



Corey Keller, MD, PhD

Assistant Professor of Psychiatry and Behavioral Sciences (Public Mental Health and Population Sciences)

 Curriculum Vitae available Online

CONTACT INFORMATION

- **Alternate Contact**

Email ckeller1@stanford.edu

Bio

BIO

Dr. Keller is an Assistant Professor of Psychiatry and Behavioral Sciences at Stanford University and an Assistant Professor at the Veterans Affairs Palo Alto Health Care System (VAPAHCS). He is a member of Stanford Bio-X and the Wu Tsai Neurosciences Institute. Dr. Keller received his MD and PhD in neuroscience from the Medical Scientist Training Program at Albert Einstein College of Medicine. He completed his residency in psychiatry at Stanford University Medical Center focused on interventional psychiatry. Dr. Keller has received several grants including the F31, T32, K23, DP5 Early Independence Award, SBIR, and R01 awards. He co-developed a fully automated non-invasive brain mapping technique used across industry and academia, and has run two clinical trials (NCT01829165 and NCT02843373) collecting over 1500 participants across ten clinical centers. Dr. Keller has extensive experience in the assessment and management of individuals with treatment-resistant depression. He has developed methodology for capturing the neurophysiology of human brain networks and the effect of stimulation through invasive and non-invasive electrophysiology.

The overarching goal of Dr. Keller's Laboratory, the Laboratory for Personalized Neurotherapeutics (kellerlab.stanford.edu) is to improve brain stimulation treatment for neurological and psychiatric disease. His lab focuses on understanding the neural mechanisms of how brain stimulation technologies induce alter brain circuits in an effort to develop novel, personalized, and more effective brain stimulation treatments. His lab combines invasive and noninvasive human electrophysiology to answer these critical questions.

ACADEMIC APPOINTMENTS

- Assistant Professor - University Medical Line, Psychiatry and Behavioral Sciences
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- NIH Director's Early Independence Award (DP5), NIH (2019)
- BWF Career Awards for Medical Scientists (CAMS), Burroughs Wellcome Fund (2019)
- NIH K23 Mentored Patient-Oriented Research Career Development Award, NIMH (2019)
- NIMH T32 Postdoctoral Fellowship, Stanford University (2018)
- Alpha Omega Alpha Medical Honor Society, Alpha Omega Alpha (2018)
- Collaborative Research Fellowship, Stanford Society of Physician Scholars (2018)

- Career Development Institute for Psychiatry, Stanford University (2018)
- Outstanding Resident Award, NIMH (2017)
- New Investigator Award, American Society of Clinical Psychopharmacology (2017)
- Travel Fellowship, Winter Conference on Brain Research (2016)
- Early Career Investigator Travel Award, Society of Biological Psychiatry (2016)
- Postgraduate Research Award, Alpha Omega Alpha (2016)
- Fellowship for Clinical Trials, American Society of Clinical Psychopharmacology (2016)
- Collaborative Research Fellowship, Stanford Society of Physician Scholars (2015)
- Medical School Scholar, Society of Biological Psychiatry (2015)
- Senior Research Fellowship, Albert Einstein College of Medicine (2014)
- Combining Clinical and Research Careers in Neuroscience Travel Award, NINDS (2014)
- Endowed Scholarship Fund, Neural Systems and Behavior Course (2013)
- Medical Scientist Training Program Pre-Doctoral Fellowship, Ruth L. Kirschstein National Research Service Award (2011-2015)
- Pre-Doctoral Research Training Fellowship, Epilepsy Foundation (2010-2011)
- Grant for Summer Research, Albert Einstein College of Medicine (2009)
- Master's Thesis Highest Honors, Tufts University (2009)
- Magna Cum Laude and Senior Thesis Highest Honors, Tufts University (2007)
- Eta Kappa Nu – Electrical Engineering Honors Society, Tufts University (2007)
- Dean's List Honors, Tufts University (2004-2007)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Diplomat, American Board of Psychiatry and Neurology (2019 - present)
- Research and Scientific Oversight, International Neuromodulation Society (2016 - present)
- Research Committee Member, Clinical TMS Society (2017 - present)

