Trends in Amplification
Volume XX Number X
Month XXXX xx-xx

10.1177/1084713808321184
http://tia.sagepub.com
hosted at
http://online.sagepub.com

Using Therapeutic Sound With Progressive Audiologic Tinnitus Management

James A. Henry, PhD, Tara L. Zaugg, AuD, Paula J. Myers, PhD, and Martin A. Schechter, PhD

Management of tinnitus generally involves educational counseling, stress reduction, and/or the use of therapeutic sound. This article focuses on therapeutic sound, which can involve three objectives: (a) producing a sense of relief from tinnitus-associated stress (using soothing sound); (b) passively diverting attention away from tinnitus by reducing contrast between tinnitus and the acoustic environment (using background sound); and (c) actively diverting attention away from tinnitus (using interesting sound). Each of these goals can be accomplished using three different types of sound—broadly categorized as environmental sound, music, and speech—resulting in nine combinations of uses of sound and types of sound to manage tinnitus. The authors explain the uses and types of sound, how they can be combined, and how the different combinations are used with Progressive Audiologic Tinnitus Management. They also describe how sound is used with other sound-based methods of tinnitus management (Tinnitus Masking, Tinnitus Retraining Therapy, and Neuromonics).

Keywords: auditory; hearing disorders; intervention; outcomes; rehabilitation; tinnitus

Tinnitus is the perception of sound in the absence of an acoustic source. The origin of tinnitus is activity somewhere within the auditory pathways. Tinnitus is distinguished from somatosounds that have an internal acoustic source (Dobie, 2004b). The perception of somatosounds is due to vibration of the cochlear fluids or partitions.

Chronic tinnitus is experienced by about 10% to 15% of adults (H. J. Hoffman & Reed, 2004). The tinnitus is "clinically significant" (i.e., requiring some degree of clinical intervention) for about 20% of those who experience it (A. Davis & Refaie, 2000; Jastreboff & Hazell, 1998). Tinnitus normally cannot be cured; those with clinically significant tinnitus, therefore, must learn management techniques to minimize its detrimental effects on activities of daily life. Numerous intervention protocols have been described for tinnitus (Tyler, 2005; Vernon, 1998).

Medical management of tinnitus includes surgical intervention and use of medications, both of which rarely result in elimination of tinnitus perception. No drug has yet been developed specifically for tinnitus, although eliminating certain drugs may result in cessation of tinnitus (e.g., acetylsalicylic acid, quinine). Thus, it is important to be aware that some drugs may actually cause or exacerbate tinnitus (DiSogra, 2001; Folmer, Griest, Meikle, & Martin, 1999). Because the precise mechanisms of tinnitus are unknown, there is no rational basis to select drugs to control tinnitus perceptual characteristics. Drugs most commonly are used to address

From VA Medical Center, Portland, Oregon (JAH, TLZ, MAS); Oregon Health & Science University, Portland (JAH); and James A. Haley VA Medical Center, Tampa, Florida (PJM).

Funding for this work was provided by Veterans Health Administration and Veterans Affairs Rehabilitation Research and Development Service. All figures were created by Lynn Kitagawa, MFA, Medical Media Service, Portland VA Medical Center. Special thanks to Stephen Fausti, PhD, and Sara Ruth Oliver, AuD, for their consistent support of this tinnitus research.

Address correspondence to: Dr. James A. Henry, VA Medical Center (NCRAR), P.O. Box 1034, Portland, OR 97207; e-mail: james.henry@va.gov.

coexisting sleep disorders and mental health disorders—primarily depression and anxiety (Dobie, 2004a; J. A. Henry, Zaugg, & Schechter, 2005a; Robinson, Viirre, & Stein, 2004). Medical management of sleep and mental health problems can be an essential component of an overall approach to managing reactions to tinnitus.

A variety of nutritional supplements have been advocated as treatment for tinnitus, including minerals such as magnesium and zinc, herbal preparations such as ginkgo biloba, homeopathic remedies, and B vitamins (Seidman & Babu, 2003). Other complementary and alternative treatments include acupuncture, hypnosis, acupressure, naturopathy, homeopathy, ear-canal magnets, and so on. Reviews of complementary and alternative methods of tinnitus treatment have been published (Dobie, 1999, 2004a; Seidman & Babu, 2003). Some of these therapies have been studied to verify anecdotal claims, but there is no scientific evidence that these remedies are more effective than placebo (Dobie, 2004a). Patients should be cautioned against claims that any of these methods will cure tinnitus. The cure for tinnitus would involve some kind of intervention that could be administered safely and that would result in permanent elimination of the tinnitus percept.

Counseling plays an important role in every type of tinnitus management. Some methods use counseling only, whereas others combine counseling with a different intervention modality. Psychological approaches to managing tinnitus include, primarily, Cognitive Therapy and Cognitive-Behavioral Therapy (CBT; J. L. Henry & Wilson, 2001; McKenna, 1998; Sweetow, 2000). These methods are not intended to eliminate the tinnitus or reduce its perceived loudness. They are intended to reduce reactions to tinnitus and to aid in coping with the deleterious effects of tinnitus on quality of life. Psychological intervention also can be an important component of an overall approach to managing tinnitus. Psychological intervention is particularly important for tinnitus patients who are also experiencing posttraumatic stress disorder (PTSD), depression, anxiety, or other mental health problems.

Using therapeutic sound for tinnitus management has been referred to, generally, as sound therapy and acoustic therapy. Most methods of tinnitus management (including some psychological methods) incorporate the use of sound in some manner to reduce the negative effects of tinnitus (Andersson & Kaldo, 2006; J. L. Henry & Wilson, 2001). Most generally, sound is used to directly or indirectly shift attention away from the tinnitus. The beneficial effects of using sound can be immediate, delayed, or both (P. B. Davis, 2006; J. A. Henry, Zaugg, & Schechter, 2005b; Jastreboff & Hazell, 2004; Vernon & Meikle, 2000). Recognized sound-based methods (Tinnitus Masking [TM], Tinnitus Retraining Therapy [TRT], and Neuromonics Tinnitus Treatment[1] [NTT]) involve specific protocols and certain restrictions for using sound to manage tinnitus. However, varying individual preferences and circumstances may require different approaches to using sound. For example, people who work in a quiet environment may be disturbed by tinnitus while at work. Those who work in a moderately noisy environment may only recognize tinnitus as a problem when in a quiet environment away from work.

The method of Audiologic Tinnitus Management (ATM) is described as a sound-based method of tinnitus management for clinical application by audiologists (J. A. Henry et al., 2005a, 2005b). ATM involves defined procedures to conduct a tinnitus evaluation, including an intake interview, written questionnaires, audiologic testing, and psychoacoustic assessment of tinnitus. Intervention procedures include structured informational counseling and an individualized program of sound enhancement. Therapeutic use of sound is essential, and specific procedures are used to assist patients in selecting appropriate sound-enhancing devices, including hearing aids, ear-level noise generators and combination (noise generator and hearing aid) instruments, personal-listening devices (e.g., wearable CD and MP3 players), and augmentative sound devices (e.g., tabletop sound generators). Since ATM was initially described, the methodology has undergone significant revision, especially with respect to the sound management protocol and the corresponding counseling. In addition, the method has been incorporated into a five-level hierarchical program of tinnitus management that is designed so that intervention is provided only to the degree necessary to meet patients' variable needs. By providing appropriate levels of intervention, this approach is efficient and cost-effective. The expanded and updated method is referred to as Progressive Audiologic Tinnitus Management (PATM; J. A. Henry, Zaugg, Myers, & Schechter, 2008b). The therapeutic use of sound with PATM is described fully in a patient-education workbook (J. A. Henry, Zaugg, Schechter, & Myers, 2008a). This article summarizes the different ways that sound can be used to manage tinnitus, which includes the basic rationale for using therapeutic sound with PATM. We also describe how sound is used with other recognized methods of sound-based tinnitus management (TM, TRT, and NTT).

Progressive Audiologic Tinnitus Management

The five levels of PATM include (a) Triage, (b) Audiologic Evaluation, (c) Group Education, (d) Tinnitus Evaluation, and (e) Individualized Management. Level 1 Triage provides referral guidelines for use by all health care providers who encounter patients complaining of tinnitus. Most patients are referred for a Level 2 Audiologic Evaluation, which includes standard audiometric testing, written questionnaires, and screening to determine if intervention is needed for the tinnitus. Hearing aids are provided at Level 2 as appropriate. If tinnitus intervention is needed, then patients receive the patient-education workbook (J. A. Henry et al., 2008a) and Level 3 Group Education is recommended. Level 3 includes two classes, spaced 2 weeks apart, that teach patients how to develop sound-management action plans that address their specific needs. Following Level 3, relatively few patients require the Level 4 Tinnitus Evaluation, which includes an intake interview, tinnitus psychoacoustic testing, and (if needed) in-clinic trial use of ear-level sound generators and/or combination instruments. At Level 4, it is decided if Level 5 Individualized Management is warranted. At Level 5, patients receive one-on-one assistance that focuses on using sound to manage tinnitus. (Please refer to the companion article in this issue of *Trends in Amplification* for more details of procedures conducted at each level of PATM; J. A. Henry et al., 2008b.)

Clinical intervention with PATM primarily includes teaching patients how to use sound to manage their tinnitus. The counseling information is provided to patients at Levels 2, 3, and 5, but in a different format at each level. At Level 2, patients can receive the patient-education workbook (J. A. Henry et al., 2008a). The workbook contains step-by-step instructions for patients to develop sound plans on their own, using the Sound Plan Worksheet (see Appendix A). These patients then have the option of attending the two workshops that make up Level 3 Group Education. Each workshop involves a structured PowerPoint presentation. An audiologist instructs patients in the different uses of sound to manage tinnitus and directs them through the process of developing individualized action plans using the Sound Plan Worksheet. The presentation that is provided at Level 3 has been reformatted as a patient counseling guide, which functions like a flip-chart to facilitate individualized counseling at Level 5. Level 5 can involve up to 6 months of repeated counseling appointments.

The therapeutic use of sound with PATM is flexible to accommodate the large variations in individual preferences and circumstances. Individuals can respond very differently when exposed to the same sound—a sound that is interesting and pleasant to one person may be boring or irritating to someone else. Also, there are diverse types of situations in which tinnitus can be problematic. Different tinnitus-problem situations often dictate different sound-management strategies. Patients need to be educated extensively about the variety of sounds available, different ways to think about the goals of using sound, and the varied approaches of delivering sound in a practical and individualized manner.

The main goal of PATM is for patients to learn how to develop and implement individualized plans for using therapeutic sound to manage their tinnitus. Success in achieving this goal depends largely on patients acquiring confidence in applying the self-management strategies. Breaking the process of learning how to manage tinnitus into small achievable tasks helps to ensure that patients experience initial success. This approach is in accordance with the self-efficacy theory (Bandura, 1977b). Research has demonstrated that self-efficacy is a good predictor of motivation and behavior (Bandura, 1977a; Jenkins, 1988). In general, the experience of success increases self-efficacy, whereas experiencing failure reduces self-efficacy. Strategies for teaching patients how to use sound in a series of small achievable steps are described immediately below.

