AJA

Research Article

Tinnitus and Hearing Survey: A Screening Tool to Differentiate Bothersome Tinnitus From Hearing Difficulties

James A. Henry,[a,b] Susan Griest,[a,b] Tara L. Zaugg,[a] Emily Thielman,[a] Christine Kaelin,[a] Gino Galvez,[a] and Kathleen F. Carlson[b,c]

Purpose: Individuals complaining of tinnitus often attribute hearing problems to the tinnitus. In such cases some (or all) of their reported "tinnitus distress" may in fact be caused by trouble communicating due to hearing problems. We developed the Tinnitus and Hearing Survey (THS) as a tool to rapidly differentiate hearing problems from tinnitus problems.
Method: For 2 of our research studies, we administered the THS twice (mean of 16.5 days between tests) to 67 participants who did not receive intervention. These data allow for measures of statistical validation of the THS.
Results: Reliability of the THS was good to excellent regarding internal consistency (α = .86–.94), test–retest reliability (r = .76–.83), and convergent validity between the Tinnitus Handicap Inventory (Newman, Jacobson, & Spitzer, 1996; Newman, Sandridge, & Jacobson, 1998) and the A (Tinnitus) subscale of the THS (r = .78). Factor analysis confirmed that the 2 subscales, A (Tinnitus) and B (Hearing), have strong internal structure, explaining 71.7% of the total variance, and low correlation with each other (r = .46), resulting in a small amount of shared variance (21%).
Conclusion: These results provide evidence that the THS is statistically validated and reliable for use in assisting patients and clinicians in quickly (and collaboratively) determining whether intervention for tinnitus is appropriate.

Tinnitus has been defined as head or ear noise lasting at least 5 min and occurring more than once a week (Dauman & Tyler, 1992). For most people who have tinnitus, the sound is constant or near-constant. Epidemiologic studies reveal that tinnitus is experienced by 10%–15% of the adult populations in different countries (Heller, 2003; Hoffman & Reed, 2004; Shargorodsky, Curhan, & Farwell, 2010). It is often reported that for about 80% of those who experience tinnitus, the tinnitus is not particularly bothersome, and clinical intervention for the tinnitus is not required (Cima, Vlaeyen, Maes, Joore, & Anteunis, 2011; Davis & Refaie, 2000; Jastreboff & Hazell, 1998; Krog, Engdahl, & Tambs, 2010). When intervention for tinnitus is desired by, and appropriate for, a given patient, the amount of intervention provided should depend on the individual's specific needs (Henry, Schechter, et al., 2005; Tyler & Baker, 1983).

Dobie's (2004) multilevel pyramid analogy is helpful in conceptualizing how tinnitus affects people differently (see Figure 1). The base of the pyramid contains those who have tinnitus but are not bothered by it. The next higher level contains people whose tinnitus is "bothersome," ranging from "mild" to "moderate" to "severe." The tip of the pyramid contains those relatively few individuals who are "debilitated" by their tinnitus. This pyramid analogy highlights the fact that most people who experience tinnitus do not need clinical intervention specific to the tinnitus. Those who do differ widely with respect to their clinical needs, ranging from answering a few questions (e.g., they want assurance that their tinnitus does not reflect some serious disease) to providing months/years of clinical services (Henry, Schechter, et al., 2005). A challenge for clinicians is knowing how to communicate effectively with patients so that, collaboratively, they can determine where the patient is located within this conceptualized pyramid in order to assess whether a tinnitus-specific intervention is needed.

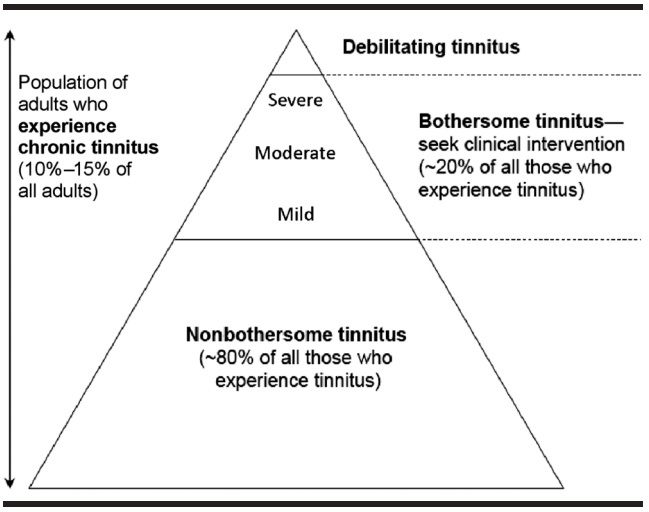
It is well known that the presence of tinnitus indicates a high probability of comorbid hearing loss (Coles, 2000; Hoare, Edmondson-Jones, Sereda, Akeroyd, & Hall, 2014). Because of this correlation, a complication when evaluating

[a]Veterans Affairs Portland Health Care System, Rehabilitation Research & Development Service, National Center for Rehabilitative Auditory Research, Portland, OR
[b]Oregon Health & Science University, Portland
[c]Veterans Affairs Portland Health Care System, Health Services Research & Development Service, Center of Innovation, Portland, OR
Correspondence to James A. Henry: james.henry@va.gov

Editor and Associate Editor: Larry Humes
Received August 29, 2014
Revision received November 15, 2014
Accepted November 21, 2014
DOI: 10.1044/2014_AJA-14-0042

Disclosure: *The authors have declared that no competing interests existed at the time of publication.*

Figure 1. The "tinnitus pyramid" (as originally conceptualized by Dobie, 2004; the graphic depicted here is original artwork by the authors of the current article, based on Dobie's "tinnitus pyramid" concept). As a conceptual rendering, the pyramid includes the entire population of adults who experience chronic tinnitus. The majority of these people (in the lower part of the pyramid) are not particularly bothered by it. Many of these people only want assurance that their tinnitus does not reflect some serious medical condition. Relatively few have tinnitus that requires some degree of clinical intervention (bothersome tinnitus). A very small fraction has "debilitating" tinnitus (in the tip of the pyramid).



patients for a reported tinnitus problem is determining how much of the complaint about tinnitus may be due to hearing problems. Clinicians typically use tinnitus-severity questionnaires, and it is generally assumed that patients' responses to these questionnaires indicate effects due to tinnitus. However, tinnitus questionnaires commonly contain questions that can elicit responses pertaining primarily to distress from communication problems caused by hearing loss or auditory processing problems. Examples of these types of questions include effects of tinnitus on social activities and/or relationships, enjoyment of life, performance at work, and communication, as well as ratings of emotional reactions due to tinnitus such as annoyance, frustration, and irritability.

Studies using tinnitus-severity questionnaires have reported that individuals with hearing loss have more severe reactions to tinnitus than those with normal hearing (Savastano, 2008; Yenigün, Doğan, Aksoy, Akyüz, & Dabak, 2014). One study has even reported that the degree of tinnitus impact increases with the degree of hearing loss (Mazurek, Olze, Haupt, & Szczepek, 2010). Further, numerous studies have reported that provision of hearing aids for patients with bothersome tinnitus tends to mitigate their reactions to tinnitus (McNeill, Tavora-Vieira, Alnafjan, Searchfield, & Welch, 2012; Searchfield, Kaur, & Martin, 2010; Shekhawat, Searchfield, & Stinear, 2013). The conclusions from all of these studies are based on the assumption that scores on the tinnitus questionnaires indicate distress due to tinnitus alone.

