

Neurophysiological Models, Psychological Models, and Treatments for Tinnitus

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What Is Tinnitus?

My favorite definition of tinnitus is from McFadden (1982). Tinnitus

- Is a perception of sound (it must be heard)
- Is involuntary (not produced intentionally)
- Originates in the head (not hearing or overly sensitive to an external sound)

I would add that the patient's reaction should be considered. It is helpful to distinguish

- Tinnitus that is problematic from that which is not (Coles, 1987)
- How often the tinnitus occurs and how long an episode is (e.g., whether it occurs once a month for 10 seconds or is present daily)

Tinnitus has been classified in several ways, such as its presumed site of generation and whether it is audible to someone other than the patient (objective tinnitus) or the patient alone (subjective tinnitus). An objective tinnitus, heard by the examiner, may be of middle ear origin or a spontaneous otoacoustic emission arising from the sensorineural system. Therefore, the terms *subjective* and *objective* are not helpful in understanding or treating tinnitus. Therefore, tinnitus can be classified in a manner analogous to hearing loss according to site of injury or generation (Tyler and Babin, 1986); that is, whether it is middle ear, sensorineural, or central tinnitus.

The treatments described in this book are applicable to all classes of tinnitus. A thorough physical examination and treatment of identified ailments, when possible, are important first steps in treating a patient with tinnitus.

The overall impact of tinnitus on a patient is influenced by the characteristics of tinnitus and of that particular patient (Dauman and Tyler, 1992). For example,

I believe that tinnitus is more likely to be annoying if it is louder or has a screeching quality. Some authors have incorrectly suggested that psychoacoustic factors are unimportant or unrelated to tinnitus annoyance. Psychoacoustic factors are indeed relevant, although they are only one thing to consider in understanding the effect tinnitus has on a patient. An absence of high correlation between loudness and annoyance does not mean that loudness is not important. Stouffer and Tyler (1990) concluded that patients with soft tinnitus are not under as much stress as those who report a loud tinnitus. Also, patients who are under stress or have not had adequate sleep find the tinnitus more annoying.

Tinnitus is not a personality disorder, but psychological factors are involved in the development and maintenance of this problem (see, e.g., Fowler and Fowler, 1955). Although patients with severe tinnitus can have clinical depression, in my experience serious psychological problems are rare among most tinnitus patients. Very few of us, after all, would not be bothered at all if we constantly heard an unwanted sound that we had no control over.

Neurophysiological Models of Tinnitus

Neurophysiological models can be considered from many different aspects. In the normal auditory system, increases in spontaneous activity evoked by acoustic stimuli are thought to be the basis for sound perception. Therefore, neurophysiological models have logically nominated an increase in spontaneous activity in the absence of acoustic stimulation as the mechanism of tinnitus. Wherever the site of origin, most probably this must be transmitted to and result in an increased spontaneous rate in the auditory cortex. **Table 1–1** reviews a few of the neurophysiological models that have been proposed over the years (for reviews, see Cacace, 2003; Eggermont, 2000; Eggermont and Roberts, 2004; Jastreboff, 1990; Salvi, Lockwood, and Burkard, 2000; Vernon and Moeller, 1995). Some of these are specific to precise anatomic or physiological sites; others are more general models referring to processing principles.

TABLE 1–1 Examples of Neurophysiological Models of Tinnitus

Kiang, Moxon, and Levine (1970)	Edge between normal and absent hair cells and subsequent neural activity
Tonndorf (1981)	Decoupling of stereocilia between the hair cells and tectorial membrane
Moeller (1984)	Cross-talk (interneural synchrony) between nerve fibers
Eggermont (1984)	
Hazell (1987)	Tinnitus a result of automatic gain control system of central nervous system (e.g., normally increasing the sensitivity in quiet), linked to outer hair cells
Penner and Bilger (1989)	Spontaneous otoacoustic emissions
Jastreboff (1990)	Discordant inner and outer hair cell damage (damaged outer hair cells with reasonably intact inner hair cells)
Salvi et al (1996, 2000)	Increase in central neurons tuned to similar frequencies following reorganization of peripheral hearing loss
Kaltenbach et al (2001)	Hyperactivity of dorsal cochlear nucleus

In general, many of these models are insightful and clever. For models to be useful, they should be testable or should lead to a broader understanding and eventually a testable hypothesis.

I believe that, whatever the initial source of tinnitus, it must be perceived in the auditory cortex (see Tyler, 1981, p. 136). Broadly, there are three different ways that the mechanism of tinnitus can be coded in the auditory cortex:

- Increased spontaneous activity fed by increase or decrease in activity or edge in activity (Kiang et al, 1970)
- Cross-fiber correlation with normal or increased spontaneous activity (Eggermont, 1984; Moeller, 1984)
- More fibers with similar best frequency following hearing loss–induced auditory plasticity (Salvi et al, 1996, 2000)

Fig. 1–1 shows a schematic representation of how we hear, interpret, and react to sounds. Sound is transformed from acoustic to electrical information in the cochlea. It is transmitted through the brainstem to the auditory centers of the brain within the temporal lobe of each hemisphere. Other parts of the brain are involved in our memory for sounds and our emotional reaction to them. Such neurophysiological models of hearing have existed for decades and were applied to tinnitus as early as 1988 (Goodey, 1988). Although the mechanism responsible for the source of tinnitus initiation may arise anywhere, its representation in the nervous system must be transmitted to the brain. Wilson (1987, pp. 30, 31) suggested that tinnitus is coded in the auditory cortex “by virtue of the pattern of activity over many cells.” Like normal sounds, any reactions patients have to their tinnitus must involve other regions of the brain, such as the amygdala and the autonomic nervous system. Hallam et al (1984, p. 44) discussed “neurophysiological models of habituation” and their importance in understanding and treating the emotional components of tinnitus. This model was widely accepted at the time (e.g., Hazell et al, 1985, p. 74).