The Sound Plan Worksheet is used to facilitate the process of identifying sounds that are expected to be effective in managing a specified tinnitus-problem situation. A separate worksheet is used to develop a customized "sound plan" for each tinnitus-problem situation that is identified. The initial objective is for patients to complete the process of writing a plan using the worksheet, carrying out the plan, evaluating the effectiveness of the plan, and then modifying the plan to improve its effectiveness. In the attempt to maximize the likelihood that the initial plan will be implemented, patients are instructed to identify the one situation in which their tinnitus is the most bothersome and to create a sound plan to manage just that particular situation using sounds and sound devices that are easily

accessible (e.g., a radio, CD player, or electric fan that the patient already owns). In this way, patients are empowered in creating a sound plan that can be implemented with minimal effort and usually at no cost to address their most bothersome tinnitus situation. After patients have gained experience and confidence with the process and the concepts, then additional bothersome tinnitus situations can be addressed and more complicated and sophisticated technology can be incorporated. Patients are encouraged to use the worksheet on a regular basis to refine and improve their sound plans.

The development of a specific plan addressing one problem situation involves four small, manageable tasks that are likely to be done successfully (#1-4 on the worksheet; see Appendix A): (1) identify a situation in which the tinnitus is particularly bothersome; (2) determine which general strategy for using sound will be tried for that situation; (3) determine a specific sound that will be used; and (4) determine a specific device for presenting the sound. The plan is implemented for 1 week (#5 on the worksheet) and then evaluated for its effectiveness (#6). A case example demonstrates how patients use the worksheet. Mr. Smith's most bothersome situation was "being annoyed by his tinnitus while falling asleep at night" (#1). As a general strategy (#2), he thought that using background sound for contrast reduction might be helpful. The type of sound he would try would be a low-frequency hum (#3) that could be created by using an electric fan (#4) in his bedroom. He tried this plan for 1 week (#5) and determined that the plan was "a little" helpful (#6). He then revised his plan by trying the strategy of using interesting sound (#2). He liked to listen to talk radio and decided to listen to a radio show (#3) using his bedside radio (#4). After trying that plan for 1 week (#5), he determined that the plan was "extremely" helpful (#6). Mr. Smith's initial sound plan demonstrated some limited success. Based on that experience, he revised his plan and the new plan worked very well for him. He experienced success using the worksheet to address one particular problem situation, and he now uses the worksheet as needed to address any other problem situations.

Effects of Sound on the Perception of Tinnitus

Prior to describing the different ways that sound can be used to manage tinnitus, it is necessary to explain the effects of sound on the *perception* of tinnitus, which is very different from a person's *responses* to tinnitus. The perception of tinnitus refers to its sound-like qualities of loudness, pitch, and timbre. Acoustic stimulation can directly affect these sound-like qualities. These direct effects of sound on the tinnitus may or may not be related to any effects of the sound on how the person responds to the tinnitus. Effects of sound on the tinnitus percept generally are referred to as masking (or suppression) effects.

With respect to masking of tinnitus, sound can have three possible effects: complete masking, partial masking, and no masking (see Figure 1). Complete masking means that the external sound has completely covered or replaced the tinnitus, rendering it inaudible (Vernon & Meikle, 2000). Complete masking might have a beneficial effect on the person's response to the tinnitus, but the intensity level required to achieve complete masking often is objectionable. Partial masking occurs when the external sound causes spectral changes in the tinnitus and/or the external sound reduces the perceived loudness of tinnitus (consistent with psychoacoustics; i.e., presentation of one sound can reduce the perceived loudness of a second sound). Partial masking may or may not have a positive effect on a person's tinnitus reactions. In the no-masking range, sound has no effect on any component of the tinnitus percept. It is still possible, however, for a sound that provides no masking to have a positive effect on a person's tinnitus reactions.

Three Strategies for Using Sound to Manage Tinnitus

Soothing Sound

Soothing sound is used to induce a sense of relief from stress or tension caused by tinnitus. In simplest terms, the goal of using soothing sound is to feel better or less stressed while using the sound. Achieving a sense of relief is the primary purpose of using sound with the method of TM, although this is commonly misunderstood (Vernon & Meikle, 2000). Achieving a sense of relief also is the primary purpose of using sound with NTT (P. B. Davis, 2006). The use of sound with TM and NTT is described later in this article.

The stress response is well understood with respect to the sympathetic and parasympathetic divisions of the autonomic nervous system (Iversen,

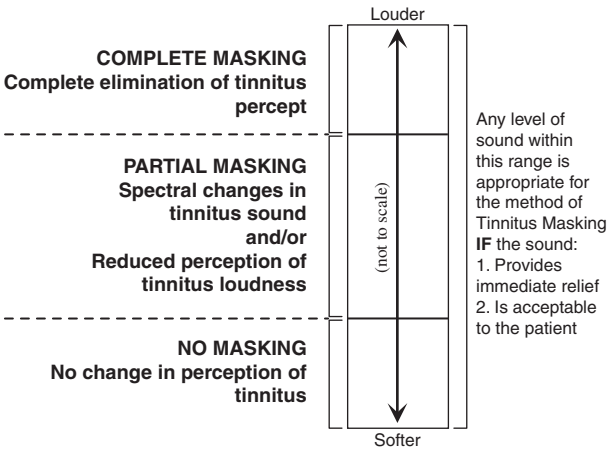

Figure 1. Three possible effects of external sound with respect to masking of tinnitus: complete masking, partial masking, and no masking.
Note: With the clinical method of Tinnitus Masking, it is acceptable for external sound to produce any of these effects. The objective is to induce an immediate sense of relief (Vernon & Meikle, 2000).

Iversen, & Saper, 2000). These two divisions innervate the same organ systems but with opposing actions. Balance in the activities of the two divisions is necessary to establish a state of homeostasis. Homeostasis is disrupted when a stressor activates the stress axis (hypothalamus, pituitary gland, adrenal cortex), resulting in a cascade of sympathetic activity that involves release of hormones and neurotransmitters (M. Davis, 2000; LeDoux, 1998; Wilson-Pauwels, Stewart, & Akesson, 1997). Prolonged arousal of the sympathetic cascade underlies the condition of chronic anxiety (which may be associated with tinnitus). Any type of intervention for anxiety must ultimately involve reduction or removal of the stressor and/or activation of the parasympathetic nervous system to help restore homeostasis (Amaral, 2000; Vingerhoets, 1985). Soothing sound has direct effects on the limbic system, which activates the parasympathetic nervous system (Brown, Martinez, & Parsons, 2004). Thus, using soothing sound for tinnitus management can calm anxiety or nervousness that is associated with the tinnitus.

Background Sound

It is important that patients understand that even if sound does not provide obvious immediate benefit, it still can be effective in managing tinnitus by reducing the contrast between the tinnitus percept and the acoustic environment. Contrast reduction creates an environment in which it is easier for tinnitus to go unnoticed (passive diversion of attention away from the tinnitus). An analogy using light (in the place of sound) helps to illustrate this concept for patients (J. A. Henry, Trune, Robb, & Jastreboff, 2007a, 2007b; J. A. Henry et al., 2005a, 2005b; Jastreboff & Hazell, 2004): A burning candle in a darkened room produces the only light in the room. The sharp contrast between the candle flame and the surrounding darkness naturally attracts attention to the flame. If the room is filled with ambient light, then the contrast between the candle and its environment is greatly reduced. The candle is just as bright as before but attracts less attention because of the reduced contextual contrast.

Contrast plays an essential role in sensory perception. According to basic psychophysical theory, the perception of a stimulus varies according to many factors extrinsic to the stimulus (Schiffman, 1976). The immediate stimulus, which is the focus of attention, is referred to as the *focal stimulus*. The extrinsic stimuli (referred to as *background stimuli*) create a frame of reference for perceiving the focal stimulus. The magnitude of the focal stimulus is judged relative to the background stimuli. The most familiar example of relative magnitude is the figure-ground relationship that underlies visual form perception. In the visual field, the "figure" (focal stimulus) stands out as distinctive relative to the "ground" (background stimuli). Numerous experiments have been conducted to identify rules that determine how figure and ground are differentiated. By manipulating the ground, the figure can be made less dominant and consequently less likely to attract attention. The candle analogy described above can be used to demonstrate this phenomenon to all tinnitus patients.

The idea of contrast reduction also applies to the auditory modality, where it is equivalent to reducing the signal-to-noise ratio. Sharp contrast between tinnitus and a quiet environment tends to direct attention to the tinnitus (which explains why tinnitus patients often have difficulty sleeping). Adding sound to the environment reduces the contrast between the tinnitus and the background—the signal-to-noise ratio is reduced. The tinnitus may be just as loud as before but tends to attract less attention because of the added sound. We will later discuss how background sound is used to induce habituation with TRT (J. A. Henry et al., 2007a, 2007b; Jastreboff & Hazell, 2004).

Interesting Sound

When using interesting sound to manage tinnitus, the goal is to shift attention away from tinnitus and onto the interesting sound (active attention diversion). Stated differently, interesting sound can be used to distract a person from the tinnitus. Using interesting sound for tinnitus management has precedent in the use of attention distraction for pain control, which is a well documented and accepted technique (M. H. Johnson, 2005). Distraction intervention involves the engagement of activities that compete with the pain sensation for the person's attention. This method has been used successfully to reduce pain and its associated anxiety in a variety of painful, invasive procedures, including burn pain (Miller, Hickman, & Lemasters, 1992), phlebotomy (Cason & Grissom, 1997), cataract surgery (Simmons, Chabal, Griffith, Rausch, & Steele, 2004), and dental anesthesia injections (Touyz, Lamontagne, & Smith, 2004). Recently, immersive virtual reality distraction has been shown to be an effective method of pain management (H. G. Hoffman et al., 2007; Sharar et al., 2007).

A few studies have addressed the effects of distraction on tinnitus. Jakes, Hallam, Rachman, and Hinchcliffe (1986) compared relaxation training with relaxation training plus distraction training. The distraction training involved only internal thought processes designed to refocus attention away from the tinnitus—no external stimulus was used. Both groups showed similar improvements. Andersson, Juris, Classon, Fredrikson, and Furmark (2006) used a paradigm of suppressing thoughts about tinnitus, which resulted in a reduction in perceived tinnitus loudness and annoyance. In a separate group of participants, positron emission tomography (PET) revealed attenuated auditory cortex activity during a cognitive activity intended to distract attention away from the tinnitus. Newman, Wharton, and Jacobson (1997) examined self-focused and somatic attention in tinnitus patients and concluded that "attentional mechanisms play an important role in patients' perception of tinnitus and should be considered when planning management strategies" (p. 143). Eysel-Gosepath, Gerhards, Schicketanz, Teichmann, and Benthien (2004) evaluated two protocols for distracting participants' attention from their tinnitus: (a) exposure to sound or music, and (b) using imagination facilitated by light and warmth. Both groups experienced similar reductions in annoyance and disability associated with tinnitus. These authors concluded, "Attention diversion is an important method for decreasing tinnitus-related distress" (p. 431).

