

Translating  
Tinnitus Research  
Findings into  
Clinical Practice

Conference  
Program



October 4 – 6, 2017

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## **Message from Gabrielle Saunders (Conference Chair) and Sarah Theodoroff (Program Chair)**

*Welcome to the 2017 NCRAR biennial conference. As in the past, we have put together a program that will provide you with information about cutting-edge research – this year we are focusing on tinnitus. We are thrilled to have a distinguished group of presenters and thank them for finding the time in their busy schedules to come here to present.*

*Over the coming three days you'll learn about epidemiology and neurophysiological models of tinnitus, neural correlates of tinnitus that are being used as the basis for targeted interventions, you'll learn about some of the challenges faced when developing a pharmacological "cure" for tinnitus, and hear the evidence for various interventional approaches to treating tinnitus. We anticipate you'll take away valuable information to apply to your work – whether that be in clinical practice, teaching or research. Once again, we have ensured the program allows time for interaction and discussion.*

*On a personal level, we are extremely grateful to Christine Kaelin, Conference Coordinator, who has spent countless hours planning the logistical aspects of the meeting, to Bonnie Becker for doing the paperwork to enable us to provide you with ASHA and AAA CEUs and of course to our sponsors whose generous support enables us to host this meeting (see Page 3 of this program).*

*We hope you enjoy the conference and that you find a little time to immerse yourself in the culture and scenic beauty of the Portland area while you are here. Make sure to walk around the city – or to use public transport – it's the Portland way.*

*We hope to have a chance to meet you over the coming few days, such as at the networking dinner on Wednesday, at the Poster Session on Thursday, or during the meetings.*

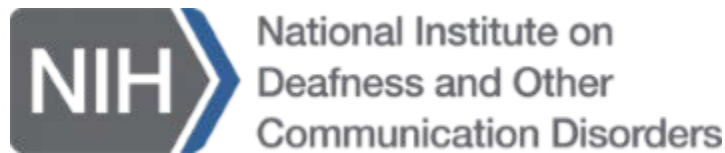
*Yours,*

*Gaby Saunders and Sarah Theodoroff*

## Conference Sponsors

The NCRAR thanks the following organizations and businesses for their sponsorship of the conference:

- **National Institutes of Health NIDCD**
- **VA Rehabilitation Research and Development Service**
- **Oticon**
- **American Tinnitus Association**
- **Phonak, LLC**
- **Otoharmonics**
- **Signia**
- **Starkey Hearing Technologies, Inc**
- **Widex**



## Conference Schedule

# Translating Tinnitus Research Findings into Clinical Practice

**PROGRAM FOR THE NCRAR BIENNIAL CONFERENCE, OCTOBER 4-6, 2017**

### Wednesday, October 4th (Full Day 7:30am – 4:15pm)

7:00a – 7:30a	Registration and light continental breakfast
7:45a – 8:00a	Welcome and introductions. <i>Gabrielle Saunders PhD and Sarah Theodoroff PhD</i>
8:00a – 9:15a	<a href="#">Keynote Address: Epidemiology of Tinnitus</a> . <i>David Baguley PhD</i>
9:15a – 10:30a	<a href="#">Neuroscience of Tinnitus: The Role of the Brainstem</a> . <i>James Kaltenbach PhD</i>
10:30a– 11:00a	BREAK
11:00a – 12:15p	<a href="#">Neuroscience of Tinnitus: The Role of the Cortex</a> . <i>Larry Roberts PhD</i>
12:15p – 1:45p	LUNCH BREAK/STUDENT-MENTOR LUNCH
1:45p – 3:00p	<a href="#">Using Brain Imaging Techniques to Find the Tinnitus Signal</a> . <i>Fatima Husain PhD</i>
3:00p– 3:15p	BREAK
3:15p – 4:30p	<a href="#">Pharmacological Interventions: Challenges in Developing a Drug for Tinnitus</a> . <i>Carol Bauer MD</i>
6:30p – 10:00p	Informal Networking Dinner: Urban Studios. 935 NW Davis Street, Portland, OR 97209

### Thursday, October 5th (Full Day 7:30am – 6:00pm)

7:00a – 7:30a	Registration and light continental breakfast
7:30a – 7:45a	Introductions
7:45a – 9:00a	<a href="#">Tinnitus Measurement in Humans</a> . <i>James Henry PhD</i>
9:00a – 10:15a	<a href="#">Clinical Presentation of Tinnitus Patients in a Polytrauma Setting &amp; Nuances of Tinnitus Management</a> . <i>Paula Myers PhD and Tara Zaugg AuD</i>
10:15a– 10:45a	BREAK
10:45a – 12:00p	<a href="#">Tinnitus Associated with Trauma</a> (e.g., PTSD, Blast-exposure). <i>Marc Fagelson PhD</i>
12:00p – 1:30p	LUNCH
1:30p – 2:45p	<a href="#">Sound-based Tinnitus Management Approaches</a> . <i>Craig Formby PhD</i>
3.15p – 6:00p	<a href="#">Poster Session</a> and 'Meet the Scientist'. Refreshments will be served. 3rd Floor World Trade Center

### Friday, October 6th (Half Day Morning 7:30am – 12:00pm)

7:00a – 7:30a	Light continental breakfast
7:30a – 7:45a	Introductions
7:45a – 9:00a	<a href="#">Interdisciplinary Approach to Tinnitus Management</a> . <i>Neil Cherian MD and Kay Cherian DPT</i>
9:00a – 10:00a	<a href="#">Cognitive Behavioral Therapy for Tinnitus</a> . <i>Caroline Schmidt PhD</i>
10:00a – 10:15a	BREAK
10:15a – 11:15a	<a href="#">Neuromodulation and Other Novel Interventions for Tinnitus</a> . <i>Robert Folmer PhD</i>
11:15a – 12:15p	Roundtable Discussion and closing comments
12:15p	Box lunch to go

# Presenters and abstracts

## Wednesday morning sessions

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### Keynote Address: Epidemiology of Tinnitus

David Baguley PhD

Wednesday, 8:00 – 9:15am

#### About Dr. Baguley:



Having led the Audiology and Hearing Implant Services at Cambridge University Hospitals NHS Trust, David Baguley is now working at the University of Nottingham as a Professor of Hearing Sciences, based in the NIHR Nottingham Biomedical Research Centre. David has co-authored over 150 scientific papers, many book chapters, and authored and edited several books, most recently 'Tinnitus: clinical and research perspectives' (Baguley and Fagelson, eds, Plural, 2016). To date his research has largely been in tinnitus, and a new theme is developing of ototoxicity in adult survivors of cancer treated with platinum-based chemotherapy. David has served as the

Chairman of the British Society of Audiology (BSA), and is the current President of the British Tinnitus Association (BTA). He has been awarded the American Academy of Audiology International Award, the BSA TS Littler Prize, Association of Independent Hearing Practitioners Outstanding Contribution to Audiology Award, and twice awarded the BTA Shapiro Research Prize.

#### Presentation overview:

Tinnitus is a prevalent and often troublesome symptom. This presentation will review what is known about the prevalence and incidence of tinnitus in both children and adults, and in developed and non-developed nations. Risk factors for tinnitus will be described, and the incidence of associated medical conditions will be reviewed. Specifically, the association of tinnitus with hyperacusis will be critically considered. In conclusion, the possibility that knowledge about the epidemiology and natural history of tinnitus gives rise to an opportunity to design and trial interventions that address specific challenges for people with troublesome tinnitus will be considered.

*David Baguley's research is funded through the NIHR Biomedical Research Centre programme.*

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### Neuroscience of Tinnitus: The Role of the Brainstem

James Kaltenbach PhD

Wednesday, 9:15 – 10:30am

#### About Dr. Kaltenbach:



Dr. Kaltenbach received his Ph.D. in Biology at the University of Pennsylvania in 1984. After completion of his postdoctoral training in 1987, he joined the faculty at Wayne State University, first in the Department of Audiology, then in the Department of Otolaryngology (1995). He moved to the Cleveland Clinic in 2008 where he jointly appointed in the Head and Neck Institute and Department of Neuroscience in the Lerner Research Institute. He has also served on numerous committees at the National Institutes of Deafness and Other Communication Disorders, the American Tinnitus Association, and the Association for Research in Otolaryngology.

#### Presentation overview:

The brainstem has long been known to be a source of tinnitus-related signals, but the brainstem's contribution to tinnitus is likely to be more complex, involving an interplay of modulatory influences from cortical and subcortical brain

centers that participate in stress reactions and auditory attention. In this presentation, we will examine what is known about the brainstem's role in generating tinnitus signals and consider what descending pathways that originate outside of the brainstem's generator sites may contribute to the tinnitus experience. This analysis will lead to a discussion of potential new therapeutic approaches that target not only the generator sites but also those that modulate them.

*The work presented here did not receive external funding.*

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## Neuroscience of Tinnitus: The Role of the Cortex

Larry Roberts PhD

Wednesday, 11:00am – 12:15pm

### About Dr. Roberts:



Larry E. Roberts is Professor Emeritus at McMaster University in Hamilton, Ontario, Canada. He received his bachelor's and PhD degrees from the University of Minnesota, Minneapolis, USA. He has studied neural plasticity in the human auditory system using laboratory training methods and musicians as models, and has investigated the role of neural plasticity in tinnitus, publishing extensively in both domains. Most recently he joined with Susan Shore and Berthold Langguth to review mechanisms of tinnitus for *Nature Reviews: Neurology*.

### Presentation overview:

While most cases of chronic tinnitus are related to some form of peripheral hearing pathology, the tinnitus percept itself is generated not by pathological neural activity persisting in the cochlea but by neuroplastic changes that occur in central auditory pathways when the brain receives reduced input from the ear. Neural changes seen in primary auditory cortex appear to relate most closely to the tinnitus percept while those observed in other brain regions reflect the consequences of tinnitus-related neural activity for cognitive and emotional processing or correlated attributes of tinnitus including somatosensory modulation and hyperacusis. Cochlear modeling of electrophysiological responses from the auditory midbrain suggests that hidden injury affecting auditory nerve fibers with high rates of spontaneous activity in quiet can distinguish individuals experiencing tinnitus from individuals exhibiting temporal processing deficits with otherwise normal hearing. Evidence for a high prevalence of tinnitus and reduced sound level tolerance among adolescents engaging in risky listening habits forecasts a challenge for the basic and clinical hearing sciences.

