



Curriculum Vitae

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Place of Birth: Kharkov, Ukraine

Education

12/1995	B.S.	Mechanical Engineering	Cornell University
05/1998	M.S.	Mechanical Engineering	Massachusetts Institute of Technology
05/2001	Ph.D.	Medical Engineering (Dr. Richard J Gilbert)	Massachusetts Institute of Technology
05/2002	M.Acup.	Acupuncture	New England School of Acupuncture

Postdoctoral Training

07/01 - 12/03	Post-Doctoral Research Fellow	Radiology (Kathleen K.S. Hui)	Martinos Center for Biomedical Imaging, MGH
08/02 - 02/03	Visiting Acupuncturist	Acupuncture	Beijing Hospital of Traditional Chinese Medicine, P.R.C.

Faculty Academic Appointments

01/04 - 08/07	Instructor	Radiology	Harvard Medical School
09/07 - 12/13	Assistant Professor	Radiology	Harvard Medical School
01/10 - 12/13	Assistant Professor	Anaesthesiology	Harvard Medical School
01/14 -	Associate Professor	Radiology	Harvard Medical School
01/14 -	Associate Professor	Anaesthesiology	Harvard Medical School

Appointments at Hospitals/Affiliated Institutions

Past

07/01 - 12/03	Research Fellow	Radiology (Neuroscience)	Massachusetts General Hospital
01/04 - 12/15	Assistant	Radiology (Neuroscience)	Massachusetts General Hospital

Current

01/05 -	Adjunct Faculty	Radiology	Logan University, Chesterfield, MO (non-voting)
09/06 -	Acupuncturist	Pain Management Center, Anesthesiology	Brigham and Women's Hospital
01/16 -	Research Staff	Radiology (Neuroscience)	Massachusetts General Hospital

Other Professional Positions

Past

2015 - 2018	Consultant (study on nausea neurocircuitry)	Glaxo-Smith-Kline, Inc
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Current

2018 - Consultant and Scientific Advisory Board
(Technology transfer for neuromodulation devices) Cala Health, Inc.

Major Administrative Leadership Positions

Local

2005 – 2012 Scientific Coordinator, NCCIH CERC program project grant “Neuroimaging Acupuncture Effects on Human Brain Activity,” PI: Bruce Rosen Massachusetts General Hospital

2015 – present Director, Center for Integrative Pain Neuroimaging (CiPNI) Massachusetts General Hospital

2018 - Director of Cognitive Neuroscience, Program in Placebo Studies & Therapeutic Encounter (PiPS) Harvard Medical School

National

2005 Co-Chair, Neural Correlates of Acupuncture Action Conference, Bethesda, MD NCCIH, NIH

Committee Service

Local

2000 – 2001 Admissions Committee Harvard-MIT Division of Health Sciences and Technology

2015 - 2017 Neuroimaging Workgroup, The Football Players Health Study Harvard University

2014 - Training Program Faculty Neuroimaging Training Program (NTP), Harvard-MIT Division of Health Sciences and Technology

National and International

2015 International Society for Complementary Medicine Research Program Committee, International Congress on Complementary Medicine Research

2016 - 2018	External Advisory Committee	National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), NIH Multi-Disciplinary Approach to the Study of Chronic Pelvic Pain (MAPP) Research Network
2017 -	External Advisory Board	University of Michigan Center of Research Translation (CORT) program project grant for chronic musculoskeletal pain (NIAMS, P60AR070600)
2018	Program Committee, The Role of Nonpharmacological Approaches to Pain Management: A Workshop	National Academies of Sciences, Engineering, and Medicine
2019 -	Exploratory Committee	United States Association for the Study of Pain (US-ASP)

Professional Societies

1998 - 2002	International Society of Magnetic Resonance in Medicine	member
2002 -	Organization for Human Brain Mapping	member
2003 - 2006	American Association of Oriental Medicine	member
2004 -	Society for Neuroscience	member
2004 -	Society for Acupuncture Research	
	2004-	Board of Directors
	2008-2011	Treasurer
	2009-2012	Chair of Scientific Review Committee
	2011-2018	President
	2015, 2017, 2019	Co-Chair, Program Committee

2008 -	International Association for the Study of Pain	member
	2018	Local Organizing Committee, 17 th IASP World Congress on Pain, Boston, MA, USA
	2018	Lead organizer for the Pain Neuroimaging Night @ the A.A. Martinos Center for Biomedical Imaging
2012 -	American Pain Society	Member

Grant Review Activities

2006, 2009	Grant Review Committee	Physicians' Services Incorporated Foundation, Toronto, Ontario, Canada Ad hoc Reviewer
2007	Grant Review Committee	National Health and Medical Research Council of Australia Ad hoc Reviewer
2011	MOSS-K SBIR/STTR Study Section	NIH Ad hoc Member
2014	Peer Reviewed Medical Research Program (PMRP) of the Department of Defense	DoD Ad hoc Member
2015	Special Emphasis Panel, ZCA1 RPRB-J M2 S	NCI, NIH Ad hoc Member
2015	MAPP Network EEP/Review Panel	NIDDK, NIH Invited Reviewer
2016	Special Emphasis Panel, ZRG1 BBBP-X (02) M	Motor Function, Speech and Rehabilitation (MFSR) committee, NIH Invited Reviewer
2016	Special Emphasis Panel, Myalgic Encephalomyelitis/Chronic Fatigue Syndrome ME/CFS SEP	NIH, Invited Reviewer

2017	Fellowship, Career Development, and Research Grant Programs Review Panel, ZAT1 VS 06 KF	NCCIH, NIH, Invited Reviewer
2018	Fellowship, Career Development, and Research Grant Programs Review Panel 2019/01 ZAT1 VS (12) 1	NCCIH, NIH, Invited Reviewer
2018	SPARC Tools & Technologies, Other Transactions (OT) 2 Review Panel	Office of Director, NIH, Invited Reviewer
2018	Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) Award Panel ZRG1 MOSS-D (10) B	Motor Function, Speech and Rehabilitation (MFSR) committee, NIH Invited Reviewer
2019	Exploratory Clinical Trials of Mind and Body Interventions Review Panel 2019/10 ZAT1 PJ (06) 1	NCCIH, NIH, Chair of Review Panel
2020	Special Emphasis Panel, Myalgic Encephalomyelitis/Chronic Fatigue Syndrome ME/CFS SEP	NIH, Invited Reviewer
2020	Special Emphasis Panel/Scientific Review Group 2020/08 ZAT1 SM (56) 1 - Loan Repayment Program (LRP) Review panel at NCCIH	NCCIH, NIH, Invited Reviewer
2020	Behavioral Medicine, Interventions and Outcomes (BMIO) Study Section	NIH, Invited Reviewer

Editorial Activities

Ad hoc Reviewer

Acupuncture in Medicine

Arthritis and Rheumatology

BioMed Central: Complementary and Alternative Medicine

Biological Psychology

Brain

Bulletin of the Museum of Comparative Zoology, Harvard University

Clinical Journal of Pain

Clinical Science
Complementary Therapies in Medicine
eNeuro
evidence-based Complementary and Alternative Medicine (eCAM)
European Journal of Neurology
F1000
Frontiers in Human Neuroscience
Gastroenterology
Itch
Journal of Alternative and Complementary Medicine (JACM)
Journal of Pain
Journal of Theoretical Biology
MAGMA, Magnetic Resonance Materials in Physics, Biology and Medicine
Medical Acupuncture
NeuroImage
NeuroImage: Clinical
Neurorehabilitation and Neural Repair
Neuroscience Letters
Pain
Pain Medicine
Pain Reports
Proceedings of the National Academy of Sciences

Other Editorial Roles

2009 -	Editorial Board	Journal of Alternative and Complementary Medicine
2010 -	Editorial Board	Evidence-based Complementary and Alternative Medicine
2011 -	Section Co-Editor	Pain Medicine
2018 -	Editorial Board	Frontiers in Human Neuroscience
2018	Co-Editor for Special Issue: "Neural Substrates of Acupuncture: from	Frontiers in Human Neuroscience

Peripheral to Central Nervous System
Mechanisms”

Honors and Prizes

1996-2001	Graduate Fellowship	Whitaker Foundation for Biomedical Engineering	Academic Merit
2000	Finalist	Schnitzer Prize for the Visual Arts	
2018	Excellence in Integrative Medicine Research Award	European Society for Integrative Medicine	Academic Merit
2019	Academy Distinguished Investigator Council	Academy for Radiology & Biomedical Imaging Research	Academic Merit

Report of Funded and Unfunded Projects

Funding Information

Past

2003-2011	Neuroimaging Acupuncture Effects on Human Brain Activity NCCAM: P01-AT002048 Co-I and Project PI (2009-2011) (PI: Rosen) (\$2,395,610 annual total costs) The central goal of this application is to investigate the neurobiology of acupuncture. All three projects will investigate the possible brain pathways and circuitries involved in acupuncture.
2004-2009	Exploring Neurocircuitry of Acupuncture Action with fMRI NCCAM: K01-AT002166 PI (\$608,750 total direct costs) The goals of this study are to understand the neurobiology involved with the full duration acupuncture treatment, thereby promoting the development of this ancient healing technique into evidence-based medicine.
2006-2009	FMRI of Autonomic Regulation with Acupuncture NCCAM: F05-AT003770 Co-investigator (PI: Rosen) (\$193,908 total direct costs) The goals of this study are to decipher the brain correlates for acupuncture modulation of the autonomic nervous system using multi-modal techniques combining functional MRI with physiological monitoring.
2009-2011	Brain Plasticity in Carpal Tunnel Syndrome and its Response to Acupuncture NCCAM: R01-AT004714 (Competitive Revision under ARRA)

PI (\$604,160 annual direct costs)

We propose that a biobehavioral assessment of cortical disinhibition quantified by maladaptive change in adaptation metrics will be sensitive to brain abnormalities in CTS. In this study, we will combine biobehavioral testing with fMRI neuroimaging to better delineate the central mechanisms by which acupuncture ameliorates CTS pathology.

