

# TINNITUS

Facts, Theories, and Treatments



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# **TINNITUS**

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## **Facts, Theories, and Treatments**

DENNIS McFADDEN

Working Group 89

Committee on Hearing, Bioacoustics,  
and Biomechanics

Commission on Behavioral and Social Sciences  
and Education

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# Foreword

Many readers who work in fields related to hearing and deafness are familiar with the reports of working groups of the Committee on Hearing, Bioacoustics, and Biomechanics (CHABA). These reports are prepared by special study committees, known as working groups, set up by CHABA to advise federal agencies on issues of significant national need.

The original impetus for this report was a request brought to the National Academy of Sciences in 1980 by the Food and Drug Administration (FDA) of the U.S. Department of Health and Human Services. The FDA asked for assistance in evaluating the efficacy and safety of tinnitus masking units and tinnitus instruments (masker/hearing aid combinations). The National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) shared the FDA's interest in concerns about these matters and, in addition, had a broader interest in the status of knowledge about tinnitus. In response to the joint request from these two agencies, CHABA, with the approval of the Commission on Behavioral and Social Sciences and Education and the National Research Council, created Working Group 89 and charged it with the preparation of a general, critical review of the entire topic of tinnitus, including tinnitus maskers and instruments.

The performance of a working group depends strongly on the energy and wisdom of its chairman. Considerable skill and, often, diplomacy are required in preparing a final report that incorporates the scientific knowledge and opinions of a range of experts while providing the practical guidance needed by those who originally raised the question. In the case of tinnitus and tinnitus masking, it was felt that the person charged with the preparation of an evenhanded review and evaluation of current knowl-

edge should be an experienced auditory scientist who was not associated with a specific position on the issues to be studied. The broad scope of the following report, the balanced manner with which controversial questions are treated, and a light touch where many would have fallen into turgid scientific prose show how well this challenge was met by the chairman of Working Group 89, Dennis McFadden.

The members of CHABA deeply appreciate the efforts of the members of Working Group 89 and especially of its energetic chairman in providing this timely report.

CHARLES S. WATSON

Chairman

Committee on Hearing,

Bioacoustics, and Biomechanics

## Preface

Most of the work on this report was done during 1981 and early 1982, but it is not possible to specify a single cutoff date for the source materials used for the report. In some instances, no information more recent than several years old was uncovered; in other instances, preprints of articles or chapters to be published later in 1981 or 1982 were available and were used. It was not possible to be systematic, comprehensive, and up to date in all of the various literatures touched by this report, and the purely fortuitous way that some information was discovered makes it believable that important facts may have been missed. During the writing of the report, two symposium volumes on tinnitus appeared (CIBA Foundation, 1981; Shulman, 1981a); both are widely cited throughout this report, but the serious student of tinnitus is encouraged to examine the originals. In an attempt to provide as comprehensive a research bibliography as possible, some sources have been included even though they were not cited in the report for one reason or another.

Much of the information on tinnitus maskers/instruments comes from a single source--the University of Oregon tinnitus clinic. Because I wanted the review of that information to be as objective as possible, I tried to maintain a degree of distance between myself and personnel at the clinic, none of whom I have met. I did exchange several letters with Jack Vernon, the clinic's director, and he provided me with helpful comments on an early draft of the section on the efficacy of tinnitus maskers/instruments.

I wish to thank the members of the working group for their splendid assistance in preparing this report. All were generous with their time and prompt in their replies to requests for comments on my successive drafts. Their



cogent comments about style, substance, and organization contributed greatly to the content and form of the report.

Beyond the members of the working group, many people contributed to the final form of this report. Milton Whitcomb, study director of the Committee on Hearing, Bioacoustics, and Biomechanics (CHABA), offered excellent counsel and guidance at critical points and, as always, proved to be an effective, genial, and unobtrusive administrator. I am indebted to CHABA members Donald H. Eldredge, William D. Neff, and Charles S. Watson for their valuable comments on the manuscript. Earleen Elkins of the National Institute of Neurological and Communicable Disorders and Stroke and Harry Sauberman of the Food and Drug Administration frequently provided me with the necessary perspective on the problem. Eugenia Grohman of the National Research Council was meticulous in her copy editing of the manuscript and did more than anyone else to render it readable and correct. Judy Searcy made preparation of the index as painless as such a job can be. And most important, the timely preparation and form of the report are due in large part to the word-processing skills of Lanier Bayliss, whose careful attention to detail and persistent good cheer are deeply appreciated.