*This work was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).*

## Wednesday afternoon sessions

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### Using Brain Imaging Techniques to Find the Tinnitus Signal

Fatima Husain PhD

Wednesday, 1:45 – 3:00pm

### About Dr. Husain:



Dr. Fatima T. Husain has a PhD in Cognitive and Neural Systems from Boston University. She worked for several years, first as a PostDoc and later as a Research Fellow, in the Brain Imaging and Modeling section of the National Institute on Deafness and Other Communication Disorders, National Institutes of Health. Throughout, her work has focused on understanding brain function related to speech and hearing. Since 2006, the primary focus of her work has been on using the latest brain imaging techniques to better understand the neural correlates of tinnitus and hearing loss, with a view to helping patients.

**Presentation overview:**

Patients with tinnitus vary in their psychological reaction to the chronic sound – at one end, we have successful copers who have managed to habituate to their tinnitus and score low on tinnitus-related questionnaires. At the other end are those who score very highly on the questionnaires, are extremely bothered by the presence of tinnitus and may often suffer from related mood disorders. In this talk, I will review the latest research, from our lab and from other centers, about the neural correlates of this psychological reaction to tinnitus. I will concentrate on three overarching dimensions, namely, attention, emotion, and audition, along which individual patients vary. Brain imaging, specifically MRI, is an excellent tool to study the functional properties of the neural networks involved in auditory and extra-auditory processing, both during ‘rest’ and during goal-directed tasks. I will end the talk with a potential model of habituation, that of the attention system (via the frontal cortex) suppressing the response from the emotion processing network (via the limbic system). Successful tinnitus management options need to address the psychological reaction at an individual level and possibly be tailored to their unique needs.

*This work was funded by grants from DoD/CDMRP (grant# W81XWH-15-2-0032), American Tinnitus Association, Tinnitus Research Consortium, and University of Illinois at Urbana-Champaign.*

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**Pharmacological Interventions: Challenges in Developing a Drug for Tinnitus**

*Carol Bauer MD*

Wednesday, 3:15 – 4:30pm

**About Dr. Bauer:**

Dr. Carol A. Bauer is a Neurotologist and Chair of the Division of Otolaryngology Head and Neck Surgery at Southern Illinois University in Springfield, Illinois. She completed her residency at the University of Iowa in 1994 and a Neurotology fellowship at Baylor College of Medicine in 1995. She directs the Tinnitus Clinic, Cochlear Implant Center, and the Hearing and Balance Center at SIU. Her practice focuses on the evaluation and management of hearing and balance disorders encompassing the peripheral and central auditory pathways, including the evaluation and management of the tinnitus patient. The Auditory Research Group at SIU has received funding from the National Institutes of Health, the Tinnitus Research Consortium and the American Tinnitus Association to investigate the physiologic and neurologic bases of tinnitus. As a clinician-scientist, her clinical work informs her basic science research and has led to clinical

trials of pharmacologic and acoustic therapies for chronic tinnitus. In collaboration with Dr. Thomas Brozoski she has developed a robust animal model of tinnitus that has resulted in significant advances in the current understanding of mechanisms underpinning noise-induced chronic tinnitus. The animal model has led to translational investigations of pharmacologic and non-pharmacologic treatments of tinnitus.

**Presentation overview:**

There is a long history of pharmacologic treatments for tinnitus. The goal of finding a drug that will cure tinnitus has been elusive and even the less ambitious goal of tinnitus control has met with varying success. Over the centuries, drug interventions have evolved from empirical trials driven by anecdotal observations to rational drug choices derived from theoretical mechanisms and scientific evidence. Animal models of tinnitus have been instrumental for investigating the mechanisms that underlie tinnitus and to develop and test novel compounds to treat tinnitus. Nevertheless, the pharmacologic modulation of tinnitus remains challenging because of the complex interplay between the tinnitus perception and the emotional response or functional impact of tinnitus. Clinical trial design must utilize outcome measures that discriminate between psychophysical features of tinnitus and measures of tinnitus impact. In addition, knowledge of the various subtypes of tinnitus with potentially different pathophysiology is limited and constrains finding a single drug that is effective for all forms of tinnitus. Finally, the placebo response observed in many tinnitus clinical trials can be considerable. Recommendations for appropriate trial design and execution that account for these factors will be discussed.

*This work was funded by Tinnitus Research Consortium grant numbers 5R01DC009669; 5R01DC004830*



## Thursday morning sessions

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### Tinnitus Measurement in Humans

James Henry, PhD

Thursday, 7:45 – 9:00am

#### About Dr. Henry:



Dr. Henry earned an M.S. in Audiology from Portland State University in 1987, and a Ph.D. in Behavioral Neuroscience at Oregon Health & Science University in 1994. He has received continuous research funding since 1995 to study and develop methods to improve clinical procedures for the management of tinnitus. His initial studies focused on tinnitus psychoacoustic assessment, and this work has continued to the present. He has also been involved in the development of tinnitus questionnaires, including the Tinnitus Functional Index, Tinnitus and Hearing Survey, and Tinnitus Screener. Dr. Henry directs an integrated program of research, education, and professional training. His research focuses on developing tinnitus diagnostic tests, treatment options, and outcome measures, and bringing these into clinical practice. In addition, a significant portion of Dr. Henry's duties involves education of Veteran patients and their families, education and training of clinicians, and professional mentoring. Perhaps the most

significant result of Dr. Henry's efforts is the development of "Progressive Tinnitus Management" (PTM). PTM is a program of tinnitus management that involves five stepped levels of care to address patients at all levels of need. PTM has been endorsed by VA Central Office officials as the standard method of tinnitus management for VA medical centers nation-wide. Dr. Henry's goals are to document the effectiveness of PTM for Veterans, and to make PTM available to all Veterans needing quality clinical services to assist them in managing their tinnitus.

#### Presentation overview:

Curing tinnitus relates to what is perceived as an auditory sensation and not to how the person reacts to the percept. A cure for tinnitus would eliminate the percept completely with minimal or no side effects. A partial cure would reduce its intensity. To date, no cure for tinnitus exists. Therapies for tinnitus must therefore focus on reducing reactions to tinnitus.

Evaluating outcomes of tinnitus therapy would ideally involve assessing both the perception of, and reactions to, tinnitus. Perceptual attributes of tinnitus include its loudness and spectral composition. Reactions to tinnitus include sleep disturbance, concentration difficulties, and emotional distress.

"Measures" of tinnitus perception typically involve some form of loudness matching and pitch matching. The loudness of tinnitus can be matched to tones with generally reliable results. Matching the pitch of tinnitus to tones is less reliable and repeated pitch matches most often range over 2-3 octaves. More sophisticated psychoacoustic testing attempts to shape a stimulus spectrally to match the timbre of the tinnitus. Testing is also done to determine the potential effects of sound on the tinnitus percept, including minimum masking level (MML) and residual inhibition.

Tinnitus psychoacoustic measures are generally not useful for diagnostic purposes, nor for assessing outcomes of intervention. Pitch matching, however, is used with various sound therapy methods to specify the target frequency for the therapeutic stimulus, and loudness matches and MMLs have been used to evaluate outcomes of therapy. Because methods for obtaining these measures are not standardized, it is difficult to assess their validity for achieving the desired purpose. Normative standards are needed as a starting point to enable a proper interpretation of these measures.

No method exists to objectively determine the presence of tinnitus, which becomes an issue whenever a person claims tinnitus for compensation purposes. One promising method is the pre-pulse gap detection method that has been demonstrated in animal studies.

Using questionnaires is the preferred method of assessing tinnitus impact and outcomes of intervention. With tinnitus questionnaires, however, some patients attribute their hearing problem to their tinnitus, causing them to confound

responses about tinnitus impact with their hearing difficulties. The result is an inflated score, supposedly reflecting a tinnitus problem but also reflecting a hearing problem.

Considering the concerns with psychoacoustic testing and tinnitus questionnaires, a clinical protocol is suggested. Tinnitus questionnaires are essential if tinnitus-specific intervention will be performed—to obtain a baseline assessment of tinnitus impact and to assess outcomes of the intervention. However, for evaluating any patient who reports tinnitus, the tinnitus assessment should be limited to using a questionnaire that clearly distinguishes between a tinnitus problem and a hearing problem. One such questionnaire exists (Tinnitus and Hearing Survey), which can be used with a routine audiologic assessment to determine if tinnitus-specific intervention is needed. Tinnitus psychoacoustic testing is not normally recommended, unless the measures will be helpful for counseling purposes. Pitch matching to specify acoustic parameters for sound therapy should be performed with the caveat that these measures tend to be unreliable upon repeated testing.

This work was funded by VA RR&D grant #s C9247S and 1L01RX001205-01A1.

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## Clinical Presentation of Tinnitus Patients in a Polytrauma Setting & Nuances of Tinnitus Management

*Paula Myers PhD and Tara Zaugg AuD*

Thursday, 9:00 – 10:15am

### **About Dr. Myers:**



Paula Myers, Ph.D. is Chief of the Audiology Section at the Tampa VA Hospital. She has worked at the Tampa VA for 29 years. Her expertise and research focuses on development of audiology educational materials, tinnitus management, traumatic brain injury and auditory rehabilitation. She chaired the Audiology Southern Professional Standard Board and National Audiology Patient Education Workgroup and is a former teacher of the Deaf and Deaf-Blind and Assistant Professor at University of South Florida.

### **About Dr. Zaugg:**



Dr. Tara Zaugg is a certified, licensed, and clinically privileged research audiologist employed at the National Center for Rehabilitative Auditory Research (NCRAR) located at the Department of Veterans Affairs (VA) Portland Health Care System. Through involvement in tinnitus clinical trials over the last 17 years at the NCRAR, she has acquired extensive experience with a wide range of tinnitus assessment and management methods. She also has extensive experience with training audiologists to implement various methods of tinnitus management. Dr. Zaugg is a co-developer of Progressive Tinnitus Management (PTM), which is endorsed by the Department of Veterans Affairs (VA) Central Office as the standard method of tinnitus management for VA hospitals. Dr. Zaugg strives to understand the perspective of clinicians and patients using PTM, and to incorporate their needs and insights into PTM as it evolves.

### **Presentation overview:**

The intensified use of explosive devices (IEDs) and mines in warfare and excessive noise of weapons has created an extraordinary amount of auditory dysfunction including tinnitus, traumatic brain injury (TBI), and mental health complaints among returning Service Members, military Veterans and even civilians from blast injury related events. Mild TBI, particularly for those with closed head injuries, may not be immediately obvious. In both civilians and Veterans, TBI is often associated with concurrent trauma to the auditory system with tinnitus a common reported symptom. If the tinnitus persists for many months or over one year, it is likely that the tinnitus is permanent. Tinnitus can occur not only as a symptom of TBI and side effect of medications commonly used to treat cognitive,

behavioral, pain and physical problems associated with TBI, but can also be a direct consequence of the event causing TBI, as in the case of blasts.