- 2009-2011 Core Center for Multimodal Evaluation of Acupuncture Mechanisms
NCCAM: P30-AT005895
Co-investigator (PI: Rosen) (\$1,150,000 total direct costs)
This Center will develop multi-modal technologies including fMRI and ultrasound to evaluate mechanisms associated with acupuncture effects, and provide support for new faculty focused on enacting these methods.
- 2008-2014 Brain Plasticity in Carpal Tunnel Syndrome and its Response to Acupuncture
NCCAM: R01-AT004714
PI (\$4,014,928 total costs)
This study will characterize brain plasticity in Carpal Tunnel Syndrome and will determine how this central fMRI biomarker is modulated by acupuncture. This study will also investigate the behavioral consequences of maladaptive cortical plasticity in this disease population.
- 2007-2014 Neuroenteric Research Program
International Foundation of Functional GI Disorders
Consultant (PI: Kuo) (\$450,000 total costs)
This project is aimed at providing resources towards the clinical care and clinical and translational research of neuroenteric disorders such as nausea, cyclic vomiting syndrome and GI motility, as well as chronic pain disorders.
- 2011-2017 Neuroimaging Acupuncture Effects on Brain Activity in Chronic Low Back Pain
NCCAM / NIH: P01-AT006663
Project PI on a program project (PI: Rosen/Gollub) (\$6,333,600 total costs)
This program project grant will investigate the different neurophysiological mechanisms underlying the clinical response for different acupuncture interventions in chronic low back pain patients.
- 2012-2014 Brain Mechanisms for Autonomic Outflow and Nausea in Cyclic Vomiting Syndrome
NIDDK / NIH: R21-DK097499
PI (multi-PI: Napadow/Kuo) (\$478,625 total costs)
This study will evaluate altered brain processing in patients with cyclic vomiting syndrome, and investigate how this brain circuitry contributes to abnormal autonomic physiology and symptomatology.
- 2012-2013 SAR 2013: Impact of Acupuncture Research on 21st Century Health Care
NCCAM: R13-AT007742
PI (multi-PI: Napadow/Harris) (\$25,000)
This conference support grant will provide financial support for the 2013 Society for Acupuncture Research international conference in Ann Arbor, MI. This conference was attended by almost 300 participants from 19 different countries.
- 2012-2017 Martinos Center / KIOM Research Program
Korean Institute for Oriental Medicine
PI (\$201,250)

This agreement with KIOM supports a broader scope for our on-going NIH-funded program project grant (P01-AT006663) and sets up continuing collaboration between our Center and the Korean Institute for Oriental Medicine.

- 2014-2015 SAR 2015: Reaching across Disciplines to Broaden the Acupuncture Research Network
NCCIH / NIH: R13-AT008760
PI (multi-PI: Napadow/Harris) (\$30,000)
This conference support grant will provide financial support for the 2015 Society for Acupuncture Research international conference in Boston, MA.
- 2014-2015 Desarrollo de un estimulador electrico transcutaneo del nervio vago regulado por movimientos respiratorios [Respiratory-gated Auricular Vagal Afferent Nerve Stimulation (RAVANS)]
ColCiencias (Colombian National Science Foundation)
Co-Investigator (PI: Garcia)
This grant will aid in the development and miniaturization of the RAVANS device, invented and patented at MGH.
- 2014-2016 Vagus Nerve Stimulation: Intervention for Mood and Cardiac Modulation
NIMH / NIH: R21-MH103468
PI (multi-PI: Napadow/Goldstein) (\$275,000 total direct costs)
This project will evaluate biosignatures for mood changes following transcutaneous vagus nerve stimulation in major depressive disorder patients. Neuroimaging outcomes will be used to understand autonomic control circuitry and how these physiological responses relate to changes in mood.
- 2014-2016 The Role of Neuroimmune Activation in Chronic Pain and Negative Affect
NINDS / NIH: R21-NS087472
Co-Investigator (PI: Loggia) (\$275,000 total direct costs)
Animal studies suggest that both exposure to stressful conditions, as well as persistent pain, lead to the activation of brain microglia –the principal innate immune cells of the central nervous system. As chronic pain patients exhibit high prevalence of mood disorders, we will use integrated MR-PET imaging to investigate whether brain microglia are also involved in pain and negative affect, as well as alterations in brain physiology, in chronic low back pain patients.
- 2014-2017 An In-Vivo Investigation of Brain Inflammation in Gulf War Illness with Integrated PET/MR Imaging
DoD: GW130100
Co-Investigator (PI: Loggia) (\$200,000 total costs)
The goal of this project is to demonstrate in vivo the pathological occurrence of microglial activation in the brain of GWI patients, and to document the effects of this activation on GWI symptomatology and brain anatomophysiology, using novel imaging approaches.
- 2016-2017 SAR 2017: Advancing the Precision Medicine Initiative through Acupuncture Research
NCCIH / NIH: R13-AT009422
PI (multi-PI: Napadow/Harris) (\$30,000)
This conference support grant will provide financial support for the 2017 Society for Acupuncture Research international conference in San Francisco, CA.

2016-2018 An Exploratory Randomized, 2-Part, Single-blind, 2-Period Crossover Study Comparing the Effect of Albiglutide with Exenatide on Regional Brain Activity Related to Nausea in Healthy Volunteers
Glaxo Smith Kline study 201840
Co-I (PI: Rosen)(\$910,000 total costs)
The study is designed to evaluate if albiglutide and exenatide modulate nausea-related brain activity and connectivity as assessed by MRI.

Current

2013 - 2019 Neuroimaging Approaches to Deconstructing Acupuncture for Chronic Pain (NCE)
NCCAM / NIH: R01-AT007550
PI (multi-PI: Napadow/Harris) (\$3,370,545 total costs)
This study will evaluate novel brain biomarker response, including resting state connectivity and magnetic resonance spectroscopic assessed glutamate and GABA, to acupuncture versus non-somatosensory sham acupuncture in fibromyalgia.

2014 - 2019 Brain mechanisms underlying CBT-related reductions in fibromyalgia
NIAMS / NIH: R01-AR064367
PI (multi-PI: Napadow/Edwards) (\$3,844,035 total costs)
We hypothesize that CBT in this study will reduce catastrophizing early in treatment, resulting in adaptive changes in the brain's responses to an externally applied noxious stimulus.

2016 - 2020 Mapping the linkage between auricular vagus nerve receptors and visceral organ modulation
NIH Office of Director: OT2-TR001978 (Common Fund's Stimulating Peripheral Activity to Relieve Conditions, SPARC)
PI (\$1,367,236 total costs)
Vagus nerve stimulation may be an important neuromodulatory approach to impact heart and gut function, and cutaneous vagal receptors can be targeted as a non-invasive approach to vagus nerve stimulation. Our proposal will apply non-invasive ultrahigh field MRI in humans, gastric MRI, and cervical vagus nerve activity recording in rats to map the neurophysiological pathway from the auricular branch of the vagus nerve to visceral organs including the heart and stomach.

2018 - 2019 SAR 2019: Acupuncture Research, Health Care Policy and Community Health - Closing the Loop
NCCIH / NIH: R13-AT010320
PI (\$30,000 total costs)
This conference support grant will provide financial support for the 2019 Society for Acupuncture Research international conference in Burlington, VT.

2016 - 2021 New England Gastroparesis Consortium: Neurobiology of Gastroparesis
NIDDK / NIH: U01-DK112193
Co-I (PI: Kuo) (\$1,274,670 total costs)
This Center will develop and apply imaging approaches to better understand the brain circuitry changes in gastroparesis and how this circuitry can be targeted to make meaningful quality of life improvements for gastroparesis patients.

