Zhi-De Deng

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Research Specialties

- Noninvasive brain stimulation: technology development, modeling, device safety, translational and clinical applications
- Computational electromagnetics
- Electrophysiological and neuroimaging biomarker development
- Neural plasticity
- Nonlinear dynamics of physiological systems
- Translational neuromodeling

Education

expected 2019 **M.H.Sc., Clinical Research**, Duke University
- Thesis: *Kappa Opioid Receptor and the Neural Circuitry of Anhedonia*

2013 **Ph.D., Electrical Engineering**, Columbia University
- Dissertation: *Electromagnetic Field Modeling of Transcranial Electric & Magnetic Stimulation: Targeting, Individualization, and Safety of Convulsive & Subconvulsive Applications*

2011 **M.Phil., Electrical Engineering**, Columbia University
- Graduate minor in Neuroscience

2007 **M.Eng., Electrical Engineering and Computer Science**, MIT
- Thesis: *Stochastic Chaos and Thermodynamic Phase Transitions: Theory and Bayesian Estimation Algorithms*

2007 **S.B., Electrical Science and Engineering**, MIT

2006 **S.B., Physics**, MIT
- Minor in Economics

Professional Appointments & Employment

Academic

2016–present **Research Fellow**, Noninvasive Neuromodulation Unit, Experimental Therapeutics & Pathophysiology Branch, Intramural Research Program, NIMH
- § Richard J. Wyatt Memorial Fellowship for Translational Research

2016–present **Adjunct Assistant Professor**, Department of Psychiatry & Behavioral Sciences, Duke University School of Medicine

2015–present **Faculty**, Duke Institute for Brain Sciences, Duke University

2014–2016 **Medical Instructor**, Department of Psychiatry & Behavioral Sciences, Duke University School of Medicine
- § Duke Translational Medicine Institute KL2 Fellow

2013–2014 **Postdoctoral Associate**, Department of Psychiatry & Behavioral Sciences, Duke University School of Medicine

2010–2013 **Visiting Graduate Research Assistant**, Department of Psychiatry & Behavioral Sciences, Duke University School of Medicine

2007–2010 **Graduate Research Assistant**, Department of Psychiatry, Columbia University College of Physicians and Surgeons/New York State Psychiatric Institute
- § Columbia Irving Institute for Clinical and Translational Research T32 Fellow

2006–2007 **Graduate Research Assistant**, Harvard–MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology

2005–2006 **Undergraduate Research Assistant**, Harvard–MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology

Internships

2004 **Executive Intern**, Department of Anesthesiology, New York–Presbyterian Hospital/Weill Cornell Medical College

2003 **Internship Coordinator**, The New York Times Company Foundation

2002 **News Technology Intern**, The New York Times Company

Publications (* denotes first, joint first, or senior author)

Refereed Journal Articles

37 P. E. Croarkin, P. A. Nakonezny, **Z.-D. Deng**, M. Romanowicz, J. L. Vande Voort, D. Doruk Camsari, K. M. Schak, J. D. Port, and C. P. Lewis, "High frequency repetitive TMS for suicidal ideation in adolescents with depression," *Journal of Affective Disorders*, vol. 239, no. 3, pp. 282–290, 2018. PMID: 30031247. DOI: 10.1016/j.jad.2018.06.048

36 B. Wang, M. R. Shen, **Z.-D. Deng**, J. E. Smith, J. J. Tharayil, C. J. Gurrey, L. J. Gomez, and A. V. Peterchev, "Redesigning existing transcranial magnetic stimulation coils to reduce energy: application to low field magnetic stimulation," *Journal of Neural Engineering*, vol. 15, no. 3, 036022, 2018. PMCID: PMC5929994. DOI: 10.1088/1741-2552/aaa505

Refereed Journal Articles (continue)

35 S. Grehl, D. Martina, C. Goyenvalle, **Z.-D. Deng**, J. Rodger, and R.M. Sherrard, "*In vitro* magnetic stimulation: a simple stimulation device to deliver defined low intensity electromagnetic fields," *Frontiers in Neural Circuits*, vol.10, 85, 2016. PMCID: PMC5093126. DOI:10.3389/fncir.2016.00085

*34 **Z.-D. Deng**, S.H. Lisanby, and A.V. Peterchev, "Effects of anatomical variability on electric field characteristics of electroconvulsive therapy and magnetic seizure therapy: a parametric modeling study," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 23, no. 1, pp. 22–31, 2015. PMCID: PMC4289667. DOI: 10.1109/TNSRE.2014.2339014