There is a high rate of comorbidity between TBI and other invisible injuries, such as tinnitus, hearing loss, auditory processing difficulties and PTSD. A person with blast injury may suffer from multiple injuries simultaneously, making proper diagnosis and treatment a challenge. Hearing, tinnitus and balance issues are often overlooked in polytrauma patients, as visible and life threatening wounds take medical priority. Additionally, even patients without TBI often find it difficult to put their experiences with tinnitus and other invisible auditory problems into words; this difficulty is likely exacerbated in those experiencing symptoms of TBI. Given the association and comorbidity between history of TBI, hearing loss, tinnitus, PTSD, and other invisible injuries, it is important to understand each condition and their clinical implications for evaluation and management.

Practical tips for providing care for tinnitus will be explored. The tips will be applicable to all populations of people struggling with tinnitus, including those in a polytrauma setting. Topics to be covered include: 1) how to foster a (realistic) sense of hope about a future with tinnitus, 2) the importance of figuring out what people *really* mean when they say their tinnitus is a problem, 3) reasons to consider avoiding use of the word masking when discussing use of sound for tinnitus, 4) what to do when your patient believes the only path to feeling better is to quiet tinnitus 5) ways to respond when patients ask about the impact of sodium, caffeine, alcohol, stress and other lifestyle factors on tinnitus, and 6) how to help your patient understand the various effects of trying multiple methods to quiet tinnitus.

*This work was funded by VA RR&D grant # C74521 and RX-000294-01.*

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## Tinnitus Associated with Trauma (e.g., PTSD, Blast-exposure)

Marc Fagelson PhD

Thursday, 10:45am – 12:00pm

### **About Dr. Fagelson:**



Marc Fagelson is Professor of Audiology at East Tennessee State University. He teaches classes in audiologic assessment, pathologies, medical audiology, and tinnitus management. He opened the James H. Quillen Mountain Home VAMC tinnitus clinic in 2001, at which time the links between tinnitus and posttraumatic stress disorder became a research and clinical focus. He has worked with more than 1000 patients at the VA clinic, and has published several articles, book chapters, and presented at national and international meetings the results of this clinically-directed research.

### **Presentation overview:**

Dr. Fagelson, (Professor Audiology, ETSU) will discuss the unusual challenges facing patients and providers when tinnitus severity is linked to traumatic exposure. Interactions between neural mechanisms associated with tinnitus, post-traumatic stress-disorder (PTSD), and traumatic memory will be reviewed with particular attention to the way and degree to which such interactions affect tinnitus and disorders of sound tolerance. Conference attendees will be provided theoretical models of emotional memory consolidation that underscore trauma's durable effects on a patient's emotional state, reaction to the tinnitus signal, and to potentially-triggering environmental sounds. The putative benefits of tinnitus counseling will be presented in the context of trauma interventions that employ well-established counseling techniques as an element of patient-centered care. Audiologists must provide trauma patients a safe environment and opportunity for dialogue that contributes to a holistic understanding of the patient's situation and perceptions; the ultimate goal is to employ interventions and self-assessment instruments that can be used to evaluate patient needs and progress when tinnitus is related to trauma. The potentially-exacerbating effects of comprehensive audiologic assessment will also be addressed.

*This work was supported by funding from East Tennessee State University and James H. Quillen Mountain Home VAMC tinnitus clinic*

## Thursday afternoon session

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### Sound-based Tinnitus Management Approaches

Craig Formby PhD

Thursday, 1:30 – 2:45pm

#### About Dr. Formby:



Dr. Craig Formby completed his doctoral training at Washington University and the Central Institute for the Deaf in 1982, and then post-doctoral training in neurology. He is a past director of audiological and speech-language services at the Johns Hopkins University and the University of Maryland Schools of Medicine, serving in a dual assistant dean capacity for the latter. Dr. Formby currently is appointed as a distinguished graduate research professor in the Colleges of Arts & Sciences, Medicine, and Engineering at the University of Alabama. His research has been continuously funded by federal awards since 1987, including the inaugural K24 midcareer award from the National Institute on Deafness and other Communication Disorders (NIDCD). Dr. Formby serves as the study chair and principal investigator for the NIDCD-sponsored Tinnitus Retraining Therapy Trial, which is now being conducted in military treatment centers across the

United States in collaboration with the Johns Hopkins Bloomberg School of Public Health. Dr. Formby is a fellow of the Acoustical Society of America and a past editor of the Journal of Speech, Language, Hearing Research.

#### Presentation overview:

Dr. Formby will discuss the implications of comorbid auditory conditions (e.g., hearing loss, hyperacusis) for planning and selecting tinnitus management options. He will also explain the scientific rationale for a variety of sound-based tinnitus therapies including devices that target tinnitus alone, devices that target both hearing loss and tinnitus, and approaches that combine sound and psychological interventions. Conference attendees will learn the science that underlies sound-based tinnitus management, and clinical considerations for selecting sound-based tinnitus therapy to meet the needs of individual tinnitus patients.

*This work was funded by NIH-NIDCD award #s U01DC007411 and U01DC007422.*

## Friday morning sessions

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### Interdisciplinary Approach to Tinnitus Management

Neil Cherian MD and Kay Cherian DPT

Friday, 7:45 – 9:00am

#### About Dr. Neil Cherian:



Neil Cherian, MD is a neurologist at the Cleveland Clinic in Cleveland, Ohio. He has subspecialized as an otoneurologist and is interested in the interplay between the auditory and vestibular systems and its interactions with other areas of the brain. His practice is focused on patients with dizziness, imbalance, tinnitus, syncope and various headache syndromes. With his background in electrical engineering, Neil finds it helpful to apply systems engineering theories to the understanding of complex brainstem disorders. His current focus is on the neural control of the neck and role of the mechanics of the neck and jaw on tinnitus. Dr. Cherian is a board certified in Neurology and also in Headache Medicine. He is a member of the Cleveland Clinic's Center for Neuro-Restoration's Headache Section, the Tinnitus Management Clinic and the Concussion Center. Neil is a self-proclaimed closet musician. This interest has been a driving force in his clinical and research endeavors. It has also fueled his active involvement in the music industry with activities regarding recording, live

performance, product development and artist relations. He collaborates with the Audio Engineering Society and its technical committee on hearing and hearing loss prevention and was a board director for the American Tinnitus Association (ATA) from 2006 to 2012.

#### **About Dr. Kay Cherian:**



**Kay Cherian, PT, DPT, Cert. MDT**, received her graduate Physical Therapy degree from Nova Southeastern University in 1998 and her DPT from the University of St. Augustine in 2014. She has been involved in patient care at the Cleveland Clinic since 2004, where she was an integral member of the interdisciplinary chronic headache (IMATCH) and the tinnitus management teams. She received the Herdman Vestibular Competency Certification in 2000 and the McKenzie Credentialing in 2005. Currently she is a member of the Brain and Health Restoration Program that focuses on care for retired NFL players through the NFL Players Association. She is an active member of APTA and OPTA where she has delivered numerous presentations and posters. Clinical interests include concussion, vestibular disorders, headaches, cervical spine disorders, temporomandibular disorders and tinnitus. Her past experience in the military has given her a passion to assist other soldiers with issues including tinnitus and hyperacusis.

#### **Presentation overview:**

Our portion will provide a brief overview of the Cleveland Clinic Tinnitus Management Clinic (TMC), discuss pertinent considerations from the neurologist's perspective and also from our physical therapist.

The multi-disciplinary approach to tinnitus management has been an option at the Cleveland Clinic for a number of years. The visit includes up to six patients referred by an ENT (providing medical clearance) over a 3.5 hour period. Team members include providers from audiology, auditory neuroscience, psychology, dentistry, neurology and physical therapy. Portions include patient self-introduction, didactic portions and individual screening visits with the various providers (15 minutes each). The basic purpose of the screen visit is to ascertain whether and full evaluation is needed.

Elements include pre-visit questionnaires, a didactic portion providing an overview concept of tinnitus phenomenology, diagnosis and management; brief presentations from each of the services included, case review conference and an after-visit summary letter with recommendations.

The program has been well-received and has a wait list of patients. Patient feedback has included increases in acceptance of a tinnitus diagnosis, deeper understanding of the complexities of tinnitus and the auditory system, diminished feelings of being marginalized by other medical providers...

The neurology portion of the screening evaluation attempts to ascertain the presence of any pertinent vestibular dysfunction, various headache disorders and or other pain syndromes (such as fibromyalgia) and the phenomenon of somatic modulation (as described by Robert A. Levine, MD). Potential future interventions include advanced-level cervical and jaw physical therapy, various oral medications (often antineuritic medications such as gabapentin, duloxetine, amitriptyline or oxcarbazepine), occipital nerve blocks and or botulinum toxin.

The physical therapy portion attempts to identify any joint derangement or muscle dysfunction in the cervical and thoracic spines as well as the TMJ region. Repeated motions are performed to these areas while monitoring signs and symptoms, especially the quantity and quality of tinnitus. A complete physical therapy evaluation will be requested if findings suggest biomechanical abnormalities in any of the regions, especially if tinnitus can be altered in any way during the screen. Treatment may consist of manual techniques, therapeutic exercises, ergonomic and posture education.

This work did not receive external funding.

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## Cognitive Behavioral Therapy for Tinnitus

Caroline Schmidt PhD

Friday, 9:00 – 10:00am

### About Dr. Schmidt:



Caroline J. Schmidt, Ph.D. has been a full-time clinical health psychologist and researcher at the VA Connecticut Healthcare System (VACHS) in West Haven, Connecticut since 2008. She is also affiliated with Yale School of Medicine (SOM) Department of Psychiatry as an assistant clinical professor. She earned her doctorate in clinical psychology at Gallaudet University in Washington, D.C. in 2004 and has been licensed since 2008. She completed an NIH T-32 funded residency administered through Yale SOM at the VACHS examining mental health care disparities among Veterans with auditory disabilities while receiving specialized training in clinical health psychology.

In 2009 she received a Career Development Award, Level 1 to from the VA RR&D to examine receipt of cognitive behavioral therapy (CBT) for tinnitus among Veterans. Results from that study informed what is now known as Progressive Tinnitus Management (PTM). She served as a local PI for two clinical trials examining the effectiveness of PTM for Veterans funded by VA RR&D to Dr. James Henry. Additionally, she serves as a supervisor for clinical health psychology trainees, offers PTM to Veterans at VACHS, and conducts pre-surgical cochlear implant psychological evaluations. She also works in primary care – mental health integration serving Veterans with general health needs such as sleep disorders, smoking cessation, and obesity. Her broader interests include auditory perception in the absence of external stimuli.