PROFESSIONAL EDUCATION

- Post-doctoral Fellowship, Stanford University , Neuroscience (2019)
- Residency, Stanford University , Psychiatry (2019)
- MD, Albert Einstein College of Medicine , Medicine (2015)
- PhD, Albert Einstein College of Medicine , Neuroscience (2015)
- MS, Tufts University , Biomedical Engineering (2009)
- BS, Tufts University , Electrical Engineering (2007)

PATENTS

- Corey Keller, Amit Etkin, Wei Wu. "United States Patent 41243-520P01US, Patent Pending Use of a brain-based signal for predicting and guiding brain stimulation treatment in depression"
- Corey Keller, Amit Etkin, Wei Wu. "United States Patent 41243-520P02US, Patent Pending Artifact Rejection for Transcranial Magnetic Stimulation Electroencephalogram Data."

LINKS

- Laboratory for Personalized Neurotherapeutics: <http://www.kellerlab.stanford.edu>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The overarching goal of Dr. Keller's Laboratory, the Laboratory for Personalized Neurotherapeutics (kellerlab.stanford.edu) is to improve brain stimulation treatment for neurological and psychiatric disease. His lab focuses on understanding the neural mechanisms of how brain stimulation technologies induce alter brain circuits in an effort to develop novel, personalized, and more effective brain stimulation treatments. Specifically, his lab seeks to identify and apply individualized stimulation protocols to elicit precise and predictable long-term plasticity in order to alleviate psychiatric suffering. His lab combines invasive and noninvasive human electrophysiology to answer these critical questions.

TMS is a non-invasive brain stimulation technique focused on normalizing dysfunctional brain networks and is FDA-approved for depression, OCD, migraines, and smoking cessation, with clinical trials underway for PTSD, addiction, and Alzheimers. Unfortunately, TMS is typically applied in a one-size-fits-all manner without reference to one's biology, and as such we are in critical need for a personalized and more effective approach. Dr. Keller's seeks to improve Transcranial Magnetic Stimulation (TMS) and other brain stimulation techniques by better understanding the fundamental principles of human brain plasticity and building trans-diagnostic real-time monitoring platforms for personalized brain stimulation.

Dr. Keller's lab performs translational research at the intersection of neuroscience, electrophysiology, brain stimulation, neuroengineering, psychiatry, and precision therapeutics. Their work suggests that brain-based biomarkers may be used to predict non-responders to TMS treatment, monitor brain networks during intervention, and be used to propose novel targets and treatment paradigms.

This work has the expected outcome of producing novel stimulation treatments with enhanced specificity, plasticity, and efficacy. By increasing our understanding of the underlying mechanism and monitoring of brain changes during TMS, we will markedly increase the utility of these powerful techniques. Together, this work will help transform interventional psychiatry from an isolated (from a clinic perspective), one-size-fits-all treatment approach to one that focuses on targeting objective biomarkers and that is collaborative, large-scale, and automated, pushing the field into the age of personalized neuromodulation.

Dr. Keller emphasizes an environment conducive to team-based learning in order to train the next generation of clinically-informed circuit neuroscientists, question the status quo with rigorous scientific experiments, and make important contributions in understanding how brain stimulation alters neural circuits and behavior and translate these findings to develop targeted, personalized, and more effective treatments.