A number of my friends have noted that tinnitus is an unlikely topic for me to be reviewing and critiquing, and I am the first to agree. I do not consider myself to be an expert on tinnitus: I have never done research on the topic, nor have I ever seen a tinnitus patient. I tried to read all the material that is available on tinnitus and to draft as organized, comprehensive, and critical a summary of the topic as I could. The realities of deadlines being what they are, not everything I hoped to do got done. However, as the reader will appreciate, any tinnitus report written in the foreseeable future will necessarily be only an interim report; far too little is known for it to be otherwise. I would appreciate hearing from readers about omissions, errors of fact or interpretation, and differences of opinion.

DENNIS MCFADDEN  
Chairman  
Working Group 89

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# Introduction

Hearing sounds that do not originate in the world outside the body is an experience that probably every human has at one time or another in life. The sounds heard range from popping and clicking to intermittent roaring and buzzing to continuous pure tones. In their diversity, these experiences have two things in common. they all originate, in one way or another, from inside the head, and they are all known as tinnitus.

Tinnitus can accompany a wide array of serious and minor disorders of the ear and of the body in general. As shall be seen, some causes are reasonably well understood, but most are not. Effective palliative treatment has been established for some forms of tinnitus, but for most, effectiveness of treatment continues to be unpredictable.

The following section provides an overview of the tinnitus problem and of the various topics that are discussed in detail in subsequent sections.

## OVERVIEW OF THE REPORT

Tinnitus can be defined as the conscious experience of a sound that originates in the head of its owner. In some cases tinnitus exists because there is actually a source of acoustic energy located somewhere in the head and neck area--a contracting muscle, a clicking jaw, a defective vein or artery, etc.--that can also be heard by a second party, with or without the aid of special devices. However, the majority of tinnitus cases have no detectable acoustic basis, but instead arise from anomalies in one or more of the elements of the neural chain that constitutes the auditory nervous system. It is important to

emphasize at the outset that tinnitus is itself not a disease, but a symptom that is common to many maladies that afflict many different structures within and without the auditory system. A frequently drawn analogy is to fever and headache--symptoms that accompany many different disorders. Like those two symptoms, tinnitus can range in severity from mild and easily overlooked to severe and debilitating.

Existing estimates of the prevalence of tinnitus are all flawed in one way or another, but all are in accord over its ubiquity. A recent British survey indicates that about 1 percent of the general population has severe, occasionally debilitating tinnitus; were this percentage an accurate estimate of prevalence in the United States, there would be about 2.5 million Americans afflicted with severe tinnitus. At the other extreme, it may be that nearly everyone experiences a mild form of tinnitus at one time or another in life and thus that mild episodes of tinnitus are "normal" in the sense that an occasional backache or pimple is normal.

The majority of tinnitus cases are probably never reported as medical or auditory problems, but are simply accepted as normal phenomena or as occasional minor irritants. For some people, however, tinnitus can become as totally debilitating as any serious systemic disorder. It can be severe enough to turn an otherwise healthy, well-adjusted person into someone unable to work or socialize. Anecdotes persist about people committing, or threatening to commit, suicide because of severe tinnitus and of others begging to have their offending ear surgically destroyed in the hope of escaping a relentless tinnitus. Every experienced hearing specialist has seen less severe, but nevertheless serious, cases.

Given the multiple origins of tinnitus, it should be expected that no single treatment for tinnitus is likely to be found. Also, it should be no surprise that many forms of treatment have been attempted over the years. Unfortunately, few of these have had much success until recently. Indeed, until lately, hearing specialists have had little to offer tinnitus sufferers in the way of relief, and far and away the most common "treatment" even for severe tinnitus has been the statement that lots of other people have the problem, that there is nothing much that can be done about it, and that the patient will simply have to learn to live with it. This grim situation has brightened considerably, however, and the prospects now appear good that the symptom of severe

tinnitus will eventually be alleviated for a substantial fraction of its sufferers. The two most promising areas of advancement in the treatment of tinnitus involve drugs and masking.

In the past few years, several drugs have been identified as potent agents against several of the common forms of tinnitus. These include lidocaine, carbamazepine, and sodium amylobarbitone. So far each has drawbacks of one sort or another that prevent its immediate widespread use, but related drugs are being developed and studied.

Many tinnitus sufferers independently discover that sounds from the external world can cover up or mask their tinnitus. Such people realize relief in relatively noisy environments or from background sounds such as the interstation noise on a radio. Hearing specialists have known about the effectiveness of masking against tinnitus for decades, but not until recently was it offered in a systematic way as a palliative for tinnitus.

In the mid-1970s a group of hearing specialists at the University of Oregon Medical School developed a device for generating a masking sound that could be mounted in a standard hearing aid chassis. This tinnitus masker was later combined with a hearing aid in the same chassis, and this combination was called a tinnitus instrument. For about 5 years, tinnitus maskers and instruments have been prescribed and distributed to tinnitus patients coming to the Oregon tinnitus clinic. The primary question posed to CHABA Working Group 89 was to evaluate the efficacy and safety of tinnitus maskers/instruments.