It has been posited by several researchers that many people with bothersome tinnitus commonly (and erroneously) attribute their hearing difficulties to the tinnitus (Coles, 1995; Dobie, 2004; Zaugg, Schechter, Fausti, & Henry, 2002). However, only Ratnayake, Jayarajan, and Bartlett (2009) prospectively and systematically studied the link between hearing loss and distress reportedly due to tinnitus. These authors provided results from 96 patients with a primary complaint of tinnitus. A significant correlation was found between the hearing thresholds in the better hearing ear and responses to a subset of the Tinnitus Handicap Inventory (THI) that focuses on communication (Newman, Jacobson, & Spitzer, 1996; Newman, Sandridge, & Jacobson, 1998). The same subset of the THI was also found to correlate significantly with the overall score on the THI. Newman et al. (1998) concluded that "in tinnitus subjects, the awareness of impaired hearing may in fact be due to an underlying hearing loss rather than their tinnitus. In these cases, the impairment of hearing may contribute significantly to the perceived distress caused by the tinnitus" (p. 159). Their conclusion supports the premise that responses to tinnitus questionnaires may indicate distress from some combination of tinnitus and hearing problems.

It is essential to separate tinnitus problems from hearing problems when making decisions about intervention that might be needed for a patient. Some interventions for tinnitus do not address hearing problems, which may be the primary contributor to a patient's distress as reported on a tinnitus questionnaire. Both the clinician and patient should understand how much of the distress is rooted in hearing problems versus reactions to tinnitus. With this understanding, options for intervention can be realistically discussed while acknowledging which options will be helpful for each problem.

For these reasons, we developed a brief screening tool, the Tinnitus and Hearing Survey (THS), to assist in determining how much of a patient's complaint about tinnitus is due to a hearing problem and how much is due specifically to the tinnitus (Henry, Zaugg, Myers, & Kendall, 2010). Since its development, the THS has been used to help in determining candidacy for tinnitus-specific clinical intervention and to telephone-screen potential candidates for our tinnitus clinical trials (Henry, Frederick, Sell, Griest, & Abrams, 2015; Henry, Zaugg, et al., 2012; Myers et al., 2014). Anecdotally, the THS has functioned successfully for these purposes. Because sound tolerance problems (*hyperacusis*) are often reported by patients with tinnitus (Dauman & Bouscau-Faure, 2005; Nelson & Chen, 2004; Tyler & Conrad-Armes, 1983), we added two items to the THS to screen for problems with sound tolerance.

In this article, we describe the THS with respect to its construction and its test–retest reliability and other basic psychometric properties. We conclude with specific suggestions for using the THS as a clinical tool to determine a patient's candidacy for receiving tinnitus-specific intervention.

Method

Construction of the THS

The conceptualized design for the THS was for it to contain two short lists of items: (a) commonly experienced

tinnitus problems that would not be confounded by hearing problems, and (b) commonly experienced hearing problems that would not be confounded by tinnitus complaints. Its construction resulted in three sections/subscales (A, B, and C; see Figure 2). Section A consists of four items that address common tinnitus problems, including difficulty sleeping, concentrating, relaxing, and focusing attention away from the tinnitus. Section B contains four items that address hearing in a background of noise and understanding speech from TV/movies, soft voices, and group conversations. Responses for Sections A and B can range from 0 (*not a problem*) to 4 (*very big problem*). Consequently, the total score for each section can range from 0 to 16. Section C, which includes two items, was designed within the context of progressive tinnitus management (PTM) to identify individuals who would not be able to attend group education (the primary intervention provided with PTM) due to a severe sound tolerance problem (Henry et al., 2010; Henry, Zaugg, Myers, & Schechter, 2008). Section C was not the focus of the present investigation. Nonetheless, test–retest

Figure 2. Tinnitus and Hearing Survey (THS). The THS contains three sections. Section A contains items that are specific to effects of tinnitus that would not be confused with hearing problems. Section B contains items that ask about common hearing problems that would not be confused with tinnitus problems. Section C asks about sound tolerance problems (hyperacusis).

Tinnitus and Hearing Survey

	No, **not** a problem	Yes, a **small** problem	Yes, a **moderate** problem	Yes, a **big** problem	Yes, a **very big** problem	
A. Tinnitus						
Over the last week, tinnitus kept me from sleeping.	0	1	2	3	4	
Over the last week, tinnitus kept me from concentrating on reading.	0	1	2	3	4	
Over the last week, tinnitus kept me from relaxing.	0	1	2	3	4	
Over the last week, I couldn't get my mind off of my tinnitus.	0	1	2	3	4	
		Total of each column				Grand Total
B. Hearing						
Over the last week, I couldn't understand what others were saying in noisy or crowded places.	0	1	2	3	4	
Over the last week, I couldn't understand what people were saying on TV or in movies.	0	1	2	3	4	
Over the last week, I couldn't understand people with soft voices.	0	1	2	3	4	
Over the last week, I couldn't understand what was being said in group conversations.	0	1	2	3	4	
		Total of each column				Grand Total
C. Sound Tolerance						
Over the last week, everyday sounds were too loud for me.*	0	1	2	3	4	
If you responded 1, 2, 3, or 4 to the statement above:						
Being in a meeting with five to 10 people would be too loud for me.*	0	1	2	3	4	

*If sounds are too loud for you when wearing hearing aids, please tell your audiologist.

reliability results from Section C were analyzed and are reported herein.

The items in each of the three sections begin with the phrase "Over the last week . . . ." This phrase was added so that respondents would consider their recent history with tinnitus, rather than their entire history (potentially many years) and/or the time when their tinnitus was the most bothersome. The concern is not so much to assess problems experienced during the exact timeframe of the prior week but to assess a current problem (U.S. Department of Health and Human Services, 2006). As an example, using an open-ended timeframe would make it difficult to assess something that may have been a big problem once but is not currently much of a problem.

Sources of THS Test–Retest Reliability Data

Two of our studies provided the opportunity to evaluate test–retest reliability and basic psychometric properties of the THS. For these studies, research participants were administered the THS twice over a period of several weeks providing data to evaluate the stability of the THS through test–retest reliability (Newman, Sandridge, & Jacobson, 2014). Administration of the two tests for each participant was intended to be 1–4 weeks apart, with no tinnitus intervention occurring during this interval (each of these studies involved tinnitus assessment only). For Study 1 (National Institute on Deafness and Other Communication Disorders Grant 1R03DC009012-01A1), 24 participants were tested twice with the THS. The mean interval between tests was 16.5 days (*SD* = 6.1; range = 14–41). For Study 2 (Veterans Affairs Rehabilitation Research and Development Service Grant C4698R), 43 participants were tested twice with the THS, with a mean interval of 15.6 days (*SD* = 5.4; range = 9–42) between tests. These studies were approved by the Institutional Review Board at the Veterans Affairs Portland Health Care System. All participants completed informed consent procedures and were paid for their participation.