### Presentation Overview:

Tinnitus is the most common service-connected disability among Veterans. Cognitive-behavioral therapy (CBT) is an essential intervention for reducing distress experienced by some people with tinnitus. CBT has been integrated within the Progressive Tinnitus Management protocol for serving Veterans with tinnitus. CBT along with audiologic counseling and education are recommended in the literature (Tunkel, et al., 2014). Recent clinical trials investigating Progressive Tinnitus Management (PTM) provide further evidence for these best practices. This presentation serves to provide information for providers about the essential components of CBT for tinnitus and how to offer such care. Psychologists can learn the basics of offering this intervention and audiologists learn how to enlist the help of mental health providers at their sites.

*This work was funded by VA RR&D grant #s C74521 and RX-000294-01 and from clinical resources at the VA Connecticut Healthcare System*

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## Neuromodulation and Other Novel Interventions for Tinnitus

Robert Folmer PhD

Friday, 10:15 – 11:15am

### About Dr. Folmer:



Robert L. Folmer earned B.A. and M.A. degrees in biology from San Francisco State University. He received his Ph.D. in Speech and Hearing Science from the University of California, San Francisco. At U.C.S.F., he conducted numerous EEG and evoked potential studies and evaluations for the Departments of Psychiatry, Neurology, Otolaryngology, and Neurosurgery. He also provided neurophysiological monitoring services during brain and spinal surgeries. In 1998, he became the Chief of Clinical Services for the Tinnitus Clinic at Oregon Health & Science University (OHSU) where he maintains an appointment of Associate Professor in the Department of Otolaryngology. He joined the NCRAR in 2007 and serves as Principal Investigator for research projects involving

transcranial magnetic stimulation (TMS); electrophysiological assessment of auditory processing; evaluation of auditory, vestibular and cognitive functions in patients who have multiple sclerosis (MS), Parkinson Disease, or traumatic brain injury (TBI).

## Presentation Overview

Since the perception of chronic tinnitus is associated with superfluous neural activity in the brain, the condition should respond to one or more therapies that utilize neuromodulation techniques. This presentation will describe several different neuromodulation therapies that are being studied as potential treatments for tinnitus, including transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), and vagus nerve stimulation (VNS). Evidence for the efficacy of these interventions will be examined; future directions for research and clinical applications will be explored.

*This work was funded by VA RR&D grant #s C7448I and C9230C*

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## Posters: Abstracts and presenters

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1.

### **ATA's Core Purpose: To Promote Relief, Prevent and Eventually Cure Tinnitus**

*Torryn Brazell, MS, CAE  
American Tinnitus Association*

This poster will highlight the new strategic vision and plan created by American Tinnitus Association (ATA) leadership aimed at raising awareness of tinnitus for the purpose of promoting existing management techniques and ways to prevent tinnitus and other hearing disorders. It will also include information on recent research that ATA has funded focused on optimizing diagnostic tools for tinnitus research and current clinical management strategies to help more people manage their tinnitus while cures continued to be pursued. An updated and enhanced *Roadmap to a Cure* will be included in the poster presentation; The *Roadmap* initially developed in 2005 by members of ATA's Scientific Advisory Committee, has recently been revamped based on new scientific understanding from the past decade. It will include more of a focus on the clinical aspects of tinnitus research and treatment as well as ideas for even more targeted research approaches for ATA-funded research in the future.

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## Scholarship recipient

2.

### **Implementation of Progressive Tinnitus Management at the Iowa City VA HCS**

*Jessica L. Egge, Au.D. and Doris J. Stormoen, Ph.D.  
Iowa City VA Health Care System, Iowa City, Iowa*

Progressive Tinnitus Management (PTM) was developed by the National Center for Rehabilitative Auditory Research (NCRAR) as a method to help patients learn to manage their reactions to tinnitus. Implementation may vary from one VA to the next.

Progressive Tinnitus Management was implemented at the Iowa City VA Health Care System in 2013. Basic services such as general education and amplification are provided by all staff audiologists. Higher levels of the program are coordinated by the PTM audiologist, who maintains a secure list of patients interested in the group workshops (PTM level 3). Series of workshops are scheduled 2-3 times per year and are attended by 3-8 participants. Workshops are scheduled for 5 consecutive weeks, at 2 hours per session. These are led by the audiologist or the psychologist. A packet of questionnaires is completed by each patient at the audiologic evaluation (level 2 PTM), at sessions 1 and 5, and 6 weeks after completion of the workshop series. The patient is contacted by telephone 6 weeks after completion of the workshops to determine if further intervention is desired. Patients interested in moving to level 4 or 5 of the program are scheduled for individual sessions with psychology or audiology as appropriate.

Early challenges included connecting with an interested psychologist, determining appropriate session logistics, and planning the program structure. Ongoing challenges include working with outdated materials and finding patients willing

and able to travel to the workshops for 5 weekly sessions. Most planning for the program continues to take place outside of regular work hours due to limited administrative time available in a busy clinic.

Future goals for the program include adding telehealth workshops to improve accessibility and adding dedicated administrative time to allow for more consistent assessment of patient outcomes.

*This study did not receive external funding. It was completed as part of the authors' clinical duties.*

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### **3. Comparison and Reliability of Tinnitus Pitch Measures: Traditional Pitch Matching, Bayesian Modeling, and Forced-Choice Double Staircase**

*Leslie Grush, AuD<sup>1</sup>, Candice Manning, AuD, PhD<sup>1,2</sup>, Emily Thielman, MS<sup>1</sup>, James Henry, PhD<sup>1,2</sup>*

*<sup>1</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>2</sup>Oregon Health & Science University, Portland, OR*

Audiological tinnitus evaluation most often includes psychoacoustic measurements of tinnitus pitch. Tinnitus pitch refers to the perceived frequency of the tinnitus or the center frequency of the spectrum of nontonal tinnitus. The standard method of measuring tinnitus pitch is pitch matching. However, a major limitation of pitch matching is the lack of reliable testing procedures to determine a valid response. In clinical procedures, a pitch match is usually obtained once and reported as the patient's perceived tinnitus frequency. When pitch matching is repeated, however, the responses typically vary over 2-3 octaves. Due to this criticism, other techniques have been investigated. Bayesian modeling can be used to calculate how many repeated matches must be obtained to estimate an individual's tinnitus frequency with a certain level of precision. Another approach, the forced-choice double staircase (FCDS) method, uses a forced-choice paradigm to narrow in on the tinnitus frequency. However, this procedure can be time consuming and is often difficult for participants to understand. Ultimately, our objective is to develop and validate an accurate, reliable, and time-efficient procedure to measure tinnitus pitch as well as characterize normal response variability for the establishment of normative standards. The current study utilizes these three approaches to measure pitch perception. Data from 150 participants will be presented including descriptions of each method of pitch measurement along with an estimate of reliability across multiple study visits. Results will include correlation of all measures to compare these methods of pitch measurement.

*This work was funded by VA RR&D grant # 1I01RX001205-01A1*

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### **4. Perception vs. Reaction: Comparison of Tinnitus Psychoacoustic Testing and Tinnitus Functional Index (TFI) Scores**

*Candice Manning, AuD, PhD<sup>1,2</sup>, Emily Thielman, MS<sup>1</sup>, Leslie Grush, AuD<sup>1</sup>, James Henry, PhD<sup>1,2</sup>*

*<sup>1</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>2</sup>Oregon Health & Science University, Portland, Oregon*

It is estimated that 20% of people who experience tinnitus report that the sound adversely affects daily living such that clinical intervention is warranted. Numerous clinical studies have reported positive outcomes of various interventions for tinnitus; however, because methodology to measure such outcomes is inconsistent, statistical evidence supporting effectiveness of tinnitus interventions remains inconclusive. Interventions for tinnitus target the perception of tinnitus and/or reactions to tinnitus. Perception of tinnitus refers to the auditory perceptual characteristics of tinnitus, including pitch and loudness. Perceptual measurements of tinnitus are referred to as psychoacoustic measures. Typically following tinnitus psychoacoustic testing, if it is determined by an audiologist that a patient would benefit from tinnitus-specific intervention, then a validated tinnitus questionnaire should be administered in order to track changes in the patient's reactions to tinnitus. The Tinnitus Functional Index (TFI) is one of numerous tinnitus questionnaires which have been validated for intake assessment. The TFI has also been validated for being sensitive to changes in tinnitus reactions resulting from intervention. Although widely used and reported, tinnitus psychoacoustic measures have not been shown to correlate with questionnaire scores or validated for assessing outcomes of treatment. Normative data are needed to identify relationships between measures of tinnitus perception and other factors that could facilitate a more definitive assessment of the association between these measures and measures of tinnitus impact. The current study obtained



overall TFI and subscale scores from 150 participants undergoing automated psychoacoustic tinnitus testing. The TFI scores will be compared to pitch and loudness matching data to explore the relationship between perception of tinnitus and reaction to tinnitus.

*This work was funded by VA RR&D grant # 1I01RX001205-01A1*

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## Scholarship recipient

5.

### **Yes! PTM Level 3 Workshops Do Help Veterans!**

*Catherine M. Edmonds, AuD<sup>1</sup>, Cheri R. Ribbe, AuD<sup>2</sup>, Tina Penman, AuD<sup>3,4</sup>,*

*<sup>1</sup>Audiology/Speech Pathology Service, Bay Pines VAHCS, Bay Pines, Florida; <sup>2</sup>VA Central Western Massachusetts (formerly of Boston VAHCS), Worcester, Massachusetts; <sup>3</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>4</sup>Department of Defense Hearing Center of Excellence*

**Purpose:** The primary purpose of this study was to determine if Progressive Tinnitus Management (PTM) Level 3 Skills Education workshops conducted at the Bay Pines and Boston Veterans Affairs hospitals result in tinnitus management strategies being used consistently by patients 1-5 years after completing the workshops.

**Method:** In fiscal year (FY) 2015, the Tinnitus Workshop Follow-up form was mailed to all Veterans who completed the Level 3 workshops between FY 2010 and FY 2014. Data were compiled to determine which, if any, of the skills taught in the workshops were being used 1-5 years post-completion of the workshops and the impact on quality of life (QOL) indicators.

**Results:** Results show all self-management skills were being utilized up to 5 years post-completion; therapeutic sound was utilized the most. The majority of patients reported improved ability to manage reactions to tinnitus and improved QOL indicators. Over 90% of patients from both sites recommended the program to others with tinnitus.