- 2016 - 2021 Optimization of brain-based mechanism supporting psychosocial aspects of acupuncture therapy – a hyperscanning fMRI study
NCCIH / NIH: R61-AT009306 / R33-AT009306
PI (multi-PI: Napadow/Kaptchuk) (\$3,258,176 total costs)
The patient-clinician interaction is central to mind-body therapies, and key mechanisms of action likely include brain circuitries supporting social mirroring networks underlying clinician empathy and therapeutic alliance. We will use hyperscanning functional MRI to link patient/acupuncturist brain activity concordance in social mirror neuron regions during treatment, and relate this concordance with ratings of therapeutic alliance and analgesia. Our proposal will define an augmented acupuncture interaction style based on brain concordance to optimize healthcare outcomes for acupuncture and other medical therapies. This is a phased R61/R33 award with executed go / no-go criteria.
- 2016 - 2021 In-vivo imaging of spinal and brain glial activation in low back pain patients
NINDS / NIH: R01NS095937
Co-I (PI: Loggia) (\$2,060,000 total costs)
In this project, we will use PET/MR imaging to image brain and spinal glial activation in patients with subacute and chronic low back pain, and the effects of its pharmacological modulation. The identification of a role for glia in the development and/or maintenance of persistent pain will have important practical implications for the management of pain, and the development of tailored preventive interventions focused on glial modulation.
- 2016 - 2021 The role of brain glial activation in human knee osteoarthritis
NIAMS / NIH: R01-NS094306
Co-I (PI: Loggia)(\$2,057,895 total costs)
In this project, we will use PET/MR imaging to test the hypothesis that low brain levels of the translocator protein (TSPO), which is upregulated in activated glial cells, predict higher likelihood of developing post-TKA pain.
- 2017 - 2019 Development of an electroceutical (Cardiorespiratory-gated Auricular Vagal Afferent Nerve Stimulator) for the Treatment of the Comorbidity Between Hypertension and Major Depression
NHLBI / NIH: U54 HL119145
Co-I (PI: Loscalzo/Golan/Parrish; Goldstein, Project PI)(\$200,000 direct costs)
Boston Biomedical Innovation Center, B-BIC, is a collaboration of academic centers, government, venture capital, and industry partners that have co-invested to create an integrated infrastructure to improve the translation of early stage biomedical innovations into commercially viable products. Our study will extend the work on development of respiratory-enhanced tVNS to hypertension and comorbid major depression. Funding will support clinical efficacy in this population.
- 2018 - 2023 Imaging Neuroglial Mechanisms of neuropathic pain-opioid interaction in HIV
NIDA / NIH: R01-DA047088
Co-I (PI: Loggia/Ratai) (\$1,840,486 – total direct costs)
This project will use PET/MR imaging and ultra-high field MRI and MR spectroscopy to image brain glial activation, neuronal integrity, and chemical neurotransmitter imbalance in HIV-infected patients with and without pain and chronic opioid use. Advancing our understanding of the mechanisms mediating the HIV pain-opioid interaction will have important practical implications for pain management, and toward the development of tailored interventions focused on glial modulation and neurotransmitter signaling.
- 2018 - 2023 Boosting mind-body mechanisms and outcomes for chronic pain

NCCIH / NIH: P01-AT009965

PI (multi-PI: Napadow/Rosen) (\$10,944,840 total costs)

This Program Project Grant will evaluate synergistic effects of top-down and bottom-up mind/body therapies for pain. We will apply functional MRI, MR spectroscopy, autonomic testing and PET to evaluate measures of central sensitization, dysautonomia and neuroinflammation in patients with migraine headache. Our approach will assess combined mindfulness meditation training and transcutaneous vagus nerve stimulation.

- 2018 - 2020 Neuromodulation of the Brain-Gut Axis by Transcutaneous Vagal Nerve Stimulation in Functional Dyspepsia
 NIDDK / NIH: R21-DK116029
 PI (\$275,000 total direct costs)
 Functional Dyspepsia (FD) is a common functional gastrointestinal disorder and there is a strong link between FD symptoms and compromised vagal function. We thus propose that auricular tVNS is a novel therapeutic strategy and will use gastric/autonomic measures combined with multimodal neuroimaging to interrogate the peripheral and central nervous system changes that accompany neuromodulation of brain-gut axis signaling.
- 2019 - 2020 4D cine MRI-assessed stomach motility in diabetic gastroparesis
 Diabetes Complication (DiaComp) Consortium, Pilot & Feasibility (PF2019)
 Co-I (PI: Kuo) (\$100,000 total costs)
 Diabetic autonomic neuropathy is among the least recognized and understood complications of diabetes despite its significant negative impact on survival and quality of life. While validated cardiac clinical measures can document autonomic dysfunction, there are few tools to objectively assess autonomic dysfunction within the gastrointestinal tract. The most common clinical method of measuring gastric function, gastric emptying scintigraphy, has poor correlation with symptoms and other measures of autonomic dysfunction, in addition to requiring exposure to radiation. In this proposal, we will use a non-invasive, safe technique based on 4D cine magnetic resonance imaging (MRI), able to evaluate multiple aspects of gastric motor function simultaneously.

Report of Local Teaching and Training

Teaching of Students in Courses

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|------------|---|--|
| 2005-2017 | Neuroimaging applications to acupuncture
HMS AP101 - Structural Acupuncture for Physicians | Single presentation per year, HMS |
| 2006, 2008 | HST-583: Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Graduate and undergraduate students | Massachusetts Institute of Technology
1 1-hour lecture and discussion |
| 2008-2010 | Resting State Brain Connectivity with fMRI – State or Trait?
Advanced Neuroimaging Techniques, Continuing Education Department, Harvard Medical School | Single presentation per year, HMS |

Formal Teaching of Residents, Clinical Fellows and Research Fellows (post-docs)

2008 - 2012	MIT Traditional Medicine Society advisory board	Undergraduate student mentorship
2007 -	Pain Fellowship, Pain Management Center, Dept. Anesthesiology, BWH	Lecturer on the role of acupuncture in pain medicine, ad hoc mentorship
2020	Inter-institutional Pain Fellowship COVID-19 seminar series, University of Washington and Pain Management Center, Dept. Anesthesiology, BWH	Lecturer on pain neuroimaging and the role of acupuncture in pain medicine, ad hoc mentorship

Research Supervisory and Training Responsibilities

2005 -	Supervision of post-doctoral fellows, research assistants, undergraduate summer students, high school students, visiting faculty (see below for detail)	Martinos Center for Biomedical Imaging, MGH One hour lab meeting per week; 1:1 supervision 1-3 hours per week per trainee
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Mentored Trainees and Faculty

2005-2007	Rupali Dhond, PhD / Post-doctoral Research Fellow <i>Career stage:</i> Research Fellow. <i>Mentoring role:</i> primary Postdoctoral mentor <i>Accomplishments:</i> Multiple first-authored publications of mentored research in top peer-reviewed journals including Brain, Pain. Mentored her successful transition to faculty and K01 training grant submission to NCCAM, NIH.
2006-2009	Kyungmo Park, PhD / Associate Professor, Dept. Biomedical Engineering, Kyunghee University, Korea <i>Career stage:</i> Visiting Professor. <i>Mentoring role:</i> Supervisor / Collaborator <i>Accomplishments:</i> Multiple co-authored publications of mentored research. Collaboration continues through joint research and student mentorship, leading to funded KIOM / Martinos Collaboration Center.
2006-2007	Calvin Yeh, MS / Research Assistant <i>Career stage:</i> Research technologist. <i>Mentoring role:</i> primary Research Assistant mentor <i>Accomplishments:</i> co-authored publications of mentored research, transitioned to industry position.
2007-2010	Lauren LaCount, BS / Research Assistant <i>Career stage:</i> Research technologist. <i>Mentoring role:</i> primary Research Assistant mentor

Accomplishments: first- and co-authored publications of mentored research and successfully transitioned to DO program.

- 2010-2011 Ang Li, BS / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: Co-authored publications of mentored research and successfully transitioned to MD program.
- 2007-2015 Jieun Kim, PhD / Post-Doctoral Research Fellow
Career stage: Post-Doctoral Research Fellow. *Mentoring role:* PhD Thesis Committee and primary Postdoctoral mentor
Accomplishments: Multiple first-authored publications of mentored research in top peer-reviewed journals including Pain, Arthritis and Rheumatology, etc. Jieun successfully transitioned to KIOM in Korea as a leading member of their NeuroImaging team.
- 2007-2015 Steve Cina, LAc / Research Assistant
Career stage: Research assistant and acupuncturist. *Mentoring role:* primary RA mentor
Accomplishments: co-authored publications of mentored research and transitioned to leadership academic role at New England School of Acupuncture, MCPHS
- 2008-2011; Jeungchan Lee, PhD / Doctoral Student at Kyunghee University, Korea; Post-
2015- doctoral Fellow
Career stage: Post-Doctoral Research Fellow. *Mentoring role:* PhD Thesis Committee and primary Postdoctoral mentor
Accomplishments: Multiple first-authored publications of mentored research in top peer-reviewed journals. Awarded Martinos Center post-doctoral fellow research grant.
- 2008-2015 Yumi Maeda, DDS PhD / Post-Doctoral Research Fellow
Career stage: Post-Doctoral Research Fellow. *Mentoring role:* primary Postdoctoral mentor
Accomplishments: Multiple first-authored publications of mentored research and transition to clinical dentistry fellowship at Boston University.
- 2011-2013 Marco Loggia, PhD / Post-Doctoral Research Fellow
Career stage: Post-Doctoral Research Fellow. *Mentoring role:* Postdoctoral mentor
Accomplishments: Multiple first-authored publications of mentored research and successful transition to independent faculty at the Martinos Center where he supervises his own Lab. Marco also co-founded the Center for Integrative Pain NeuroImaging (CiPNI) with myself, where he serves as Associate Director.
- 2010-2012 Florian Pfab MD PhD / visiting Associate Professor, TU-Munich, Germany
Career stage: Visiting Professor. *Mentoring role:* primary Supervisor / Collaborator

Accomplishments: Multiple first- and co-authored publications of mentored research and successfully transitioned to head physician of Ingolstadt Futbol Club, Bundesliga, Germany and private practice.