Sixty-seven participants (24 from Study 1 and 43 from Study 2) were included in the present analysis. Mean age of participants was 57 years (*SD* = 14.3; range = 24–83). They were predominantly White (90%), males (88%), with the majority (76%) reporting some college education (see Table 1). Seventy-eight percent indicated military veteran status, with 19% service-connected for tinnitus and 15% service-connected for hearing loss ("service connection" indicates assignment of a disability award by the Veterans Benefits Administration). Perceived location of tinnitus was varied, with 61% reporting bilateral tinnitus (of which 22% reported tinnitus in the head and ears), 17% reporting unilateral tinnitus, and 22% who perceived tinnitus to be only in their head. The duration of tinnitus ranged from less than 1 year to more than 20 years, with the majority (58%) experiencing tinnitus for more than 10 years. Number of reported tinnitus sounds ranged from one (53%) to more than three (25%), and tinnitus severity ranged from *not a problem* (8%) to *big problem* or *very big problem* (29%). Mean score on the THI (Newman et al., 1996, 1998) on a scale of 0–100 was 30.7 (*SD* = 21.8; range = 2–90).

Table 1. Demographic characteristics of participants, study groups combined.

Demographic characteristic	Study groups combined (*n* = 67)
Age, *M* (*SD*)	57.1 (14.3)
Ethnicity, %	
Non-White	10
White	90
Gender, %	
Male	88
Female	12
Education, %	
Completed less than high school	6
Completed high school	18
Some college or vocational school	37
Completed college	39
Veteran, %	
No	22
Yes	78
Service-connected for tinnitus	19
Service-connected for hearing loss	15
Tinnitus localization,* %	
One ear only	17
Both ears	39
In head only	22
Both ears and in head	22
Tinnitus duration, %	
<1 year	2
1–2 years	3
3–5 years	13
6–10 years	24
11–20 years	22
>20 years	36
Number of reported tinnitus sounds,* %	
One sound	53
Two sounds	19
Three or more sounds	25
Unsure	3
Tinnitus problem, %	
Not a problem	8
Small problem	15
Moderate problem	48
Big problem	28
Very big problem	1
Tinnitus Handicap Inventory,* *M* (*SD*)	30.7 (21.8)

*Significant difference between two study groups; $p \leq .004$ Bonferroni correction (.05/12 tests).

Data Analysis

Analyses were conducted to evaluate the psychometric properties of the THS, specifically the consistency, stability, and validity of the instrument. Test–retest reliability, using Pearson product-moment correlations, was evaluated for each of the subscales, Tinnitus (Section A) and Hearing (Section B) complaints, across study groups and with study groups combined. Criteria provided by Fleiss (1981) were used to evaluate strength of correlation—coefficients more than .75 are classified as "excellent," coefficients between .40 and .75 are classified as "fair" to

"good," and coefficients less than .40 are classified as "poor." In addition, stability of responses from Test 1 to Test 2 was compared across individual item responses and total subscale scores.

Internal consistency reliability was conducted using Cronbach's alpha, which reflects whether responses to the items are intercorrelated and the extent to which items within a subscale measure the same concept or construct. Nunnally and Bernstein (1994) recommended that reliability estimates of at least .70 in the early stages of predictive validation research are desirable. George and Mallery (2003) suggested that coefficients greater than .9 are classified as "excellent," greater than .8 are classified as "good," greater than .7 are classified as "acceptable," greater than .6 are classified as "questionable," greater than .5 are classified as "poor," and less than .5 are classified as "unacceptable." Validity regarding the internal structure of the THS was provided by factor analysis of the items within the A (Tinnitus) and B (Hearing) subscales. Principal Axis Factoring with oblique rotation was chosen to account for covariation among the factors. Convergent validity was assessed using Pearson product-moment correlation between the A (Tinnitus) subscale of the THS and the THI, which was completed by all participants.

Results

THS Subscales, A (Tinnitus) and B (Hearing) for Test–Retest Participants (Studies 1 and 2)

Demographic characteristics of participants in the combined study group are shown in Table 1. Chi-square analysis and independent *t* tests were performed to detect potential differences in demographic characteristics across the two study groups. Based on a Bonferroni correction for multiple comparisons (12 items/.05 = $p \leq .004$), three characteristics were found to be significantly different between the two groups. Study 1 participants tended to have more complex tinnitus (43% with three or more tinnitus sounds compared to 16% for Study 2 participants) and more problematic tinnitus (54% with *big problem* or *very big problem* compared to 16% for Study 2 participants). Mean THI scores were also different between the two groups (41.6 for Study 1 compared to 24.6 for Study 2).

Table 2 presents the means, standard deviations, and ranges for the THS subscales at each time period by study group and groups combined. There were no significant differences in the THS subscale means from Time 1 to Time 2 across study groups or groups combined. However, significant differences between the two study groups were found. Study 1 participants (with "bothersome" tinnitus) had higher mean scores than Study 2 participants (for which "bothersome" tinnitus was irrelevant) on both the Section A (Tinnitus) subscale (5.8 vs. 2.6) and the Section B (Hearing) subscale (11.4 vs. 7.3).

Test–retest reliability. In Figure 3, scatterplots for the A (Tinnitus) and B (Hearing) subscales (Time 1 vs. Time 2) are displayed for the combined group. Table 3 displays test–retest reliability for each THS item in the A (Tinnitus) and B (Hearing) subscales. According to criteria provided by Fleiss (1981), two of the eight items show correlation coefficients within the "excellent" range with the remaining items falling within the "good" range. Table 4 shows test–retest reliability for each of the A and B subscales by study group and groups combined. The A (Tinnitus) subscale demonstrates "excellent" test–retest reliability for each of the study groups and for the groups combined. The B (Hearing) subscale shows "good" reliability for each of the study groups and "excellent" reliability for the groups combined.

Consistency of responses. Table 3 presents the consistency of item responses from Time 1 to Time 2 for individual THS items in the A (Tinnitus) and B (Hearing) subscales for the groups combined. Differences between Time 1 and Time 2 were calculated and then categorized into three groups: "no difference," "±1 point difference," and ">1 point difference." The majority of participants showed "no difference" in their responses from Time 1 to Time 2 (43%–69%) across the individual items of the two subscales. Approximately one third of the participants showed stability within ±1 point, and a small percentage (1%–16%) presented differences >1 point between Time 1 and Time 2.

Table 4 shows consistency of responses for the total score of each of the A and B subscales broken down by study group and groups combined. Because the range of scores for the total subscales is greater compared to the individual items, differences between Time 1 and Time 2 were categorized into "no difference," "±2 points," and ">2 points." In general, the A (Tinnitus) and B (Hearing) subscales showed good consistency, with the A subscale showing greater consistency compared to the B subscale for the study groups and for the groups combined. Eighty percent of the combined group showed consistency within ±2 points for the A subscale. Sixty-two percent of the combined group showed consistency within ±2 points for the B subscale.