**Conclusion:** The self-management skills taught in the PTM Level 3 workshops are sustained over time even if limited resources prevent the full complement of workshops or the involvement of Mental Health services. The workshops can also be successfully implemented via tele-health.

The authors acknowledge Michelle Menendez (Chief of Audiology & Speech Pathology Services, Bay Pines VAHCS), Anne Hogan (Chief of Audiology & Speech Pathology Services, Boston VAHCS), and Jill Hawley (Chief of Audiology & Speech Pathology Services, Central Western Massachusetts VAHCS) for supporting this project.

*This work did not receive external funding.*

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6.

### **Randomized Controlled Trial to Evaluate a Customized Acoustic Stimulus for Tinnitus Sound Therapy During Sleep**

*James Henry, PhD<sup>1,2</sup>; Sarah M. Theodoroff, PhD<sup>1,2</sup>, Garnett P. McMillan, PhD<sup>1</sup>, Tara L. Zaugg, AuD<sup>1</sup>, Megan Cheslock, BA<sup>1</sup>, Chan Roberts, BA<sup>1</sup>*

*<sup>1</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>2</sup>Department of Otolaryngology/Head & Neck Surgery, Oregon Health & Science University, Portland, Oregon*

**Background:** In a prior study, participants sound-matched their tinnitus, and were shown to experience changes in electroencephalographic waves while listening to that sound stimulus during sleep (Pedemonte et al, 2014. The impact of sound on electroencephalographic waves during sleep in patients suffering from tinnitus. *Sleep Science*, 7(3):143-151). These observations led to the development of a commercially-available product (in-ear Levo System, Otoharmonics Corp., Portland, Oregon) that we evaluated in a randomized controlled trial (RCT).

**Methods:** Fifty-eight participants with bothersome tinnitus, and who met other eligibility requirements, were randomized into one of three groups: (1) Levo System with a tinnitus-matched stimulus; (2) Levo System with a noise stimulus (white noise and/or band noise); or (3) Marsona 1288 bedside sound generator. Outcome assessment for 3 months of treatment involved the Tinnitus Functional Index (TFI), numeric rating scale of tinnitus loudness (NRS), and tinnitus loudness match (LM) at 1 kHz.

**Results:** All groups showed improvement from baseline on all three measures. Average TFI reductions were 21.2 points for the tinnitus-matched group, 20.6 points for the noise-stimulus group, and 16 points for the bedside sound generator group. The tinnitus-matched group showed about a 0.75-point greater reduction in the NRS than the other two groups. There was little difference between groups in LM reduction at 1 kHz (3.6-4.0 dB).

**Conclusions:** The in-ear devices, compared to the bedside sound generator group that served as a standard of care, offer some support for greater improvement in reactions and perceptions of tinnitus. The extent of these relative effects in terms of meaningful differences between treatments needs further study. The next step is to replicate the findings from this RCT and integrate these results into an evidence-based approach towards patient care.

*This work was funded by Baker Group LLP*

## 7.

### **Clinical Effectiveness of a Modified Progressive Tinnitus Management Protocol**

Jenifer E Beck, AuD<sup>1</sup>, Elizabeth N. Lima, PhD<sup>2</sup>

<sup>1</sup>Audiology/Speech Pathology Service, Charles George VA Medical Center, Asheville, North Carolina; <sup>2</sup>Learning Resources Service, Charles George VA Medical Center, Asheville, North Carolina

**Introduction:** More than 1.4 million veterans have tinnitus, the most prevalent service-connected disability<sup>1</sup>. In 2014, the authors developed a tinnitus program for the VA Medical Center in Asheville, North Carolina, and chose Progressive Tinnitus Management (PTM) because of its broad clinical application and strong evidence base.

**Methods:** During planning and implementation, several aspects of the original protocol were modified to streamline clinical application and to meet the specific needs of the local veteran population. Modifications included reducing the number of workshop sessions, changing the use of pre- and post-workshop questionnaires, requiring amplification before workshop participation for aidable hearing losses, eliminating one skills section, and adding a new skills section. Outcomes were measured six months after workshop completion using a comparison of pre- and post-treatment Tinnitus Functional Index (TFI) and Self-Efficacy for Managing Reactions to Tinnitus (SMRT) scores, as well as the Tinnitus Workshop Follow Up questionnaire.

**Results:** Six months after veterans completed PTM workshops, the average reduction in TFI score was 19.3 points with 58% of veterans showing a clinically meaningful reduction in TFI scores of 13 points or greater<sup>2</sup>. The average increase in SMRT score was 17.2 points.

The following percentages of Veterans reported “a lot”, “somewhat”, or “a little”:

- feeling more in control of reactions to tinnitus: 93%
- better ability to cope with tinnitus: 89%
- better quality of life: 81%
- less bothered by tinnitus: 81%

**Conclusions:** Veterans who participated in a modified PTM protocol reported they were able to change their reactions to tinnitus and sustain a reduction in the negative effects of tinnitus six months after skills education. Pre- and post-treatment TFI scores demonstrated a significant reduction in tinnitus severity, and SMRT scores indicated an increase in the veterans’ degree of confidence in their ability to manage their reactions to tinnitus.

#### **References:**

<sup>1</sup>VBA Annual Benefits Report Fiscal Year 2015. (updated 2016, May 9). Retrieved from <http://www.benefits.va.gov/REPORTS/abr/ABR-Compensation-FY15-05092016.pdf>

<sup>2</sup>Meikle, M.B., Henry, J.A., Griest, S.E., Stewart, B.J., Abrams, H.B., McArdle, R., Vernon, J.A. (2011). The Tinnitus Functional Index: Development of a new clinical measure for chronic, intrusive tinnitus. *Ear and Hearing* 32 (5), 1-24.

*This study did not receive external funding. It was completed as part of the authors’ clinical duties as VA employees.*

## 8.

**Identifying the Impact of Tinnitus on the Warfighters**

James Henry, PhD<sup>1,2</sup>, Susan Griest, MPH<sup>1,2</sup>, Emily Thielman, MS<sup>1</sup>, Cody Blankenship, BS<sup>1,2</sup>, Quintin Hecht, AuD<sup>3</sup>, Aries Okungbowa-Ikponmwosa, MPH<sup>4</sup>, Rozela Melgoza, AuD<sup>4</sup>, Kathleen Carlson, PhD<sup>1,5,6</sup>, Samantha Lewis, PhD<sup>1,2</sup>, Sarah M. Theodoroff, PhD<sup>1,2</sup>

<sup>1</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>2</sup> Department of Otolaryngology/Head & Neck Surgery/Oregon Health & Science University, Portland, Oregon; <sup>3</sup>Core Business Solutions in support of the DoD Hearing Center of Excellence (HCE), Defense Health Agency; <sup>4</sup>Geneva Foundation in support of the DoD Hearing Center of Excellence (HCE), Defense Health Agency; <sup>5</sup>Center to Improve Veteran Involvement in Care (CIVIC), VAPORHCS, Portland, Oregon; <sup>6</sup>School of Public Health, OHSU, Portland, Oregon

**Background:** Per the Veterans Benefits Administration, tinnitus and hearing loss have been the two most prevalent service-connected disabilities for Veterans for over 10 years. The Institute of Medicine (IOM) recommended research “to fill the void for prospective, longitudinal, epidemiological data on noise-induced hearing loss and tinnitus in military personnel” (Humes, Joellenback, & Durch, 2006). In response to this recommendation, the Noise Outcomes in Servicemembers Epidemiology Study (NOISE Study) was funded by the Congressionally Directed Medical Research Programs (CDMRP) in 2013. In March of 2017, the NOISE study received another four-year award to continue the work toward those objectives. A major gap identified through the work of the NOISE study is how active military are impacted by having tinnitus. Casali et al., 2009, note that a reduction in auditory perception can reduce speech communication and decrease situational awareness, both imperative skills for the safety and productivity of warfighters.

**Methods:** The NOISE Study consists of two testing sites, one at the VA Portland Health Care System (VAPORHCS) and one at the Department of Defense Hearing Center of Excellence (HCE) in San Antonio, Texas. The study began enrolling participants in March of 2014 and as of July 2017, n=438 participants have been enrolled and tested (333 in Portland; 105 in San Antonio). For this report, results will be presented from n=350 participants from both sites. 18 questionnaires are administered at baseline for those who screen positive for tinnitus via the Tinnitus Screener.

**Results:** Data will be presented for both sites; comparing the several self-administered questionnaires and other test measures which help identify the power that tinnitus and hearing loss can have on the warfighter and their functionality in the field.

*This work was funded by the Joint Warfighter Medical Research Program of the Department of Defense grant number W81XWH-16-JWMRP*

## 9.

**The Tinnitus Screener: Data from 350 Research Participants**

James Henry, PhD<sup>1,2</sup>, Susan Griest, MPH<sup>1,2</sup>, Cody Blankenship, BS<sup>1,2</sup>, Quintin Hecht, AuD<sup>3</sup>, Aries Okungbowa-Ikponmwosa, MPH<sup>4</sup>, Rozela Melgoza, AuD<sup>4</sup>, Jane Gordon, MS<sup>1</sup>, Wendy Helt, MA<sup>1</sup>

<sup>1</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>2</sup> Department of Otolaryngology/Head & Neck Surgery/Oregon Health & Science University, Portland, Oregon; <sup>3</sup>Core Business Solutions in support of the DoD Hearing Center of Excellence (HCE), Defense Health Agency; <sup>4</sup>Geneva Foundation in support of the DoD Hearing Center of Excellence (HCE), Defense Health Agency

**Background:** According to the Veterans Benefits Administration, tinnitus and hearing loss have been the two most prevalent service-connected disabilities for Veterans for over 10 years. The Institute of Medicine (IOM) recommended research “to fill the void for prospective, longitudinal, epidemiological data on noise-induced hearing loss and tinnitus in military personnel” (Humes, Joellenback, & Durch, 2006). In response to this recommendation, the Noise Outcomes in Servicemembers Epidemiology Study (NOISE Study) was funded by the Congressionally Directed Medical Research Programs (CDMRP) in 2013. In March of 2017, the NOISE study received another four-year award to continue these aims. A major concern addressed by the NOISE Study was the lack of a tool to accurately determine if a Veteran indeed experienced tinnitus and, if so, if it was “constant” or “intermittent.” We developed the 4-item Tinnitus Screener (TS) and previously reported data from the first that version. Since then, we have collected responses for a 6-item version including results from our secondary site, who’s participants are active duty.