33 J.K. Mueller, E.M. Grigsby, V. Prevosto, F.W. Petraglia, III, H. Rao, **Z.-D. Deng**, A.V. Peterchev, M.A. Sommer, T. Egner, M.L. Platt, and W.M. Grill, "Simultaneous transcranial magnetic stimulation and single-neuron recording in alert non-human primates," *Nature Neuroscience*, vol.17, no.8, pp.1130–1136, 2014. PMCID: PMC4115015. DOI: 10.1038/nn.375. Presented at the White House Conference on the BRAIN Initiative, 2014

*32 **Z.-D. Deng**, S.H. Lisanby, and A.V. Peterchev, "Coil design considerations for deep transcranial magnetic stimulation," *Clinical Neurophysiology*, vol.125, no.6, pp.1202–1212, 2014. PMCID: PMC4020988. DOI: 10.1016/j.clinph.2013.11.038. Commentary in pp. 1077–1078. Top 10 most cited *Clin Neurophysiol* paper since 2014

*31 **Z.-D. Deng**, S.H. Lisanby, and A.V. Peterchev, "Controlling stimulation strength and focality in electroconvulsive therapy via electrode size, spacing, and current amplitude," *The Journal of ECT*, vol.29, no.4, pp.325–335, 2013. PMCID: PMC3905244. DOI: 10.1097/YCT.0b013e3182a4b4a7. Top 10 most viewed *J ECT* paper in 2014

30 B. Luber, J. Stener, A. Tucker, C. Habeck, A.V. Peterchev, **Z.-D. Deng**, R. Basner, Y. Stern, and S.H. Lisanby, "Extended remediation of sleep deprived-induced working memory deficits using fMRI-guided transcranial magnetic stimulation," *Sleep*, vol.36, no.6, pp.857–871, 2013. PMCID: PMC3649828. DOI: 10.5665/sleep.2712

*29 **Z.-D. Deng**, S.H. Lisanby, and A.V. Peterchev, "Electric field depth–focality tradeoff in transcranial magnetic stimulation: simulation comparison of 50 coil designs," *Brain Stimulation*, vol.6, no.1, pp.1–13, 2013. PMCID: PMC3568257. DOI: 10.1016/j.brs.2012. 02.005. Commentary in pp. 14–15

- Top 3 most highly cited paper in *Brain Stimulation* since 2013
- Journal cover and in issue highlights
- Featured at the Institute of Medicine Workshop on Non-Invasive Neuromodulation of the Central Nervous System, 2015

28 W.H. Lee, **Z.-D. Deng**, T.S. Kim, A.F. Laine, S.H. Lisanby, and A.V. Peterchev, "Regional electric field induced by electroconvulsive therapy in a realistic head model: influence of white matter anisotropic conductivity," *NeuroImage*, vol.59, no.3, pp. 2110–2123, 2012. PMCID: PMC3495594. DOI: 10.1016/j.neuroimage.2011.10.029

*27 **Z.-D. Deng**, S.H. Lisanby, and A.V. Peterchev, "Electric field strength and focality of electroconvulsive therapy and magnetic seizure therapy: a finite element simulation study," *Journal of Neural Engineering*, vol.8, no.1, 016007, 2011. PMCID: PMC3903509. DOI: 10.1088/1741-2560/8/1/016007

Refereed Journal Articles (continue)

26 N. M. Arzeno, **Z.-D. Deng**, and C.-S. Poon, "Analysis of first-derivative based QRS detection algorithms," *IEEE Transactions on Biomedical Engineering*, vol. 55, no. 2, pp. 478–484, 2008. PMCID: PMC2532677. DOI: 10.1109/TBME.2007.912658. Top 15 most cited *IEEE Trans Biomed Eng* paper since 2008

Refereed IEEE Proceedings

*25 **Z.-D. Deng** and S. H. Lisanby, "Electric field characteristics of low-field synchronized transcranial magnetic stimulation (sTMS)," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2017, pp. 1445–1448. PMID: 29060150. DOI: 10.1109/EMBC.2017.8037106

*24 **Z.-D. Deng**, S. M. McClintock, and S. H. Lisanby, "Brain network properties in depressed patients receiving seizure therapy: a graph theoretical analysis of peri-treatment resting EEG," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2015, pp. 2203–2206. PMID: 26736728. DOI: 10.1109/EMBC.2015.7318828