Internal reliability. Internal consistency reliability was good to excellent (coefficient alpha ranging from .80 to .95) for the A (Tinnitus) and B (Hearing) subscales across study groups and with groups combined, reflecting good internal consistency of responses and relationships among scale items (see Table 4).

Validity of internal structure. Factor analysis was applied to determine the factor structure among the eight items within the A (Tinnitus) and B (Hearing) subscales of the THS. Principal Axis Factoring with oblique rotation was chosen to account for covariation among the factors. Table 5 shows the pattern matrix for the factor analysis when applied to the eight items. Two distinct factors emerged (eigenvalues ≥ 1), corroborating previously developed subscales. These two factors explained 71.7% of the variance. They also showed low correlation to one another ($r = .46$), indicating a small amount of shared variance (21%).

Convergent validity. High correlation was found between the THS A (Tinnitus) subscale and the 25-item THI

Table 2. Means, standard deviations, and ranges for A (Tinnitus) and B (Hearing) subscales by study and combined groups, Time 1 and Time 2.

Study group	Time 1		Time 2		Time 1 vs. Time 2
	M (*SD*)	Range	*M* (*SD*)	Range	(*p* value)
Study 1 group (*n* = 24)					
A (Tinnitus) subscale total score	5.8 (3.6)*	0–12	6.5 (3.8)	0–12	*ns*
B (Hearing) subscale total score	11.4 (3.2)*	4–16	10.7 (3.9)	0–16	*ns*
Study 2 group (*n* = 43)					
A (Tinnitus) subscale total score	2.6 (3.2)	0–11	1.9 (2.8)	0–10	*ns*
B (Hearing) subscale total score	7.3 (4.8)	0–16	7.1 (5.2)	0–16	*ns*
Combined group (*n* = 67)					
A (Tinnitus) subscale total score	3.8 (3.7)	0–12	3.6 (3.9)	0–12	*ns*
B (Hearing) subscale total score	8.8 (4.7)	0–16	8.4 (5.1)	0–16	*ns*

*Significant difference between two study groups; $p \leq .02$ Bonferroni correction (.05/3 tests).

($r = .78$, $p < .0001$). Due to this being a secondary data analysis, a similar questionnaire to assess convergent validity of the THS B (Hearing) subscale was not available.

Section C: Sound Tolerance for Test–Retest Participants (Studies 1 and 2)

Section C of the THS contains two items designed to screen for a sound tolerance problem (hyperacusis). The initial item asks whether "everyday sounds" are "too loud." If the response is "yes" (to any degree), then a second item is completed, which determines whether "being in a meeting with 5–10 people would be too loud." Although not the express purpose of the present study, we evaluated the test–retest reliability of these two items. In Figure 4, scatterplots (Time 1 vs. Time 2) of the two Section C items are displayed for the combined group. Table 6 presents the means, standard deviations, and ranges for Section C items at each time period for the Study 1 and Study 2 groups combined. There were no significant differences in item means from Time 1 to Time 2. Test–retest coefficients for the two items fell within the fair-to-good range of reliability (.48 for Item 1 and .61 for Item 2).

Discussion

The results of this study confirmed, through various psychometric analyses, that the THS is a valid and reliable

Figure 3. Scatterplots for Tinnitus and Hearing Survey subscales, Time 1 versus Time 2. Subscales A (Tinnitus) and B (Hearing).

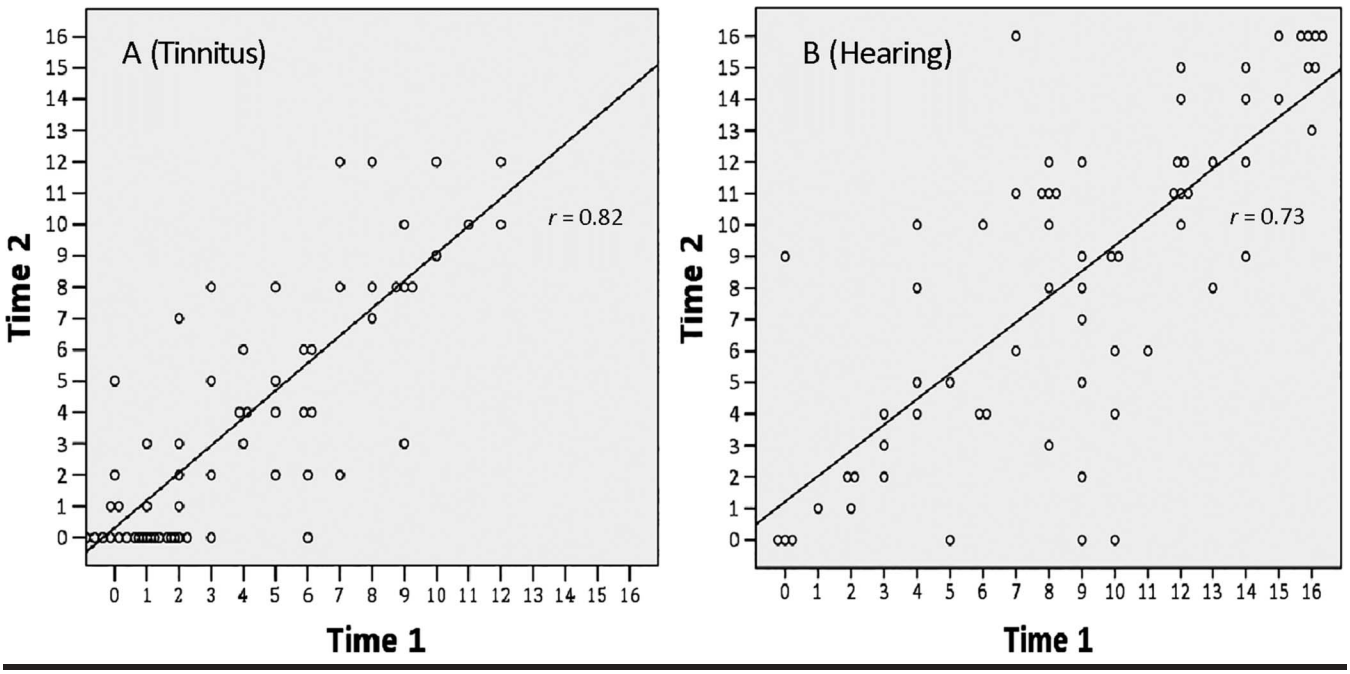


Table 3. Test–retest reliability and consistency of responses for individual items of the A (Tinnitus) and B (Hearing) subscales, combined group.