CLINICAL TRIALS

- Closed-loop Optimized rTMS for Depression, Not Recruiting

Teaching

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Jessica Ross, Austin Talbot

Doctoral Dissertation Co-Advisor (NonAC)

Christopher Minasi

Postdoctoral Research Mentor

Jennifer Lissemore

Publications

PUBLICATIONS

- **Intracortical dynamics underlying repetitive stimulation predicts changes in network connectivity.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
Huang, Y., Hajnal, B., Entz, L., Fabo, D., Herrero, J. L., Mehta, A. D., Keller, C. J.
2019
- **Brain Stimulation Therapies** *AMERICAN PSYCHIATRIC ASSOCIATION PUBLISHING TEXTBOOK OF PSYCHIATRY, 7TH EDITION*
Keller, C., Bhati, M. T., Downar, J., Etkin, A., Roberts, L. W.
2019: 861–98
- **Induction and Quantification of Excitability Changes in Human Cortical Networks** *JOURNAL OF NEUROSCIENCE*
Keller, C. J., Huang, Y., Herrero, J. L., Fini, M. E., Du, V., Lado, F. A., Honey, C. J., Mehta, A. D.
2018; 38 (23): S384–S398
- **ARTIST: A fully automated artifact rejection algorithm for single-pulse TMS-EEG data.** *Human brain mapping*
Wu, W. n., Keller, C. J., Rogasch, N. C., Longwell, P. n., Shpigel, E. n., Rolle, C. E., Etkin, A. n.
2018
- **Tuning face perception with electrical stimulation of the fusiform gyrus.** *Human brain mapping*
Keller, C. J., Davidesco, I., Megevand, P., Lado, F. A., Malach, R., Mehta, A. D.
2017; 38 (6): 2830-2842
- **The Clinical Applicability of Functional Connectivity in Depression: Pathways Toward More Targeted Intervention.** *Biological psychiatry. Cognitive neuroscience and neuroimaging*
Fischer, A. S., Keller, C. J., Etkin, A.
2016; 1 (3): 262–70
- **The Limited Utility of Multiunit Data in Differentiating Neuronal Population Activity** *PLOS ONE*
Keller, C. J., Chen, C., Lado, F. A., Khodakhah, K.
2016; 11 (4)
- **The clinical applicability of functional connectivity in depression: Pathways toward more targeted intervention** *Journal of Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*
Fischer, A. S., Keller, C. J., Etkin, A.
2016
- **Mapping human brain networks with cortico-cortical evoked potentials** *PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES*
Keller, C. J., Honey, C. J., Megevand, P., Entz, L., Ulbert, I., Mehta, A. D.
2014; 369 (1653)
- **Corticocortical Evoked Potentials Reveal Projectors and Integrators in Human Brain Networks** *JOURNAL OF NEUROSCIENCE*
Keller, C. J., Honey, C. J., Entz, L., Bickel, S., Groppe, D. M., Toth, E., Ulbert, I., Lado, F. A., Mehta, A. D.
2014; 34 (27): 9152-9163
- **Neurophysiological Investigation of Spontaneous Correlated and Anticorrelated Fluctuations of the BOLD Signal** *JOURNAL OF NEUROSCIENCE*
Keller, C. J., Bickel, S., Honey, C. J., Groppe, D. M., Entz, L., Craddock, R. C., Lado, F. A., Kelly, C., Milham, M., Mehta, A. D.
2013; 33 (15): 6333-6342
- **Intrinsic functional architecture predicts electrically evoked responses in the human brain** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Keller, C. J., Bickel, S., Entz, L., Ulbert, I., Milham, M. P., Kelly, C., Mehta, A. D.
2011; 108 (25): 10308-10313
- **Heterogeneous neuronal firing patterns during interictal epileptiform discharges in the human cortex** *BRAIN*
Keller, C. J., Truccolo, W., Gale, J. T., Eskandar, E., Thesen, T., Carlson, C., Devinsky, O., Kuzniecky, R., Doyle, W. K., Madsen, J. R., Schomer, D. L., Mehta, A. D., Brown, et al