Noise-induced hearing loss, one of the most common causes of tinnitus, is known to inflict cochlear damage. Early studies of noise-induced hearing loss emphasized that outer hair cells are affected first and then inner hair cells (e.g.,

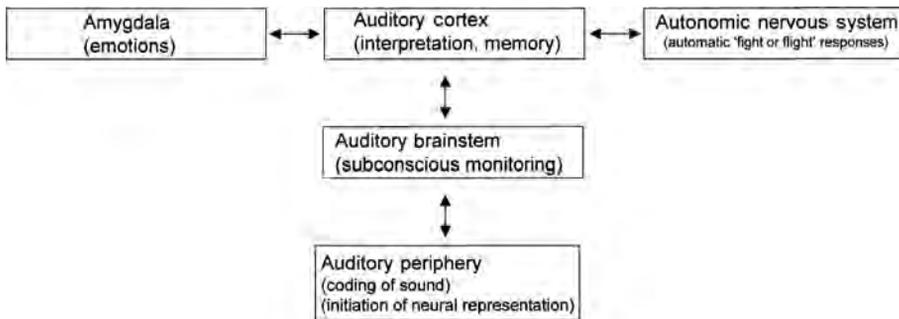


Figure 1–1 A general schematic representation of the process of hearing, interpreting, and reacting to sounds. The mechanism for the initiation of tinnitus may arise anywhere, but its representation eventually occurs in the auditory cortex. Any emotional responses must involve the amygdala and the autonomic nervous system.

Liberman and Dodds, 1984). However, I have argued that tinnitus must also intimately involve the brainstem and cortex (Tyler, 1981, p. 136). This was based on several observations, including that

- Sectioning the auditory nerve is often ineffective in reducing tinnitus.
- Masking can be just as effective in the ear ipsilateral to the tinnitus as in the ear contralateral to the tinnitus (e.g., Tyler and Conrad-Armes, 1984).
- One can observe that a person who is convinced about hearing tinnitus in the right ear can suddenly hear the tinnitus in the left ear when the right ear tinnitus is masked.

Coles (1987) also noted, as have many others since, that disorders of the central auditory pathways can cause tinnitus.

It is of interest, and perhaps a puzzle, that tinnitus can be influenced by other neurophysiological systems (for recent reviews, see Cacace, 2003, 2004; Levine et al, 2003). For example, in some patients tinnitus can be altered by touches to the hand, jaw movement, pressure to the head, and changes in eye gaze.

Of course, because tinnitus can provoke emotional reactions, other neurophysiological systems that are responsible for emotions must also be involved, including the autonomic nervous system and the amygdala. Both Hallam et al (1984) and Slater and Terry (1987) described how the autonomic nervous system is involved in tinnitus. This unconscious involuntary control system is for “fight or flight.” The sympathetic system sets up the body for action, and the parasympathetic system operates after the extra alertness is past, to bring the body from its “highly aroused state to its normal state” (Slater and Terry, 1987, p. 177). The authors emphasized how the “dangers” sensed are typically stress related, and reviewed in great deal the neurophysiological responses. They suggested coping strategies (e.g., relaxation techniques) as a treatment for the “inappropriate” autonomic response of tinnitus patients. It has been known for decades that the limbic system of the brain is involved whenever emotions are triggered (for reviews, see LeDoux, 1994; Mega et al, 1997). Jastreboff (1990) pointed out that the limbic system therefore must be involved in tinnitus patients who have emotional reactions. Cacace (2003) prefers the term *amygdala* to *limbic system*.

I like the way Goodey (1988, p. 84) explains tinnitus to his patients: “Too few messages are passing through the ear to keep the hearing nerve busy and ... especially in quiet conditions, the electrically active nerve generates its own messages which are heard as tinnitus.”

Psychological Models of Tinnitus

Physiological and psychological models are inherently linked. One cannot have a change in thinking or behaving without some neurophysiological correlate. Studies, and related conceptual frameworks, that focus on thinking and behaving can be considered psychological. **Table 1–2** reviews some psychological frameworks for considering tinnitus treatment.

These models are certainly not mutually exclusive. For example, Hallam et al (1984), in their habituation model, noted that an organism needs to analyze (or attend to) new and potentially important stimuli. How we think about tinnitus

TABLE 1–2 Psychological Factors Considered in Treating Tinnitus

Cognitive	Have developed inappropriate ways of thinking about tinnitus	Sweetow (1984, 1986) Andersson and Kaldo (Chapter 8) Hallam and McKenna (Chapter 6)
Habituation	Bothersome tinnitus is failure to habituate	Hallam et al (1984) Hallam (1989) Hallam and McKenna (Chapter 6)
Attention	Failure to shift attention away from tinnitus	Hallam et al (1984) Hallam (1989) Hallam and McKenna (Chapter 6)
Learning	Responses to tinnitus are learned	Jastreboff and Hazell (1993) Bartnik and Skarzyński (Chapter 10) also McKenna (2004), Hallam et al (1984)

influences our inclination to attend to it. External events can reinforce or inhibit our behavior. Learning theory, particularly classical conditioning, has been proposed as an important factor in the reaction to tinnitus (e.g., Jastreboff, 2000; McKenna, 2004). Hallam et al (1984, p. 44) suggested that “habituation can be delayed by intense, aversive and unpredictable stimuli to which affective significance has been attached by learning.”

