

NATIONAL CENTER OF

**NM4R**

Neuromodulation  
for Rehabilitation

A Medical Rehabilitation Research Resource  
Network Center at Medical University of South Carolina

# Introductory Workshop

## October 12-17, 2023

# Objectives

The purpose of this workshop is to provide you with foundational knowledge including background, theory, safety, and methodology of a range of brain stimulation and operant conditioning techniques integrated with medical rehabilitation principles. We will provide a combination of virtual lectures and in-person laboratory demonstration/ hands-on participation in addition to panel discussions with our faculty centered on key rehabilitation problems.

Upon completion of this workshop, you will:

1. Understand neuromodulation for rehabilitation (NM4R) principles and develop a working knowledge of technologies and equipment utilized in NM4R.
2. Understand techniques, clinical uses, and safety guidelines to apply these approaches to rehabilitation research experiments in human participants with and without pathology.
3. Be prepared to participate in advanced training opportunities and workshops including mentored collaborative consultations and applications for pilot funding.
4. Become familiar with other members of the NM4R Research Community and colleagues in your field of interest.
5. Become oriented to other infrastructure resources available to you in NM4R research.

# Acknowledgements

The National Center of Neuromodulation for Rehabilitation is supported by the **National Institutes of Health** under award number P2C HD086844 through:

**Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)**

**National Center for Complementary and Integrative Health (NCCIH)**

**National Institute on Deafness and Other Communication Disorders (NIDCD)**

**National Institute of Neurological Disorders and Stroke (NINDS)**

The content of this educational program solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

# Agenda

Day 1: Thursday, October 12, 2023, all times Eastern

9:45 a.m.: Zoom meeting room opens

10:00 to 10:15 a.m.

**Welcome, Introduction**

Steve Kautz, Ph.D.; Mark George, M.D.  
Medical University of South Carolina

10:15 to 11:15 a.m.

**Neuromodulation for Rehabilitation: A Biopsychosocial Overview of Opportunities and Risks.**

Michelle Woodbury, Ph.D., OTR/L  
Medical University of South Carolina

11:15 a.m. to 12:15 p.m.

**Physics of Brain Stimulation**

Mark George, M.D.  
Medical University of South Carolina

12:15 to 1:00 p.m.

**Lunch**

1:00 to 2:00 p.m.

**Clinical Applications of Transcranial Magnetic Stimulation**

Stephanie Aghamoosa, Ph.D.  
Medical University of South Carolina

2:00 to 3:00 p.m.

**Functional Implications and Application of Operant Conditioning**

Aiko Thompson, Ph.D.  
Blair Dellenbach, MSOT  
Medical University of South Carolina

3:00 to 3:15 p.m.

**Break**

3:15 to 4:15 p.m.

**Transcutaneous Auricular Vagus Nerve Stimulation**

Bashar Badran, Ph.D.  
Medical University of South Carolina

4:15 to 4:30 p.m.

**Follow-up: Q&A with presenters**  
**Adjourn**

# Agenda

Day 2: Friday, October 13, 2023 – All Times Eastern

9:30 a.m.: Zoom meeting room opens

9:45 to 10:00 a.m.

**Welcome Session:**  
Follow up on Day 1 via Q&A with presenters

10:00 to 11:00 a.m.

**Combining Neurostimulation and Neuroimaging to Study Functional Plasticity in the Language Network**

Gesa Hartwigsen, Ph.D.  
Cognitive and Biological Psychology  
Leipzig University (Germany); and  
Lise Meitner Research Group Cognition and Plasticity, MPI CBS

11:00 a.m to 12:00 noon

**Transcranial Electrical Stimulation: Basic Modalities and Applications to Rehabilitation**

John Kindred, Ph.D.  
Medical University of South Carolina

12:00 noon to 1:00 p.m.

**Lunch**

1:00 to 2:00 p.m.

**Non-invasive flicker neurostimulation boosts resilience to psychological stress**

Tina C. Franklin, Ph.D.  
Senior Research Scientist  
Coulter Department of Biomedical Engineering  
Georgia Tech & Emory University

2:00 to 3:00 p.m.

**Transauricular vagal nerve stimulation to address feeding deficits in premature infants: from bedside to bench and back**

Heather McGhee, MS, CCC-SLP, PhD student  
Speech-Language Pathologist  
Medical University of South Carolina  
Evelyn Trammell Institute for Voice and Swallowing  
Shawn Jenkins Children's Hospital

Melanie Wiley Gail, MD/PhD student  
Department of Neuroscience  
Medical University of South Carolina

3:00 to 3:15 p.m.

