitus make it difficult for you to enjoy life? | ___ | ___ | ___ |
| 13F. | Does your tinnitus interfere with your job or household responsibilities? | ___ | ___ | ___ |
| 14F. | Because of your tinnitus do you find that you are often irritable? | ___ | ___ | ___ |
| 15F. | Because of your tinnitus is it difficult for you to read? | ___ | ___ | ___ |
| 16E. | Does your tinnitus make you upset? | ___ | ___ | ___ |
| 17E. | Do you feel that your tinnitus problem has placed stress on your relationship with members of your family and friends? | ___ | ___ | ___ |
| 18F. | Do you find it difficult to focus your attention away from your tinnitus and on other things? | ___ | ___ | ___ |
| 19C. | Do you feel that you have no control over your tinnitus? | ___ | ___ | ___ |
| 20F. | Because of your tinnitus do you often feel tired? | ___ | ___ | ___ |
| 21E. | Because of your tinnitus do you feel depressed? | ___ | ___ | ___ |
| 22E. | Does your tinnitus make you feel anxious? | ___ | ___ | ___ |
| 23C. | Do you feel that you can no longer cope with your tinnitus? | ___ | ___ | ___ |
| 24F. | Does your tinnitus get worse when you are under stress? | ___ | ___ | ___ |
| 25E. | Does your tinnitus make you feel insecure? | ___ | ___ | ___ |

*F denotes an item on the functional subscale; E, an item on the emotional subscale; and C, an item on the catastrophic response subscale.*