Categories of Tinnitus Treatments

We can categorize tinnitus treatments in two ways. First, a treatment can focus on the tinnitus directly, reducing its magnitude or eliminating it completely. This can be accomplished by medications (e.g., Dobie, 1999; Murai et al, 1992) or electrical suppression (e.g., Dauman, 2000; Dobie et al, 1986; Quaranta et al, 2004; Rubinstein and Tyler, 2004; Zwolan et al, 1992). Although there have been important gains in both of these approaches, no clinical protocol is currently available, and they will not be reviewed in this book.

Second, it is possible to treat a patient’s reaction to tinnitus. Medications can be used to treat patients with depression and anxiety and to help with sleep problems. Chapter 4 in this book highlights how some of the more common medical conditions influence the counseling strategy. Medications for some patients are important, but they are not specific to tinnitus and will not be reviewed here. Counseling and sound therapy are two treatments that have been in common use since the early 1980s.

Counseling in the Treatment of Tinnitus

Whether we spend 1 minute or 60 minutes with a patient, talking with and listening to the patient are the cornerstone of the current treatment. Counseling for tinnitus patients is often performed by audiologists without a strong theoretical background in the many counseling strategies available. Psychologists frame different counseling approaches (and there are literally hundreds) using very specific guidelines. **Table 1–3** provides a few examples of these frameworks, taken from an excellent summary by Flasher and Fogle (2004).

TABLE 1–3 Psychological Counseling Approaches

Existential therapy	Concerns with individual's overall existence in life, and how one deals with problems. Considers uncertainty, meaning, and isolation (see Chapter 15)
Cognitive therapy	Thoughts influence behavior, erroneous ways of thinking are identified, and steps for coping and correcting thoughts are identified (see Chapters 6 and 8)
Humanistic therapy	Promotes personal growth and positive support in a nondirective fashion (see Chapters 5 and 15)
Behavioral therapy	Focus is on changing the ways patients behave (see Chapters 6, 9, and 14)

These theoretical frameworks are also not mutually exclusive, but I suspect that tinnitus counseling would benefit from a deeper understanding of the theoretical background of different counseling approaches. Those clinicians who have some training in these approaches will put themselves in a better position to serve their tinnitus patients.

Be Supportive

We, and others, have noted how important it is to be supportive and to offer positive encouragement to the tinnitus patient (e.g., Coles and Hallam, 1987; Hazell, 1987; Tyler et al, 2001). This applies to any counseling strategy and includes the following:

- Be perceived as a knowledgeable professional.
- Demonstrate that you understand tinnitus.
- Provide a clear therapy plan.
- Be sympathetic.
- Show that you sincerely care.
- Provide reasonable hope.

Whatever counseling strategy is adopted, adherence to these general guidelines will likely be helpful.

Provide Information

Most of the therapies designed for tinnitus provide information. Whichever neurophysiological or psychological model you adhere to, providing information helps patients better understand their problems and feel less victimized, and puts them in a position of moving forward in treatment. **Table 1–4** outlines the kinds of information that can be provided.

The relative importance of each of these topics is unclear. It is unlikely that discussing any of them would have a negative impact, and thus the question really is which to include or exclude, and how much time to spend on each topic. Obviously, too much information can be overwhelming for some patients, and it is possible to provide the information in too much detail or without sufficient clarity. This may prevent a patient from engaging in the other aspects of the

TABLE 1–4 General Categories of Information Typically Provided to Tinnitus Patients

Hearing	How we hear Anatomy and physiology of hearing
Hearing loss	Anatomy and physiology of hearing loss Consequences of hearing loss
Tinnitus epidemiology	Prevalence of tinnitus Causes of tinnitus Common problems associated with tinnitus
Tinnitus mechanisms	Spontaneous activity of nerves Neurophysiological models (see Table 1–1)
Central nervous system	Role of the brain in perceiving and reacting to sound
Habituation	Effect of repeated exposure to stimuli Consequences of fearful stimuli Consequences of not habituating to tinnitus
Attention	Factors that contribute to attention
Learning	Factors that contribute to learning
Sleep	Factors that influence sleep
Concentration	Factors that contribute to concentration
Auditory training	Things that influence our hearing and understanding
Lifestyles	How our overall lifestyle, including eating, exercise, and activities, influences our health
Self-image	How our self-image influences our beliefs and reactions
Treatment options for hearing loss	Variety of treatment options available for hearing loss, including hearing aids, cochlear implants, and auditory training
Treatment options for tinnitus	Variety of treatment options available for tinnitus, including coping strategies, relaxation therapy, cognitive behavior therapy, and sound therapies

treatment. We have proposed using pictures to facilitate the counseling process (see Tyler and Bergan, 2001).

Many of the counseling components of treatment focus primarily on providing information about hearing, hearing loss, and tinnitus (e.g., Bentler and Tyler, 1987; LaMarte and Tyler, 1987; Sheldrake et al, 1985; Tyler and Babin, 1986; Tyler and Baker, 1983). Some researchers, such as Hallam (1989), include discussions about habituation and attention in their approaches (see Chapters 6 and 10 in this book), whereas others focus more on brain mechanisms and learning. All of the clinicians writing in this book provide information on their particular counseling approach, and the diversity of topics and emphasis is evident. For example, in Chapter 2, Sizer and Coles present an informative brochure for patients, often a useful item to help patients remember tinnitus facts. Andersson and Kaldo in Chapter 3 show how the Internet can be used by patients to facilitate the transfer of information in conjunction with clinic visits. Newman and Sandridge in Chapter 14 show how the information can be shared efficiently in group therapy.

Many treatments for tinnitus are limited to providing information, and for many patients that is enough. If you can explain the causes of some problems, and perhaps even tell patients how they should react, this can be sufficient for patients' understanding of their problems. With such knowledge, some patients

will change their behavior regarding tinnitus. This is generally referred to as cognitive restructuring.