People have the inherent ability to focus their attention on stimuli that are considered important, while avoiding distraction by less relevant stimuli (Vander, Sherman, & Luciano, 1990). A reasonable argument for why tinnitus becomes problematic is that the tinnitus sound is attended to because it is meaningful (Hallam, Jakes, & Hinchcliffe, 1988; Hallam, Rachman, & Hinchcliffe, 1984). The use of interesting sound introduces a stimulus that is acutely more meaningful than the tinnitus signal, and by shifting attention to the interesting sound, attention is shifted away from the tinnitus. This shifting of attention away from tinnitus might be explained by various neural mechanisms that are involved in performing the task of filtering incoming sensory signals to differentiate task-relevant (important) from task-irrelevant (unimportant) stimuli. This filtering function occurs at the subconscious level and largely involves the reticular formation (Brodal, 2004). The reticular formation is part of the ascending arousal system, which includes the thalamus, hypothalamus, and other cell groups (Saper, 2000). Unimportant neural signals are blocked, or inhibited, to facilitate focused attention on important stimuli. Thus, when paying attention to one sound, competing signals from other sounds are suppressed. As with all sensory systems, neurons in the auditory pathways have receptive fields with inputs that are both excitatory and inhibitory. This combination of excitatory and inhibitory connections is what allows the passage of important signals to higher centers while unimportant signals are blocked. This process, which is generally referred to as lateral inhibition, involves the inhibition of surrounding neurons by active neurons (Gardner & Martin, 2000). To differentiate between sounds, the auditory system creates a stream of neural activity for each sound (Cusack, Deeks, Aikman, & Carlyon, 2004). Through lateral inhibition, the dominant stream suppresses less dominant streams. Based on our understanding of neural mechanisms of auditory selective attention, it may be conjectured that focused auditory attention (on interesting sound) becomes the dominant auditory neural signal and the tinnitus signal is suppressed (Gerken, 1996).

Demonstrating the Three Uses of Sound to Patients

With PATM, it is essential that patients fully understand the three uses of sound (soothing, background, interesting) as specific strategies for managing

1. Choose a sound that you think will give you **relief** from the tension caused by your tinnitus (a "soothing" sound).
2. While listening to the sound, make it louder or softer to find the loudness level that gives you the most **relief**.
3. Answer the question "when I listen to this sound, how much **relief** do I feel?"

Figure 2. Tinnitus Relief Scale.
Note: This scale is used to approximate the degree to which a particular sound provides a sense of relief from the stress or tension caused by tinnitus.

tinnitus. If patients grasp the concepts, then they are more likely to implement the strategies to self-manage their tinnitus. Before each use of sound is demonstrated to the group, patients are given a visual scale to rate the effect of each sound demonstrated. Use of the scales keeps the participants actively involved in the demonstration and highlights to patients that sounds have varying effects across individuals. Patients are encouraged to use the scales outside of the group setting to evaluate the effectiveness of different sounds for ongoing tinnitus management.

Tinnitus Relief Scale

The Tinnitus Relief Scale (see Figure 2) was developed as a tool for PATM patients to (a) learn the concept of using soothing sound to manage tinnitus, and (b) identify sounds that are most effective in providing a sense of relief. To use the scale, patients listen to a sound, adjust the level of the sound to achieve the most relief possible, and then answer the question, "How much relief do I feel?" The 6-point response scale ranges from *no relief* to *complete relief*. No relief means that there is no reduction in the stress or tension caused by the tinnitus. Complete relief means that, with the sound, the stress or tension caused by the tinnitus is alleviated completely.

Tinnitus Contrast Scale

The concept of reducing auditory contrast between tinnitus and background sound can be demonstrated to patients using a visual analog.

1. Choose a sound that will create a background for your tinnitus. The sound should be pleasant or neutral.
2. Listen to the sound. Note how it reduces contrast between your tinnitus and the quiet. You can *picture* what is taking place by looking at the boxes with the word "tinnitus." As the boxes get darker, the "tinnitus" doesn't stand out as much.
3. Repeat this exercise using different sounds. You will hear how all sounds reduce contrast, but to different amounts depending on the loudness and type of the sound.

Figure 3. Tinnitus Contrast Scale.
Note: This scale is used to help patients understand the concept of contrast reduction with respect to tinnitus.

Tinnitus in quiet results in high contrast. As sound is added, the contrast is reduced. Patients can hear the difference by listening to their tinnitus in quiet, and then adding sound. The Tinnitus Contrast Scale is a visual analog that helps them to appreciate this effect (see Figure 3). As the background (sound) on the scale gets darker (louder), there is less contrast between tinnitus and the acoustic background. Patients can use the scale while they listen to different sounds. Each sound will reduce contrast by a different amount. Any amount of contrast reduction can be beneficial as long as the background sound is not annoying in quality or loudness.

Tinnitus Attention Scale

We previously described the use of attention-getting sound as a distinct tinnitus-management strategy (J. A. Henry et al., 2005b). We now refer to attention-getting sound as "interesting" sound. The Tinnitus Attention Scale (see Figure 4) was developed to create an activity for PATM patients to learn the concept of using interesting sound to divert attention away from tinnitus. Patients use the scale as a tool to help them identify the kinds of sounds that most effectively shift their thoughts away from the tinnitus. Patients are instructed to select any sound or sound passage that they believe will keep their attention. They listen to the sound for at least 1 minute and then estimate the percentage of their attention that was given to the interesting sound relative to the tinnitus.

Three Types of Sound

To assist PATM patients in devising ideas for each *use* of sound (soothing, background, interesting), they

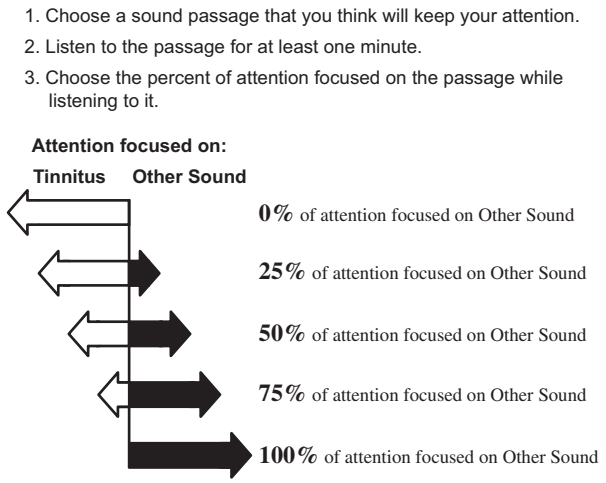

Figure 4. Tinnitus Attention Scale.
Note: This scale is used by patients to approximate the degree to which a particular sound, or sound passage, shifts attention away from the tinnitus.

	Type of Sound		
Use of Sound	**Environmental Sound**	**Music**	**Speech**
Soothing	✓	✓	✓
Background	✓	✓	✓
Interesting	✓	✓	✓

Figure 5. Tinnitus-Management Sound Grid.
Note: For each of the three basic uses of sound (soothing, background, interesting) for managing tinnitus, three types of sound can be applied (environmental, music, speech). The therapeutic use of sound with PATM can involve all nine combinations of uses and types of sound.

are taught about *types* of sound. Each of the three uses of sound can involve one of three different types of sound (environmental, music, speech). The Tinnitus-Management Sound Grid (see Figure 5) shows the three uses of sound relative to the three types of sound. The 3 × 3 grid creates nine possible combinations (depicted by the nine check-marks). The grid can help patients to conceptualize the different combinations of uses and types of sound for managing their tinnitus.

Environmental

Environmental sounds include any sounds that are not music or speech. Environmental sounds thus include a huge range of sounds, which broadly can be subcategorized as sounds of nature (sounds produced by animals, insects, weather, and moving water) and manufactured sounds (sounds produced by machines, mechanical devices, electronic devices, and any other objects created by humans). Most of these types of environmental sounds are available on digital media. Several Internet sites specialize in providing environmental sounds on CD or via download (see Appendix B for examples).

Environmental sound can be used for tinnitus management—as soothing sound, background sound, and/or interesting sound. It might seem unusual for environmental sound to be perceived as interesting. However, certain environmental sounds are interesting to some people. For example, some people study the sounds of birds, whales, and dolphins. If the sound keeps their attention, then it qualifies as interesting sound. If environmental sound provides a feeling of relief from tension or stress, then it qualifies for use as soothing sound. Examples of environmental sounds commonly used as soothing sound include wide-band or filtered noise from ear-level noise generators, custom tinnitus-relief sounds, sounds of moving water, and other nature sounds. Finally, any environmental sound that is neutral or pleasant can be used as background sound to achieve contrast reduction and passive attention diversion. The sound should not be irritating or uncomfortable, and it should not keep the person's interest.

Music

All kinds of music can be used to manage tinnitus if it is not listened to at hazardous or uncomfortably loud levels that can damage hearing or exacerbate tinnitus. Music can be used as interesting sound if it keeps the person's attention for a period of time. Music with lyrics often is considered more interesting than instrumental music. The use of music for relaxation and stress reduction has received extensive research (Salamon, Kim, Beaulieu, & Stefano, 2003). Grocke and Wigram (2007) stated, "Since ancient times, music has been recognized as a catalyst for stimulating the emotions and inducing rest and relaxation" (p. 13). Music therapy can help patients who suffer from many kinds of disorders and diseases. Music has been adapted for inducing relaxation in the management of tinnitus (P. B. Davis, Paki, & Hanley, 2007). Music also can be used for background sound if it is not attention getting. The

purpose of using music as background sound is simply to reduce contrast, which facilitates passive attention diversion. Usually, music with lyrics is not appropriate for background sound unless the lyrics are in a foreign language.

Speech

The category of speech includes any vocalized sound, either live or recorded, that is not a component of music. Speech is used to communicate ideas and, thus, is inherently capable of attracting and maintaining attention and can be used as an effective tool to divert attention away from tinnitus. Many opportunities exist for using speech or speech communication for active attention diversion. Cassette tapes were popular in the 1970s and 1980s for listening to lectures, books-on-tape, sermons, and so on and have since been all but replaced by CDs. More recently, *podcasts* have become available over the Internet. There is a large, and growing, number of podcasts available for download, and these offer a wide variety of active listening options (see Appendix B). Active listening to speech should be done only in situations when the person's attention is not needed for other activities. For example, one would not normally listen to an audiobook while working at the computer. However, listening to an audiobook can shift attention away from tinnitus while attempting to fall asleep, when relaxing, or when concentration on a task is not required.

Any speech that results in a sense of relief from stress caused by tinnitus can be used as soothing sound. Guided imagery (guiding the mind toward a relaxed, focused state through imagery) is commonly used and supported by research as a method to induce relaxation (Johnsen & Lutgendorf, 2001). Guided imagery involves instructing people to close their eyes, listen to a description of a serene setting, and imagine the setting being described (Baird & Sands, 2004; Watanabe et al., 2006). Another relaxation technique that is guided by a speaker is Progressive Muscle Relaxation (PMR). PMR involves systematic tensing and relaxing of muscles to facilitate relaxation. Guided imagery and PMR both have been adapted for inducing relaxation in the management of tinnitus (J. L. Henry & Wilson, 2001; Nickel, Hillecke, Argstatter, & Bolay, 2005). Many CDs have been developed with recordings of speech that can be used to facilitate relaxation through guided imagery and PMR (see Appendix B).