**Methods:** The NOISE Study consists of two testing sites, one at the VA Portland Health Care System (VAPORHCS) and one at the Department of Defense Hearing Center of Excellence (HCE) in San Antonio, Texas. The study began enrolling participants in March of 2014 and as of July 2017 n=438 participants have been enrolled and tested (333 in Portland; 105 in San Antonio). For this report, results will be presented from n=350 participants from both sites. The TS is administered over the phone initially and then again at the initial audiological visit to evaluate test-retest reliability. In addition, a study audiologist verifies the TS results with the participant in the sound booth. Possible categories obtained by the TS include “chronic” (including “constant” and “intermittent”), “acute” (including “constant” and “intermittent”), “occasional,” “temporary,” and “no tinnitus.” The latter three categories would indicate the lack of pathological tinnitus.

**Results:** Descriptive data will be presented for both the 4- and 6-item versions of the TS. Data comparing the repeatability of the 4-item TS and 6-item TS will be presented. We will also report associations of tinnitus with variables including military branch, military status and degree of noise exposure.

*This work was funded by the Joint Warfighter Medical Research Program of the Department of Defense grant number W81XWH-16-JWMP*

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10.

### **Applications of Bibliotherapy for Clinical Use in Patients with Tinnitus: A Review**

*Brandon Cyrus, AuD<sup>1</sup>, Gail Whitelaw, PhD<sup>2</sup>, Eric Bielefeld, PhD<sup>2</sup>, Julie Hazelbaker, PhD<sup>2</sup>*

*<sup>1</sup>Landmark Hearing Services, Sunnyvale, California; <sup>2</sup>Department of Speech and Hearing Science, The Ohio State University, Columbus, Ohio*

The use of bibliotherapy, or self-help texts, has been studied and found to be beneficial in the treatment of various psychiatric conditions, but has yielded relatively little attention to potential applications for patients with tinnitus. Principles of Cognitive-Behavioral Therapy (CBT) employed in bibliotherapy are similar to those currently used and effective for the management of both patients with tinnitus and psychiatric conditions. Because of this overlap, it would seem plausible that bibliotherapy may hold potential as an effective treatment for some tinnitus patients. The purpose of this literature review is to evaluate the available research concerning the use of bibliotherapy to determine its suitability in clinical practice, as well as identify areas of need where further study is required.

A review of the available research revealed four studies with sufficient grades of clinical evidence to support the use of bibliotherapy as both an efficacious and efficient approach to reducing tinnitus-related distress. The outcomes varied across studies, depending on the treatment design and statistics used in interpretation of results. With minimal guidance from the clinician, between 17-28% of patients obtained a clinically significant improvement in tinnitus-related distress, but with weekly contact, between 28-52% demonstrated clinically significant improvements with small to medium effect sizes. The four available studies on the topic of using bibliotherapy for tinnitus patients support suitability for clinical use, however further study is needed to better define the place of bibliotherapy as a component of comprehensive treatment care, as well as assessing outcomes over a wider subject base.

*This study did not receive external funding.*

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11.

### **Associations between Tinnitus and Mental Health Diagnoses Among Veterans using VA Healthcare**

*Kathleen F. Carlson, PhD<sup>1-3</sup>; Tess A. Gilbert, MHS<sup>1,2</sup>; James A. Henry, Ph<sup>3,4</sup>; Tara Zaugg, AuD<sup>3</sup>; Candice A. Manning, PhD<sup>3</sup>; Christine Kaelin, MBA<sup>3</sup>; Emily Thielman, MS<sup>3</sup>; Kelly M. Reavis, MS, MPH<sup>1-3</sup>*

*<sup>1</sup>Center to Improve Veteran Involvement in Care (CIVIC), (VAPORHCS), Portland, Oregon; <sup>2</sup>School of Public Health, OHSU, Portland, Oregon; <sup>3</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>4</sup>Department of Otolaryngology/Head & Neck Surgery/Oregon Health & Science University, Portland, Oregon*

**Background:** Tinnitus is prevalent among Veterans and may frequently co-occur with mental health disorders. The goal of this study is to understand the overlap and interplay between tinnitus and mental health diagnoses among Veterans who receive Department of Veterans Affairs (VA) healthcare.

**Methods:** We drew a 10% random sample of Veterans (n=715,400) who used VA services nationally between October 2011 and September 2016. Tinnitus and other diagnoses were identified using International Classification of Diseases (ICD) diagnosis codes. We examined demographic and clinical characteristics of Veterans with and without tinnitus diagnoses. Logistic regression was used to compute odds ratios (ORs) and 95% confidence intervals (CIs) estimating associations between tinnitus and mental health diagnoses.

**Results:** Among VA-using Veterans, 12% (n=87,870) had received a tinnitus diagnosis in the five-year time period. We observed greater prevalence levels of tinnitus diagnoses among Veterans whose race was categorized as White compared to Black (14% versus 8%); males compared to females (13% versus 8%); married compared to not married (14% versus 10%); and those with a VA service-connected disability for any condition compared to those without (18% versus 7%). Tinnitus diagnoses were also more prevalent among Veterans diagnosed (versus not diagnosed) with hearing loss (34% versus 3%) or auditory processing disorder (42% versus 12%). Associations were observed between tinnitus and any mental health diagnosis (OR=1.38; 95% CI: 1.36-1.39), including post-traumatic stress disorder (OR=2.00; 95% CI: 1.97-2.03), depression (OR=1.46; 95% CI: 1.43-1.48), and substance use disorders (OR=1.14; 95% CI: 1.10-1.18). Tinnitus was also associated with pain diagnoses (OR=1.74; 95% CI: 1.72-1.77) and traumatic brain injury diagnoses (OR=2.38; 95% CI: 2.31-2.45).

**Conclusions:** Our findings suggest that mental health diagnoses are prevalent among Veterans diagnosed with tinnitus. Ongoing analyses are examining these associations in more detail using multivariable analyses controlling for important covariates.

*This work was funded by VA RR&D Small Projects in Rehabilitation Research (SPIRE) grant #1 I21 RX002216-01*

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## 12. Measuring the effect of tinnitus on attention

LaGuinn P. Sherlock, AuD<sup>1</sup>, Douglas S. Brungart, PhD<sup>2</sup>

<sup>1</sup>US Army Public Health Center/Army Hearing Program, Bethesda, MD; <sup>2</sup>National Military Audiology and Speech Center Walter Reed National Military Medical Center, Bethesda, MD

People who report they are bothered by tinnitus frequently describe problems with sleep, concentration and/or mood. This may explain why those with bothersome tinnitus perform more poorly on tests that require concentration (e.g., memory and reaction time tasks) than those without tinnitus. Considering the correlation between bothersome tinnitus and poor performance on tests of attention, a clinical protocol incorporating such tests might enhance the evaluation and management of tinnitus.

While we know low-level broadband noise appears to provide relief for some people with tinnitus, and we know the presence of irrelevant speech interferes with memory tasks for people without tinnitus, little is known about how the external auditory environment affects concentration for those with bothersome tinnitus. The purpose of this prospective study is to compare performance on tests of attention as a function of the auditory environment between those with bothersome tinnitus and those with no tinnitus, using measures of reaction time (a selective attention test) and short-term memory (a letter locating binding test).

Preliminary results indicate longer reaction times on the selective attention test in the presence of white noise and irrelevant speech for the tinnitus group compared to the control group, with no differences between groups in quiet. Results from the spatial location test indicate significantly better performance for the control group compared to the tinnitus group.

The efficacy of tinnitus management programs such as Tinnitus Retraining Therapy and Progressive Tinnitus Management has been demonstrated using subjective questionnaires such as the Tinnitus Functional Index. An objective measure of improvement would be a valuable addition to the tinnitus management protocol. An overall improvement in well-being would be expected to result in an improvement in concentration and therefore simple and quick tests of attention could potentially be implemented clinically to measure the efficacy of tinnitus treatment. This study will help to quantify the impact of bothersome tinnitus on activities that require concentration. These findings will help to develop evidence-based standards for addressing reports of bothersome tinnitus in military personnel.

*This study did not receive external funding.*

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## Scholarship recipient

13.

### Tinnitus in Veterans with a history of blast-exposure and normal hearing

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The increased incidence of blast-induced traumatic brain injury (TBI) during military deployments has been associated with a substantial rise in tinnitus as a service-connected disability. Although tinnitus is common with severe and moderate TBI, the relationship with mild TBI (mTBI) is less clear. Additionally, mTBI, Post-Traumatic Stress Disorder (PTSD) and loudness sensitivity often co-occur yet the nature of their coexistence is not well understood.

To better understand the relationships between tinnitus and loudness sensitivity in blast-exposed Veterans, data from an on-going multi-site study were examined. Tinnitus was measured through self-report, and the Tinnitus Functional Index (TFI; Meikle et al., 2012); and loudness sensitivity was documented with loudness discomfort levels (LDL; Sherlock & Formby, 2005). The larger study from which the data were drawn is looking at blast-exposed Veterans with auditory complaints but normal standard audiometric test results.

The data from 51 Veterans were analyzed to evaluate the effects of PTSD, mTBI and LDLs on (1) tinnitus rates and (2) tinnitus severity. The Veterans were placed into four groups: Control, mTBI-only, PTSD-only and mTBI+PTSD.

The results showed tinnitus rate differences between the mTBI-only and Control groups, and the mTBI+PTSD and Control groups. In addition, tinnitus severity was greater for the mTBI +PTSD group as compared to the Control group. When looking at the TFI subtest level, the mTBI+PTSD group was more severe than the PTSD-only group on the *Ability of Relaxation* and *Quality of Life* subtests, highlighting a potential superposition effect for mTBI and PTSD. Finally, LDLs interacted with the *Emotional Distress* subtest results for all groups.

These preliminary results suggested that tinnitus rate and severity are associated with mTBI, with the effects most pronounced with those Veterans who also have PTSD; whereas loudness sensitivity interacted significantly with tinnitus severity (as reflected by emotional distress) but not tinnitus rate.

*This work was funded by VA RR&D grant 1I01RX001164-01A2.*

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## Scholarship recipient

14.

### Recognizing and Reacting to Risk Signs for Patient Self-Harm

Lori Zitelli, AuD  
UPMC / University of Pittsburgh

Patients suffering from tinnitus can be difficult to treat due to enhanced activation of the limbic and autonomic-nervous systems. While not every patient suffering from tinnitus is diagnosed with a psychiatric disorder, comorbid behavioral health disorders are common in this population. Data related to the prevalence of psychiatric disorder in the general population as compared to the population with tinnitus will be highlighted.