- 2011-2012 Jaehyun Im, BS / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: Co-authored publications of mentored research.
- 2011-2012 Wei-Ta Chen, MD / visiting fellow from Taiwan
Career stage: Visiting Post-Doctoral Fellow. *Mentoring role:* co-mentor
Accomplishments: A co-authored publication of mentored migraine imaging research and successfully transitioned to faculty position in Taiwan.
- 2012-2017 Jessica Gerber, MS / research coordinator
Career stage: Research assistant and Clinical coordinator. *Mentoring role:* primary RA supervisor
Accomplishments: Co-authored publications of mentored research, coordination of complex Program Project grant, transition to lead coordinator for IBC in Dept. Neurology, MGH.
- 2013-2014 Florian Beissner, PhD / visiting Post-doctoral fellow, University of Hannover, Germany
Career stage: Visiting fellow. *Mentoring role:* primary supervisor
Accomplishments: Multiple first- and co-authored publications of mentored research. Transitioned to lead his own Lab at University of Hannover.
- 2012-2014 Alexandra Libby, BS / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: Co-authored publications of mentored research and successfully transitioned to PhD program at Princeton University.
- 2013-2015 Hyungjun Kim, PhD / visiting fellow from KIOM, Korea
Career stage: Visiting fellow. *Mentoring role:* primary supervisor
Accomplishments: Multiple first- and co-authored publications of mentored research. Transitioned to lead his own Lab at Korean Institute of Oriental Medicine, Daejeon, Korea
- 2013- Roberta Sclocco, PhD / visiting fellow from Milan Polytechnic, post-doctoral fellow
Career stage: Post-Doctoral Research Fellow. *Mentoring role:* primary mentor
Accomplishments: Multiple first-authored publications of mentored research
- 2014-2017 Ishtiaq Mawla, BA / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: First-authored publications of mentored research and successfully transitioned to PhD program at University of Michigan.

- 2014-2017 Ekaterina Protsenko, BA / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: Co-authored publications of mentored research and successfully transitioned to MD program at University of California San Francisco.
- 2014- Ronald Garcia, MD PhD / Post-doctoral Research Fellow
Career stage: Post-Doctoral Fellow. *Mentoring role:* co-postdoctoral mentor
Accomplishments: Multiple first-authored publications of mentored research and successful transition to faculty in the Department of Psychiatry, MGH. Served as PI for grants from National Science Agency in Colombia and foundation grant from NARSAD.
- 2015-2018 Dan-Mikael Ellingsen PhD / Post-doctoral Research Fellow
Career stage: Post-Doctoral Fellow. *Mentoring role:* Post-doctoral mentor
Accomplishments: Multiple first-authored publications of mentored research and awarded EU grant support through the University of Oslo, Norway under my supervision.
- 2016-2018 Changjin Jung, MS / visiting fellow from KIOM, Korea
Career stage: Visiting fellow. *Mentoring role:* primary supervisor
Accomplishments: Co-authored publications of mentored research. Transitioned to researcher position at Korean Institute of Oriental Medicine, Daejeon, Korea
- 2016-2018 Jacqueline Lutz, PhD / post-doctoral research fellow
Career stage: Post-Doctoral Fellow. *Mentoring role:* co-postdoctoral mentor
Accomplishments: Multiple first- and co-authored publications of mentored research and successfully transitioned to industry position.
- 2016-2018 Catherine Hubbard, PhD / post-doctoral research fellow
Career stage: post-doctoral fellow. *Mentoring role:* primary supervisor
Accomplishments: Multiple first- and co-authored publications of mentored research. Transitioned to faculty position at Martinos Center, MGH
- 2016- Kylie Isenburg, BA / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: Co-authored publications of mentored research
- 2017- Harrison Fisher, BS / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: Co-authored publications of mentored research
- 2018- Michael Datko, PhD / Post-doctoral Research Fellow
Career stage: post-doctoral fellow. *Mentoring role:* co-supervisor
Accomplishments: Poster presentation and OHBM annual meeting

- 2018- Alessandra Anzolin, PhD / Post-doctoral Research Fellow
Career stage: post-doctoral fellow. *Mentoring role:* primary supervisor
Accomplishments: Poster presentation at OHBM annual meeting
- 2018- Rowan Staley, BS / Research Assistant
Career stage: Research technologist. *Mentoring role:* co-Research Assistant mentor
Accomplishments: Poster presentations at GI conferences
- 2019- Arvina Grahl, PhD / Post-doctoral Research Fellow
Career stage: post-doctoral fellow. *Mentoring role:* primary supervisor
Accomplishments: Oral presentation at SIPS annual meeting
- 2019- Mackenzie Hyman, BS / Research Assistant
Career stage: Research technologist. *Mentoring role:* primary Research Assistant mentor
Accomplishments: instrumental in hardware development for the Lab

Local Invited Presentations

No presentations below were sponsored by outside entities.

- 2004 Employing functional MRI for the study of acupuncture: Experiment design and the neurocorrelates of acupuncture deqi sensation / Invited Lecture
Osher Institute, Harvard Medical School
- 2006, 2009 The Role of Acupuncture in Chronic Pain Management / Invited Lecture
Pain Management Center, Brigham and Women's Hospital, Harvard Medical School
- 2006 Sham and Placebo Acupuncture in Clinical Trials: The Neuroimaging Evidence / Invited Lecture
Harvard Medical School
- 2006 Evidence of Somatosensory Cortical Plasticity in Carpal Tunnel Syndrome Treated with Acupuncture - an fMRI Assessment / Invited Lecture
Martinos Center for Biomedical Imaging, Dept. Radiology, MGH
- 2007 Acupuncture Modulation of Resting State Networks / Invited Lecture
Martinos Center for Biomedical Imaging, Dept. Radiology, MGH
- 2011 How does Acupuncture work? Brain activity underlying acupuncture efficacy / Invited Lecture
Massachusetts General Hospital CSSA

- 2012 Neuroimaging markers for chronic pain disorders - objective outcomes for evaluating acupuncture therapy / Invited Lecture
Brainmap Lecture, Martinos Center for Biomedical Imaging, MGH
- 2012 Acupuncture for the Treatment of Chronic Pain: Integrating Clinical and Neuroimaging Research / Invited Lecture
Osher Center for Integrative Medicine at Harvard Medical School and Brigham and Women's Hospital
- 2013 Neuroimaging evaluation of acupuncture mechanisms - from carpal tunnel syndrome to fibromyalgia / Invited Lecture
The Fellowship in Integrative Medicine at Beth Israel Deaconess Medical Center, Boston MA
- 2013 Investigating the autonomic brain and pain / autonomic interactions with neuroimaging / Invited Lecture
Children's Hospital, Waltham, MA
- 2014 Sex-differences in brain circuitry supporting nociception, pain, and pain empathy: the neuroimaging evidence / Invited Lecture
Conference on pain in women, Connors-Bri Center for Research on Women's Health and Gender Biology, Brigham and Women's Hospital, Boston, MA
- 2014 Overview of Integrative Medicine Programs / Osher Inaugural Integrative Medicine Research Forum / Session Chair
Joseph B. Martin Conference Center, Harvard Medical School, Boston, MA
- 2017 Neuroimaging applied to assess objective outcomes for acupuncture in carpal tunnel syndrome / Invited Grand Rounds Lecture
Osher Center for Integrative Medicine at Harvard Medical School and Brigham and Women's Hospital, Boston, MA
- 2017 Brain Imaging at the MGH Martinos Center / Invited Lecture
Lunch and Learn series, Partners Healthcare Research Management, Somerville MA
- 2017 Ultrahigh Field (7T) fMRI Approaches to Brainstem Neuroimaging for Targeted Neuromodulation / Invited Lecture
7T MRI Scientific Symposium, Brigham and Women's Hospital, Boston, MA
- 2018 The Role of Acupuncture in the Treatment of Chronic Pain / Invited Lecture
Pain Management Center, Department of Anesthesiology, Brigham and Women's Hospital
- 2018 Sex Differences and Pain: Do different brain circuitries contribute to differences in pain sensitivity? / Panel and Invited Lecture, Radcliffe Seminar, Radcliffe College, Cambridge MA

- 2019 Neuromodulation in Tune with the Body's Rhythms: Enhancing Clinical Outcomes with Respiratory-Gated Auricular Vagal Afferent Nerve Stimulation (RAVANS) / Grand Rounds invited lecture, Osher Center for Integrative Medicine, Brigham and Women's Hospital, Boston, MA

Report of Regional, National and International Invited Teaching and Presentations

No presentations below were sponsored by outside entities.