Speech can be used as background sound, but only if it is not perceived as interesting. Examples of using speech as background sound include people talking in a foreign language and crowd noise. Various types of crowd noise are available on CD, which can function well as background sound (see Appendix B).

Effects of Amplitude Variations

Music and speech signals characteristically contain amplitude variations that are substantial over time. These peaks and valleys can affect the audibility of the tinnitus percept in a dynamic fashion, which can be envisioned by referring to Figure 1. As the acoustic signal increases and decreases in amplitude, the tinnitus can shift between the conditions of complete masking, partial masking, and no masking. These shifts are highly individualized; some patients easily identify transitions between the different states of masking, whereas others do not. These effects also will be mediated by the integrity of an individual's auditory system.

In contrast to the dynamic amplitude variations inherent to music and speech signals, many environmental sounds typically are more constant in amplitude over time. As a consequence, exposure to these types of environmental sound typically does not cause shifts between complete, partial, and no masking of the tinnitus (see Figure 1). A noteworthy exception, however, is found in the form of masking sound called Dynamic Tinnitus Mitigation (DTM; SoniTeK Systems, formerly Petroff Audio Technologies, Marina Del Rey, CA). Unlike conventional TM sounds that generally include filtered white noise, some of the computer-generated DTM sounds use proprietary dynamic sound formats. The dynamic processing provides expanded amplitude peaks of 5 to 15 dB, over corresponding time durations of 10 to 500 milliseconds. We completed a study evaluating the ability of different sounds to reduce tinnitus annoyance (J. A. Henry, Rheinsburg, & Zaugg, 2004). Using a scale similar to the Tinnitus Relief Scale (see Figure 2), 21 participants listened to white noise, the dynamic DTM sounds ("E-Water," "E-Nature," and "E-Air"), and seven sounds included on the Moses/Lang CD7 system (Oregon Hearing Research Center). Two of the DTM sounds (E-Nature and E-Water) resulted in significantly greater reduction in tinnitus annoyance than any of the other nondynamic sounds used. These data

suggest that specially designed dynamic tinnitus-relief sounds may be more effective than the use of filtered bands of noise. Further research is needed to evaluate the efficacy of dynamic amplitude variations in the use of all types of sound to promote immediate relief from tinnitus annoyance.

Different Uses of Sound With Sound-Based Methods of Tinnitus Management

Methods of tinnitus management conducted by audiologists rely on specific uses of therapeutic sound. In addition to PATM, these methods include TM, TRT, and NTT. We now will summarize each of these methods and explain how each method uses therapeutic sound with respect to the nine possible combinations of uses and types of sound as depicted on the Tinnitus-Management Sound Grid (see Figure 5). In addition, hearing aids are used for tinnitus management, either independently or in conjunction with a specific methodology. We will start with a discussion of hearing aids as tinnitus-management devices.

Hearing Aids

Audiologists have long recognized the value of using hearing aids in the management of tinnitus (Saltzman & Ersner, 1947). Surr, Montgomery, and Mueller (1985) found that 124 of 200 new hearing aid users experienced tinnitus and that "partial or total" tinnitus relief could be achieved for half of them. Surr, Kolb, Cord, and Garrus (1999) used the Tinnitus Handicap Inventory (THI; Newman, Jacobson, & Spitzer, 1996) to evaluate self-perceived tinnitus handicap in new hearing aid users who experienced tinnitus. Comparing pre- and postfitting results, mean THI index scores were significantly reduced. Trotter and Donaldson (2008) evaluated, on a prospective basis, the subjective perception of tinnitus in 2,153 consecutive patients who were fitted with hearing aids over a 25-year period. Overall, more than two thirds of these patients reported an improvement in tinnitus perception after receiving hearing aids. It is important that the percentage of patients reporting improvement increased significantly with the advent of digital hearing aids: 82% of patients fitted unilaterally and 96% of patients fitted bilaterally with digital aids reported some degree of improvement. These studies reveal that hearing aids can independently provide effective tinnitus management for many patients. Through the use of special procedures, hearing aids can be optimized for managing tinnitus (J. A. Henry et al., 2008b; J. A. Henry et al., 2005a; Searchfield, 2005). All patients with significant hearing loss need to have previously or simultaneously addressed their amplification requirements as part of maximizing the effectiveness of tinnitus intervention.

The percentage of tinnitus patients who require amplification is unclear due to the widely differing reports, for example, 20% to 30% (Gold, Gray, Hu, & Jastreboff, 1996; Jastreboff, Gray, & Gold, 1996); 60% (Wedel, Wedel, & Walger, 1998); and up to 90% (R. M. Johnson, 1998). It is important that patients with bothersome tinnitus who are marginal hearing aid candidates should be considered for amplification to manage their tinnitus (J. A. Henry et al., 2008b; J. A. Henry et al., 2005a; Schechter & Henry, 2002).

With respect to the three basic uses of sound (soothing, background, interesting) to manage tinnitus as described in this article, the benefits to patients from using amplification can include (a) enhanced capability of hearing soothing sounds to provide a sense of relief from tinnitus-associated stress; (b) general increase in background sound to facilitate passive diversion of attention away from the tinnitus via contrast reduction; and (c) increased accessibility of interesting sound to shift attention off of the tinnitus (active attention diversion). (For patients who have significant hearing loss, the effectiveness of any sound that is used will depend on the degree and slope of the loss, and the auditory distortion level.) Additional benefits of using amplification can include (a) masking effects on tinnitus (including reduction in perceived loudness of tinnitus; see Figure 1); (b) reduced stress associated with straining to hear (which the patient might have attributed to the tinnitus); and (c) stimulation of regions of the auditory system deprived of auditory input.

Hearing aids are used in conjunction with both TM and TRT (Jastreboff & Hazell, 1998; Vernon, 1988), although with these methods they are used less commonly than noise generators and combination instruments. When combination instruments or hearing aids are used with TM and TRT, their primary purpose is to manage the tinnitus—management of hearing loss is considered a secondary benefit. With PATM, hearing aids normally are fitted as necessary based on the Level 2 Audiologic Evaluation (J. A. Henry et al., 2008b). Special procedures are recommended with PATM to optimize hearing aids to manage tinnitus either as the primary objective, or secondary to managing hearing loss.

Tinnitus Masking

The method of TM became available as a clinical technique in the late 1970s (Vernon, 1977; Vernon & Schleuning, 1978). It was popular through the 1980s and continues to be used. The main objective of TM is to use broadband sound to provide a sense of relief from tension or stress caused by tinnitus (Vernon & Meikle, 2000). Because of the label *masking*, however, the main objective has been commonly misunderstood to be to cover up, or mask, the tinnitus (J. A. Henry, Schechter, Nagler, & Fausti, 2002). Focusing on masking the tinnitus, rather than achieving a sense of relief, can actually increase tension or stress if the masking sound is perceived as loud or unpleasant. Maximizing a sense of relief is accomplished with complete masking for some people, partial masking for others, and sometimes even no masking (see Figure 1).

TM patients normally are fitted with ear-level devices (maskers) that present wide-band noise to the ears. Patients are instructed to adjust the noise to the level that provides the greatest sense of relief. With respect to the Tinnitus-Management Sound Grid, the use of sound with TM is an example of using environmental sound as soothing sound (see Figure 6). Patients also are advised to use various sound-producing devices to achieve relief, including CDs, tabletop fountains, sound machines, sound pillows, and so on. Counseling is used with TM, but the use of therapeutic sound to induce a sense of relief is the primary mode of intervention (J. A. Henry et al., 2002; Schechter & Henry, 2002).

Type of Sound

Use of Sound	Environmental Sound	Music	Speech
Soothing	✓		
Background			
Interesting			

Figure 6. How therapeutic sound is used with Tinnitus Masking.
Note: With the method of Tinnitus Masking, environmental sound (broadband noise) is used primarily as soothing sound (sound that provides an immediate sense of relief from tinnitus-related stress).

Tinnitus Retraining Therapy

The method of TRT has two basic components: educational (directive) counseling and sound therapy (J. A. Henry et al., 2007a, 2007b; Jastreboff & Hazell, 2004). Unlike TM, the use of therapeutic sound with TRT is not meant to give a sense of relief. With TRT, the patient should hear the tinnitus clearly, but with constant sound in the background. The background sound reduces the contrast between the tinnitus and the quiet environment, thus making the tinnitus less likely to attract attention (passive attention diversion). TRT patients are supposed to use sound in this way every day to eventually achieve habituation (i.e., reduction or elimination of tinnitus reactions and perception).

TRT patients are instructed to maintain therapeutic sound at a level just below the "mixing point" (see Figure 7). The mixing point is the lower threshold of the "partial suppression" range in which changes in tinnitus spectral characteristics occur (with or without changes in perceived tinnitus loudness). (With TRT, the word *suppression* is used rather than *masking* to more accurately represent the effect of sound on tinnitus-related neural activity; Jastreboff & Hazell, 2004.) As sound is made louder, it eventually causes "complete suppression" of tinnitus (equivalent to complete masking as shown in Figure 1). The only appropriate range for using sound with TRT is the "no suppression" range. In the no suppression range, sound has no effect on the spectral characteristics of the tinnitus, that is, the sound quality of the tinnitus does not change (although the perceived tinnitus loudness may or may not change). With TRT, it is posited that "patients cannot habituate to their 'usual' tinnitus if the tinnitus percept is changed during sound therapy" (J. A. Henry et al., 2007a, p. 111).

Evaluation of patients for TRT results in their placement into one of five categories: 0, 1, 2, 3, and 4. Patients in all categories are counseled to "enrich their sound environment" at all times with soft, pleasant, or neutral background sound. Category 0 patients have tinnitus that is not severe enough to warrant the use of ear-level devices, thus, they receive TRT counseling only. Category 1 patients are severely bothered by their tinnitus, and ear-level devices (sound generators, combination instruments, or hearing aids) are advised for use each day for at least 1 year. Patients are instructed to adjust the sound from their ear-level devices to below the mixing point (see Figure 7). With respect to the grid, the use of broadband noise with TRT is an example of using environmental sound as background sound (see Figure 8).

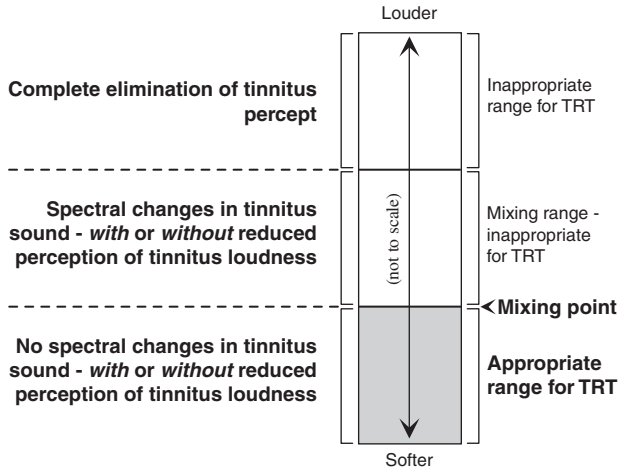

Figure 7. The mixing point as defined for Tinnitus Retraining Therapy (TRT).