Evidence-based suggestions for developing an effective clinician-client relationship built upon trust and honesty will be shared, as well as a review of the relevant scope of practice issues for audiologists. Audiologists and their students need to be prepared if a patient threatens self-harm. Many patients do not spontaneously report their suicidal thoughts and intentions to their care providers, so we need to be alert to warning signs. Information about the strongest predictors of suicide, how to ask about suicidal intentions, and how to assess the risk of suicide will be presented. Survey data highlighting the current treatment of this subject within audiology academic programs will be presented.

Although it is our responsibility to recognize suicidal tendencies and have a plan for preventive intervention, it is not our responsibility to conduct a suicide evaluation. Tips for collecting critical information to be provided to qualified professionals will be shared, as well as additional information about how and to whom to disclose this information.

A list of suicide warning signs will be reviewed as well as some additional suggestions for how to react when a patient discloses their suicidal intent. A review of available resources (for both the patient and the clinician) will be provided, along with instructions for how and when it is appropriate to access them. This material could be used as a model for academic training programs.

This work was funded by University of Pittsburgh Medical Center.

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15.

## Comparison of Hearing Aid Sound Generator Fitting Strategies as a Tinnitus Treatment

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University of Pittsburgh/VAMC Pittsburgh

**Introduction:** Tinnitus and hearing loss are currently the most claimed service connected disabilities. Hearing aids have been found to be an effective treatment for both hearing loss and tinnitus. Despite this, not every hearing aid user with tinnitus finds relief from hearing aid use only. Many hearing aid manufacturers now include sound generators as an available tinnitus treatment. Little independent literature exists evaluating the efficacy of these sound generators. The purpose of this project is to compare outcomes among three different tinnitus treatment approaches.

**Methods:** Veterans at the Pittsburgh VA with bilateral, symmetric, high frequency hearing loss and tinnitus were included and randomly assigned into one of three groups: (1) hearing aid only, (2) hearing aid plus sound generator set to manufacturer proprietary levels, and (3) hearing aid plus Veteran customized sound generator. Groups were compared on three pre- and post-assessments: Tinnitus Handicap Inventory (THI), Tinnitus Functional Index (TFI), and Tinnitus Interview Form (TIF). Data-logging was recorded for all groups while percentage of time spent using the tinnitus programs was recorded for groups 2 and 3. All participants (n=48) were new users fit with Starkey open fit Receiver-In-Canal devices.

**Results:** Data show that there is no significant difference between the three groups any of the outcome measures. All of the groups found improved tinnitus benefit regardless of which treatment they received. Veterans with the manual tinnitus sound generator program used their hearing aids 2 hours more per day on average than the hearing aid only group.

**Conclusions:** Results show that each tinnitus management strategy is effective in reducing Veteran's perception of tinnitus. Emerging evidence indicates that providing a tinnitus program leads to longer daily hearing aid use.

*This study was a VA Quality Improvement (QI) project with no external funding.*

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16.

## Hear Well: A Mobile Application for Auditory Training and Tinnitus Management

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In this poster we present a cross platform mobile application (app) for auditory training and tinnitus management for individual users. The app allows users to navigate several activities on their own, or to take a more guided approach based on answers to an initial assessment and subsequent app usage. The app has two primary goals: helping users improve hearing in noise, and supporting users with managing tinnitus symptoms. Both goals have supporting educational materials related to hearing, hearing protection, listening strategies, and tinnitus in the form of multimedia presentations including interactive graphics, pictures, and videos. Tinnitus management is inspired by the Progressive Audiologic Tinnitus Management (PATM) program developed at the VA, and allows the user to generate personalized behavioral and cognitive interventions delivered through the app. Auditory training comes in the form of three engaging video games (in addition to educational materials) that maintain user interest over time and provide context for listening

tasks. To encourage adherence, users get graphical usage feedback and can configure reminders outside the app. This poster will present the strategies used to leverage an existing clinical program such as the PATM and translate it into an app that is self-managed. It will also show how game mechanics can be leveraged to help users develop better listening strategies in background noise. Data will be presented from a pilot usability study with 10 users, as well as preliminary data from an extended field trial with 40 users running the app on personal smartphones.

*This work was supported by the US Army Medical Research and Materiel Command under Contract No. W81XWH-16-C-0015.*

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## Scholarship recipient

17.

### **The utility of electrophysiological gap detection to assess if tinnitus masks silent gaps in noise**

*Kenneth Morse, BS, Kathy Vander Werff PhD, MA*

*Communication Sciences and Disorders Department, Syracuse University, Syracuse, New York*

The idea that tinnitus can fill-in, or mask, a silent gap in noise was initially supported by studies of gap pre-pulse inhibition of the acoustic startle reflex in animals (Turner et al., 2006). However, human behavioral gap detection (BGD) studies have not supported this theory. That is, tinnitus subjects have not been shown to have poorer BGD thresholds than controls without tinnitus (Boyen, Baskent, & van Dijk, 2015). BGD behavioral performance, therefore, may not be sensitive enough to detect impaired gap detection due to tinnitus.

Alternatively, the cortical auditory evoked potential (P1-N1-P2) recorded in an electrophysiological gap detection (EGD) paradigm may provide objective evidence that tinnitus fills-in gaps in the form of changes of neural encoding of silent gaps. In this study, we assessed the utility of EGD to detect if tinnitus alters the neural response to silent gaps in white noise. We hypothesized that even in the absence of BGD threshold differences between groups that tinnitus subjects would have reduced gap-evoked amplitudes/areas and longer latencies compared to age, hearing, and gender matched control subjects.

P1-N1-P2 was recorded in 10 tinnitus and 10 control subjects to three gap duration conditions relative to behavioral threshold (measured by the GIN test): suprathreshold (20 ms), threshold (BGD threshold+2 ms), and subthreshold (2 ms). Grand mean data suggested increased latencies for the tinnitus group for threshold and suprathreshold gaps, although no group differences for P1-N1-P2 peak amplitudes/areas or latencies reached statistical significance. The inconsistency between the hypothesis and results could be due to the small sample size or the fact that the tinnitus group had slightly, but significantly, better BGD thresholds than controls (5.9 vs. 7.6 ms;  $p=.028$ ). Results suggest further EGD studies using narrowband stimuli or specific tinnitus subgroups may provide evidence of altered neural processing of silent gaps in tinnitus subjects.

Boyen, K., Baskent, D., & van Dijk, P. (2015). The Gap Detection Test: Can It Be Used to Diagnose Tinnitus? *Ear Hear*, 36(4), e138-145. doi:10.1097/AUD.000000000000156

Turner, J. G., Brozoski, T. J., Bauer, C. A., Parrish, J. L., Myers, K., Hughes, L. F., & Caspary, D. M. (2006). Gap detection deficits in rats with tinnitus: a potential novel screening tool. *Behav Neurosci*, 120(1), 188-195. doi:10.1037/0735-7044.120.1.188

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18.

### **Tinnitus and Normal Hearing: The Role of Central Inhibition**

*Julia Campbell, PhD, AuD, CCC-A, F-AAA, Connor Bean, BA, Ali LaBrec*

*Dept. of Communication Sciences and Disorders, University of Austin, Texas*

It is hypothesized that decreased inhibitory processes, possibly related to reduced auditory stimulation from cochlear damage, may underlie tinnitus. However, there are many individuals with clinically normal hearing who report tinnitus, indicating that inhibitory function may not underlie tinnitus for this population. One measure of central inhibition that has been utilized extensively in the field of neuropsychology is sensory gating. Sensory gating involves the suppression



of non-novel input, and may be assessed via EEG responses to paired stimuli. Appropriate gating processes are demonstrated by a reduced cortical response to the second stimulus in comparison to the first, illustrating inhibitory activity. Using this measure, we aimed to evaluate central inhibitory processes in normal hearing young adults with and without tinnitus. Cortical auditory evoked potentials (CAEPs) were recorded via high-density EEG in response to tonal pairs. Non-clinical auditory thresholds were assessed at 10, 12.5, and 16 kHz to ascertain cochlear damage at higher frequencies. Tinnitus severity was quantified using the numerical score from the Tinnitus Handicap Questionnaire (THI). CAEP amplitude ratio and difference values were calculated for Pa, P50, N1, and P2 peak components to determine gating function within and across groups, and were correlated with high frequency pure tone averages (PTA) and THI scores of the tinnitus group. While the non-tinnitus group demonstrated gating via the CAEP P50 component, no gating function was observed in the tinnitus group. In addition, tinnitus severity was found to be correlated with decreased gating, as well as lower high frequency PTA. Thus, central auditory gating appears to be atypical in young, normal hearing adults with tinnitus, with the Pa component possibly representing a biomarker of tinnitus in this population. Furthermore, improved high frequency pure tone thresholds are indicated in increased tinnitus severity, which may indicate an overall heightened awareness of the central auditory system.

*This research was funded by the Hearing Health Foundation/Les Paul Foundation and the Texas Speech-Language-Hearing Foundation.*

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19.

### **Long-term evaluation of a new hearing aid supported tinnitus treatment**

Ronny Hannemann, PhD

Signia

Tinnitus affects a staggering number of individuals. Population studies conducted in six different countries reported the incidence of prolonged tinnitus varying between 4.4 and 15.1 percent for adults. One study reported 2.4 percent of the population responded “yes” to the description of tinnitus as “tinnitus plagues me all day” (Moller, 2011). Tinnitus not only causes a decreased quality of life for some individuals, but is also a health issue with an economic impact (Wunderlich et al., 2015). In the U.S., tinnitus is the most common service-related injury (Department of Defense Centers for Hearing Excellence Statistical Data, 2016) affecting more than 800,000 US veterans (U.S. Department of Affairs, 2016). With such a prevalent epidemiology, it is not surprising that many hearing instrument manufacturers have added tinnitus treatment options. Hearing instruments (with or without a sound generator component) are a mainstay of the audiologic management of tinnitus (Hoare, Searchfield, Refaie, & Henry, 2014). Hearing aids are considered the number-one treatment to help the tinnitus patient manage their tinnitus, even when their hearing loss is mild (Baguley, 2016). Surr and colleagues (1985) surveyed 200 new hearing instrument wearers and found 62 percent of the respondents reported tinnitus. Of these individuals, approximately half noted either a partial or total relief from tinnitus secondary to wearing the hearing aids. The respondents further reported the relief from tinnitus was an important contributor to wearer satisfaction. Habituation through acoustic therapy (which usually includes wearing hearing instruments) can be applied to all types of tinnitus, and therefore is the treatment method of choice for many hearing care professionals. For individuals who present with tonal tinnitus, that is, the perception of a near-continuous sound or overlapping sounds with a well-defined frequency (American Tinnitus Association), an alternative to habituation therapy is available. Tonal tinnitus is present in the majority of individuals with tinnitus. A joint comprehensive tinnitus study conducted by the Kresge Hearing Research Laboratory and the University of Oregon Health Sciences Center Tinnitus Clinic revealed that tinnitus pitch falls largely into two broad categories: tonal and noise. Their research found that more than half of the subjects, reported tonal tinnitus, 25 percent reported noise-type tinnitus, and 16 percent presented with a combination. New research supports attempts to mitigate tonal tinnitus from its anatomic origin utilizing spectral notching rather than treating the effects of tinnitus through traditional habituation noise therapy. This paper will discuss a novel approach of utilizing hearing instruments employing notch-modified acoustic output to treat patients with tonal tinnitus.