Response item	Test–retest reliability		Consistency of responses		
	Pearson's *r*	Class	No difference	±1 point	>1 point
A (Tinnitus) subscale individual items					
Over the last week					
Tinnitus kept me from sleeping.	.84	Excellent	46 (69%)	20 (30%)	1 (1%)
Tinnitus kept me from concentrating on reading.	.65	Good	39 (58%)	20 (30%)	8 (12%)
Tinnitus kept me from relaxing.	.74	Good	42 (63%)	20 (30%)	5 (7%)
I couldn't get my mind off tinnitus.	.68	Good	38 (57%)	21 (31%)	8 (12%)
B (Hearing) subscale items					
Over the last week					
I couldn't understand what others were saying in noisy or crowded places.	.69	Good	38 (57%)	21 (31%)	8 (12%)
I couldn't understand what people were saying on TV or in movies.	.70	Good	36 (54%)	20 (30%)	11 (16%)
I couldn't understand people with soft voices	.68	Good	29 (43%)	30 (45%)	8 (12%)
I couldn't understand what was being said in group conversations.	.75	Excellent	27 (55%)	21 (31%)	9 (14%)

clinical tool. Factor analysis confirmed that the internal structures of the two THS subscales, A (Tinnitus) and B (Hearing), are valid, showing strong correlations among the items within each subscale (see Table 5). The total explained variance of the two subscales was 71.7%, and correlation between the two subscales was low (r = .46), indicating a small amount of shared variance (21%). The small amount of shared variance between the two subscales validates that they are measuring two different constructs (i.e., problems due to tinnitus vs. problems hearing). The reliability of the THS was shown to be good to excellent through measurement of internal consistency (α = .86 and .94 for A and B subscales, respectively), test–retest reliability (r = .83 and .76 for A and B subscales, respectively; see Table 4), and convergent validity between the THI and the A (Tinnitus) subscale (r = .78). These results provide strong evidence that the THS is statistically validated and reliable for use in assisting patients and clinicians in quickly and collaboratively determining whether intervention for tinnitus is appropriate.

We have used the THS since 2008 to identify appropriate candidates for participation in our tinnitus clinical trials (Henry et al., 2008). The THS has been useful when used in telephone screening, not only for providing qualifying scores for participation in research but also to serve as a framework for guiding a conversation between screener and caller that efficiently separates hearing issues from tinnitus issues, leaving both feeling confident that the right decision was made regarding participation in the study.

The THS was developed originally without statistical validation for our use to aid in recruiting appropriate research participants. It has functioned well for this purpose. We subsequently introduced it to clinical audiologists who provided favorable reports concerning its use with patients. The clinical interest beyond our research use of the THS indicated the need to document its psychometric properties for validation purposes. Participants in two separate studies at the Veterans Affairs Portland Health Care System each completed the THS on two occasions, enabling an assessment of its test–retest reliability. Study 1 required that participants were at least "moderately bothered" by their tinnitus (Henry, Galvez, et al., 2012). Study 2 did not require "bothersome" tinnitus but only that the tinnitus perception was chronic and "measurable" using equipment we developed to perform a tinnitus psychoacoustic assessment (Henry et al., 2013). These differences between cohorts were evident in that the Study 1 participants had more "complex" tinnitus, more "problematic" tinnitus, and higher THI index scores than the Study 2 participants (see Table 1). Additionally, the Study 1 participants had significantly greater

Table 4. Test–retest reliability, consistency of responses, and internal reliability for A (Tinnitus) and B (Hearing) subscales by study and combined groups.

Study group	Test–retest reliability		Consistency of responses			Internal reliability
	Pearson's *r*	Class	No difference	±2 points	>2 points	(Cronbach's α)
Study 1 group (n = 24)						
A (Tinnitus) subscale total score	.82	Excellent	6 (25%)	14 (58%)	4 (17%)	.80
B (Hearing) subscale total score	.73	Good	5 (21%)	13 (54%)	6 (25%)	.84
Study 2 group (n = 43)						
A (Tinnitus) subscale total score	.77	Excellent	19 (45%)	15 (36%)	8 (19%)	.85
B (Hearing) subscale total score	.71	Good	13 (31%)	11 (26%)	18 (42%)	.95
Combined group (n = 67)						
A (Tinnitus) subscale total score	.83	Excellent	25 (37%)	29 (43%)	12 (20%)	.86
B (Hearing) subscale total score	.76	Excellent	18 (27%)	24 (35%)	23 (38%)	.94

Table 5. Results of two-factor solution, principal-axis factor analysis with oblique rotation of eight items from A (Tinnitus) and B (Hearing) subscales, Study 1 and Study 2 groups combined.

Response item	Pattern matrix factor loadings	
	A (Tinnitus)	B (Hearing)
Tinnitus kept me from sleeping.	**.537**	.139
Tinnitus kept me from concentrating on reading.	**.800**	.065
Tinnitus kept me from relaxing.	**.908**	–.100
I couldn't get my mind off tinnitus.	**.846**	–.041
I couldn't understand what others were saying in noisy or crowded places.	.076	**.845**
I couldn't understand what people were saying on TV or in movies.	–.048	**.910**
I couldn't understand people with soft voices.	.013	**.890**
I couldn't understand what was being said in group conversations.	–.006	**.887**

Note. Values in bold represent the items that have the strongest correlation within each of the two factors.

scores on both the Tinnitus (Section A) and Hearing (Section B) subscales (see Table 2).

Whereas the two cohorts differed with respect to these variables, the differences did not affect the psychometric properties of the THS. More specifically, the within-group differences were not significantly different between Time 1 and Time 2 (see Table 2) for either of the cohorts. It was therefore reasonable to combine cohorts to provide test–retest reliability data from the combined group of participants (n = 67). This analysis showed that the individual items (see Table 3) and the two subscales (see Table 4) all provided "good" or "excellent" reliability. Thus, by combining the two somewhat disparate groups, the present study was strengthened by providing a wider representation of study participants than would have been achieved with a single study sample.

Clinical Application of the THS

We have incorporated the THS into PTM to assist clinicians and patients with collaboratively determining whether intervention for tinnitus is appropriate at the time of a standard audiologic evaluation (Henry et al., 2010). For the patient with tinnitus, results of an audiometric assessment combined with administration of the THS will normally provide all the information needed to determine whether the patient requires tinnitus-specific intervention. This assessment protocol is used within PTM but is appropriate for other

Figure 4. Scatterplots for Tinnitus and Hearing Survey Sound Tolerance items, Time 1 versus Time 2. A (Item 1): "Everyday sounds were too loud for me." B (Item 2): "Being in a meeting with 5–10 people would be too loud for me."