*23 **Z.-D. Deng**, A. V. Peterchev, A. D. Krystal, B. Luber, S. M. McClintock, M. M. Husain, and S. H. Lisanby, "Topography of seizures induced by electroconvulsive therapy and magnetic seizure therapy," *Proceedings of the IEEE Engineering in Medicine and Biology Society Conference on Neural Engineering*, 2013, pp. 577–580. DOI: 10.1109/NER.2013.6696000

22 W. H. Lee, **Z.-D. Deng**, A. F. Laine, S. H. Lisanby, and A. V. Peterchev, "Influence of white matter conductivity anisotropy on electric field strength induced by electroconvulsive therapy," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2011, pp. 5473–5476. PMID: 22255576. DOI: 10.1109/IEMBS.2011.6091396

*21 **Z.-D. Deng** and A. V. Peterchev, "Transcranial magnetic stimulation coil with electronically switchable active and sham modes," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2011, pp. 1993–1996. PMID: 22254725. DOI: 10.1109/IEMBS.2011.6090561

*20 **Z.-D. Deng**, S. H. Lisanby, and A. V. Peterchev, "Transcranial magnetic stimulation in the presence of deep brain stimulation implants: induced electrode currents," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2010, pp. 6812–6824. PMID: 21095849. DOI: 10.1109/IEMBS.2010.5625958

*19 **Z.-D. Deng**, D. E. Hardesty, S. H. Lisanby, and A. V. Peterchev, "Electroconvulsive therapy in the presence of deep brain stimulation implants: electric field effects," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2010, pp. 2049–2062. PMID: 21096149. DOI: 10.1109/IEMBS.2010.5626517

*18 W. H. Lee, **Z.-D. Deng**, T. S. Kim, A. F. Laine, S. H. Lisanby, and A. V. Peterchev, "Regional electric field induced by electroconvulsive therapy: a finite element simulation study," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2010, pp. 2045–2048. PMID: 21096148. DOI: 10.1109/IEMBS.2010.5626553

*17 **Z.-D. Deng**, S. H. Lisanby, and A. V. Peterchev, "Effect of head anatomical variability on neural polarization strength and focality in electroconvulsive therapy and magnetic seizure therapy," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2009, pp. 682–688. PMID: 19964484. DOI: 10.1109/IEMBS.2009.5334091

Refereed IEEE Proceedings (continue)

*16 **Z.-D. Deng**, A. V. Peterchev, and S. H. Lisanby, "Coil design considerations for deep brain transcranial magnetic stimulation," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2008, pp. 5675–5679. PMID: 19164005. DOI: 10.1109/IEMBS.2008.4650502

*15 **Z.-D. Deng**, C.-S. Poon, N. M. Arzeno, and E. S. Katz, "Heart rate variability in pediatric obstructive sleep apnea," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2006, pp. 3565–3568. PMID: 17946187. DOI: 10.1109/IEMBS.2006.260139

*14 N. M. Arzeno, C.-S. Poon, and **Z.-D. Deng**, "Quantitative analysis of QRS detection algorithms based on the first derivative of the ECG," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2006, pp. 1788–1791. PMID: 17946480. DOI: 10.1109/IEMBS.2006.260051. Student paper competition finalist

Review Articles & Consensus Papers

*13 M. Bikson, A. R. Brunoni, L. E. Charvet, V. P. Clark, L. G. Cohen, **Z.-D. Deng**, J. P. Dmochowski, D. J. Edwards, F. Frohlich, E. S. Kappenman, K. O. Lim, C. Loo, A. Mantovani, D. P. McMullen, L. C. Parra, M. Pearson, J. D. Richardson, J. M. Rumsey, P. Sehatpour, D. I. Sommers, G. Unal, E. M. Wassermann, A. J. Woods, and S. H. Lisanby, "Rigor and reproducibility in research with transcranial electrical stimulation: an NIMH-sponsored workshop," *Brain Stimulation*, vol. 11, no. 3, pp. 465–480, 2018. PMCID: PMC5997279. DOI: 10.1016/j.brs.2017.12.008

12 S. M. Goetz and **Z.-D. Deng**, "The development and modeling of devices and paradigms for transcranial magnetic stimulation," *International Review of Psychiatry*, vol. 29, no. 2, pp. 115–145, 2017. PMCID: PMC5484089. DOI: 10.1080/09540261.2017.1305949