Source: Adapted from J. A. Henry, Trune, Robb, and Jastreboff (2007b, p. 142) with permission from the authors.
Note: The three possible effects of sound on tinnitus according to TRT are no suppression, partial suppression, and complete suppression. The appropriate range for using sound with TRT is below the mixing point (in the no suppression range).

	Type of Sound		
Use of Sound	**Environmental Sound**	**Music**	**Speech**
Soothing			
Background	✓		
Interesting			

Figure 8. How therapeutic sound is used with Tinnitus Retraining Therapy.
Note: With the method of Tinnitus Retraining Therapy, environmental sound (broadband noise) is used primarily as background sound to promote long-term habituation to tinnitus reactions and perception.

TRT Category 2 patients also have a severe tinnitus problem, but in addition, they have hearing loss requiring amplification. These patients are fitted with hearing aids or combination instruments, and sound therapy is conducted as for Category 1 patients. Patients in Category 3 require primary management for hyperacusis, which involves special desensitization procedures using sound to increase tolerance levels (J. A. Henry et al., 2007a; Jastreboff & Hazell, 2004). Category 4 refers to patients whose tinnitus is exacerbated by exposure to certain sounds. These latter patients require judicious use of sound to systematically reduce their reactions to sound.

Neuromonics Tinnitus Treatment

Intervention with NTT involves at least 6 months of using a proprietary, wearable listening device 2 to 3 hours per day (P. B. Davis, 2006). The device is similar to an MP3 player and plays Baroque or New Age music that is specially selected for having relaxation-inducing qualities. For each patient, the device is customized by the company so that the sound output is adjusted ("equalized") for hearing loss. The device is used to implement desensitization to the tinnitus in two stages.

During the first 2 months of treatment (Stage 1), wide-band noise ("shower sound") is added to the music. Patients are instructed to achieve a "high level of interaction" between the music and the tinnitus. This interaction was explained above in the section "Effects of Amplitude Variations" that describes how the amplitude "peaks and valleys" inherent to music can result in fluctuations in the audibility of the tinnitus. The wide-band noise used during Stage 1 of NTT reduces the audibility of the tinnitus during the quiet portions (valleys) of the recorded music, which tends to keep patients mostly in the complete masking range (see Figure 1). The objective of Stage 1 is to attain a "sense of relief and control over the tinnitus, and promote a reduction in general anxiety levels" (P. B. Davis, 2006, p. 149). Relative to the 3 × 3 grid, the use of sound during Stage 1 of NTT is an example of using a combination of music and environmental sound as soothing sound (Figure 9a).

During the next 4 months (Stage 2), the wide-band noise is removed from the audio signal, thereby increasing the audibility of the tinnitus during the quiet portions of the music. Patients are instructed to gradually reduce the volume of the music during Stage 2 to decrease the level of interaction between the music and the tinnitus. The objective of Stage 2 is essentially the same as for TRT: less awareness of, and less reaction to, the tinnitus. The use of sound during Stage 2 of NTT is an example of using music as soothing sound, transitioning to using music as background sound prior to discontinuing use of the device (see Figure 9b).

Patients With Sound Tolerance Problems

It is well documented that many tinnitus patients also suffer from reduced sound tolerance. This problem is referred to generally as hyperacusis, although there is no commonly accepted definition of hyperacusis (Jastreboff & Jastreboff, 2004; Vernon, 2002). Clinicians have reported that up to 45% of their

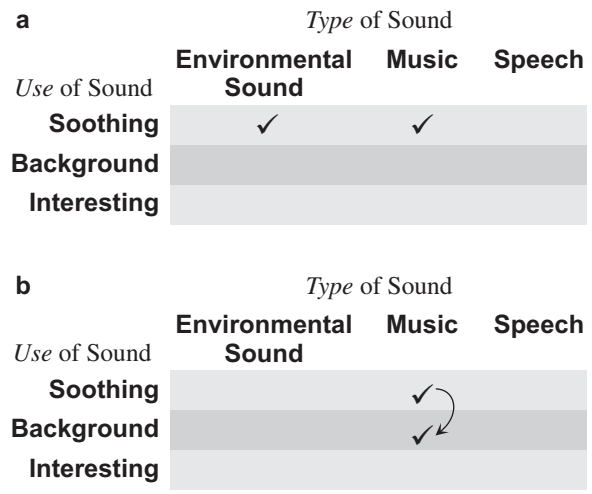

Figure 9. How therapeutic sound is used with Neuromonics. Note: With the method of Neuromonics, (a) during Stage 1, a combination of music (Baroque or New Age) and environmental sound (shower sound) is used as soothing sound to facilitate a sense of relief and control over the tinnitus, and (b) during Stage 2, the same music, but with the shower sound removed, is used as soothing sound—transitioning to background sound—to facilitate desensitization to the tinnitus.

patients experience reduced loudness tolerance (Coles, 1996; Gold, Frederick, & Formby, 1999; Hazell, 1999; Jastreboff, 2000). Thus, it is critical that audiologists are aware that their tinnitus patients may have a loudness sensitivity problem. If so, then using sound to manage tinnitus may have limitations or may be precluded altogether. It is fortunate that sound tolerance problems often can be treated successfully. Detailed clinical guidelines for assessing and treating reduced sound tolerance are available (J. A. Henry et al., 2007a; J. A. Henry et al., 2005a, 2005b).

Research Evidence Supporting PATM

Controlled clinical studies are essential to document the efficacy of methods of tinnitus intervention. We have completed three clinical studies and currently are completing a fourth. Conducting these trials has required the development of defined methodologies to perform all aspects of patient screening, assessment, and intervention. The motivation behind these trials has been not just to evaluate the effectiveness of different methods but to identify elements of tinnitus management that are essential to incorporate into a comprehensive program that is resourceful and efficient. Research data that support PATM come primarily from these different trials but also from numerous studies that have documented the effectiveness of using therapeutic sound in different ways for tinnitus management.

Our first study evaluated the efficacy of TRT versus TM (J. A. Henry et al., 2006a, 2006b). Following screening to ensure that participants had severely bothersome tinnitus warranting 18 months of intervention, 123 participants were placed alternately into TRT or TM groups. All participants underwent a comprehensive tinnitus assessment, followed by intervention appointments at 0, 3, 6, 12, and 18 months. Outcomes for this study were based primarily on the THI (Newman et al., 1996; Newman, Sandridge, & Jacobson, 1998). A multilevel modeling approach was used to conduct an intent-to-treat analysis for 118 of the 123 enrolled participants. Overall, both groups showed significant improvements on the mean THI index scores, with the TRT improvements being significantly greater than for TM. More specifically, TM provided better results at 3 months. At 6 months, both groups showed comparable improvement. By 12 and 18 months, the TRT group showed significantly greater improvement than the TM group. These findings suggest that therapeutic sound can be beneficial for tinnitus management using two very different approaches. Using sound with the purpose of achieving a sense of relief (as for TM) might be preferable for short-term benefit. Long-term effects might be best achieved using sound in the manner prescribed for TRT (i.e., using background sound for passive attention diversion).

For the second study, we hypothesized that tinnitus patients would benefit from group education that was based on TRT counseling. Two hundred sixty-nine participants with tinnitus bothersome enough to warrant intervention were randomized into one of three groups: group educational counseling, traditional support group, or no-intervention control (J. A. Henry et al., 2007). Participants in the education and support groups each attended four weekly 1.5-hour sessions. The education group received TRT-based counseling. The support group was facilitated by a moderator who did not provide any tinnitus education. Primary outcome measures were obtained at baseline, 6 months, and 12 months using the Tinnitus Severity Index (TSI), which has been validated for use with tinnitus patients (J. A. Henry et al., 2005; J. A. Henry et al., 2006b; R. M. Johnson, 1998; Meikle, Griest, Stewart, & Press, 1995). Analysis of mean TSI scores revealed that TRT-based group education provided significant

benefit, which was sustained over the 12-month outcome period. The support and no-intervention groups did not show significant benefit at any of the outcome points.

The second trial provided two important findings that influenced the clinical protocol for PATM: (a) Eighty-four percent of the participants reported that they experienced hearing difficulty at least sometimes. However, none of the participants had a hearing evaluation, and none received hearing aids or other ear-level instruments. Thus, it seems likely that not addressing the participants' audiologic needs significantly reduced the effectiveness of the educational intervention. For this reason, the hierarchical protocol used with PATM involves a hearing evaluation and fitting of hearing aids if necessary as the first stage of audiologic management—prior to any tinnitus-intervention appointments. (b) The significant benefit observed with the education group was sustained over 12 months even though no intervention was provided after 4 weeks. This sustained benefit contrasts with results of another controlled study that evaluated group education as intervention for tinnitus (J. L. Henry & Wilson, 1996). In that study, participants were randomized into one of three groups: education (covering the auditory system and various aspects of tinnitus), education combined with instruction in cognitive coping skills, or no intervention. Participants in the two intervention groups attended six weekly 90-minute sessions. Outcomes were assessed at baseline, immediate postintervention, and 12 months postintervention. Only the cognitive/education group showed significant improvement, which was observed immediately postintervention, but not at 12 months—in contrast with the education group in our second trial that had sustained benefit at 12 months. Our education-group participants received instruction in the proper use of sound to achieve habituation, thus, it may be that the sustained benefit was due to their ongoing use of background sound. With PATM, all patients are instructed to use background sound on an ongoing basis.

The third study was a four-site (four VA medical centers) study designed to compare long-term outcomes between TRT and TM. At each site, qualifying veterans who experienced sufficiently severe tinnitus were randomized into TRT, TM, or a third group that received tinnitus educational counseling and hearing aids (if needed). All three groups received comparable time and attention from audiologists. Assessment of outcomes took place using the THI at 0, 3, 6, 12, and 18 months. Preliminary analyses have been done for the 97 participants who completed the THI at all five time points (unpublished data). Each group showed significant improvement from baseline to 3 months. Additional significant improvement was observed for each group between 3 and 6 months. Following 6 months, modest improvements in mean THI scores were observed for each group, but these improvements were not significant. There were no significant differences in mean THI scores between the three groups at any of the time points. Because of the preliminary nature of the analyses, definitive conclusions are not possible. However, it appears that each of the three sound-based methods resulted in significant reduction in self-perceived handicap due to tinnitus. Development of the protocol for the counseling and hearing aids group was instrumental to the development of certain components of PATM.

The fourth study, under way at the James A. Haley (Tampa) VA Medical Center, is a randomized clinical trial to compare the effectiveness of PATM to "usual care." Patients must have tinnitus that is clinically significant to qualify for enrollment. If they qualify and are willing to participate, then they are randomized into one of the two groups. Patients receiving PATM progress only as far through the five levels as needed. Patients in usual care receive management that is typical of what is provided at VA audiology clinics—audiology testing, minimal counseling, and hearing aids as needed. Usual care patients also can be fitted with ear-level sound generators or combination instruments at the audiologists' discretion. This study will determine the relative proportions of patients who use different types of ear-level devices and the relative effectiveness of the different devices for each of the two cohorts. Outcomes will be evaluated with the THI 12 months following enrollment. Development of the research protocol for the PATM group resulted in detailed clinical procedures that are partially described in the companion article in this issue of *Trends in Amplification* (J. A. Henry et al., 2008b).