**Break**

3:15 to 4:15 p.m.

**Emerging Topics: Focused Ultrasound (FUS)**

Kevin Caulfield, Ph.D.  
Medical University of South Carolina

4:15 to 4:30 p.m.

**Follow-up: Q&A, Adjourn**

## Agenda – In-Person Attendance Only

\*If you are not attending in-person, please access the recordings of prior workshop demonstrations at the link provided

**Day 3: Monday, October 16, 2023 – All Times Eastern**

**8:30 a.m.: On-site registration**

College of Health Professions, Building C, Room 317  
77 President St, Charleston, SC

<b>9:00 to 11:00 a.m.</b>	<b><u>Lab Demonstration: TMS/ERIK</u></b> Mark George, M.D. Bridgette Holland Medical University of South Carolina CHP C 317
<b>11:00 to 12:15 a.m.</b>	<b><u>tAVNS Demonstration</u></b> Bashar Badran, Ph.D., and Team Medical University of South Carolina CHP C 317
<b>12:15 a.m. to 1:00 p.m.</b>	<b><u>Lunch</u></b>
<b>1:00 to 2:00 p.m.</b>	<b><u>tACS/tDCS Demonstration</u></b> Kirstin-Friederike Heise, Ph.D. Kevin Caulfield, Ph.D. Medical University of South Carolina CHP C 317
<b>2:00 to 3:15 p.m.</b>	<b><u>Hands-On Human Neuroanatomy Opportunity</u></b> Heather Boger, Ph.D. Medical University of South Carolina CHP C 317
<b>3:15 to 3:30 p.m.</b>	<b><u>Break</u></b> , walk to Bioengineering Building, BE112, 68 President Street
<b>3:30 to 4:30 p.m.</b>	<b><u>Keynote: Harnessing Our Senses: Sensory Stimulation to Mitigate Alzheimer’s Pathology and Epileptiform Activity</u></b> Annabelle C. Singer, Ph.D. McCamish Foundation Early Career Professor Associate Professor, Coulter Dept. of Biomedical Engineering Georgia Tech & Emory University Bioengineering Building, BE 112, 68 President Street
<b>4:30 to 6:00 p.m.</b>	<b><u>Poster Session and Reception</u></b> Bioengineering Building Lobby 68 President Street

## Agenda – In-Person Attendance Only

\*If you are not attending in-person, please access the recordings of prior workshop demonstrations at the link provided

**Day 4: Tuesday, October 17, 2023 – All Times Eastern**

**8:30 a.m.: On-site registration**

College of Health Professions, Building C, Room 317  
77 President St, Charleston, SC

**9:00 to 10:15 a.m.**

**Lab Demonstration: Neuronavigating TMS**

John Kindred, Ph.D.  
Ralph H. Johnson VA Medical Center  
Medical University of South Carolina  
Jasmine Cash, MS  
Medical University of South Carolina  
CHP C 317

**10:15 to 11:30 a.m.**

**Operant Conditioning Methods Overview**

Aiko Thompson, Ph.D.  
Medical University of South Carolina  
CHP C 317

**11:30 a.m. to 12:15 p.m.**

**Lab Demonstration: MEP Conditioning**

Evoked Potential Operant Conditioning (EPOC) Lab  
CHP C 105a

**12:15 to 1:00 p.m.**

**Lunch**

**1:00 to 2:30 p.m.**

**Lab Demonstration: Hands-on Spinal Reflex Testing and Operant Conditioning**

Evoked Potential Operant Conditioning (EPOC) Lab  
CHP C 105a

**2:30 to 3:30 p.m.**

**Panel with Workshop Faculty**

CHP C 317

## NM4R Faculty Biographies and Research Summaries



### **Steve Kautz, Ph.D.**

Dr. Kautz is the PI and Program Director for the National Center of Neuromodulation for Rehabilitation (NC NM4R) and the NIH-funded Center of Biomedical Research Excellence (COBRE) in Stroke Recovery. He is widely recognized as an expert in applying biomechanical and neurophysiological principles to understand the coordination of movement in persons with post-stroke hemiparesis. His research combines theoretical and experimental studies of the control of movement, functional biomechanics, and clinical neurorehabilitation with the goal of improving function in persons with neurological disorders. He has >25 years of experience measuring motor performance related to neuromuscular control and has published >120 peer-reviewed papers. As PI or Co-PI, he has been awarded >\$50 million in rehabilitation research funding.