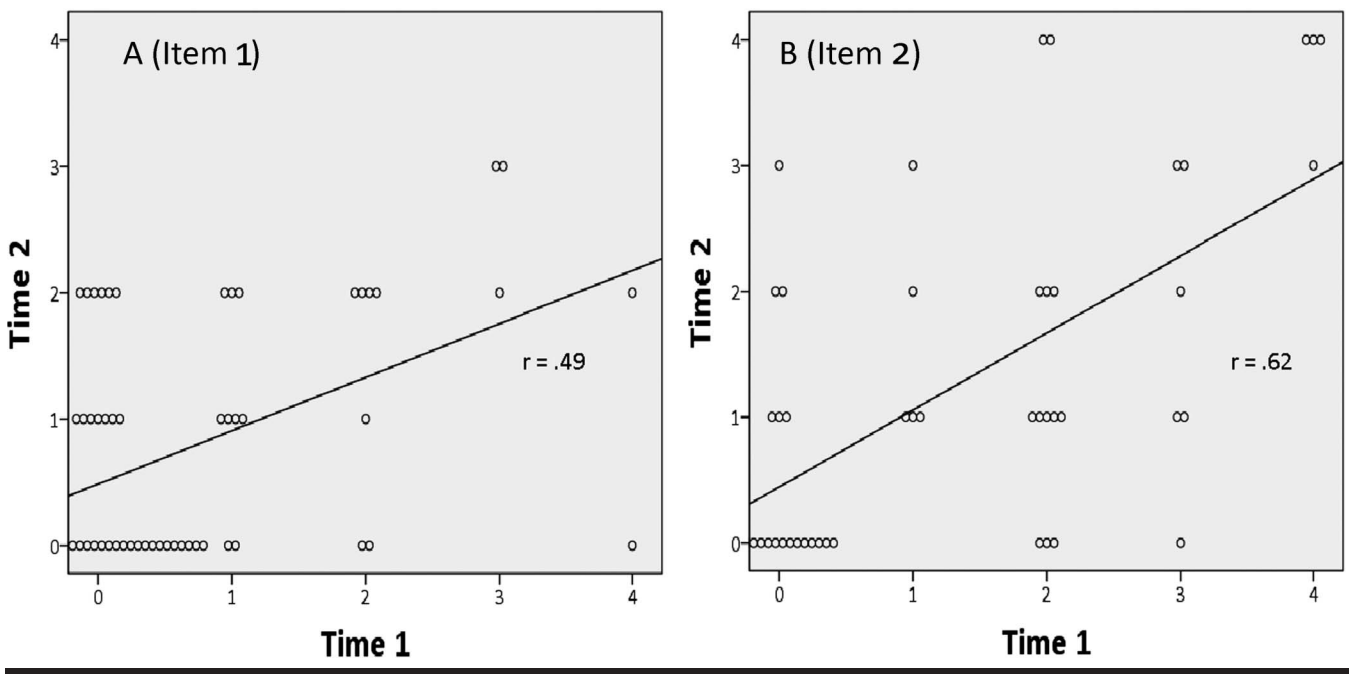


Table 6. Results of Tinnitus and Hearing Survey Section C (Sound Tolerance) individual items for Study 1 and Study 2 groups combined.

Response item	*N*	*M* (*SD*)	Minimum	Maximum	Pearson's *r*
Time 1: Over the last week, everyday sounds were too loud for me.	65	0.62 (1.06)	0	4	.49
Time 2: Over the last week, everyday sounds were too loud for me.	65	0.75 (0.92)	0	3	
Time 1: Being in a meeting with five to 10 people would be too loud for me.	58	1.16 (1.32)	0	4	.62
Time 2: Being in a meeting with five to 10 people would be too loud for me.	57	1.23 (1.32)	0	4	

methods of tinnitus intervention that are geared toward changing reactions to tinnitus. It should be mentioned that use of the THS is intended for clinicians who have knowledge of both tinnitus and hearing problems and how they interact, and who work in an environment where appropriate services for both problems are available either on-site or by referral. Such clinicians would normally be audiologists, although some mental health providers, otolaryngologists, and other clinicians would also be qualified to use the THS.

If intervention for tinnitus is indicated, it would then be appropriate to administer a questionnaire that can be used to establish a baseline before beginning intervention and postintervention to assess outcomes. We advocate use of the Tinnitus Functional Index (TFI; Meikle et al., 2012) for this purpose because it is the only tinnitus questionnaire validated for sensitivity to changes in tinnitus distress resulting from intervention (i.e., "responsiveness"). It might be questioned why the TFI (or any tinnitus questionnaire) would not be part of the initial assessment, along with audiologic testing and the THS. As explained previously, many patients with both hearing problems and tinnitus ascribe the hearing problems to the tinnitus. When responding to questions about effects of tinnitus, some responses will be exaggerated due to this misconception, resulting in a questionnaire index score that is spuriously high. Although the TFI is validated for assessing responsiveness, it is nevertheless vulnerable to influence from hearing problems, which makes it problematic for use in determining need for intervention specific to tinnitus.

Administering the THS. The four items in the A (Tinnitus) subscale describe common problems with tinnitus that are unrelated to hearing problems. The four items in the B (Hearing) subscale describe common hearing problems that would not be associated with the perception of, or reactions to, tinnitus. Step-by-step instructions for using the THS to determine candidacy for intervention for tinnitus are as follows. With the patient's completed THS in view,

1. Explain that tinnitus intervention that is offered can help with the problems in Section A.
2. Explain that the tinnitus intervention that is offered would not help with any of the problems listed in Section B.
3. Describe what would be required to engage in the tinnitus intervention that is offered (e.g., logistics, cost).
4. Be available to answer questions or concerns about the tinnitus intervention that is offered, or about tinnitus in general.
5. Let the patient make a decision about engaging in the intervention.

Although we have developed minimum-score criteria for identifying individuals who would be appropriate candidates for our tinnitus clinical trials, we believe it is best to not use cutoff scores to determine candidacy for clinical intervention. Clinically, the best use of the THS is as a tool to guide a conversation wherein it is made clear that intervention will be helpful for the kinds of problems described in Section A (Tinnitus) and not helpful for the Section B (Hearing) types of problems. The clinician's role is to explain to the patient how hearing issues and tinnitus issues differ, and how each pertains to the patient's unique situation (use of the THS facilitates this process). The clinician also explains appropriate interventions that are available. The patient's role is to decide whether any of the interventions being offered are a good match for his or her lifestyle and for problems he or she wishes to address. Variables other than the THS Section A (Tinnitus) score that can affect the decision include patient factors (e.g., personality type, financial resources, overall health, motivation, access to the site of service) and clinical factors (e.g., type of intervention available, cost of services, clinician expertise). Patients always know their life circumstances and motivations better than clinicians and as such are best at deciding whether an intervention is appropriate (Constand, MacDermid, Dal Bello-Haas, & Law, 2014). Using a cutoff score to make such a decision negates all of these variables. Tinnitus intervention that is geared toward changing reactions to tinnitus is time consuming and requires significant effort on the part of the patient. Using the THS to facilitate patients' decision making, without depending on cutoff scores, increases the likelihood that those who choose to receive intervention will be motivated to participate fully in the process.

We have observed that some individuals with low scores on Section A (Tinnitus) can benefit from education regarding coping skills for tinnitus. In a one-on-one setting, these individuals may learn important coping skills for managing the problem they have (which may prevent the problem from becoming worse) and are unlikely to need a long-term, ongoing intervention. In a group setting, these individuals can offer useful support and camaraderie to other group participants in addition to learning useful skills for managing tinnitus. It is also important to note that a patient might be a good candidate for intervention even if the Section B (Hearing) score is higher than the Section A score. The scores themselves are not the determinant—what matters most is that patients fully understand what is being

offered, have reasonable expectations, and wish to participate; use of the THS facilitates this understanding.

It should be stressed that the THS is not a substitute for a comprehensive case history, which would be required for any patient who undergoes a formal tinnitus assessment (Henry, Zaugg, & Schechter, 2005; Newman & Sandridge, 2004). The THS is a screening tool to assist patient and clinician in rapidly understanding the nature of reported auditory problems and agreeing on an appropriate course of action. In the process of administering and reviewing the THS responses, a certain amount of "informational counseling" might take place, which would equate to a rudimentary level of intervention. The brief counseling can be sufficient to address the concerns of people who are only slightly bothered by their tinnitus, or who only require their questions to be answered.