Nearly all the available information on efficacy comes from follow-up questionnaire data collected, collated, and published by the Oregon group. Their series of reports contains some inconsistencies and some (perhaps understandable) exaggerations, but overall the outcomes are encouraging. It is important to remember in what follows that the Oregon group surely does not see a random selection of tinnitus sufferers, but rather, those severely enough afflicted to be motivated to travel to the clinic (and affluent enough to be able to). That is, the patients in the Oregon sample probably include some of the most severely afflicted tinnitus sufferers in the country, and the various success rates should be interpreted accordingly.

There are a number of reasonable ways to calculate estimates of success from the Oregon data; the basic issue is what number is most appropriate for use as the

denominator of the success ratio. About 25 percent of the people who appear at the Oregon clinic are sent away without a recommendation to try a masker, hearing aid, or instrument, and this number has been essentially constant over the years. If these people are included in the denominator when calculating a success ratio, the estimates obtained are very conservative ones. Less conservative estimates are obtained by excluding this 25 percent of the people from the denominator on the grounds that they were not regarded to be good candidates for masking and thus should not be "counted against" the success of the treatment. Still less conservative estimates involve excluding both this 25 percent and those people who were given a recommendation for one of the three devices--masker, aid, or instrument--but who did not purchase one after the trial period. Depending upon which of these increasingly less conservative denominators is used, between about 42 percent and 93 percent of the respondents to the Oregon clinic's questionnaire report either total or partial relief from their tinnitus through use of the recommended devices. Considering the presumed degree of tinnitus severity in this sample, such success rates are certainly encouraging. Masking of tinnitus is not a panacea, but from these statistics, and from the absence of other, equally effective treatments, masking must now be regarded as the treatment of first choice. The primary reason for caution regarding this conclusion is that at present essentially all of the data on efficacy originate from a single source.

The safety of tinnitus maskers/instruments is more difficult to evaluate at this time than is their efficacy. There are several reasons for this. First of all, there is essentially no information available about the sound-pressure levels (SPL) experienced by typical wearers of tinnitus maskers/instruments, nor about the temporal patterns of these exposures. Such information is crucial, of course, if safety is to be evaluated by consulting standard damage/risk criteria or exposure guidelines. Most tinnitus maskers/instruments have maximum outputs of 85-95 dBA, and some are rated as high as 105-110 dBA. The most widely used U.S. exposure guideline permits exposure to 90 dBA for only 8 hours per day when the exposures occur 5 days per week. Thus, nearly all currently available maskers/instruments are capable of exceeding common damage/risk criteria and therefore have the potential to produce hearing loss.



There exists a serious question, however, of whether tinnitus maskers/instruments should be regulated on the basis of their presumed, or even demonstrated, risk to hearing. The issue is that for many thousands of people tinnitus is a severe, debilitating condition, and it can be argued that the risk, or even the inevitability, of some additional hearing loss caused by a masker/instrument is a price worth paying for the relief from the tinnitus. An obvious parallel exists with hearing aids. Evidence is accumulating that the levels and durations experienced by many wearers of hearing aids may eventually cause additional hearing loss, yet few hearing professionals regard that risk (or inevitability) to be serious enough to warrant restricting the availability or use of hearing aids, nor presumably would hearing-impaired people be willing to forfeit their aids on these grounds. Similarly, certain drugs carry long-term risks (or inevitabilities) that do not rule out their use when they are all that is available for treatment of a serious malady.

It appears that for the moment the best policy to follow in regard to the safety of tinnitus maskers/instruments is to make users explicitly aware of the virtues for hearing conservation of low masker levels and of intermittent patterns of exposure. Until more is known about the levels and durations of exposure experienced by typical users of tinnitus maskers/instruments, more restrictive policies are premature, and even when more is known, such policies may be judged inappropriate.

In summary, after years of neglect, tinnitus is rapidly coming to be a topic of active interest to clinicians, physiologists, psychoacousticians, and other hearing specialists. Much is left to be learned, but it is clear that tinnitus is now an established, legitimate research area; it is not just another buzz word.

In the rest of this report, the issues briefly mentioned here are examined in more detail, and the evidence on which current beliefs about tinnitus are based is presented and evaluated.

#### A DEFINITION OF TINNITUS

As is true for so many phenomena, a concise yet precise definition of tinnitus is difficult to achieve. As noted, one distinguishing feature of tinnitus is that the origin of the perceived sound is inside the head. In some cases there is an actual sound source--a vibrating body--under-