Regional

- 2004 What can functional MRI tell us about acupuncture and the "Sea of Marrow" that we don't already know? / Invited Lecture
New England School of Acupuncture, Newton, MA
- 2004 The Modulatory Effects of Acupuncture on the Brain as Imaged by fMRI / Invited Lecture
Tufts School of Medicine, Boston, MA
- 2005 Pain Relief and Acupuncture Research: from Endorphins to fMRI / Invited Lecture at Biomatrix Evening Colloquium
Massachusetts Institute of Technology, Cambridge, MA
- 2006 Neuroplasticity in Carpal Tunnel Syndrome Treated by Acupuncture: An fMRI Evaluation / Invited Lecture
Dept. PM&R, Tufts-New England Med Center, Boston, MA
- 2006 22.013 MIT: Freshman Seminar: Careers in Biomedical Engineering / Invited Lecture
Massachusetts Institute of Technology, Cambridge MA
- 2007 Neuroimaging the Effects of Acupuncture for Carpal Tunnel Syndrome / Grand Rounds
Massachusetts Institute of Technology Medical Clinic, Cambridge, MA
- 2007 Acupuncture in Pain Management: From Philosophy to Brain Imaging / Pain Management Deep Learning Summit: Future of Pain Prevention and Treatment
Massachusetts Institute of Technology Faculty Club, Cambridge, MA (Johnson and Johnson)
- 2008-2010 The Neuroscience of Acupuncture / Invited Lecture in course: Evidence-based Complementary and Alternative Medicine
Tufts Medical School, Boston, MA
- 2010 An Overview of Acupuncture Research: from clinical trials to neuroimaging

- Intercollegiate Taiwanese American Students Association (ITASA) Annual Meeting, Massachusetts Institute of Technology, Cambridge, MA
- 2010 Neuroimaging for Complex Pain Syndromes / Future of Pain Management Summit Massachusetts Institute of Technology Faculty Club, Cambridge, MA (Johnson and Johnson)
- 2011 Paradoxes in Acupuncture Research: A Brain's-eye View Using Neuroimaging / New England Society of Medical Acupuncture, Children's Hospital, Waltham, MA
- 2012 Neuroimaging Potential Brain Mechanisms for Acupuncture – from Carpal Tunnel Syndrome to Fibromyalgia / Neuroscience Grand Rounds, University of Vermont, Burlington, VT
- 2013 Neuroimaging Approaches to Acupuncture Research: from localized to widespread pain syndromes / Invited Lecture Tufts University School of Medicine, Boston, MA
- 2013 Neuroimaging for non-invasive assessment of brain circuitry supporting nausea in humans / Invited Lecture Man Vehicle Laboratory Seminar, Massachusetts Institute of Technology, Cambridge, MA
- 2015 Integrated Care: Exploring Diverse Approaches to Health / Tufts University Chapter of Minority Association for Pre-Health Students (MAPS) / Invited Panelist Tufts University, Medford, MA
- 2016 What is acupuncture? From research to clinical practice / Course CPSYC-1451-BH01, Bunker Hill Community College / Invited Speaker Charlestown, MA
- 2017 The Neuroscience of Acupuncture / Invited Lecture in course: Medical Acupuncture elective Tufts Medical School, Boston, MA
- 2018 Boosting Mindfulness-based Interventions with Neuromodulation / Invited Lecture Symposium for Technology-Assisted Meditation, Harvard University, Cambridge MA
- 2018 From somatosensory neuromodulation to therapeutic alliance: Neuroimaging applications to better understand how acupuncture alleviates pain / The John B. Pierce Laboratory seminar series, Yale University, New Haven, CT
- 2019 Neuromodulation in tune with the body's rhythms: Pain neuromodulation with respiratory-gated auricular vagal afferent nerve stimulation (RAVANS) / Atlanta Department of Veterans Affairs CVNR Seminar Series, Atlanta, GA

2020 Rewiring the primary somatosensory cortex in carpal tunnel syndrome with acupuncture / Invited Lecture in course: Medical Acupuncture elective
Tufts Medical School, Boston, MA

National

2003 The Modulatory Effects of Acupuncture on the Brain as Imaged by fMRI / Grand Rounds
Physical Rehabilitation Branch, National Institutes of Health, Bethesda, MD

2003 A Biomechanical Investigation of the Structure-Function Relationships in the Tongue / Grand Rounds
Physical Rehabilitation Branch, National Institutes of Health, Bethesda, MD

2003 A Biomechanical Investigation of the Structure-Function Relationships in the Tongue / Grand Rounds
Physical Rehabilitation Branch, National Institutes of Health, Bethesda, MD

2005 Evidence of Cortical Plasticity in Carpal Tunnel Syndrome Treated with Acupuncture / Invited Lecture
National Center for Complementary and Alternative Medicine (NCCAM), National Institutes of Health, Bethesda, MD

2006 Sham / Placebo Controls in Acupuncture: The Evidence from Neuroimaging / Invited seminar lecture
North American Research Conference on Complementary and Integrative Medicine. Edmonton, Alberta, Canada

2006 Acupuncture for Carpal Tunnel Syndrome: Neuroimaging Cortical Plasticity and Acupuncture Processing for Chronic Pain / Oral abstract presentation
North American Research Conference on Complementary and Integrative Medicine. Edmonton, Alberta, Canada

2007 NCCAM Center of Excellence: Neuroimaging Acupuncture Effects on Brain Activity / Invited Lecture
NCCAM Centers Meeting. Bethesda, MD

2007 Acupuncture for Carpal Tunnel Syndrome: Neuroimaging Cortical Plasticity and Acupuncture Processing for Chronic Pain / Keynote Lecture
American Academy of Medical Acupuncture 19th Annual Symposium, Baltimore, MD

2008 Acupuncture Modulates Resting Brain Networks / Invited Lecture
Chronic Pain and Fatigue Research Center, University of Michigan. Ann Arbor, MI

2008 Evaluating Acupuncture with fMRI: From Characterization to Translational Research / Grand Rounds

Physical Medicine and Rehabilitation Branch, National Institutes of Health,
Bethesda, MD

- 2009 Neuroimaging in basic and translational acupuncture research / Invited Lecture in the Integrative Medicine Lecture Series
College of Pharmacy, University of Texas at Austin.
- 2009 Neuroimaging of CAM techniques / Invited Lecture in the 3rd National Symposium on Complementary & Alternative Geriatric Health Care
Logan College of Chiropractic, Chesterfield, MO
- 2011 Acupuncture relief of itch in Atopic Dermatitis associated with reduced fMRI activation of salience and affective brain circuitries / Oral abstract presentation
Society for Neuroscience annual meeting, Washington DC
- 2013 Functional Brain Connectivity: A Potential Biomarker for the Chronic Pain State? / Invited plenary Lecture in the American Academy of Pain Management annual meeting, Fort Lauderdale, FL
- 2013 Martinos Center CERC for Acupuncture Neuroimaging: Application of MRI Biomarkers to Better Understand Acupuncture Analgesia / Invited plenary lecture at the CAM preconference symposium of the American Pain Society annual conference, New Orleans, LA
- 2014 Neuroimaging Approaches to Acupuncture and CAM Research: What Do We Know? What Lies Ahead? / Invited keynote lecture at the New York Chiropractic College, Seneca Falls, NY
- 2014 Neuroimaging outcomes as biomarkers for acupuncture analgesia / Invited symposium lecture at the American Academy of Pain Management, Phoenix, AZ
- 2014 As We Better Understand the Brain, We Better Understand Acupuncture: Neuroimaging Approaches to Acupuncture Research / Invited keynote lecture at the 26th Annual American Academy of Medical Acupuncture Symposium, Denver, CO
- 2014 Brain neuroplasticity in carpal tunnel syndrome treated by acupuncture / Invited symposium lecture in "Neural Basis of Nonpharmacological Pain Treatments" at American Pain Society Annual Meeting, Tampa, FL
- 2015 Neuroimaging altered brain circuitries and neurotransmitter levels in cyclic vomiting syndrome / Invited symposium lecture for Biology and Control of Nausea and Vomiting 2015, Pittsburgh, Pennsylvania
- 2016 Acupuncture - a somatosensory conditioning neuromodulatory therapy / Invited lecture at the National Center for Complementary and Integrative Health, NIH, Bethesda, Maryland