Screening for sound tolerance problems. Section C of the THS did not result in strong test–retest reliability (see Table 6), confirming our own impressions that performance of these two items was less than satisfactory. Candidates being screened often seemed confused about the items, giving responses that did not accurately represent their experience with sound tolerance. Consequently, face validity for this section was also suboptimal.

It is clear that many people do not know what a sound tolerance problem is and, thus, do not realize the intent of the Section C items. Some respond that participating in a group meeting would be "too loud," suggesting a sound tolerance problem when in actuality the issue is a problem understanding speech in noise or multiple speakers. Others report that everyday sounds are too loud but then give examples *only* of very loud sounds that anyone would consider uncomfortably loud. Such a response misses the intent of Section C, which is to determine if sounds are uncomfortably loud that would be considered normal to most people. For these reasons, we have rewritten the two Section C items (the updated THS can be accessed at http://www.ncrar.research.va.gov/Education/Documents/TinnitusDocuments/THS.pdf). These two new items are, thus far, performing well for our clinical trials and appear to have greater face validity than the previous version. Specifically, they serve to facilitate a discussion between the participant/patient and the audiologist, providing the audiologist with information to determine whether sound tolerance issues in fact exist and need to be addressed. For future validation purposes, face validity of the items will be a useful addition to the other statistical analyses. Participants should be asked to rate or comment on whether the items appear to measure sound tolerance.

Some comment is necessary with respect to management of sound tolerance problems. Tinnitus specialists often report that a relatively high percentage of patients with tinnitus also suffer from hyperacusis (Dauman & Bouscau-Faure, 2005; Jastreboff & Hazell, 2004; Nelson & Chen, 2004). In our experience, many/most patients who are identified as hyperacusic do not require intervention specific to sound tolerance. Treatment for reduced sound tolerance usually requires a program of systematic exposure to sound. In general, sound therapy for tinnitus simultaneously addresses reduced sound tolerance. Therefore, sound therapy can be the starting point for patients who have reduced sound tolerance and are able to participate in a program of sound-based tinnitus therapy. The key concern for clinicians is to determine whether reduced sound tolerance will interfere with the intervention. Of course, in cases where the patient prefers to work on sound tolerance rather than tinnitus (even when it is possible to work on tinnitus without directly addressing sound tolerance), those wishes should always be respected.

Limitations of the Study

This study provides initial data that validate the THS for use as a clinical tool to assist in determining the need for tinnitus-specific intervention. Certain limitations of the study, however, should be mentioned: First, the data are reported from a relatively small sample of participants. Additional studies with larger sample sizes should be conducted to confirm and expand the validation and reliability of the THS. Second, for one of the two study groups, audiometric data were not obtained, which could have been used to determine convergent validity of the B (Hearing) subscale. Future studies should include variables that can be used to examine convergent and discriminant validity of the THS.

We are currently completing two randomized controlled trials that have used the THS to screen hundreds of study participants, all of whom have audiometric data. These participants also completed different tinnitus (and other) questionnaires, and they are using the revised version of the THS that contains the new Section C (Sound Tolerance) items. Completion of these studies will provide the data needed to analyze the psychometric properties of the THS more completely, which will be done in the near future.

Conclusions

Patients who report problems with tinnitus may primarily be experiencing problems with hearing. The THS is a brief questionnaire designed specifically to assist patients and clinicians in determining how much of a patient's reported problem is due to tinnitus and how much is due to hearing difficulties. The THS also contains two items that screen for sound tolerance problems.

The original purpose of the THS was to recruit participants for our tinnitus clinical trials. The THS can, however, be used for any application that requires an efficient and effective method of determining whether intervention specific to tinnitus is appropriate. The THS can facilitate collaborative decision making in a manner that is expeditious for both patient and clinician. Clinicians who use the THS should be those who have expertise in addressing both hearing and tinnitus problems.

Conducting the THS requires an average of about 5 min. Certain types of tinnitus evaluations can require hours of clinical time (some clinics require a full day), and this point alone highlights the need for an effective method of

screening prospective patients or research participants. The THS provides a validated, formalized clinical decision tool to rapidly assess the needs of individuals who report the presence of tinnitus.

Acknowledgments

Funding for this study was provided by Veterans Affairs Rehabilitation Research and Development Service Grants C4698R and F7070S, and by National Institute on Deafness and Other Communication Disorders Grant 1R03DC009012-01A1. Kathleen F. Carlson's effort was supported by a career development award (CDA 08-025) from the Veterans Affairs Health Services Research & Development Service.

The opinions expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the U.S. government.

References

Cima, R. F., Vlaeyen, J. W., Maes, I. H., Joore, M. A., & Anteunis, L. J. (2011). Tinnitus interferes with daily life activities: A psychometric examination of the Tinnitus Disability Index. *Ear and Hearing, 32,* 623–633.

Coles, R. R. A. (1995). Classification of causes, mechanisms of patient disturbance, and associated counseling. In J. A. Vernon & A. R. Moller (Eds.), *Mechanisms of tinnitus* (pp. 11–19). Needham Heights, MA: Allyn & Bacon.

Coles, R. R. A. (2000). Medicolegal issues. In R. S. Tyler (Ed.), *Tinnitus handbook* (pp. 399–417). San Diego, CA: Singular.

Constand, M. K., MacDermid, J. C., Dal Bello-Haas, V., & Law, M. (2014). Scoping review of patient-centered care approaches in healthcare. *BMC Health Services Research, 14,* 271–280.

Dauman, R., & Bouscau-Faure, F. (2005). Assessment and amelioration of hyperacusis in tinnitus patients. *Acta Oto-Laryngologica, 125,* 503–509.

Dauman, R., & Tyler, R. S. (1992). Some considerations on the classification of tinnitus. In J.-M. Aran & R. Dauman (Eds.), *Proceedings of the Fourth International Tinnitus Seminar, Bordeaux, France* (pp. 225–229). Amsterdam, the Netherlands: Kugler.

Davis, A., & Refaie, A. E. (2000). Epidemiology of tinnitus. In R. Tyler (Ed.), *Tinnitus handbook* (pp. 1–23). San Diego, CA: Singular.

Dobie, R. A. (2004). Overview: Suffering from tinnitus. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 1–7). Shelton, CT: PMPH-USA.

Fleiss, J. L. (1981). *Statistical methods for rates and proportions*. New York, NY: Wiley.

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference.* (11.0 update; 4th ed.). Boston, MA: Allyn & Bacon.

Heller, A. J. (2003). Classification and epidemiology of tinnitus. *Otolaryngologic Clinics of North America, 36,* 239–248.

Henry, J. A., Frederick, M., Sell, S., Griest, S., & Abrams, H. (2015). Validation of a novel combination hearing aid and tinnitus therapy device. *Ear and Hearing, 36,* 42–52.

Henry, J. A., Galvez, G., Turbin, M. B., Thielman, E. J., McMillan, G. P., & Istvan, J. A. (2012). Pilot study to evaluate ecological momentary assessment of tinnitus. *Ear and Hearing, 33,* 179–290.