However, much more is involved in most counseling procedures than just providing information, or directing patients to some information that may be important. The next section discusses some counseling options.

Components of Counseling

Briefly, there are three components of most successful counseling programs:

- Changing thoughts
- Changing behavior
- Understanding an individual patient's needs

CHANGING THOUGHTS

Providing information can change the way patients think about their tinnitus. However, simply lecturing a patient is not enough, even if the information is useful. Understanding what caused the tinnitus, how the patient learned to react to it, and how the patient can help himself or herself is important. This is a key part of treatments that include aspects of cognitive therapy (see Hallam et al, 1988; see also Chapters 6, 8, and 10 in this book), even for young children (see Chapter 16).

CHANGING BEHAVIOR

Sometimes it is possible to change behavior simply by providing information. However, it is usually more effective to practice the desired behavior. Some coping strategies involve changing behavior; others deal with emotional reactions. Providing specific tasks to engage in is part of changing behavior. Chapters 5, 9, and 14 offer numerous examples of engaging the patient in behavior management.

UNDERSTANDING AN INDIVIDUAL PATIENT'S NEEDS

A broader perspective on tinnitus treatment involves understanding the individual patient, how the person views tinnitus, what support the patient has, and how tinnitus fits into the bigger picture of the patient's overall life. Listening, as opposed to providing information, is the first step. Tinnitus existentialist therapy, as discussed in Chapter 15, is a wonderful example of this.

Examples of Counseling Treatment Protocols

Several counseling treatment protocols and strategies have been proposed. Most contain some aspect of providing information. Several go beyond that. Tyler and Baker (1983) suggest that counseling needs to consider all of the patient's difficulties. They recommend that the major emphasis of counseling address the emotional problems related to tinnitus. Hazell (1987, p. 113) suggests that "it is fruitless and unrealistic to approach the tinnitus in isolation." **Table 1-5** reviews some of these protocols and strategies.

TABLE 1–5 Tinnitus Treatment Counseling Strategies

Tyler and Baker (1983) Tyler and Babin (1986) Tyler et al (1989)	Informational counseling	Providing information Considering emotional problems related to tinnitus
Clark and Yanick (1984)	Informational counseling	Understanding individual patient needs Nurturing expectations
Sweetow (1984, 1986)	Cognitive behavioral therapy	Providing information Sleep Changing attitude and self-esteem Diversionary tactics (attention) Coping strategies Cognitive behavior therapy
Hallam (1989)	Habituation therapy	Habituation Attention Relaxation Modifying the environment
Coles (1987), Coles and Hallam (1987)	Habituation therapy	Providing information Relaxation Habituation of reaction to tinnitus
Hazell (1987)	Masking therapy	Providing information Consideration of all the patient's problems (e.g., business, financial, and domestic) Reassurance Attention Relaxation The use of diaries Modifying the environment
Slater and Terry (1987)	Guided therapy	Providing information Attention Activities Habituation Lifestyle changes (being positive and active)
Lindberg et al (1988)	Tinnitus behavior therapy	Providing information Coping Various relaxation procedures
Stouffer et al (1991)	Informational counseling	Providing information Keeping diaries Changing activities
Jastreboff and Hazell (1994)	Retraining therapy	Providing information "Directive" approach
Davis (1995)	Living with tinnitus	Providing information Stress management Sleep Changing thinking

(Continued)

TABLE 1–5 Tinnitus Treatment Counseling Strategies (Continued)

McKenna (1998)	Habituation therapy	Providing information Habituation Relaxation Reactions to stress Listening to the patient
Henry and Wilson (2001, 2002)	Cognitive behavioral therapy	Providing information Self-help strategies Sleep, depression Attention control Cognitive behavior therapy Relaxation Coping strategies Relapse prevention
Tyler and Erlandsson (2000)	Refocus therapy	Three tiers of treatment Attention Engagement in other activities

COGNITIVE BEHAVIORAL THERAPY

Cognitive behavioral therapy has been applied to tinnitus for some time, has been discussed in the literature in great detail, and is arguably the only approach that has been shown to be effective in controlled studies (Andersson and Lyttkens, 1999; Dobie, 1999). Several general concepts are used in many tinnitus counseling protocols, although not always acknowledged. The “providing information” component is intended to change the way individuals think about their tinnitus. The basic premise of cognitive behavioral therapy (Henry and Wilson, 2001, 2002; Sweetow, 1984, 1986; see also Chapter 8 in this book) is the following: Your tinnitus is there. The way that you think about it results in a particular emotional reaction.

DIRECTIVE COUNSELING

One approach, directive counseling, or retraining therapy, stands alone in that it explicitly frowns upon considering individual needs, addressing personal concerns, and providing suggestions for initiating behavioral changes. For example, Jastreboff (1999, p. 291) describes it as a “teaching session”: “It is not, and never was, intended to be . . . collaborative.” Furthermore, it was never intended to “change a patient’s perception, attention and emotions towards tinnitus . . . , to improve a patient’s well-being, everyday life, social interactions and work abilities.”

The directive counseling approach prompted some concerns from several clinicians. For example, Wilson et al (1998) criticized retraining therapy for its “teaching” approach to counseling, which seemed to disregard standard counseling procedures that include a more interactive approach. Retraining therapy omitted basic principles leading the patient to discover unhelpful thoughts, develop realistic beliefs and attitudes, and modify their emotional response. Kroener-Herwig et al (2000) went on to criticize many components of retraining

therapy, one of which was that it “completely neglected” procedures to help the patient modify behavior. They believed that many tinnitus sufferers require more sophisticated strategies than simply teaching information to them. Instead, they felt that some patients should receive intervention programs to change their beliefs about tinnitus, their emotions and behavior. McKenna (2004) questioned the underlying philosophy of Jastreboff’s model, noting that its reliance on a classical conditioning perspective ignores the human component of tinnitus.