- 2016 A view from above: Investigating acupuncture mechanisms for chronic pain with brain functional MRI / Invited lecture at Integrative Medicine Lecture Series, University of Texas MD Anderson Cancer Center, Houston, TX
- 2016 Non-invasive neuromodulatory approaches to the treatment of chronic pain / Invited lecture
Pain Week, Las Vegas, NV
- 2016 Neuroimaging acupuncture mechanisms in Carpal Tunnel Syndrome: can targeting the brain affect pain in the wrist? / Invited lecture
Pain Week, Las Vegas, NV
- 2017 Neuroimaging Acupuncture Effects for Neuropathic Pain and the Role of Objective Outcomes in CTS / Invited keynote lecture at the American Academy of Medical Acupuncture 30th Annual Symposium, Pittsburgh, PA
- 2017 Is brain concordance linked with therapeutic alliance & pain relief? Hyperscan fMRI applied to decipher the brain circuitry of patient/clinician interactions / Invited webinar presentation for Director's Webinar Series, Office of Behavioral and Social Sciences Research, National Institutes of Health (NIH)
- 2018 Neuroimaging to assess S1 neuroplasticity following acupuncture therapy for neuropathic pain / Selected Session (competitive, chair)
Neurobiological Mechanisms Supporting Integrative and Mind-Body Therapies for Pain, American Pain Society annual meeting, Anaheim, CA
- 2018 Applications of respiratory-gated auricular vagal afferent nerve stimulation (RAVANS) / Invited lecture
Cardiac Autonomics Group, University of California Los Angeles, Los Angeles, CA
- 2018 Respiratory-gated Auricular Vagal Afferent Nerve Stimulation for Pain Disorders / Invited Lecture
2018 NYC Neuromodulation & North American Neuromodulation Society Summer Series, New York City, NY, USA
- 2019 Neuroimaging the brain circuitry underlying pain catastrophizing and its influence on pain processing / Selected Session (competitive)
Multimodal Contributors to the Negative Impact of Pain Catastrophizing, American Pain Society annual meeting, Milwaukee, WI
- 2019 What has fMRI revealed about central sensitization and chronic pain? / Invited lecture
Analgesic, Anesthetic, and Addiction Clinical Trial Translations, Innovations, Opportunities and Networks (ACTTION), IMMPACT-XXIII meeting, Research Design Considerations for Chronic Pain Clinical Trials Addressing Central Sensitizations/Somatosensory Amplification and Multiple Comorbidities, Washington DC

- 2019 Neuroimaging and Functional Gastric Response to Respiratory-gated Transcutaneous Vagus Nerve Stimulation / Invited Lecture
Joint meeting of NYC Neuromodulation and the Neuromodulation: The Science symposia, Napa, CA
- 2019 Brain imaging to assess neuroplasticity following acupuncture for neuropathic pain / Invited Lecture
College on Problems of Drug Dependence (CPDD) Symposium, San Antonio, TX
- 2019 Therapeutic engagement of interoceptive pathways with respiratory-gated vagus nerve stimulation / Invited Lecture
The Science of Interoception and its Roles in Nervous System Disorders, NIH Blueprint Workshop, NIH, Lister Hill Auditorium, Bethesda MD
- 2020 Neuromodulation in Tune with the Body's Rhythms: Respiratory-gated Auricular Vagal Afferent Nerve Stimulation (RAVANS) / Invited Lecture
National Center of Neuromodulation for Rehabilitation Advanced Transcutaneous Auricular Vagus Nerve Stimulation (taVNS) Symposium, Charleston, SC
- 2020 Functional Neuroimaging of Psychosocial States: Brain circuitries supporting pain and catastrophizing / Invited Lecture
Measurement of Pain: Behavioral, Social and Biological Factors Office of Behavioral and Social Sciences Research National Institutes of Health, Bethesda, MD
- 2020 Underlying Physiology, Clinical Applications, and Technology Transfer of a Novel Technique for Transcutaneous Respiratory-Gated Auricular Vagus Afferent Nerve Stimulation (RAVANS) / Oral zoom presentation
NYC Neuromodulation 2020 Online Conference (Covid19-modified)

International

- 2005 Correlating Acupuncture fMRI in the Human Brainstem with Heart Rate Variability / Oral abstract presentation
27th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Shanghai, China
- 2007 Evaluating Acupuncture with Functional MRI: From Characterization to Translational Research / Invited lecture
Society for Acupuncture Research Annual Conference: The Status and Future of Acupuncture Research: 10 Years Post-NIH Consensus Conference, Baltimore, MD
- 2008 Evaluating Acupuncture with fMRI: From Characterization to Translational Research / Keynote lecture
Acupuncture Research Resource Council Annual Conference, London, UK

- 2009 Elucidating Acupuncture Mechanisms of Action with fMRI / Invited lecture
1st Sino-German Conference in Acupuncture and Moxibustion, Chengdu, Sichuan
Province, People's Republic of China (Chinesisch-Deutsches Zentrum fur
Wissenschaftsforderung)
- 2010 Neuroimaging in Basic and Translational Acupuncture Research / Invited lecture
York Neuroimaging Centre, University of York, York, United Kingdom
- 2010 Acupuncture Neuroimaging Research / Invited lecture
Kyunghee University, Seoul, Republic of Korea
- 2010 Neuroimaging in Basic and Translational Acupuncture Research / Invited plenary
lecture
International Symposium on Acupuncture and Meridian Studies (ISAMS), Pusan,
Republic of Korea
- 2010 Acupuncture modulates intrinsic brain connectivity in fibromyalgia – a potential
neuroimaging marker for disease severity and therapeutic efficacy / Oral abstract
presentation
International Congresses in Complementary Medicine Research, Tromso, Norway
- 2011 The Research Matrix: Mapping Acupuncture Effects on the Human Brain / Invited
Keynote Lecture
AACP (Acupuncture Association of Chartered Physiotherapists) Annual
Conference, Wyboston, United Kingdom
- 2011 Neuroimaging Acupuncture: acupoint specificity and potential mechanisms of
action / Invited Keynote Lecture
DAGfA (Deutsche Arztegesellschaft fur Akupunktur, German Medical Acupuncture
Association), Bad Nauheim, Germany
- 2012 Neuroimaging evaluation of acupuncture mechanisms / Invited Plenary Lecture
Korean Institute for Oriental Medicine Acupuncture Neuroimaging Symposium,
Daejeon, Korea
- 2012 Brain Circuitry Subservicing Acupuncture Relief of Itch in Atopic Dermatitis: an fMRI
Study / Selected Session (chair, competitive)
“A Window to the Brain: Neuroimaging Technologies for Integrative Medicine
Research” at International Research Congress on Integrative Medicine and
Health, Portland, OR, USA
- 2013 Neuroimaging Approaches to Acupuncture Research: What Do We Know? What
Lies Ahead? / Invited Keynote Lecture
Society for Acupuncture Research International Conference, Ann Arbor, MI
- 2013 Brain mechanisms supporting anti-pruritic effects of acupuncture / Invited plenary
lecture
International Scientific Acupuncture and Meridian Symposium, Stockholm,

Sweden

- 2013 Brain circuitry supporting nocebo itch perception in atopic dermatitis / Invited plenary lecture 7th World Congress on Itch, Boston, MA
- 2014 International Scholar: Visiting Professorship in the Department of Biomedical Engineering at Kyunghee University, Yongin, Korea.
- 2014 Acupuncture modulates brain neuroplasticity in carpal tunnel syndrome / Invited Lecture
Chengdu University of Traditional Chinese Medicine, Chengdu, China
- 2014 Neuroimaging Correlates of Acupuncture: What Do We Know? What Lies Ahead? / Invited Keynote Lecture
CAAM and SAR International Symposium on Acupuncture Research, Beijing, China
- 2014 Neuroimaging approaches to acupuncture research: from carpal tunnel syndrome to fibromyalgia / Invited Lecture
The University of Hong Kong, Hong Kong, China
- 2014 Neuroimaging in acupuncture research: background and applications / Invited Lecture
Korean Institute of Oriental Medicine, Daejeon, Korea
- 2014 Neuroanatomy and Neurophysiology of the Human Brain: functional MRI applications / Kyunghee University lecture series
Kyunghee University, Yongin, Korea
- 2015 Neuroimaging in Multicenter Trials / Invited Lecture
1st Annual International Conference, Kyunghee University Clinical Trials Center, Kyunghee University Korean Medicine Hospital, Seoul, Korea
- 2015 Brain circuitry supporting placebo and nocebo effects of itch / Invited Lecture
Summer School „Allergy and the Brain“
The Christine Kühne Center for Allergy Research and Education (CK-CARE), Davos, Switzerland
- 2015 Neuroimaging nausea to better understand CAN physiology – a multimodal approach / Oral presentation at selected session (competitive)
37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Milan, Italy
- 2016 Evaluating acupuncture-associated neuroplasticity in carpal tunnel syndrome with brain imaging / Invited Plenary Lecture
International Scientific Acupuncture and Meridian Symposium (ISAMS), Hong Kong, China