Henry, J. A., McMillan, G. P., Thielman, E. J., Galvez, G., Zaugg, T. L., Porsov, E., & Silaski, G. (2013). Evaluating psychoacoustic measures for establishing presence of tinnitus. *Journal of Rehabilitation Research and Development, 50,* 573–584.

Henry, J. A., Schechter, M. A., Loovis, C., Zaugg, T., Kaelin, C., & Montero, M. (2005). Clinical management of tinnitus using a "progressive intervention" approach. *Journal of Rehabilitation Research and Development, 42*(Suppl. 2), 95–116.

Henry, J. A., Zaugg, T. L., Myers, P. M., & Kendall, C. J. (2010). *Progressive tinnitus management: Clinical handbook for audiologists*. San Diego, CA: Plural.

Henry, J. A., Zaugg, T. L., Myers, P. J., Kendall-Schmidt, C. J., Kaelin, C., Thielman, E., . . . Carlson, K. (2012). Pilot study to develop telehealth tinnitus management for persons with and without traumatic brain injury. *Journal of Rehabilitation Research and Development, 49,* 1025–1042.

Henry, J. A., Zaugg, T. L., Myers, P. J., & Schechter, M. A. (2008). The role of audiologic evaluation in progressive audiologic tinnitus management. *Trends in Amplification, 12,* 169–184.

Henry, J. A., Zaugg, T. L., & Schechter, M. A. (2005). Clinical guide for audiologic tinnitus management: I. Assessment. *American Journal of Audiology, 14,* 21–48.

Hoare, D. J., Edmondson-Jones, M., Sereda, M., Akeroyd, M. A., & Hall, D. (2014). Amplification with hearing aids for patients with tinnitus and co-existing hearing loss (Art. No. CD010151). *Cochrane Database of Systematic Reviews*. doi:10.1002/14651858.CD010151.pub2

Hoffman, H. J., & Reed, G. W. (2004). Epidemiology of tinnitus. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 16–41). Shelton, CT: PMPH-USA.

Jastreboff, P. J., & Hazell, J. W. P. (1998). Treatment of tinnitus based on a neurophysiological model. In J. A. Vernon (Ed.), *Tinnitus treatment and relief* (pp. 201–217). Needham Heights, MA: Allyn & Bacon.

Jastreboff, P. J., & Hazell, J. W. P. (2004). *Tinnitus retraining therapy: Implementing the neurophysiological model*. New York, NY: Cambridge University Press.

Krog, N. H., Engdahl, B., & Tambs, K. (2010). The association between tinnitus and mental health in a general population sample: Results from the HUNT Study. *Journal of Psychosomatic Research, 69,* 289–298.

Mazurek, B., Olze, H., Haupt, H., & Szczepek, A. J. (2010). The more the worse: The grade of noise-induced hearing loss associates with the severity of tinnitus. *International Journal of Environmental Research and Public Health, 7,* 3071–3079.

McNeill, C., Tavora-Vieira, D., Alnafjan, F., Searchfield, G. D., & Welch, D. (2012). Tinnitus pitch, masking, and the effectiveness of hearing aids for tinnitus therapy. *International Journal of Audiology, 51,* 914–919.

Meikle, M. B., Henry, J. A., Griest, S. E., Stewart, B. J., Abrams, H. B., McArdle, R., . . . Vernon, J. A. (2012). The Tinnitus Functional Index: Development of a new clinical measure for chronic, intrusive tinnitus. *Ear and Hearing, 33,* 153–176.

Myers, P. J., Griest, S., Kaelin, C., Legro, M. W., Schmidt, C. J., Zaugg, T. L., & Henry, J. A. (2014). Development of a progressive audiologic tinnitus management program for veterans with tinnitus. *Journal of Rehabilitation Research and Development, 51,* 609–622.

Nelson, J. J., & Chen, K. (2004). The relationship of tinnitus, hyperacusis, and hearing loss [Review]. *Ear, Nose, & Throat Journal, 83,* 472–476.

Newman, C. W., Jacobson, G. P., & Spitzer, J. B. (1996). Development of the Tinnitus Handicap Inventory. *Archives of Otolaryngology—Head and Neck Surgery, 122,* 143–148.

Newman, C. W., & Sandridge, S. A. (2004). Tinnitus questionnaires. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 237–254). Shelton, CT: PMPH-USA.

Newman, C. W., Sandridge, S. A., & Jacobson, G. P. (1998). Psychometric adequacy of the Tinnitus Handicap Inventory (THI) for evaluating treatment outcome. *Journal of the American Academy of Audiology, 9,* 153–160.

Newman, C. W., Sandridge, S. A., & Jacobson, G. P. (2014). Assessing outcomes of tinnitus intervention. *Journal of the American Academy of Audiology, 25,* 76–105.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York, NY: McGraw-Hill.

Ratnayake, S. A., Jayarajan, V., & Bartlett, J. (2009). Could an underlying hearing loss be a significant factor in the handicap caused by tinnitus? *Noise & Health, 11,* 156–160.

Savastano, M. (2008). Tinnitus with or without hearing loss: Are its characteristics different? *European Archives of Oto-Rhino-Laryngology, 265,* 1295–1300.

Searchfield, G. D., Kaur, M., & Martin, W. H. (2010). Hearing aids as an adjunct to counseling: Tinnitus patients who choose amplification do better than those that don't. *International Journal of Audiology, 49,* 574–579.

Shargorodsky, J., Curhan, G. C., & Farwell, W. R. (2010). Prevalence and characteristics of tinnitus among US adults. *The American Journal of Medicine, 123,* 711–718.

Shekhawat, G. S., Searchfield, G. D., & Stinear, C. M. (2013). Role of hearing aids in tinnitus intervention: A scoping review [Review]. *Journal of the American Academy of Audiology, 24,* 747–762.

Tyler, R. S., & Baker, L. J. (1983). Difficulties experienced by tinnitus sufferers. *Journal of Speech and Hearing Disorders, 48,* 150–154.

Tyler, R. S., & Conrad-Armes, D. (1983). The determination of tinnitus loudness considering the effects of recruitment. *Journal of Speech and Hearing Research, 26,* 59–72.

U.S. Department of Health and Human Services. (2006). *Guidance for industry. Patient-reported outcome measures: Use in medical product development to support labeling claims.* Rockville, MD: U.S. Food and Drug Administration.

Yenigün, A., Doğan, R., Aksoy, F., Akyüz, S., & Dabak, H. (2014). Assessment of tinnitus with Tinnitus Severity Index, Tinnitus Handicap Inventory and distortion product otoacoustic emissions in patients with normal hearing and hearing loss. *Kulak Burun Boğaz İhtisas Dergisi* [*The Turkish Journal of Ear, Nose, and Throat*]*, 24,* 11–16.

Zaugg, T. L., Schechter, M. A., Fausti, S. A., & Henry, J. A. (2002). Difficulties caused by patients' misconceptions that hearing problems are due to tinnitus. In R. Patuzzi (Ed.), *Proceedings of the Seventh International Tinnitus Seminar* (pp. 226–228). Crawley, Western Australia, Australia: The University of Western Australia.