2010; 133: 1668-1681

- **Anticipatory human subthalamic area beta-band power responses to dissociable tastes correlate with weight gain.** *Neurobiology of disease*
Kakusa, B., Huang, Y., Barbosa, D. A., Feng, A., Gattas, S., Shivacharan, R., Lee, E. B., Kuijper, F. M., Saluja, S., Parker, J. J., Miller, K. J., Keller, C., Bohon, et al
2021: 105348
- **The insulo-opercular cortex encodes food-specific content under controlled and naturalistic conditions.** *Nature communications*
Huang, Y., Kakusa, B. W., Feng, A., Gattas, S., Shivacharan, R. S., Lee, E. B., Parker, J. J., Kuijper, F. M., Barbosa, D. A., Keller, C. J., Bohon, C., Mikhail, A., Halpern, et al
2021; 12 (1): 3609
- **Deep Transcranial Magnetic Stimulation Combined With Brief Exposure for Posttraumatic Stress Disorder: A Prospective Multisite Randomized Trial.** *Biological psychiatry*
Isserles, M., Tendler, A., Roth, Y., Bystritsky, A., Blumberger, D. M., Ward, H., Feifel, D., Viner, L., Duffy, W., Zohar, J., Keller, C. J., Bhati, M. T., Etkin, et al
2021
- **Global connectivity and local excitability changes underlie antidepressant effects of repetitive transcranial magnetic stimulation.** *Neuropsychopharmacology : official publication of the American College of Neuropsychopharmacology*
Eshel, N. n., Keller, C. J., Wu, W. n., Jiang, J. n., Mills-Finnerty, C. n., Huemer, J. n., Wright, R. n., Fonzo, G. A., Ichikawa, N. n., Carreon, D. n., Wong, M. n., Yee, A. n., Shpigel, et al
2020
- **Reproducibility in TMS-EEG studies: A call for data sharing, standard procedures and effective experimental control** *BRAIN STIMULATION*
Belardinelli, P., Biabani, M., Blumberger, D. M., Bortoletto, M., Casarotto, S., David, O., Desideri, D., Etkin, A., Ferrarelli, F., Fitzgerald, P. B., Fornito, A., Gordon, P. C., Gosseries, et al
2019; 12 (3): 787–90
- **Using fMRI connectivity to define a treatment-resistant form of post-traumatic stress disorder.** *Science translational medicine*
Etkin, A., Maron-Katz, A., Wu, W., Fonzo, G. A., Huemer, J., Vertes, P. E., Patenaude, B., Richiardi, J., Goodkind, M. S., Keller, C. J., Ramos-Cejudo, J., Zaiko, Y. V., Peng, et al
2019; 11 (486)
- **Using fMRI connectivity to define a treatment-resistant form of post-traumatic stress disorder** *SCIENCE TRANSLATIONAL MEDICINE*
Etkin, A., Maron-Katz, A., Wu, W., Fonzo, G. A., Huemer, J., Vertes, P. E., Patenaude, B., Richiardi, J., Goodkind, M. S., Keller, C. J., Ramos-Cejudo, J., Zaiko, Y., Peng, et al
2019; 11 (486)
- **Reproducibility in TMS-EEG studies: A call for data sharing, standard procedures and effective experimental control.** *Brain stimulation*
Belardinelli, P., Biabani, M., Blumberger, D. M., Bortoletto, M., Casarotto, S., David, O., Desideri, D., Etkin, A., Ferrarelli, F., Fitzgerald, P. B., Fornito, A., Gordon, P. C., Gosseries, et al
2019
- **Reliability of Transcranial Magnetic Stimulation EEG Evoked Potentials**
Kerwin, L., Keller, C., Wu, W., Narayan, M., Etkin, A.
ELSEVIER SCIENCE INC.2017: S131
- **Test-retest reliability of transcranial magnetic stimulation EEG evoked potentials.** *Brain stimulation*
Kerwin, L. J., Keller, C. J., Wu, W. n., Narayan, M. n., Etkin, A. n.
2017
- **Test-retest reliability of transcranial magnetic stimulation EEG evoked potentials** *Brain Stimulation*
Kerwin, L. J., Keller, C., Wu, W., Narayan, M., Etkin, A.
2017
- **Cotard Delusion in the Context of Schizophrenia: A Case Report and Review of the Literature** *FRONTIERS IN PSYCHOLOGY*
Bott, N., Keller, C., Kuppaswamy, M., Spelber, D., Zeier, J.
2016; 7
- **A case of butane hash oil (marijuana wax)-induced psychosis** *SUBSTANCE ABUSE*
Keller, C. J., Chen, E. C., Brodsky, K., Yoon, J. H.