- 2016 Brainstem processing in migraine: can the gateway to chronic pain be down-regulated? / Selected Session (competitive)
“Neuroimaging pain-related circuitries in the human brainstem with functional MRI”
at Organization for Human Brain Mapping annual meeting, Geneva, Switzerland
- 2017 Neuroimaging Acupuncture Effects for Neuropathic Pain and the Role of Objective Outcomes in CTS / Invited Plenary Lecture
Society for Acupuncture Research International Conference, San Francisco CA
- 2017 When perception is reality: How nocebos mimic real pruritogens in brain processing of clinically-relevant itch / Invited Plenary Lecture
Society for Interdisciplinary Placebo Studies (SIPS) Conference, Leiden, Netherlands
- 2017 Functional Neuroimaging as a Window into Human Brain Function: Applications to Better Understand and Optimize Neuromodulatory Therapies / Invited Keynote Lecture
International Society for Neurofeedback Research, Ledyard, CT, USA
- 2018 Rewiring the primary somatosensory cortex in carpal tunnel syndrome with acupuncture / Invited Keynote Lecture
World Congress on Medical Acupuncture, Munich, Germany
- 2018 Neural mechanisms of non-specific effects of mind and body approaches / Invited Plenary Lecture
“Chronic Pain: The Science of Complementary and Integrative Health Approaches”, Satellite to the 17th IASP World Congress on Pain, Boston, MA, USA
- 2018 Rewiring the primary somatosensory cortex in carpal tunnel syndrome with acupuncture / Invited Lecture
Annual Meeting for the Chinese Society of Integrative Anesthesiology, Shenyang, China
- 2018 Rewiring the primary somatosensory cortex in carpal tunnel syndrome with acupuncture / Invited Keynote Lecture
British Medical Acupuncture Society Autumn Scientific Meeting, London, UK
- 2018 Role of neuroimaging to assess acupuncture-induced neuroplasticity in pain relief / Invited Plenary Lecture
6th International Scientific Symposium at the Institute for Complementary and Integrative Medicine, Zurich, Switzerland
- 2018 Role of neuroimaging to assess acupuncture-induced neuroplasticity in pain relief / Invited Plenary Lecture
A.M.A.B. ASSOCIAZIONE MEDICI AGOPUNTORI BOLOGNESI 2nd International Symposium on Research in Acupuncture, Bologna, Italy
- 2019 The role of neuroimaging in developing acupuncture and other neuromodulatory

approaches for chronic pelvic pain / Invited Plenary Lecture
2019 Annual Scientific Meeting on Pelvic Pain, International Pelvic Pain Society
(IPPS), Toronto, Canada

2019 Brain concordance supports patient/clinician therapeutic alliance and modulates placebo analgesia: a hyperscan fMRI approach / Invited Plenary Lecture
Society for Interdisciplinary Placebo Studies (SIPS) Conference, Leiden, Netherlands

2020 Brain concordance supports patient/clinician therapeutic alliance and modulates analgesia: a hyperscan fMRI approach / Accepted panel submission titled "Neuroimaging Applications for Social and Affective Modulation of Pain"
Winter Conference on Brain Research (WCBR), Big Sky, Montana, USA

2020 Rewiring the primary somatosensory cortex in carpal tunnel syndrome with acupuncture / Invited Lecture
University of Sao Paulo Medical Acupuncture Grand Rounds (Online, Covid19-modified), Sao Paolo, Brazil

Report of Clinical Activities and Innovations

Current Licensure and Certification

2002- Acupuncture
Committee on Acupuncture, Board of Registration in Medicine, Executive Office of Health and Human Services, Commonwealth of Massachusetts

Practice Activities

2006- Acupuncturist Pain Management Center, 1 afternoon clinic per week
Dept. Anesthesiology,
BWH

Clinical Innovation

Protocol for the treatment of carpal tunnel syndrome with electro-acupuncture
Since our published protocol in 2007, in which we evaluated acupuncture induced neuroplasticity in primary somatosensory cortex in carpal tunnel syndrome patients, multiple acupuncturists around the nation have successfully used this protocol in their own clinic (personal communication). I was involved in the development of this clinical protocol, and have been principally responsible for the dissemination of the protocol in the medical community.

Novel approach for transcutaneous vagus nerve stimulation, 2009
Innovative approach to transcutaneous auricular neuromodulation, which has been researched for multiple clinical applications (due to the broad innervation of the vagus nerve), from gastroparesis and hypertension, to mild cognitive impairment, migraine and depression. Our approach has been issued a patent, which is licensed and being developed as a potential FDA-approved device by a medical device company (Cala Health, Inc.). I was the inventor of the technology and

am listed as such on the primary patent, and follow-up patent applications stemming from this innovation.

Report of Technological and Other Scientific Innovations

Respiratory-gated Auricular Vagal Afferent Nerve Stimulation (RAVANS)	US Patent awarded (2013): US Patent 8,428,719 Envisioned and built a prototype of a novel device which can be used to provide a form of non-invasive vagal nerve stimulation to treat chronic pain and other disorders. This technology was licensed to Cala Health, Inc in 2018 and a commercial prototype is currently being evaluated for clinical efficacy. US Provisional Patent: 62/530,913 PCT/US2018/041485 (WO, PCT) "SYSTEMS AND METHODS FOR RESPIRATORY-GATED NERVE STIMULATION" Application of RAVANS for cardiovascular and gastrointestinal disorders.
MRI assessment of gastric motility	Development of a non-invasive 4D cine MRI assessment of gastric motility using a naturalistic contrast meal and ultrafast 3D MRI sequence. Patent application with Braden Kuo, Christopher Nguyen, Roberta Sclocco. MGH Application for Provisional Patent application in process (25655), patent application submitted May 2020.

Report of Education of Patients and Service to the Community

No presentations below were sponsored by outside entities

Recognition

2005	Presented research talk to acupuncturists and lay public entitled "Cortical Plasticity in Carpal Tunnel Syndrome Treated with Acupuncture"	Acupuncture and Oriental Medicine Society of Massachusetts Annual Meeting
2006	Presented research talk to bodyworkers and lay public entitled "Neuroimaging of Acupuncture for Carpal Tunnel Syndrome."	American Organization for Bodywork Therapies of Asia
2009	Authored a review for acupuncture professionals entitled "Promise of Neuroimaging for Acupuncture Research."	American Acupuncturist Journal

2017	Publicity for 2017 Brain publication on brain mechanisms of acupuncture treatment of Carpal Tunnel Syndrome	New York Times, The Guardian (UK), Popular Science, Time magazine, Boston Magazine, Daily Mail (UK), Korean Broadcasting Service (Korea), Arirang TV (Korea), Le Figaro (France)
2019	Publicity for hyperscan fMRI study investigating mechanistic role of patient / clinician relationship in clinical pain outcomes	National Geographic magazine

Report of Scholarship

Peer-Reviewed Scholarship in print or other media

*=equal contribution

#=first/co-first author is a mentee

Research investigations

1. **Napadow V**, Chen Q, Wedeen VJ, Gilbert RJ. Intramural mechanics of the human tongue in association with physiological deformation. *Journal of Biomechanics*. 1999; 32 (1):1-12.
2. **Napadow V**, Chen Q, Wedeen VJ, Gilbert RJ. Biomechanical basis for lingual muscular deformation during swallowing. *American Journal of Physiology*. 1999; 40 (3):G695-G701.
3. Wedeen V, Reese TG, **Napadow V**, Gilbert RJ. Demonstration of primary and secondary muscle fiber architecture of the Bovine tongue by diffusion tensor MRI. *Biophysical Journal*. 2001; 80 (2):1024-8.
4. **Napadow V**, Wedeen VJ, Chen Q, Mai V, So PTC, Gilbert RJ. Quantitative analysis of 3D-resolved lingual fiber architecture in intact tissue with diffusion tensor MRI and two-photon microscopy. *Biophysical Journal*. 2001; 80 (6):2968-75.
5. Chen Q, Mai V, Bankier AA, **Napadow V**, Gilbert RJ, Edelman R. An ultra-fast MR grid tagging sequence for assessment of local mechanical properties of the lungs. *Magnetic Resonance in Medicine*. 2001; 45 (1):24-8.
6. **Napadow V**, Mai V, Bankier AA, Gilbert RJ, Edelman R, Chen Q. Determination of regional pulmonary parenchymal strain during normal respiration using spin inversion tagged magnetization MRI. *Journal of Magnetic Resonance Imaging*. 2001; 13 (3):467-74.
7. **Napadow V**, Kamm RD, Gilbert RJ. A biomechanical model of sagittal tongue bending. *Journal of Biomechanical Engineering*. 2002; 124 (5):547-56.
8. **Napadow V**, Kaptchuk TJ. Patient characteristics for outpatient acupuncture in Beijing, China. *J Altern Complement Med*. 2004 Jun;10(3):565-72.
9. **Napadow V**, Liu J, Kaptchuk TJ. A systematic study of acupuncture practice: acupoint usage in an outpatient setting in Beijing, China. *Complement Ther Med*. 2004 Dec;12(4):209-16.
10. **Napadow V**, Makris N, Liu J, Kettner NW, Kwong KK, Hui KK. Effects of electroacupuncture versus manual acupuncture on the human brain as measured by fMRI. *Hum Brain Mapp*. 2005 Mar;24(3):193-205.
11. Gilbert RJ, **Napadow VJ**. Three-dimensional muscular architecture of the human tongue determined in vivo with diffusion tensor magnetic resonance imaging. *Dysphagia*. 2005 Winter;20(1):1-7.
12. Hui KK, Liu J, Marina O, **Napadow V**, Haselgrove C, Kwong KK, Kennedy DN, Makris N. The integrated response of the human cerebro-cerebellar and limbic systems to acupuncture stimulation at ST 36 as evidenced by fMRI. *Neuroimage*. 2005 Sep;27(3):479-96.
13. **Napadow V**, Kettner N, Ryan A, Kwong KK, Audette J, Hui KKS. Somatosensory Cortical Plasticity in Carpal Tunnel Syndrome - a Cross-sectional fMRI Evaluation. *Neuroimage*. 2006 Jun;31(2):520-30.