Numerous studies have supported the use of therapeutic sound for tinnitus management. We have already described the different methods of sound-based tinnitus management other than PATM (i.e., hearing aids, TM, TRT, and NTT) with respect to how they use therapeutic sound differently. Space limitations preclude an exhaustive review of the literature that supports these methods. Briefly, evidence exists in the peer-reviewed literature for the beneficial use of hearing aids (Del Bo & Ambrosetti, 2007; Saltzman & Ersner, 1947; Surr et al., 1999; Surr et al., 1985; Trotter & Donaldson, 2008), ear-level

masking devices (Hazell et al., 1985; Schleuning, Johnson, & Vernon, 1980; Stephens & Corcoran, 1985), TRT (Bartnik, Fabijanska, & Rogowski, 2001; Berry, Gold, Frederick, Gray, & Staecker, 2002; Herraiz, Hernandez, Plaza, & de los Santos, 2005; Herraiz, Hernandez, Toledano, & Aparicio, 2007), and NTT (P. B. Davis et al., 2007). Our first clinical trial (described above) showed the efficacious use of all types of ear-level devices—hearing aids, sound generators, and combination instruments—all of which were used with both TM and TRT (J. A. Henry et al., 2006a, 2006b). Folmer and Carroll (2006) evaluated long-term outcomes in three groups of 50 patients each who attended a comprehensive tinnitus management clinic: patients who (a) used hearing aids, (b) used ear-level sound generators, and (c) did not use devices. All three groups experienced significant improvement, and the improvement for the patients who used hearing aids and sound generators was significantly better than for patients who did not use devices.

Although these various studies all differed with regard to procedures, outcome instruments, and criteria for improvement, taken together, they make up a strong body of support for the efficacy of using therapeutic sound to manage tinnitus. The evidence does not support one method of sound-based management as being superior relative to the others. Research is needed to define systematically the specific parameters of sound and sound-generating devices that result in the greatest effectiveness. The approach of PATM is that the use of sound is generally effective for tinnitus management and that its effectiveness can be optimized by (a) informing patients about the different uses of sound for tinnitus management and how each sound-based method uses sound; (b) developing individualized sound-management plans to address patients' unique needs; and (c) using procedures that encourage patients to incorporate good self-management practices.

Level 1 Triage

Level 1 Triage does not involve intervention but rather includes a succinct listing of referral guidelines for non-audiologists who encounter patients complaining of tinnitus (J. A. Henry et al., 2008b). The guidelines are based on published best practices for referring tinnitus patients (Harrop-Griffiths, Katon, Dobie, Sakai, & Russo, 1987; J. A. Henry et al., 2005a; J. L. Henry & Wilson, 2001; Wackym & Friedland, 2004). More comprehensive referral guidelines have been developed for audiologists who see patients in any of PATM Levels 2 through 5 (J. A. Henry et al., 2008b). Because tinnitus often is best managed using a multidisciplinary approach, proper referral is an essential aspect of PATM.

Level 2 Audiologic Evaluation

Level 2 Audiologic Evaluation involves primarily assessment procedures but includes some intervention (J. A. Henry et al., 2008b). At a minimum, patients learn about their hearing function and have questions answered about their tinnitus. Thus, some basic education is provided during Level 2, which is known to address the needs of many tinnitus patients (Dobie, 2004b). In addition, patients receive hearing aids if indicated. We have already mentioned studies that support the use of hearing aids as effective intervention for many tinnitus patients.

For efficiency purposes, the PATM assessment procedures are split between the Level 2 Audiologic Evaluation and the Level 4 Tinnitus Evaluation. It has been our experience that a basic hearing test plus some tinnitus screening is all that is needed for many patients, even those who initially complain of a severe tinnitus problem. Our initial trial involved a multistage screening process to ensure that only those requiring long-term management (equivalent to Level 5) were enrolled in the study (J. A. Henry et al., 2006b). Of the 800 persons who had tinnitus and expressed interest in participating, only 171 (21%) passed the first level of telephone-interview screening. Those 171 completed an initial assessment (comparable to PATM Levels 2 and 4 combined), and only 123 (72%) qualified to receive long-term management. The 123 who required long-term management represented only 15% of the original 800 candidates. It is unknown how many of these 123 participants would have had their needs met by attending Level 3 Group Education, which would have obviated further intervention.

Level 3 Group Education

The research evidence for Level 3 Group Education comes from two primary sources. First, a well-known hospital-based tinnitus clinic uses group education in a hierarchical program of tinnitus management that is similar to PATM (Newman & Sandridge, 2005). A study was conducted at that clinic to evaluate the effectiveness of participation

in a single group education session (Sandridge & Newman, 2005). The study included 52 patients who had attended an audiologic evaluation comparable to PATM Level 2. The THI (Newman et al., 1996; Newman et al., 1998) was completed before the session and 30 days later to assess changes in perceived tinnitus handicap. Results revealed a mean reduction in the THI (range = 0–100 points) of 21 points, which reflects a clinically significant improvement. Attending the session was considered beneficial by 69% of the participants, and 43% planned to return for an individual tinnitus assessment (comparable to the PATM Level 4 Tinnitus Evaluation).

Second, as already described above, we completed a randomized clinical trial to evaluate the effectiveness of group education (J. A. Henry et al., 2007). For this trial, patients received only education (i.e., they did not receive a prior audiologic evaluation). Interested candidates were telephone screened. Of the 750 callers, 549 were determined to be eligible for educational intervention (the screening standards were considerably more liberal than those used to screen for long-term intervention as described above for our initial trial). Of the 549 who passed screening, 373 attended an open house to learn more about the study. Of these 373, 269 were randomized into the study. Thus, of the original 750 candidates, 36% actually signed up for the study, suggesting that almost two thirds of the callers needed only some basic information. With respect to outcomes, those randomized into the education group showed significantly more improvement in their self-perceived tinnitus handicap relative to the two control groups.

Level 4 Tinnitus Evaluation

The Level 4 Tinnitus Evaluation involves primarily assessment, but patients also receive counseling during the assessment. Mostly, patients at this level are afforded the opportunity to address their tinnitus problems in depth with a knowledgeable and caring clinician. In the process of responding to the questions from the Tinnitus Intake Interview (J. A. Henry et al., 2005a), patients explain how the tinnitus affects their lives and the clinician answers questions and provides suggestions. Our initial clinical trial revealed that this degree of an in-depth interview was sufficient for 28% of qualifying study candidates to feel that no further intervention was necessary (J. A. Henry et al., 2006b). The remaining 72% (15% of the original callers) elected to receive individualized long-term management that was comparable to PATM Level 5.

Level 5 Individualized Management

At Level 5, all patients receive individualized counseling that focuses on developing and implementing specific action plans for using sound to manage tinnitus. The advantage of this approach is that all forms of using sound for tinnitus management are options for patients (see Figure 5). Many of these patients have received ear-level noise generators or combination instruments, or they continue to use their hearing aids. All of these devices have been demonstrated to provide amelioration of tinnitus distress for substantial numbers of patients, as we have already discussed. Some patients at this level opt to use other types of devices, including MP3 players, CD players, and satellite radio (J. A. Henry et al., 2005b). Our current randomized clinical trial will determine how many patients use ear-level devices versus those who use other types of devices. That trial, which will be completed in 2010, will also provide aggregate data for patients progressing through all levels of PATM.

Further Directions With PATM

With PATM, patients determine how to use sound in each tinnitus-problem situation, and then they use whatever sound-generating devices they have available, or they purchase special equipment, to perform the specified sound therapy. It is clear that a wearable device that is capable of performing all nine of the sound therapy combinations described by the Tinnitus-Management Sound Grid (see Figure 5) would be a useful tool for patients using PATM to manage their tinnitus. Efforts are under way to develop a low-cost, highly flexible, multi-use tinnitus sound-management device that will incorporate all of the capabilities of the 3×3 grid.

The essence of intervention with PATM is use of the Sound Plan Worksheet (Appendix A) to assist patients in devising individualized plans to manage their tinnitus-problem situations. We recognize that the use of sound is a critical aspect of tinnitus management but that the incorporation of psychological counseling has the potential to significantly improve outcomes of management with PATM. CBT has been shown to be effective with tinnitus patients,

and the incorporation of CBT is expected to improve overall outcomes (J. L. Henry & Wilson, 2001). As part of a newly funded grant, work is under way to add CBT training to the PATM protocol. The existing PATM Level 3 Group Education program is undergoing a complete evaluation to (a) review the current protocol to identify strengths and weaknesses, (b) incorporate self-management education to a greater extent, and (c) add CBT to the protocol. The current two-session group education will likely be expanded to four sessions to incorporate CBT. The first two sessions will continue to focus on sound therapy, although some CBT will be added to these sessions. The two new sessions will focus on CBT, with a secondary emphasis on using sound.

Conclusion

We have identified three uses of sound (soothing, background, interesting) for tinnitus management, that is, three definable strategies for using sound to mitigate the effects of tinnitus. Although these strategies are distinctly different, they often are overlapping. For example, a sound may be both soothing and interesting at the same time. Other sounds may be either soothing or interesting, but not both. Any sound can be considered background sound, regardless of any other effect the sound has on the individual. Thus, a soothing sound is also background sound, an interesting sound is also background sound, and a sound that is neither soothing nor interesting is solely background sound.

We also have identified three types of sound (environmental, music, speech), each of which can be used with the three uses of sound for management of tinnitus. The Tinnitus-Management Sound Grid (see Figure 5) reveals nine combinations of uses and types of sound for tinnitus management. The use of sound with each of the sound-based methods of tinnitus management (PATM, NTT, TM, and TRT) can be explained with respect to the grid.

Regardless of the intervention method employed, all tinnitus patients should be educated as to the different sound options that are currently available (J. A. Henry et al., 2005b). Patients should be advised of the general beneficial effects of personal listening devices, which include wearable radios, CD players, tape players, and MP3 players, and of tabletop (stationary) sound-generating devices, including CD and tape players, radios, tabletop fountains, electric fans, and any other sound-generating devices. Also, technological advances have created many new options for using sound. For example, some hearing aids are Bluetooth enabled, facilitating the connection of hearing aids with sound-generating devices such as MP3 players and cell phones (Tchorz, 2005). Satellite radio has the potential to be a very effective tinnitus-management device for many tinnitus patients.

The use of sound is a common form of therapy for tinnitus, although specific uses of sound vary between methods. Research has not yet shown which methods are most effective, nor do we know what components of each method provide the greatest benefit. It also is not clear how varying levels (moderate or severe) of tinnitus distress respond to different management approaches. Coupled with the confounding effects of varying hearing loss, as well as different personalities and life circumstances, the most effective management strategies may be difficult to determine. In general, a viable approach to managing tinnitus is to use sound in a manner that provides the most benefit to the individual patient and to supplement the use of sound with education and stress-reduction techniques and, as needed, psychological and/or medical management.