### **Rick Segal, PT, Ph.D., FAPTA**

Dr. Segal is a Professor Emeritus in the Department of Health Sciences and Research and past Chair of the Department of Rehabilitation Sciences at the Medical University of South Carolina. After several years as a practicing Physical Therapist in Washington, D.C., he went to the University of Virginia to earn his Ph.D. in Anatomy and Neuroscience. He spent twenty-two years as a faculty member at Emory University before serving eight years as Director of the Division of Physical Therapy at the University of North Carolina at Chapel Hill. Dr. Segal is active in faculty and research mentorship and is a strong advocate for translational research. He has over 30 years of experience carrying out rehabilitation oriented Neuroscience research on motor control and spinal circuits. Dr. Segal was part of the NIH funded program project grant entitled “spinal circuits and the musculoskeletal systems” for 24 years. He was a mentor in the ERRIS grant writing workshops for 10 years, and PI/Co-PI and mentor for the TIGRR grant writing workshops for the past 11 years. He is working on translating research into practice through students using education research. In 2018 he coordinated the first grantsmanship and mentorship in education research (GAMER) grant writing workshop. He served on the Executive Committee of the NIH funded Interdisciplinary Rehabilitation Engineering Career Development Program (IREK K 12), where he is helped engineers make their research more applicable for rehabilitation of patients. He also was a mentor and on the advisory board of the NIH funded RMSTP program.



Finally, he is the Education Director of the NIH-funded P2C National Center of Neuromodulation for Rehabilitation (NC NM4R) along with being the lead of the Medical Rehabilitation Research Resource (MR3) Network Coordinating Center for the six P2C's across the country. Dr. Segal was selected as a Catherine Worthingham Fellow of the American Physical Therapy Association (APTA) in 2009, selected by the Academy of Physical Therapy Research as the John P. Maley Award winner for research leadership in 2023, and is a member of Global Membership Committee and Neuroscience Scholars Selection Committee of the Society for Neuroscience.



**Mark George, M.D.**

Dr. George, the Scientific Director of NC NM4R, is a Distinguished University Professor of psychiatry, radiology and neurosciences and is the director of the Medical University of South Carolina (MUSC) Center for Advanced Imaging Research as well as the Brain Stimulation Laboratory. He is a world expert in brain stimulation, and depression, and is the editor-in-chief of a journal he launched with Elsevier in 2008 called, *Brain Stimulation: Basic, Translation and Clinical Research in Neuromodulation*. He has been continuously funded by NIH and other funding agencies since his fellowships. He has received numerous national and international awards. In 2009 *U.S. News and World Report* named him one of 14 'medical pioneers who are not holding back' He has published over 400 scientific articles or book chapters and has written or edited six books.



**Michelle Woodbury, Ph.D.**

Dr. Woodbury is an Associate Professor at the Medical University of South Carolina. She has appointments in the College of Health Professions' Department of Health Science and Research, and Division of Occupational Therapy. Her extensive career as a practicing therapist motivates her rehabilitation research because it gave her first-hand insiders knowledge of stroke rehabilitation practice and allowed her to understand the challenges associated with research-practice translation/implementation. The overall goal of her research is to test translatable scientifically based models of rehabilitation to improve survivors' re-engagement in meaningful life activities. She has been PI of several NIH, VA and PCORI funded projects and is the MUSC site PI for NIH StrokeNet Recovery RCT.



**Stephanie Aghamoosa, Ph.D.**

Dr. Stephanie Aghamoosa (formerly Fountain-Zaragoza) is an Assistant Professor and licensed clinical neuropsychologist at the Medical University of South Carolina (MUSC) in the Department of Health Sciences and Research. She received her PhD in clinical psychology from The Ohio State University with a specialization in health psychology. She then completed her clinical internship in neuropsychology at the Charleston Consortium (MUSC and Ralph H. Johnson VA) and her postdoctoral fellowship in neuropsychology of aging and Alzheimer's disease at MUSC in the Department of Neurology.

Dr. Aghamoosa's research focuses on: (1) investigating changes in cognition and brain function in aging and Alzheimer's disease and (2) testing interventions for promoting cognition and psychosocial function. She conducts translational research using sensitive neuropsychological measures and advanced functional neuroimaging as tools to study the cognitive and neural effects of behavioral and neuromodulatory interventions.