14. Gilbert RJ, Magnusson LH, **Napadow V**, Benner T, Wang R, Wedeen V. Mapping complex myoarchitecture in the bovine tongue with diffusion spectrum magnetic resonance imaging. *Biophysical Journal*. 2006 Aug 1;91(3):1014-22.
15. **Napadow V**, Dhond R, Kennedy D, Hui KKS, Makris N. Automated Brainstem Co-registration (ABC) for MRI. *Neuroimage*. 2006, 32(3):1113-9.
16. Gilbert RJ, Wedeen VJ, Magnusson LH, Benner T, Wang R, Dai G, **Napadow VJ**, Roche KK. Three-dimensional myoarchitecture of the bovine tongue demonstrated by diffusion spectrum magnetic resonance imaging with tractography. *Anat Rec A Discov Mol Cell Evol Biol*. 2006, 288A(11):1173-1182.
17. **Napadow V**, Liu J, Li M, Kettner N, Ryan A, Kwong KK, Hui KKS, Audette J. Somatosensory cortical plasticity in carpal tunnel syndrome treated by acupuncture. *Human Brain Mapping*. 2007, 28(3):159-71.
18. **Napadow V**, N Kettner, J Liu, M Li, KK Kwong, M Vangel, N Makris, J Audette and KK Hui. Hypothalamus and Amygdala Response to Acupuncture Stimuli in Carpal Tunnel Syndrome. *Pain*. 2007, 130(3):254-66.
19. Hui KK, Nixon EE, Vangel MG, Liu J, Marina O, **Napadow V**, Hodge SM, Rosen BR, Makris N, Kennedy DN. Characterization of the "Deqi" Response in Acupuncture. *BMC Complement Altern Med*. 2007, 7(1):33.
20. Dhond RP#, Yeh C, Park K, Kettner N, **Napadow V**. Acupuncture modulates resting state connectivity in default and sensorimotor brain networks. *Pain*. 2008, 136(3):407-18. PMID: 18337009
21. **Napadow V**, Dhond RP, Conti G, Makris N, Brown EN, Barbieri R. Brain Correlates of Autonomic Modulation: Combining Heart Rate Variability with fMRI. *Neuroimage*. 2008, 42(1):169-77. PMID: 18524629.
22. Dhond RP#, Witzel T, Hämäläinen M, Kettner N, **Napadow V**. Spatiotemporal mapping the neural correlates of acupuncture with MEG. *J Altern Complement Med*. 2008 Jul;14(6):679-88. PMID: 18684075
23. **Napadow V**, Dhond RP, Park K, Kim J, Makris N, Kwong KK, Harris RE, Purdon P, Kettner N, Hui KKS. Time-Variant fMRI Activity in the Brainstem and Higher Structures in Response to Acupuncture. *Neuroimage*. 2009; 47(1):289-301. PMID: 19345268.
24. **Napadow V**, Dhond RP, Kim J, LaCount L, Vangel M, Harris RE, Kettner N, Park K. Brain encoding of acupuncture sensation - coupling on-line rating with fMRI. *Neuroimage*. 2009; 47(3):1055-65. PMID: 19500677
25. Harris RE, Zubieta JK, Scott DJ, **Napadow V**, Gracely RH, Clauw DJ. Traditional Chinese Acupuncture and Placebo (Sham) Acupuncture Are Differentiated by Their Effects on μ -Opioid Receptors (MORs). *Neuroimage*. 2009; 47(3): 1077-85. PMID: 19501658
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Thesis

A biomechanical investigation of the structure – function relationships in the human tongue [dissertation]. Cambridge (MA): Massachusetts Institute of Technology; 2001.

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Selection (Special recognition, and/or last three years, not yet published as full-length manuscripts)

1. Loggia ML, Kim J, Kong J, Gollub RL, **Napadow V**, Wasan AD. Chronic low back pain patients (CLBP) display altered brain connectivity in the Default Mode Network – An Arterial Spin Labeling (ASL) MRI Study. American Academy of Pain Medicine (2012), Palm Springs, CA.
 - *Best Abstract, selected for Plenary Session oral presentation, presented by ML Loggia*
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Narrative Report

In my career, my main role has been in Investigation, though I have also made significant contributions to Teaching and Educational Activities. My research is aimed at elucidating the neural mechanisms underlying chronic pain and promising non-pharmacological analgesic therapies, such as acupuncture, peripheral nerve neuromodulation, and psychosocial interventions such as cognitive behavioral therapy and mindfulness meditation training. I have been awarded multiple R01 and P01 level grants from NIH and other non-profit and for-profit sponsors, and in 2018 was the 13th top Sponsored Research Award recipient at MGH, bringing in \$9.2 million dollars in that year as Principal Investigator. While my efforts are mainly focused on research, significant supporting activities include maintaining a clinical acupuncture service at the Pain Management Center in the Department of Anesthesiology at BWH. In fact, I was the first formally credentialed acupuncturist at BWH and helped develop their credentialing and scope of practice guidelines. Additionally, I have authored patents on transcutaneous vagus nerve stimulation (tVNS), which have led to the licensing of MGB-held patents by Cala Health, Inc., a medical device company commercializing several closed-loop feedback neuromodulatory devices.

Area of Excellence – Investigation

My laboratory is focused on application of structural and functional magnetic resonance imaging (fMRI) to probe brain changes associated with chronic pain. For instance, a publication in *Arthritis and Rheumatology* [30] detailed a potential functional connectivity biomarker for spontaneous clinical pain. This finding has been corroborated in further studies by our group [45, 53, 60, 101] and others around the world. Moreover, our recent study [98], which was featured on the cover of *Pain*, extended this finding by applying machine learning to characterize and predict clinical pain intensity in low back pain patients.

To better understand how chronic pain impacts brain physiology, and how non-pharmacological therapies can effectively and safely induce beneficial neuroplasticity, my laboratory has also pushed technological and experimental design boundaries in neuroimaging research by incorporating brain imaging outcomes within longitudinal clinical trials. For example, acupuncture is an effective non-pharmacological probe for chronic pain reduction and my Lab has produced the most extensive publication record for acupuncture neuroimaging research in the world, continuing to move this nascent field forward. Included in our many findings, my group has found that acupuncture modulates the pain-associated functional brain connectivity biomarker noted above [35], supporting a central mechanism of action. Our studies were also the first to apply fMRI to assess somatosensory cortex neuroplasticity in carpal tunnel syndrome (CTS), finding more overlapped S1 representations for adjacent, median nerve-innervated fingers [13]. Acupuncture therapy was then found to increase separation in S1 finger representations [17], which was linked with clinical improvements. Following continued NIH R01-funded research, these results were replicated with a much larger longitudinal neuroimaging trial resulting in close to 10 publications, 3 in the high impact factor *Neurology* journal *Brain* [42, 59,88]. The main longitudinal results demonstrated both functional and microstructural plasticity in S1 and S1-adjacent white matter pathways following acupuncture, and were published in *Brain* in 2017. This study was highlighted by popular press and television coverage, leading to a prestigious, funded competitive Award by the European Society for Integrative Medicine.

Other ongoing projects in my Lab investigate the brain circuitry underlying pathological interoceptive states such as visceral pain, nausea and itch and other non-pharmacological approaches (e.g. neuromodulation, cognitive behavioral therapy, mindfulness meditation, placebo) to ameliorate such states. For example, in 2009 I invented a novel, enhanced form of transcutaneous vagus nerve stimulation (tVNS), called Respiratory-gated Auricular Vagal Afferent Nerve Stimulation (RAVANS), which was subsequently issued a US patent. Ongoing studies of this closed-loop neuromodulatory feedback approach are applying advanced neuroimaging techniques to assess brainstem targeting [86, 102, 116] and peripheral (e.g. heart, gastric) autonomic regulation, as we explore other promising clinical applications.

Teaching and Educational Activities

In addition to lecturing both locally and internationally, I continue to mentor other investigators at our institution. Currently, I am fortunate to be able to mentor multiple post-doctoral research fellows, research assistants, and visiting professors on various neuroimaging projects related to pain and neuromodulation.

Clinical Expertise and Innovation

I have also been engaged in clinical expertise, a significant supporting activity (SSA). After starting in private practice following graduation from the New England School of Acupuncture, I have been leading the acupuncture service at the Pain Management Center in the Department of Anesthesiology at BWH since 2006. I have been able to directly translate findings from my research to my clinic's chronic pain patients via innovative treatment protocols within my scope of practice. Further, numerous clinicians have reported successfully using our published carpal tunnel syndrome protocol in their own clinic. Also, our enhanced approach to transcutaneous vagus nerve stimulation promises to also push clinical treatment forward, once more fully developed through research in conjunction with industry partners and approved by the FDA.

In summary, while my academic focus lies squarely within Investigation and biomedical and human neuroscience research, I continue to support both clinical and teaching obligations. I have built and direct an internationally renowned pain neuroimaging program at the Martinos Center at MGH. My focus on brain-based mechanisms and non-pharmacological therapies for pain foreshadowed the growing interest in this topic by academic and governmental agencies, as society grapples with the chronic pain and opioid epidemics. My research has made seminal contributions in this field and has catalyzed others toward neuroscience-informed solutions for chronic pain.