Sound Therapies for Treating Patients’ Reactions to Tinnitus

Sound has been used for decades to treat tinnitus. Its role can be understood in terms of

- Reducing the attention drawn to the tinnitus
- Reducing the loudness of the tinnitus
- Substituting a less disruptive noise (background sound) for an unpleasant one (tinnitus)
- Giving the patient some control (Coles, 1987; Vernon, 1977)

Sound therapies include the use of background sound, hearing aids, total masking, partial masking (including retraining therapy), and music therapy. Most of the chapters in this book include sound therapy directly or indirectly.

Counseling for Sound Therapies

Virtually all sound therapies are combined with some form of counseling, even if it is just providing information. More typically, in addition to basic information about tinnitus, hearing loss, attention, and habituation, specific counseling is included on the use of sound. This is true whether the sound therapy uses hearing aids or partial masking. Bentler and Tyler (1987), in their discussion of sound therapies, noted that, regardless of the management regimen chosen, counseling needs to be considered an integral component. Coles (1987, p. 395) said that “good counseling will go far toward interrupting the sort of vicious cycles” in addition to the sound therapy. **Table 1–6** lists some of the topics that are typically covered in counseling for sound therapy.

Occasionally, sound therapies are represented as if they do not include counseling. For example, Henry and Wilson (2002, p. 574) suggest that no specific counseling protocol has been published for partial or total masking. This is at odds with the tinnitus partial masking therapy proposed by Hazell (1987). In Hazell’s discussion of masking therapy, detailed counseling strategies are an essential component. In my opinion, no sound therapy should be administered without counseling. Davis (Chapter 11), Searchfield (Chapter 12), and Folmer et al (Chapter 13) share this perspective.

Use of Hearing Aids

Listening to background sound has been recommended in treating tinnitus for over 50 years (Goodhill, 1950). Because most patients with tinnitus also have

TABLE 1–6 Components of Counseling for Sound Therapy*

Rationale behind the use of background sound
Caution about using noise generators that are too intense; may interfere with speech and everyday sound perception and may damage hearing
Selecting the type of noise generators
Selecting the ear or ears to receive noise generators
Selecting the ear mold(s) to use, if applicable
Trial periods of the background noise

*After Hazell, 1987; Tyler and Bentler, 1987.

hearing loss, the use of hearing aids to amplify the background noise is a logical step (Johnson and Goodwin, 1981; Vernon and Schleuning, 1978), and many clinicians note the benefit (e.g., Bentler and Tyler, 1987). Chapter 12 provides an excellent detailed strategy for fitting hearing aids for tinnitus patients.

Total Masking Therapy

With total masking therapy, the patient no longer hears the tinnitus. This has some obvious appeal, and many patients find it very helpful. An important benefit is providing the patient with control. A detailed total masking therapy was proposed by Vernon and Schleuning (1978), Vernon and Meikle (2000), Hazell (1987) (see also Hazell et al, 1985), and Slater and Terry (1987). Hazell and Wood (1981) emphasized the importance of using a broadband signal. The large-scale study of tinnitus maskers by Hazell et al (1985) demonstrated the effectiveness of tinnitus masking. They found that counseling is helpful and that masking can provide additional benefit. However, some patients do not like the noise generated with masking, and for others the required noise can be too loud. One of the main advantages of total masking over other forms of masking, including setting noise at the “mixing point,” as in retraining therapy (Jastreboff and Hazell, 1993), is that some patients enjoy the immediate relief of the complete elimination of the tinnitus.

There is a misperception that total masking therapy provides only temporary relief and that the benefit of total masking is helpful only while the tinnitus is being masked (see, e.g., Henry and Wilson, 2002; Jastreboff and Hazell, 2004, p. 210). Neither of these points is true. Providing the patient with relief and control is very important with total masking and all forms of partial masking. With counseling, all forms of sound therapy can break the vicious cycle and facilitate dramatic long-term benefits. For example, Hazell (1987) recommended that patients be instructed not to expect maximum benefit immediately; instead, 2 or 3 months of masker use may be required. Furthermore, Hazell noted the beneficial long-term effects of masking: “As the patient focuses less attention on the tinnitus while it is masked, it may become less troublesome and obtrusive when the masker is removed” (p. 114). Total masking therapy is one of the options discussed in Chapter 13.

Fig. 1–2 shows a schematic representation of total masking. For many patients, it will not be possible to mask the tinnitus, and for others, the noise required is so intense that total masking is inappropriate.

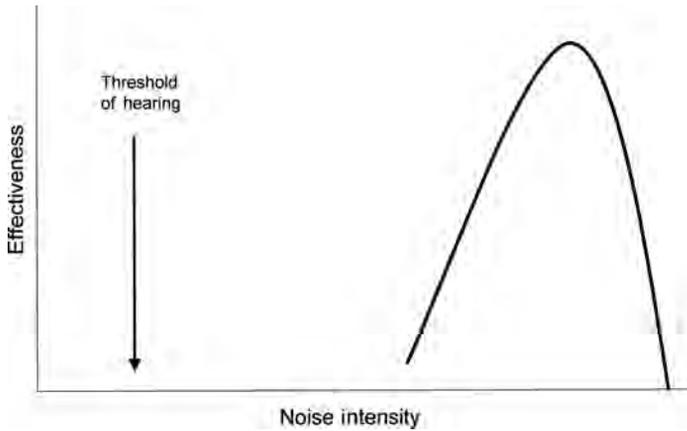


Figure 1-2 A schematic representation of total masking. With total masking, the tinnitus cannot be heard. Instead, the masker is perceived.