Appendix A

Sound Plan Worksheet

1. Write down one bothersome tinnitus situation _____

2. **Check one or more** of the three ways to use sound to manage the situation	3. **Write down the sounds** that you will try	4. **Write down the devices** you will use 5. Use your sound plan **over the next week**	6. **How helpful** was each sound plan after using it for 1 week?	7. **Comments** When you find something that works well (or not so well) please comment. You do not need to wait 1 week to write your comments.
☐ **Interesting sound** 	_____ _____ _____	_____ _____ _____	Not at all / A little / Moderately / Very much / Extremely ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	_____ _____ _____
☐ **Soothing sound** 	_____ _____ _____	_____ _____ _____	Not at all / A little / Moderately / Very much / Extremely ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	_____ _____ _____
☐ **Background sound** 	_____ _____ _____	_____ _____ _____	Not at all / A little / Moderately / Very much / Extremely ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	_____ _____ _____

Appendix B
Web Sites to Locate Therapeutic Sounds and Sound-Producing Devices

Sites for CDs and Downloads

www.sleepmachines.com
www.serenitysupply.com
www.binaural.com/bines.html
www.naturesound.com
www.purewhitenoise.com
www.empoweredwithin.com
www.audiobooks.com
www.npr.org/podcast
www.healinghealth.com

Tabletop Sound-Generating Devices

www.brookstone.com
www.catalogclearance.com
www.marpac.com
www.soundtherapyworld.com

Other Sound Devices

www.bizrate.com
www.water-fountain.biz
www.simplyfountains.com
www.overstock.com
www.sirius.com
www.soniteksystems.com

Ear-Level Tinnitus Instruments

www.unitedhearing.com/tinnitus
www.generalhearing.com
www.hearing-usa.com
www.amplisound.com

Note: Web sites accessed April 20, 2008. This list does not imply endorsement of any of these products or companies.

Note

1. Any discussion about Neuromonics refers to the company Neuromonics Pty Ltd. The company promotes and supports their method of tinnitus treatment. The VA does not endorse Neuromonics or any one specific method of clinical management for tinnitus at this time. Any information provided about Neuromonics is for information purposes only.

References

Amaral, D. G. (2000). The anatomical organization of the central nervous system. In E. R. Kandel, J. H. Schwartz, & T. M. Jessell (Eds.), *Principles of neural science* (pp. 318-336). New York: McGraw-Hill.

Andersson, G., Juris, L., Classon, E., Fredrikson, M., & Furmark, T. (2006). Consequences of suppressing thoughts about tinnitus and the effects of cognitive distraction on brain activity in tinnitus patients. *Audiology and Neurotology*, *11*(5), 301-309.

Andersson, G., & Kaldo, V. (2006). Cognitive-Behavioral Therapy with applied relaxation. In R. S. Tyler (Ed.), *Tinnitus treatment: Clinical protocols* (pp. 96-115). New York: Thieme.

Baird, C. L., & Sands, L. (2004). A pilot study of the effectiveness of guided imagery with progressive muscle relaxation to reduce chronic pain and mobility difficulties of osteoarthritis. *Pain Management Nursing*, 5(3), 97-104.

Bandura, A. (1977a). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215.

Bandura, A. (1977b). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Bartnik, G., Fabijanska, A., & Rogowski, M. (2001). Effects of Tinnitus Retraining Therapy (TRT) for patients with tinnitus and subjective hearing loss versus tinnitus only. *Scandinavian Audiology Supplement*, 52, 206-208.

Berry, J. A., Gold, S. L., Frederick, E. A., Gray, W. C., & Staecker, H. (2002). Patient-based outcomes in patients with primary tinnitus undergoing Tinnitus Retraining Therapy. *Archives of Otolaryngology, Head and Neck Surgery*, *128*(10), 1153-1157.

Brodal, P. (2004). *The central nervous system: Structure and function*. New York: Oxford University Press.

Brown, S., Martinez, M. J., & Parsons, L. M. (2004). Passive music listening spontaneously engages limbic and paralimbic systems. *Neuroreport*, *15*(13), 2033-2037.

Cason, C. L., & Grissom, N. L. (1997). Ameliorating adults' acute pain during phlebotomy with a distraction intervention. *Applied Nursing Research*, *10*(4), 168-173.

Coles, R.R.A. (1996). Tinnitus: Epidemiology, aetiology and classification. In G. Reich & J. A. Vernon (Eds.), *Proceedings of the Fifth International Tinnitus Seminar 1995* (pp. 25-29). Portland, OR: American Tinnitus Association.

Cusack, R., Deeks, J., Aikman, G., & Carlyon, R. P. (2004). Effects of location, frequency region, and time course of selective attention on auditory scene analysis. *Journal of Experimental Psychology: Human Perception and Performance*, *30*(4), 643-656.

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

Davis, M. (2000). The role of the amygdala in conditioned and unconditioned fear and anxiety. In J. P. Aggleton (Ed.), *The amygdala: A functional analysis* (pp. 213-287). New York: Oxford University Press.

Davis, P. B. (2006). Music and the acoustic desensitization protocol for tinnitus. In R. S. Tyler (Ed.), *Tinnitus treatment: Clinical protocols* (pp. 146-160). New York: Thieme.

Davis, P. B., Paki, B., & Hanley, P. J. (2007). Neuromonics tinnitus treatment: Third clinical trial. *Ear and Hearing*, *28*(2), 242-259.

Del Bo, L., & Ambrosetti, U. (2007). Hearing aids for the treatment of tinnitus. *Progress in Brain Research*, *166*, 341-345.

DiSogra, R. M. (2001, September). Adverse drug reactions and audiology practice. *Audiology Today*, *13*, 2-7.

Dobie, R. A. (1999). A review of randomized clinical trials in tinnitus. *The Laryngoscope*, *109*, 1202-1211.

Dobie, R. A. (2004a). Clinical trials and drug therapy for tinnitus. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 266-277). Lewiston, NY: BC Decker.

Dobie, R. A. (2004b). Overview: Suffering from tinnitus. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 1-7). Lewiston, NY: BC Decker.

Eysel-Gosepath, K., Gerhards, F., Schicketanz, K. H., Teichmann, K., & Benthien, M. (2004). Aufmerksamkeitslenkung in der Tinnitustherapie: Vergleich von Effekten unterschiedlicher Behandlungsmethoden [Attention diversion in tinnitus therapy: Comparison of the effects of different treatment methods]. *Hno*, 52(5), 431-439.

Folmer, R. L., & Carroll, J. R. (2006). Long-term effectiveness of ear-level devices for tinnitus. *Otolaryngology—Head and Neck Surgery*, *134*(1), 132-137.

Folmer, R. L., Griest, S. E., Meikle, M. B., & Martin, W. H. (1999). Tinnitus severity, loudness and depression. *Otolaryngology—Head and Neck Surgery*, *121*, 48-51.

Gardner, E. P., & Martin, J. H. (2000). Coding of sensory information. In E. R. Kandel, J. H. Schwartz, & T. M. Jessell (Eds.), *Principles of neural science* (pp. 411-429). New York: McGraw-Hill.

Gerken, G. M. (1996). Central tinnitus and lateral inhibition: An auditory brainstem model. *Hearing Research*, *97*(1-2), 75-83.

Gold, S. L., Frederick, E. A., & Formby, C. (1999). Shifts in dynamic range for hyperacusis patients receiving Tinnitus Retraining Therapy (TRT). In J. Hazell (Ed.), *Proceedings of the Sixth International Tinnitus Seminar 1999* (pp. 297-301). London: The Tinnitus and Hyperacusis Centre.

Gold, S. L., Gray, W. C., Hu, S., & Jastreboff, P. J. (1996). Selection and fitting of noise generators and hearing aids for tinnitus patients. In G. E. Reich & J. A. Vernon (Eds.), *Proceedings of the Fifth International Tinnitus Seminar* (pp. 312-314). Portland, OR: American Tinnitus Association.

Grocke, D., & Wigram, T. (2007). *Receptive methods in music therapy: Techniques and clinical applications for music therapy clinicians, educators and students*. Philadelphia: Jessica Kingsley.

Hallam, R. S., Jakes, J. C., & Hinchcliffe, R. (1988). Cognitive variables in tinnitus annoyance. *British Journal of Clinical Psychology*, *27*, 213-222.

Hallam, R., Rachman, S., & Hinchcliffe, R. (1984). Psychological aspects of tinnitus. In S. Rachman (Ed.), *Contributions to medical psychology* (Vol. 3, pp. 31-53). Oxford: Pergamon.

Harrop-Griffiths, J., Katon, W., Dobie, R., Sakai, C., & Russo, J. (1987). Chronic tinnitus: Association with psychiatric diagnoses. *Journal of Psychosomatic Research*, *31*(5), 613-621.

Hazell, J. W., Wood, S. M., Cooper, H. R., Stephens, S. D., Corcoran, A. L., Coles, R. R., et al. (1985). A clinical study of tinnitus maskers. *British Journal of Audiology*, *19*, 65-146.

Hazell, J.W.P. (1999). The TRT method in practice. In J. Hazell (Ed.), *Proceedings of the Sixth International Tinnitus Seminar 1999* (pp. 92-98). London: The Tinnitus and Hyperacusis Centre.

Henry, J. A., Loovis, C., Montero, M., Kaelin, C., Anselmi, K. A., Coombs, R., et al. (2007). Randomized clinical trial: Group counseling based on Tinnitus Retraining Therapy. *Journal of Rehabilitation Research and Development*, *44*(1), 21-32.

Henry, J. A., Rheinsburg, B., & Zaugg, T. (2004). Comparison of custom sounds for achieving tinnitus relief. *Journal of the American Academy of Audiology*, *15*, 585-598.

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)(4), 95-116.

Henry, J. A., Schechter, M. A., Nagler, S. M., & Fausti, S. A. (2002). Comparison of Tinnitus Masking and Tinnitus Retraining Therapy. *Journal of the American Academy of Audiology*, *13*, 559-581.

Henry, J. A., Schechter, M. A., Zaugg, T. L., Griest, S. E., Jastreboff, P. J., Vernon, J. A., et al. (2006a). Clinical trial to compare Tinnitus Masking and Tinnitus Retraining Therapy. *Acta Otolaryngology Supplementum*, *126*, 64-69.

Henry, J. A., Schechter, M. A., Zaugg, T. L., Griest, S. E., Jastreboff, P. J., Vernon, J. A., et al. (2006b). Outcomes of clinical trial: Tinnitus Masking vs. Tinnitus Retraining Therapy. *Journal of the American Academy of Audiology*, *17*, 104-132.

Henry, J. A., Trune, D. R., Robb, M.J.A., & Jastreboff, P. J. (2007a). *Tinnitus Retraining Therapy: Clinical guidelines*. San Diego: Plural.

Henry, J. A., Trune, D. R., Robb, M.J.A., & Jastreboff, P. J. (2007b). *Tinnitus Retraining Therapy: Patient counseling guide*. San Diego: Plural.

Henry, J. A., Zaugg, T. L., & Schechter, M. A. (2005a). Clinical guide for Audiologic Tinnitus Management I: Assessment. *American Journal of Audiology*, *14*, 21-48.

Henry, J. A., Zaugg, T. L., & Schechter, M. A. (2005b). Clinical guide for Audiologic Tinnitus Management II: Treatment. *American Journal of Audiology*, *14*, 49-70.