**Aiko Thompson, Ph.D.**

Dr. Thompson is the Lead of Mentored Collaborative Opportunities within NC NM4R. Dr. Thompson received her Ph.D. in Neuroscience from the University of Alberta, Canada, and did post-doctoral training at the Wadsworth Center in Albany, NY. She developed the original human H-reflex and MEP operant conditioning protocols and conducted the first H-reflex conditioning and MEP conditioning studies in people with spinal cord injury, in which successful conditioning improved people's walking. Her lab's research goals are to understand the human CNS plasticity related to motor control and to learn how to guide such plasticity to help restore useful movement function in people after injuries to the nervous system.



**Blair Dellenbach, MSOT**

Blair Dellenbach has worked as both as a research and a clinical therapist in diverse healthcare settings. From 2014 to 2017, she worked as a Research Occupational Therapist in the Center for Rehabilitation Research in Neurological Conditions and Center of Biomedical Research Excellence (COBRE) in Stroke Recovery at MUSC. During this time, she developed an interest in pairing neuromodulation techniques and traditional occupational therapy to enhance functional outcomes. She is currently a Research OT in the Evoked Potential Operant Conditioning (EPOC) laboratory at MUSC working with individuals with spinal cord injury (SCI). In this position, she became interested

in the application of operant conditioning as a neuromodulation technique, especially in regards to exploring the impact on upper extremity motor function and subsequent influence on functional independence in people with spinal cord injury. In addition, she is interested in examining the association between neurophysiological measures and clinical assessments of upper extremity motor function.



**Bashar Badran, Ph.D.**

Dr. Bashar Badran is a neuroscientist, assistant professor of psychiatry, and runs the Neuro-X Lab as well as the Computational Brain Imaging Core at the Medical University of South Carolina. Dr. Badran's Neuro-X lab is a multidisciplinary neuromodulation, engineering, and innovation laboratory that fosters an environment of neurotechnology and innovation to begin addressing complex medical and neuropsychiatric disorders. He is the inventor and co-founder of Zendo, a neuromodulation device for meditation enhancement, and has been involved in pioneering several new technologies and startups including: BabyStrong, a new feeding system for newborns; MAAVNS, an intelligent closed-loop neuromodulation platform for post-stroke motor rehabilitation, and brain stimulation platforms for zero gravity environments.



**Gesa Hartwigsen, Ph.D.**

Dr. Hartwigsen is a Professor for Cognitive and Biological Psychology at Leipzig University in Germany. She is also heading the Lise Meitner research group 'Cognition and Plasticity' at the Max Planck Institute for Human Cognitive and Brain Sciences. She is a psychologist by training and has worked at the intersection between psychology, cognitive neuroscience, and neurology for several years. Her main research interest is how the language network in our brain adapts to challenges, including perturbations induced by non-invasive brain stimulation, cognitive aging, and brain lesions. She has pioneered the application of dual-site TMS in the field of language and published several studies on reorganization and plasticity in the healthy and lesioned brain. Supported by the European Research Council and the German Research Foundation, she is currently establishing network stimulation with TMS and tDCS during fMRI to investigate stimulation-induced changes during cognitive tasks at the large-scale network level.



**John Kindred, Ph.D.**

Dr. Kindred is a Research Health Science Specialist at the Ralph H. Johnson VA Medical Center in Charleston SC. His research focuses on the neurogenesis of fatigue in neurological conditions, currently concentrating on post-stroke fatigue. He uses multiple non-invasive brain stimulation methods to assess neurophysiological behavior and as experimental treatments. Dr. Kindred received his Ph.D. in Human Bioenergetics from Colorado State University and subsequently completed a post-doctoral fellowship at the Medical University of South Carolina under the supervision of Dr. Mark G. Bowden. He has been a part of the NC NM4R since 2017. His current funding includes an NM4R Pilot grant and a Department of Veterans Affairs Rehabilitation Research and Development Service Career Development Award-2.



**Tina C. Franklin, Ph.D.**

Dr. Franklin is a Senior Research Scientist in Biomedical Engineering department in the laboratory of Dr. Annabelle Singer at the Georgia Institute of Technology in Atlanta, Georgia. Her research focuses on the neurobiology of stress in health and disease, with a current concentration on the influence of stress on the progression of neurological disorders. She uses non-invasive brain stimulation as a potential intervention for stress-related diseases by characterizing molecular, cellular and neurophysiological behavior following brain stimulation in the context of psychological stress. Dr. Franklin received her Ph.D. in Cell and Developmental Biology and Neuroscience from Rutgers University and completed a post-doctoral fellowship at Yale University under the supervision of Dr. Ronald Duman. She joins us this year as a new member of NC NM4R. Her current funding includes an NIH NINDS grant, a NIH grant via the Goizueta Alzheimer's Disease Research Center, the Alzheimer's Association Research Fellowship, and a BrightFocus grant.