The noise can sometimes result in an increase in the tinnitus. Tyler and Bentler (1987) suggest

- Occasional rest from the noise generator
- Changing the level or spectrum of the noise generator

Other strategies for limiting the potential influence of noise on speech or everyday sound perception are

- Use low-level noise in the region of 500 to 3000 Hz.
- Use a unilateral masker.

Partial Masking Therapy

In the late 1970s and early 1980s, several researchers observed that some patients required high levels of noise to mask the tinnitus, or even could not mask the tinnitus completely. Vernon and Schleuning (1978) stressed that the actual level of the noise should be under the control of the patient. Hazell and Wood (1981) found that the masking noise can be set so that the patient hears both the masking sound and the tinnitus. They noted that the noise provides a distraction that makes patients concentrate less on the tinnitus itself. Other authors reported that the intensity of the tinnitus can be reduced with the use of noise that did not completely mask the tinnitus, or partial masking.

This approach allowed patients to determine the level of noise they could tolerate. Hazell (1987, p. 114) said that the masking sound “is most often effective at an apparent intensity much less than that of the patient’s tinnitus.”

Partial masking is a term that comes from the psychoacoustic literature, referring to the observation that the loudness of a tone can be reduced in the presence of background noise (see, e.g., Scharf, 1971). Jastreboff and Hazell (1993) have argued that using partial masking at the mixing point, with the noise and the tinnitus audible, is important to facilitate habituation. This may or may not be true. Habituation can occur with counseling alone (see Chapter 6 in this book), even

with total masking therapy. If it is important to be able to hear the tinnitus to facilitate habituation, it may be that low levels of partial masking below the mixing point are more desirable because the sound of the tinnitus would be similar to its usual quality and loudness. I was taught that the terms *masking* referred to a psychophysical phenomenon and *suppression* to a physiological phenomenon, but these words often have been used interchangeably. We do not know the mechanism of partial masking, but it is important that we be clear when we reference psychophysical or physiological observations.

Table 1–7 reviews several sound therapies that have promoted partial masking, together with the instructions provided to the patient.

Detailed protocols for fitting “maskers,” including partial masking, is provided by Hazell and Wood (1981), Sheldrake et al (1985), and Hazell (1987). The use of sound therapy, including partial masking, is reviewed in Chapter 13.

Fig. 1–3 shows a schematic representation of partial masking. The advantages of this procedure are that a comfortable level can be found for most patients and that precise levels are not targeted, which may concern a patient or focus attention on the tinnitus. One disadvantage is that even low levels can interfere with speech perception; another is that some patients will find any background sound bothersome. These disadvantages are found for all types of sound therapy.

TABLE 1–7 Examples of Descriptions of Partial Masking in the Literature

Tyler and Babin (1986)	“Both the noise and tinnitus are heard, but the tinnitus is reduced in loudness” (p. 3213). Patients should “use the lowest level masker that provides adequate relief” (p. 3213).
Coles and Hallam (1987)	“A low level background sound against which the loudness of the tinnitus is reduced” (p. 994).
Erlandsson et al (1987)	Reduced the noise from the complete masking condition until it was “comfortable enough to listen to” (p. 40).
Hazell (1987)	“The masking sound does not completely cover the tinnitus,” and it provides a “distracting background sound” (p. 107). The “tinnitus tends to ‘break through’ the masking noise” (p. 112).
Coles (1987)	“When the masker is used to provide only a low level of background sound against which the loudness of the tinnitus is reduced” (p. 398).
Tyler and Bentler (1987)	“Sometimes a masker can reduce the tinnitus loudness or annoyance, even though the tinnitus remains audible” (p. 55). “Partially mask the tinnitus yet produce the lowest SPLs and the least interference with speech” (p. 59).
Bentler and Tyler (1987)	“Urge the patient to use the lowest . . . masker level that provides adequate relief” (p. 30).
Jastreboff and Hazell (2004)	“Below the level creating annoyance or discomfort” (p. 210).

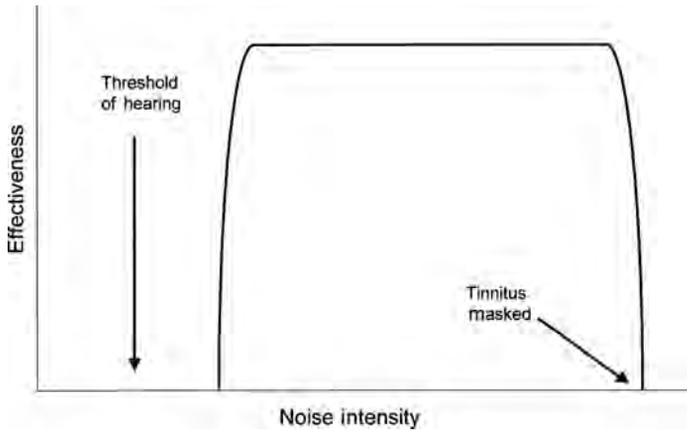


Figure 1-3 A schematic representation of partial masking. The advantage of this procedure is that a comfortable level can be found for most patients, and precise levels are not targeted, which may concern the patient or focus attention on the tinnitus. One disadvantage is that even low levels can interfere with speech perception with some patients; another is that some will find any background sound bothersome. These disadvantages are found for all types of sound therapy.