2016; 37 (3): 384-386

- **Evoked Effective Connectivity of the Human Neocortex** *HUMAN BRAIN MAPPING*
Entz, L., Toth, E., Keller, C. J., Bickel, S., Groppe, D. M., Fabo, D., Kozak, L. R., Eross, L., Ulbert, I., Mehta, A. D.
2014; 35 (12): 5736-5753
- **Exemplar Selectivity Reflects Perceptual Similarities in the Human Fusiform Cortex** *CEREBRAL CORTEX*
Davidesco, I., Zion-Golombic, E., Bickel, S., Harel, M., Groppe, D. M., Keller, C. J., Schevon, C. A., McKhann, G. M., Goodman, R. R., Goelman, G., Schroeder, C. E., Mehta, A. D., Malach, et al
2014; 24 (7): 1879-1893
- **Dominant frequencies of resting human brain activity as measured by the electrocorticogram** *NEUROIMAGE*
Groppe, D. M., Bickel, S., Keller, C. J., Jain, S. K., Hwang, S. T., Harden, C., Mehta, A. D.
2013; 79: 223-233
- **Individualized localization and cortical surface-based registration of intracranial electrodes** *NEUROIMAGE*
Dykstra, A. R., Chan, A. M., Quinn, B. T., Zepeda, R., Keller, C. J., Cormier, J., Madsen, J. R., Eskandar, E. N., Cash, S. S.
2012; 59 (4): 3563-3570
- **Parallel versus serial processing dependencies in the perisylvian speech network: A Granger analysis of intracranial EEG data** *BRAIN AND LANGUAGE*
Gow, D. W., Keller, C. J., Eskandar, E., Meng, N., Cash, S. S.
2009; 110 (1): 43-48
- **Intracranial microprobe for evaluating neuro-hemodynamic coupling in unanesthetized human neocortex** *JOURNAL OF NEUROSCIENCE METHODS*
Keller, C. J., Cash, S. S., Narayanan, S., Wang, C., Kuzniecky, R., Carlson, C., Devinsky, O., Thesen, T., Doyle, W., Sassaroli, A., Boas, D. A., Ulbert, I., Halgren, et al
2009; 179 (2): 208-218

PRESENTATIONS

- The electrophysiological signature of the DMN - Weizmann Institute, Rehovot, Israel (2013)
- The neural origins of resting functional brain networks - Human Brain Mapping Conference, Hamburg, Germany (2014)
- Testing propagation of brain stimulation with implanted electrode arrays - Berenson-Allen Center for Brain Stimulation, Harvard Medical School, Boston (2014)
- Investigating the neuronal mechanisms underlying repetitive brain stimulation with implantable microelectrode arrays - The Feinstein Institute for Medical Research, Manhasset, New York (2015)
- The neural origins of the default mode network and resting fMRI - New York Psychiatric Institute, Columbia University Medical Center, New York (2015)
- Investigating the neuronal mechanisms underlying repetitive brain stimulation with implantable microelectrode arrays - Massachusetts General Hospital, Harvard Medical School, Boston, MA (2015)
- Repetitive brain stimulation induces long-term plasticity across patient populations and spatial scales - Brain Stimulation Conference, Human Brain Mapping, Geneva, Switzerland (2016)
- Modifying neural circuits with brain stimulation - University of Milan, Milan, Italy (2016)
- Long-term plasticity underlies antidepressant effect of repetitive transcranial magnetic stimulation - Shenzhen University, Shenzhen, China (1981)
- Simultaneous TMS-EEG as a causal tool to probe functional brain networks - Winter Brain Conference, Big Sky, Montana (2017)