*11 **Z.-D. Deng**, S. M. McClintock, N. E. Oey, B. Luber, and S. H. Lisanby, "Neuromodulation for mood and memory: from the engineering bench to the patient bedside," *Current Opinion in Neurobiology*, vol. 30, pp. 38–43, 2015. PMCID: PMC4342851. DOI: 10.1016/jconb.2014.08.015

10 S. M. McClintock, J. Choi, **Z.-D. Deng**, L. G. Appelbaum, A. D. Krystal, and S. H. Lisanby, "Multifactorial determinants of the neurocognitive effects of electroconvulsive therapy," *The Journal of ECT*, vol. 30, no. 2, pp. 165–176, 2014. PMCID: PMC4143898. DOI: 10.1097/YCT.0000000000000137. Top 5 most cited *J ECT* paper since 2014

9 A. V. Peterchev, M. A. Rosa, **Z.-D. Deng**, J. Prudic, and S. H. Lisanby, "Electroconvulsive therapy stimulus parameters: rethinking dosage," *The Journal of ECT*, vol. 26, no. 3, pp. 159–174, 2010. PMCID: PMC2933093. DOI: 10.1097/YCT.0b013e3181e48165. Top 5 most cited *J ECT* paper since 2010

Book Chapters

8 B. Kadriu, S. Subramanian, **Z.-D. Deng**, I. D. Henter, L. T. Park, and C. A. Zarate, Jr., "Rapid-acting antidepressants," to appear in *Primer on Depression*, M. Trivedi, Ed. Oxford, UK: Oxford University Press. *PsyArXiv* DOI: 10.31234/osf.io/xwk57

*7 **Z.-D. Deng**, C. Liston, F. M. Gunning, M. J. Dubin, E. Axfjörð Fridgeirsson, J. Lilien, G. van Wingen, and J. van Waarde, "Electric field modeling for transcranial magnetic stimulation and electroconvulsive therapy," in *Brain and Human Body Modeling: Computational Human Modeling at EMBC 2018*, S. N. Makarov, M. Horner, and G. M. Noetscher, Eds. Switzerland: Springer Nature.

Book Chapters (continue)

6 B. Luber and **Z.-D. Deng**, "Application of non-invasive brain stimulation in psychophysiology," in *Handbook of Psychophysiology*, J. T. Cacioppo, L. G. Tassinary, G. Berntson, Eds., 4th ed. Cambridge, UK: Cambridge University Press, 2016, pp. 116–150. DOI: 10.1017/9781107415782.007

5 S. H. Lisanby and **Z.-D. Deng**, "Magnetic seizure therapy for the treatment of depression," in *Brain Stimulation: Methodologies and Interventions*, I. Reti, Ed. Hoboken, NJ: Wiley-Blackwell, 2015, pp. 123–148. DOI: 10.1002/9781118568323.ch8

4 A. V. Peterchev, **Z.-D. Deng**, and S. M. Goetz, "Advances in transcranial magnetic stimulation technology," in *Brain Stimulation: Methodologies and Interventions*, I. Reti, Ed. Hoboken, NJ: Wiley-Blackwell, 2015, pp. 165–190. DOI: 10.1002/9781118568323.ch10

Letters to the Editor, Commentaries, & Technical Reports

*3 **Z.-D. Deng**, S. H. Lisanby, and A. V. Peterchev, "On deep transcranial magnetic stimulation coil characterization," *Clinical Neurophysiology*, vol. 126, no. 7, pp. 1456–1457, 2015. PMID: 25468237. DOI: 10.1016/j.clinph.2014.10.144

*2 **Z.-D. Deng**, S. H. Lisanby, and A. V. Peterchev, "On the stimulation depth of transcranial magnetic stimulation coils," *Clinical Neurophysiology*, vol. 126, no. 4, pp. 843–844, 2015. PMID: 25088734. DOI: 10.1016/j.clinph.2014.06.048

*1 **Z.-D. Deng** and A. V. Peterchev, "Safety of transcranial magnetic stimulation and electroconvulsive therapy in patients with a deep brain stimulation implant," Technical report for St. Jude Medical/Advanced Neuromodulation System, Plano, TX, 2010.