PARTIAL MASKING AT A SIMILAR MAGNITUDE TO THE TINNITUS (THE MIXING POINT)

A specific subcategory of partial masking has been described by several authors. Hazell (1987), for example, noted how it is better for some patients to have the tinnitus just audible through the masking sound. Coles (1987) suggested that the masker be turned up until its loudness is equal to that of the tinnitus, when the patient will often have to listen hard to hear it: “When this . . . is done the patient will usually accept that [the tinnitus] is no longer something to worry about” (p. 398).

Jastreboff (1998, p. 93) later referred to this as the mixing point, “where the patient perceives that the tinnitus sound and the external sound start to mix or blend together.”

The value of the mixing point over other levels afforded by partial masking has not been tested. As noted by Hazell (1987) and Coles (1987) above, the partial masking level at which the noise and tinnitus are similar will likely be preferable for some patients.

Fig. 1-4 shows a schematic representation of the mixing point, where the masking noise is at a level similar in magnitude to the tinnitus. Some patients find it difficult to determine the mixing point, whereas others find that the noise required for a mixing point is so intense that the lower levels of partial masking are preferable.

Music Therapy

For many tinnitus sufferers, listening to background music represents a more acceptable and even pleasant alternative to background noise. Slater and Terry (1987) found that almost 50% of tinnitus patients they sampled listened to music to help with their tinnitus. I believe that the use of music therapy with tinnitus patients deserves much more attention than it currently gets. The use of background music is recommended by Searchfield in Chapter 12 and by Folmer and colleagues in Chapter 13. A very specific protocol is reviewed by Davis in Chapter 11.

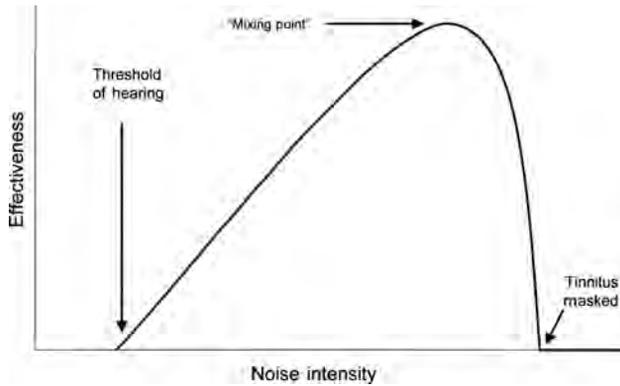


Figure 1-4 A schematic representation of one particular form of partial masking, referred to by Hazell (1987) as having tinnitus “just audible through the masking sound”; by Coles (1987) as “the masker can be turned up until its loudness is equal to that of the tinnitus, when the patient will often have to listen hard to hear the tinnitus”; and by Jastreboff (1998) as the mixing point “where the patient perceives that the tinnitus sound and the external sound start to mix or blend together” (p. 93).

Sound Therapy for Tinnitus Accompanied by Hyperacusis

WHAT IS HYPERACUSIS?

In a patient with hyperacusis, sounds that would normally be considered loud are instead heard as very loud. Thus loudness discomfort levels for pure tones are lower than normal, perhaps at 80 or 90 dB HL (for a review, see Nelting, 2003). It has been many years since hyperacusis was first associated with tinnitus (Tyler and Conrad-Armes, 1983). Hazell et al (1985) reported that the mean uncomfortable loudness levels in tinnitus patients were 10 to 15 dB lower than in hearing-impaired patients without tinnitus. However, the relationship between tinnitus and hyperacusis remains obscure. Loudness is thought to be coded by the number or level of activity of nerve fibers. The presence of hyperacusis implies that, for a given intensity, more nerve fibers or a higher rate of activity is produced than would occur normally. Hazell (1987) suggested that the central nervous system exerts a “gain control” mechanism to increase peripheral sensitivity affecting outer hair cell activity and tinnitus. This concept was included in a later model proposed by Jastreboff (1990) of a gain control mechanism involved in tinnitus.

HYPERACUSIS TREATMENT IN TINNITUS PATIENTS

The presence of hyperacusis in tinnitus patients requires some additional counseling and sound therapy considerations. Some patients develop a fear of sounds, or phonophobia. The main difficulty with hyperacusis in the treatment of tinnitus arises because the use of sound therapy can sometimes result in exacerbation of the hyperacusis or phonophobia. Therefore, it is important that clinicians treating tinnitus determine if their patients have hyperacusis, and to accommodate this if they are using sound therapy.

Sheldrake (1986, cited by Coles, 1987) recommended that noise generators be worn for hyperacusis patients for ~6 hours per day. The noise should be

“audible but comfortable (not necessarily completely masking any tinnitus . . .)” (p. 399). Sheldrake suggested that hyperacusis patients recovered over a period of a few days to up to 6 months in some cases; many patients gradually regain their tolerance of loud sounds.

Hazell (1987, p. 109) proposed a treatment of hyperacusis using a gradual and continuous introduction of sound into the ear to desensitize the ear to the effects of loud sounds. He noted that many hyperacusis patients use earplugs or earmuffs to protect their ears from loud sounds, but said that “it cannot be overstressed how counterproductive these measures are,” and that their use should be discouraged. Instead, he proposed a hyperacusis treatment procedure that begins with low levels of masking sound. Hazell recommended that the noise level be increased in level and duration gradually. A similar approach to hyperacusis has been suggested by Jastreboff et al (1998), except that they suggested the noise be used all the time. We note that hyperacusis patients often have hearing loss, and that the use of noise “all the time” may be unrealistic and can interfere with speech perception. Coles (1987) also cautioned against the use of earplugs in hyperacusis patients. Vernon and Press (1998) have suggested a desensitization protocol, whereby patients listen to intense, but not uncomfortable, “pink” noise for ~2 hours per day.