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## Scholarship recipient

20.

### Does tinnitus affect speech-in-noise recognition in patients with normal hearing sensitivity?

Yihsin Tai, AuD, Fatima T. Husain, PhD

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Studies have shown that tinnitus patients experience more difficulties in understanding speech in adverse listening conditions when compared to controls, regardless of their normal hearing sensitivity. Nonetheless, the relation between the characteristics of tinnitus (severity and loudness) and speech-in-noise recognition remains unclear. In this study, the Quick Speech-in-Noise test (QuickSIN) were conducted on 14 patients with bilateral tinnitus and 14 age-matched individuals; further, the Tinnitus Handicap Inventory (THI), visual analog scale, and tinnitus loudness matching with pure-tone and white noise were included to better understand the perceptual and psychological aspects of tinnitus. Compared to similar studies in extant literature, the patients showed a lower mean THI score in a slight to mild handicap category. The results indicated no significant between-group differences in hearing sensitivity or in speech-in-noise performance, except at the 5 dB signal-to-noise ratio (SNR) condition in the left ear. Tinnitus participants had significantly worse QuickSIN score in the left ear compared to in the right ear, even though all of them reported bilateral tinnitus percept and had symmetrical hearing thresholds. This between-ear difference is probably the result of a right-ear advantage in language, after the effect of the testing order and the listener's fatigue had been ruled out. Additionally, significant correlations found between SNR loss of the left ear and tinnitus loudness measures suggested that the perceptual factors of tinnitus had various effects on speech-in-noise performance in each ear, pointing to a possible interaction between peripheral and cognitive factors in chronic tinnitus. More studies on patients with a range of tinnitus severity and loudness scores are necessary, to better understand the impact of tinnitus in everyday listening environments, and to advance tinnitus intervention and management.

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21.

### Tinnitus and hidden hearing loss after noise exposure

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Cochlear synaptopathy, the partial loss of auditory nerve synapses on inner hair cells (IHCs), has been proposed as a possible source of some forms of tinnitus. In animal models, cochlear synaptopathy is associated with a reduction in the amplitude of wave I of the auditory brainstem response (ABR) and can occur even when auditory thresholds are normal. This study assessed whether a history of noise exposure in young people with clinically normal pure tone thresholds is associated with lower ABR wave I amplitudes and the perception of tinnitus. Young military Veterans and non-Veterans with normal pure tone thresholds were assigned to 1 of 4 groups based on their self-reported lifetime noise exposure history and Veteran status. After adjusting for individual differences in sex and distortion product otoacoustic emission (DPOAE) level, the groups containing participants with higher reported histories of noise exposure had smaller ABR wave I amplitudes at suprathreshold levels as compared to the groups with less history of noise exposure. Reporting of frequent or constant tinnitus was strongly associated with the highest noise exposure group. Tinnitus was also associated with reduced ABR wave I amplitudes and elevated wave V/I ratios. The finding that ABR wave I amplitude is reduced in humans with a history of noise exposure is similar to observations in animal models of noise-induced cochlear synaptopathy. Although post-mortem histological analysis would be necessary for confirmation, these data suggest that cochlear synaptopathy or "hidden hearing loss" may occur in response to noise exposure in humans and be correlated with tinnitus.

*This work was supported by the VA RR&D grant numbers #C1484-M (to N.F.B.) and #C9230-C (to NCRAR).*

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**22.****The Veterans Affairs (VA) and Department of Defense (DoD) Tinnitus Working Group: How can we serve you?**

Tina Penman, AuD<sup>1</sup>, Amy Boudin, AuD<sup>2</sup>, Tara Zaugg, AuD<sup>1</sup>, LaGuinn Sherlock, AuD<sup>3</sup>, Tanisha Hammill, PhD, MPH<sup>2</sup>, Christine Kaelin, MBA<sup>1</sup>, Emily Thielman, MA<sup>1</sup>, Carlos Equivel, MD<sup>2</sup>, Lynn Henselman, PhD<sup>2</sup>, Elsa Camou, MPH<sup>2</sup>, Vickie Tuten, AuD<sup>2</sup>, James Henry, PhD<sup>1,4</sup>

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The newly formed Department of Veterans Affairs (VA) and Department of Defense (DoD) Tinnitus Working Group was established in 2016. It is comprised of researchers and clinicians from the National Center for Rehabilitative Auditory Research (NCRAR), Walter Reed National Military Medical Center (NMASC), and Hearing Center of Excellence (HCE). The Tinnitus Working Group Charter, Goals, and Initiatives will be illustrated. Additionally, ideas to better serve the providers and researchers in the VA and DoD will be solicited, in hopes of finding ways to better translate tinnitus research findings into clinical practice.

*This work was funded by the Hearing Center of Excellence & zCore Business Solutions, Inc.*

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**23.****Detection of dynamic spectral change in tone, single formant, and multi-formant contexts: A comparison**

Amie Roten, B.A. and Michelle R. Molis, Ph.D.

VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon

The dynamic spectral change present in speech aids accurate speech perception. Although single tones often have been used to assess detection thresholds for frequency change, it is unclear whether individual tones can sufficiently approximate the complex spectrotemporal changes observed in dynamic harmonic signals composed of multiple frequency components. Similarly, the ability to detect a frequency transition in a single spectral peak may not reflect detection performance when that peak is presented in the context of a competing, simultaneously-shifting formant. Detection thresholds for linear frequency change up and down were measured in normally-hearing and hearing-impaired listeners for single tones and for formants presented either alone or in the context of another formant. Individual tones and formants pivoted around a center frequency of 500 or 1500 Hz, and two-formant stimuli had spectral peaks at 500 and 1500 Hz. Competing formants in the two-formant stimuli were steady or were gliding upwards or downwards. The fundamental frequency of the formant stimuli was 104.5 Hz. Durations were either 30 or 120 ms. Presentation levels were shaped across frequency to maintain approximately equal audibility for all listeners at 15 dB SL for the center frequency under assessment. Thresholds for frequency glide detection differed based on hearing status and the complexity of the stimulus, as well as stimulus direction, center frequency, and duration. These results have implications for the expectation that simple dynamic stimuli can be used to predict the speech perception ability of normally-hearing and hearing-impaired listeners.

*This work was supported by NIH/NIDCD grant R01 DC12314.*

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**24.****Randomized controlled trial of a novel device for tinnitus sound therapy during sleep**

Sarah M. Theodoroff, PhD<sup>1,2</sup>, Garnett P. McMillan, PhD<sup>1</sup>, Tara L. Zaugg, AuD<sup>1</sup>, Megan Cheslock, BA<sup>1</sup>, Chan Roberts, BA<sup>1</sup>, James A. Henry, PhD<sup>1,2</sup>

<sup>1</sup>VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon; <sup>2</sup>Department of Otolaryngology/Head & Neck Surgery/Oregon Health & Science University, Portland, Oregon

**Purpose:** Determine if a customized stimulus from the Otoharmonics Levo System reduces tinnitus perceptions and reactions for people with bothersome tinnitus.

**Method:** Sixty participants were randomized to one of three groups that used sound therapy devices during sleep that differed in their acoustic stimulus: (1) tinnitus-match (TM); (2) noise stimulus (NS); and (3) bedside sound generator (BSG). Outcome measures were the Tinnitus Functional Index (TFI), numeric rating scale of tinnitus loudness (NRS), and tinnitus loudness match. A Bayesian hierarchical model was fit to estimate the differences in treatment efficacy among groups.

**Results:** Average tinnitus reactions and perceptions improved across treatment groups. We are at least 87% certain that treatment with TM or NS reduces mean TFI compared to treatment with BSG, with an estimated relative efficacy of 4.5-5 points greater reduction. We are at least 95% certain that treatment with TM results in greater reduction in mean NRS compared to the other groups, with an estimated relative efficacy of about 0.75 points greater reduction.

**Conclusions:** This study offers some support for greater improvement in tinnitus reactions and perceptions with TM or NS devices compared to BSG. The magnitude of these relative effects and the extent to which they generalize requires additional study.

*This work was funded by Baker Group LLP*

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25.

### **Frequency-following responses elicited by tones and single formants with static and dynamic spectral features**

*William J. Bologna, PhD, Caitlin E. Milligan, BA, Brandon M. Madsen, AuD, Amie Roten, BA, Curtis J. Billings, PhD and Michelle R. Molis, PhD*

*VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), VA Portland Health Care System, Portland, Oregon*

Speech is an inherently dynamic signal, characterized by changes in amplitude and frequency over time. The movement of formant peaks in speech is a particularly important dynamic feature that contributes to both vowel and consonant identification. Electrophysiological recordings of both the envelope-following response (EFR) and the frequency-following response (FFR) have demonstrated that spectro-temporal features of pure tones and short syllables can be encoded by phase-locked brainstem neural responses. The purpose of this study was to determine the extent to which spectral change is represented physiologically as elicited by simple and complex dynamic stimuli. EFRs/FFRs were recorded from younger adults with normal hearing in response to 120-ms static and dynamic stimuli. Four stimulus types were employed: 1) a single tonal component; 2) a multi-component harmonic complex approximating a vocal source with a 104.5-Hz fundamental frequency; 3) a combination of the tonal component and the harmonic vocal source; and, 4) a single, simulated formant with a nominal peak frequency matching the single tone stimulus and the fundamental frequency of the vocal source. The frequency of the tonal component and the nominal center frequency of the formant peak were either static (500 Hz) or had an upward trajectory spanning 2/3-octave around 500 Hz (398-629 Hz). Neural responses revealed robust representations of the static pure tones as well as the temporal envelope of the vocal source, whether or not a spectral peak was present in the stimulus. Temporal analyses of the FFR waveforms revealed that neural responses also tracked the acoustic changes in the dynamic stimuli. These results will be discussed in terms of the extent to which dynamic formant transitions in natural speech may be represented physiologically in the auditory system.

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