**Heather McGhee, MS, CCC-SLP, Ph.D. Student**

Heather McGhee received her B.S. from The University of Georgia and her M.S. from Florida State University. She works primarily with pediatric patients in the acute care setting at the Medical University of South Carolina in Charleston, SC. She is also a member of the MUSC craniofacial and VPI team. She is an adjunct faculty member in the College of Health Professions at the Medical University of South Carolina and is working towards her Ph.D. under the mentorship of Dr. Heather Bonilha.



### **Melanie Wiley Gail, Ph.D./M.D. Student**

Melanie Wiley Gail is an MD/PhD student and joined the MUSC Brain Stimulation Lab in 2017. Gail's career goal is to develop innovative technologies and strategies to improve the use and applicability of neuromodulation techniques for neurodevelopment disorders. Previous clinical research experience includes TMS for post-partum depression, TMS in autistic adults for depression, and tDCS in autistic adolescents for learning enhancement. Gail's background in pre-clinical developmental neuroscience research led to her dissertation project investigating the effect of non-invasive transcutaneous vagus nerve stimulation on hypoxic-ischemic injury in newborn rats. Gail's project involved a new collaboration she assembled, including her thesis advisor, Dr. Mark George, Director of the clinical Brain Stimulation Lab, and her co-advisor, Dr. Catrina Robinson, who uses animal models to study stroke recovery. Gail gained additional expertise and mentorship for the collaboration from neonatologist Dr. Dorothea Jenkins, neuroscientist Dr. Heather Boger, and vascular pathologist Dr. Advive Ergul to make her translational project possible. Gail plans to begin a psychiatry residency after medical school and continue to apply neuromodulation techniques to neurodevelopmental disorders. Outside the lab and clinic, she enjoys being an autism advocate, doing DIY projects, growing succulent plants, and playing with her dog, Axon Hillock.



### **Kevin Caulfield, Ph.D.**

Dr. Caulfield is an Assistant Professor in the Department of Psychiatry at MUSC. His research focuses on developing personalized noninvasive brain stimulation (tES, TMS, and FUS) for transdiagnostic applications and characterizing the effects of stimulation using behavioral outcomes and multimodal imaging.



### **Kirstin-Friederike Heise, Ph.D.**

Dr. Heise joined the NM4R team from Europe. Dr. Heise received her Ph.D. from the University of Hamburg, Germany, and did her postdoctoral training at the KU Leuven in Belgium. She combines various non-invasive brain stimulation techniques with imaging and electrophysiological methods, such as MRI and EEG, to investigate the sensorimotor system at work. Together with her team, she investigates the interaction between learning and recovery mechanisms to better understand the optimal timing and frequency of rehabilitative interventions.

## Other NC NM4R Opportunities

### Pilot Project Funding

Pilot Project Grants support rehabilitation neuroscience research that utilizes neuromodulatory methods/technologies. The goal is to promote the growth of rehabilitation neuroscience research using neuromodulatory techniques and methodologies by providing NM4R research resources and expertise towards the development of new projects that will be sustainable through extramural funding mechanisms. Neuromodulatory methods and techniques currently supported by the NC NM4R include (but are not limited to): brain, spinal cord or peripheral nerve stimulation that induces plasticity and/or therapeutic effects and operant conditioning of the brain and spinal networks to guide targeted neuroplasticity.

### Conferences – Recent Events Archived

To further our educational aims, the National Center of Neuromodulation for Rehabilitation will supplement our workshop offerings with regular conferences. These conferences will offer the opportunity for an interactive and collegial learning experience, rich in discussion and networking. Additionally, conferences will be offered over the Internet in webinar format, allowing for full participation from remote attendees. When feasible, recordings of the session will be made available on this website for later viewing.

### NC NM4R Speaker Series

This series will explore diverse neuromodulation methods with a focus on rehabilitation. Researchers and clinicians of all career stages (including students and fellows), who are interested in neuromodulation and novel rehabilitation techniques, are invited. At each meeting, a speaker will present a topic or study relating to the improvement of rehabilitation techniques through the use of neuromodulation. The attendees will have the opportunity to ask questions, exchange ideas and opinions, and develop informal discussions. This monthly Speaker Series will be presented via Zoom and aims to present innovative ideas and cutting-edge methods for clinicians and researchers.