Phonophobia, the abnormal fear of sounds, is not necessarily related to loudness. The fear can be related to a specific sound or general class of sounds. Phonophobia can be helped by treating hyperacusis. It may be useful to follow the psychological principles of successive approximations. Starting with the least aversive sound, the approach would be to gradually expose the patient to sounds that are more and more similar to the sounds that elicit the phonophobia. Research is needed on treating hyperacusis and phonophobia.

Obstacles to Tinnitus Treatment

Negative Beliefs by Clinicians or Patients

Many clinicians have beliefs that represent obstacles to tinnitus treatment. For example, they believe that

- They do not have the training.
- They cannot help the patient.
- They will not be reimbursed.

One of the primary purposes of this book is to provide very concrete examples of a variety of treatment strategies. Audiologists, clinical psychologists, and otolinguists should have the training to implement most of these options. I believe patients can be helped by all the treatments described in this book. Research will eventually determine which are the most helpful and which treatments work best for which patients. Reimbursement should follow studies showing treatment effectiveness; when that happens, more clinicians will make the time to provide tinnitus treatment. It is our job, as clinicians, to show patients how to learn to live with their tinnitus.

Patients also have concepts that are obstacles. They sometimes believe that

- There is nothing that can be done.

- No one understands their tinnitus.
- Someone, somewhere, has the cure.

Patients who believe nothing can be done to ease the tinnitus often do not seek treatment. This can delay intervention and creates a more problematic case of tinnitus by the time the patient finally seeks help. The beliefs that nothing can be done and that no one understands are distressing to patients. Their crisis deepens, and they may withdraw further. Desperate patients with the financial resources will travel great distances and pay substantial fees if they believe there is hope for them. If they are unsuccessful, this often makes their situation worse. By providing good therapy, and demonstrating it by measuring clinical effectiveness and making this information public, patients in need will seek help.

DURATION AND NUMBER OF SESSIONS

The optimal number and duration of treatment sessions will vary across patients. Some patients will require long-term follow-up visits; this should not be viewed as inherently undesirable. For many patients, a simple 5-minute discussion will be sufficient. For others, much longer sessions will be necessary (see Tyler and Erlandsson, 2000, for strategies). The clinical psychology literature indicates that most patients will benefit from several short (less than 1 hour) visits over several weeks.

Hazell (1987) suggested that sound therapy typically requires 2 to 3 months of noise-generator use before any benefit is achieved. Research can be used to determine the optimum treatment duration. This will vary across individuals. The number of sessions and their duration will likely be linked to reimbursement.

REIMBURSEMENT

Reimbursement is often available for diagnosing hearing loss and tinnitus. In the United States, there are reimbursement codes for treating central auditory processing disorders and for providing aural rehabilitation. Additionally, there are numerous reimbursement codes for providing psychological treatments, including insight-oriented, behavior-modifying, and supportive psychotherapy, interactive psychotherapy, family psychotherapy, biofeedback, behavior modification, and cognitive behavior therapy. These codes are typically used by clinical psychologists and psychiatrists. Research demonstrating clinical effectiveness of tinnitus treatment will facilitate reimbursement.

QUALIFICATIONS OF AUDIOLOGISTS TO DO PSYCHOLOGICAL COUNSELING

Counseling of tinnitus patients should be performed only by clinicians who have the training and professional license to do so. Flasher and Fogle (2004) suggest that audiologists can use basic psychological principles and techniques for which they have knowledge. Clearly, patients who have clinical depression, anxiety disorders, or other psychiatric ailments demand appropriate referrals. This does not mean that audiologists cannot be involved in treating the tinnitus in these cases, however. In my experience, psychiatrists and psychologists often welcome a collaborative effort with an audiologist who has experience in treating tinnitus. Treating tinnitus patients requires a commitment, a plan, and some clinical expertise. You are likely committed if you are reading this book, and if you do

not have a plan, this book will offer several options. Clinical expertise comes from training, experience, and certain personal characteristics that can be learned and are often facilitated by personal supervision of real clinical experience. Some of the desirable characteristics are as follows (after Flasher and Fogle, 2004; Gladding, 2000; Riley, 2002):

- Ability to listen
- Patience
- Ability to be encouraging to the patient
- Ability to talk candidly about depression, anxiety, and other psychological problems
- Emotional insightfulness
- Self-awareness
- Ability to laugh at the bittersweet aspects of life
- Positive self-esteem
- Emotional stability

Conclusion

Counseling and sound therapy are the fundamental treatments for tinnitus. There are many counseling options, and most include providing information on hearing loss, tinnitus, and attention. Differences exist on how much time to spend on each area, but this is a secondary issue. I believe that counseling should consider the individual's emotional state and focus on providing coping strategies. I think audiologists can learn more from aspects of cognitive and behavioral therapy as they are applied to other problems. A greater emphasis should be placed on improving sleep. Some patients may benefit from systematic therapies covering concentration and relaxation, but these can be offered as optional. The detailed comprehensive therapy plans provided by Henry and Wilson (2001, 2002) are important contributions and supplement the comprehensive therapy protocols of Hallam (1989), Slater and Terry (1987), and Davis (1995). The chapters in this book demonstrate varied approaches to counseling.

Sound therapy, involving wearable and nonwearable devices, should be considered an option for most tinnitus patients. Providing background sound removes some of the annoying characteristics of a piercing tinnitus. I believe that total and partial masking therapies with a focus on the mixing point do help some patients, but for many the resulting background noise levels are too intense. Lower levels of partial masking generally are more acceptable. Also, many patients do not want to listen to any levels of noise, and attempts to force sound therapy on them can be counterproductive. Finally, the use of music and other types of nonrandom noise in treating tinnitus should be explored.

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