Henry, J. A., Zaugg, T. L., Schechter, M. A., & Myers, P. J. (2008a). *How to manage your tinnitus: A step-by-step workbook*. Portland, OR: VA National Center for Rehabilitative Auditory Research.

Henry, J. A., Zaugg, T. L., Myers, P. J., & Schechter, M. A. (2008b). The role of audiologic evaluation in Progressive Audiologic Tinnitus Management. *Trends in Amplification, 12*, 170-187.

Henry, J. L., & Wilson, P. H. (1996). The psychological management of tinnitus: Comparison of a combined cognitive educational program, education alone and a waiting-list control. *International Tinnitus Journal*, *2*, 9-20.

Henry, J. L., & Wilson, P. H. (2001). *The psychological management of chronic tinnitus*. Needham Heights, MA: Allyn & Bacon.

Herraiz, C., Hernandez, F. J., Plaza, G., & de los Santos, G. (2005). Long-term clinical trial of Tinnitus Retraining Therapy. *Otolaryngology—Head and Neck Surgery*, *133*(5), 774-779.

Herraiz, C., Hernandez, F. J., Toledano, A., & Aparicio, J. M. (2007). Tinnitus Retraining Therapy: Prognosis factors. *American Journal of Otolaryngology*, *28*(4), 225-229.

Hoffman, H. G., Richards, T. L., Van Oostrom, T., Coda, B. A., Jensen, M. P., Blough, D. K., et al. (2007). The analgesic effects of opioids and immersive virtual reality distraction: Evidence from subjective and functional brain imaging assessments. *Anesthesia and Analgesia*, *105*(6), 1776-1783.

Hoffman, H. J., & Reed, G. W. (2004). Epidemiology of tinnitus. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 16-41). Lewiston, NY: BC Decker.

Iversen, S., Iversen, L., & Saper, C. B. (2000). The autonomic nervous system and the hypothalamus. In E. R. Kandel, J. H. Schwartz, & T. M. Jessell (Eds.), *Principles of neural science* (pp. 960-981). New York: McGraw-Hill.

Jakes, S. C., Hallam, R. S., Rachman, S., & Hinchcliffe, R. (1986). The effects of reassurance, relaxation training and distraction on chronic tinnitus sufferers. *Behaviour Research and Therapy*, *24*, 497-507.

Jastreboff, P. J. (2000). Tinnitus Habituation Therapy (THT) and Tinnitus Retraining Therapy (TRT). In R. S. Tyler (Ed.), *Tinnitus handbook* (pp. 357-376). San Diego: Singular Publishing Group.

Jastreboff, P. J., Gray, W. C., & Gold, S. L. (1996). Neurophysiological approach to tinnitus patients. *American Journal of Otology*, *17*, 236-240.

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: Cambridge University Press.

Jastreboff, P. J., & Jastreboff, M. M. (2004). Decreased sound tolerance. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 8-15). Lewiston, NY: BC Decker.

Jenkins, L. S. (1988). Self-efficacy theory: Overview and measurement of key components. *Cardiovascular Nursing*, *24*(6), 36.

Johnsen, E. L., & Lutgendorf, S. K. (2001). Contributions of imagery ability to stress and relaxation. *Annals of Behavioral Medicine*, *23*(4), 273-281.

Johnson, M. H. (2005). How does distraction work in the management of pain? *Current Pain and Headaches Report*, *9*(2), 90-95.

Johnson, R. M. (1998). The masking of tinnitus. In J. A. Vernon (Ed.), *Tinnitus treatment and relief* (pp. 164-186). Needham Heights, MA: Allyn & Bacon.

LeDoux, J. E. (1998). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Touchstone.

McKenna, L. (1998). Psychological treatments for tinnitus. In J. A. Vernon (Ed.), *Tinnitus treatment and relief* (pp. 140-155). Needham Heights, MA: Allyn & Bacon.

Meikle, M. B., Griest, S. E., Stewart, B. J., & Press, L. S. (1995). Measuring the negative impact of tinnitus: A brief severity index. In A. Ryan (Ed.), *Abstracts of the Eighteenth Midwinter Research Meeting, Association for Research in Otolaryngology* (pp. 167). Des Moines, IA: Association for Research in Otolaryngology.

Miller, A. C., Hickman, L. C., & Lemasters, G. K. (1992). A distraction technique for control of burn pain. *Journal of Burn Care and Rehabilitation*, *13*(5), 576-580.

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. (2005). Incorporating group and individual sessions into a tinnitus management clinic. In R. S. Tyler (Ed.), *Tinnitus treatment: Clinical protocols* (pp. 187-197). New York: Thieme.

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., Wharton, J. A., & Jacobson, G. P. (1997). Self-focused and somatic attention in patients with tinnitus. *Journal of the American Academy of Audiology*, *8*(3), 143-149.

Nickel, A. K., Hillecke, T., Argstatter, H., & Bolay, H. V. (2005). Outcome research in music therapy: A step on the long road to an evidence-based treatment. *Annals of the New York Academy of Sciences*, *1060*, 283-293.

Robinson, S. K., Viirre, E. S., & Stein, M. B. (2004). Antidepressant therapy for tinnitus. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 278-293). Lewiston, NY: BC Decker.

Salamon, E., Kim, M., Beaulieu, J., & Stefano, G. B. (2003). Sound therapy induced relaxation: Down regulating stress processes and pathologies. *Medical Science Monitor*, *9*(5), RA96-RA101.

Saltzman, M., & Ersner, M. S. (1947). A hearing aid for relief of tinnitus aurium. *Laryngoscope*, 57, 358-366.

Sandridge, S. A., & Newman, C. W. (2005). Benefits of group informational counseling. In R. Dauman (Ed.), *VIIIth International Tinnitus Seminar* (p. 106). Bordeaux, France: University Hospital of Bordeaux, ENT Department.

Saper, C. B. (2000). Brain stem modulation of sensation, movement, and consciousness. In E. R. Kandel, J. H. Schwartz, & T. M. Jessell (Eds.), *Principles of neural science* (pp. 889-909). New York: McGraw-Hill.

Schechter, M. A., & Henry, J. A. (2002). Assessment and treatment of tinnitus patients using a "masking approach." *Journal of the American Academy of Audiology*, *13*, 545-558.

Schiffman, H. R. (1976). *Sensation and perception: An integrated approach*. New York: John Wiley.

Schleuning, A. J., Johnson, R. M., & Vernon, J. A. (1980). Evaluation of a tinnitus masking program: A follow-up study of 598 patients. *Ear and Hearing*, *1*, 71-74.

Searchfield, G. D. (2005). Hearing aids and tinnitus. In R. S. Tyler (Ed.), *Tinnitus treatment: Clinical protocols* (pp. 161-175). New York: Thieme.

Seidman, M. D., & Babu, S. (2003). Alternative medications and other treatments for tinnitus: Facts from fiction. *Otolaryngologic Clinics of North America*, *36*(2), 359-381.

Sharar, S. R., Carrougher, G. J., Nakamura, D., Hoffman, H. G., Blough, D. K., & Patterson, D. R. (2007). Factors influencing the efficacy of virtual reality distraction analgesia during postburn physical therapy: Preliminary results from 3 ongoing studies. *Archives of Physical Medicine and Rehabilitation*, *88*(12 Suppl. 2), S43-S49.

Simmons, D., Chabal, C., Griffith, J., Rausch, M., & Steele, B. (2004). A clinical trial of distraction techniques for pain and anxiety control during cataract surgery. *Insight*, *29*(4), 13-16.

Stephens, S., & Corcoran, A. (1985). A controlled study of tinnitus masking. *British Journal of Audiology*, *19*, 159-167.

Surr, R. K., Kolb, J. A., Cord, M. T., & Garrus, N. P. (1999). Tinnitus Handicap Inventory (THI) as a hearing aid outcome measure. *Journal of the American Academy of Audiology*, *10*(9), 489-495.

Surr, R. K., Montgomery, A. A., & Mueller, H. G. (1985). Effect of amplification on tinnitus among new hearing aid users. *Ear and Hearing*, *6*(2), 71-75.

Sweetow, R. W. (2000). Cognitive-behavior modification. In R. S. Tyler (Ed.), *Tinnitus handbook* (pp. 297-311). San Diego: Singular Publishing Group.

Tchorz, J. (2005). Utilizing Bluetooth for better speech understanding over the cell phone. *The Hearing Review*, *12*(1), 50-51.

Touyz, L. Z., Lamontagne, P., & Smith, B. E. (2004). Pain and anxiety reduction using a manual stimulation distraction device when administering local analgesia orodental injections: A multi-center clinical investigation. *Journal of Clinical Dentistry*, *15*(3), 88-92.

Trotter, M. I., & Donaldson, I. (2008, March 20). Hearing aids and tinnitus therapy: A 25-year experience. *Journal of Laryngology and Otology*, pp. 1-5.

Tyler, R. S. (Ed.). (2005). *Tinnitus treatment: Clinical protocols*. New York: Thieme.

Vander, A. J., Sherman, J. H., & Luciano, D. S. (1990). *Human physiology* (5th ed.). New York: McGraw-Hill.

Vernon, J. (1977). Attempts to relieve tinnitus. *Journal of the American Audiology Society*, *2*, 124-131.

Vernon, J. A. (1988). Current use of masking for the relief of tinnitus. In M. Kitahara (Ed.), *Tinnitus: Pathophysiology and management* (pp. 96-106). Tokyo: Igaku-Shoin.

Vernon, J. A. (1998). *Tinnitus treatment and relief*. Needham Heights, MA: Allyn & Bacon.

Vernon, J. A. (2002). Hyperacusis: Testing, treatments and a possible mechanism. *Australian and New Zealand Journal of Audiology*, *24*, 68-73.

Vernon, J. A., & Meikle, M. B. (2000). Tinnitus masking. In R. S. Tyler (Ed.), *Tinnitus handbook* (pp. 313-356). San Diego: Singular Publishing Group.

Vernon, J., & Schleuning, A. (1978). Tinnitus: A new management. *Laryngoscope*, *88*, 413-419.

Vingerhoets, A. J. (1985). The role of the parasympathetic division of the autonomic nervous system in stress and the emotions. *International Journal of Psychosomatics*, *32*(3), 28-34.

Wackym, P. A., & Friedland, D. R. (2004). Otologic evaluation. In J. B. Snow (Ed.), *Tinnitus: Theory and management* (pp. 205-219). Lewiston, NY: BC Decker.

Watanabe, E., Fukuda, S., Hara, H., Maeda, Y., Ohira, H., & Shirakawa, T. (2006). Differences in relaxation by means of guided imagery in a healthy community sample. *Alternative Therapies in Health and Medicine*, *12*(2), 60-66.

Wedel, H. V., Wedel, C. V., & Walger, M. W. (1998). Tinnitus masking with tinnitus-maskers and hearing aids. In J. A. Vernon (Ed.), *Tinnitus treatment and relief* (pp. 187-192). Needham Heights, MA: Allyn & Bacon.

Wilson-Pauwels, L., Stewart, P. A., & Akesson, E. J. (1997). *Autonomic nerves*. Hamilton, Ontario: BC Decker.