Articles in Review, Preprints, Contracted Chapters

*0 **Z.-D. Deng**, A. M. Arzeno, E. S. Katz. H. Chang, C. L. Marcus, and C.-S. Poon, "Non-high frequency heart rate chaos: a noninvasive marker of REM sleep and obstructive sleep apnea syndrome in children," *bioRxiv* DOI: 10.1101/457630

*0 S. N. Makarov, G. Bogdanov, G. M. Noetscher, W. Appleyard, R. Ludwig, J. T. Joutsa, and **Z.-D. Deng**, "Design and analysis of a whole body non-contact electromagnetic stimulation device with field modulation," *bioRxiv* DOI: 10.1101/416065

0 M. L. Cox, **Z.-D. Deng**, H. Palmer, A. Watts, L. Beynel, J. R. Young, S. H. Lisanby, J. Migaly, and L. G. Appelbaum, "Utilizing transcranial direct current stimulation to enhance laparoscopic technical skills training: a randomized controlled trial," *bioRxiv* DOI: 10.1101/455329

0 M. J. Dubin, I. Ilieva, **Z.-D. Deng**, J. Thomas, A. Cochran, K. Kravets, B. D. Brody, P. J. Christos, J. H. Kocsis, C. Liston, and F. M. Gunning, "A double-blind pilot dosing study of low field magnetic stimulation (LFMS) for treatment-resistant depression (TRD)," *bioRxiv* DOI: 10.1101/465013

0 T. Dufor, S. Grehl, A. D. Tang, M. Doulazmi, M. Traoré, N. Debray, C. Dubacq, **Z.-D. Deng**, J. Mariani, A. M. Lohof, and R. M. Sherrard, "Neural circuit repair by low-intensity magnetic stimulation requires cryptochrome," *bioRxiv* DOI: 10.1101/424317

0 S. M. Goetz, S. M. Madhi Alavi, **Z.-D. Deng**, and A. V. Peterchev, "Statistical model of motor evoked potentials for simulation of transcranial magnetic and electric stimulation," *bioRxiv* DOI: 10.1101/406777

Articles in Review, Preprints, Contracted Chapters

0 T. Popa, L. S. Morris, R. Hunt, **Z.-D. Deng**, S. Horovitz, K. Mente, H. Shitara, K. Baek, M. Hallett, and V. Voon, "Modulation of resting connectivity between the mesial frontal cortex and basal ganglia," *bioRxiv* DOI:10.1101/432609

*0 **Z.-D. Deng** and S. H. Lisanby, "Next generation seizure therapy," in *The Oxford Handbook of Transcranial Stimulation*, E. M. Wassermann, V. Walsh, A. V. Peterchev, U. Ziemann, S. H. Lisanby, and H. R. Siebner, Eds., 2nd ed. Oxford, UK: Oxford University Press.

0 R. J. Ilmoniemi, **Z.-D. Deng**, L. J. Gomez, L. M. Koponen, J. O. Nieminen, and C. M. Epstein, "Transcranial magnetic stimulation devices: coils," in *The Oxford Handbook of Transcranial Stimulation*, E. M. Wassermann, V. Walsh, A. V. Peterchev, U. Ziemann, S. H. Lisanby, and H. R. Siebner, Eds., 2nd ed. Oxford, UK: Oxford University Press.

0 B. Kadriu, C. A. Farmer, B. Shovestul, R. Moaddel, P. Yuan, E. D. Ballard, **Z.-D. Deng**, I. D. Henter, R. T. de Sousa, R. Machado-Vieira, L. T. Park, P. W. Gold, and C. A. Zarate, Jr., "The kynurenine pathway and bipolar disorder: the intersection of monoaminergic, glutamatergic, and immune response."

0 S. H. Lisanby, S. M. McClintock, G. Alexopoulos, S. H. Bailine, E. Bernhardt, M. C. Briggs, C. M. Cullum, **Z.-D. Deng**, M. Dooley, E. T. Geduldig, R. M. Greenberg, M. M. Husain, S. Kaliora, R. G. Knapp, V. Latoussakis, L. S. Liebman, W. V. McCall, M. Mueller, G. Petrides, J. Prudic, P. B. Rosenquist, M. V. Rudorfer, S. Sampson, A. Teklehaimanot, K. G. Tobias, R. D. Weiner, R. C. Young, and C. H. Kellner, "Neurocognitive effects of combined electroconvulsive therapy (ECT) and venlafaxine in geriatric depression: phase 1 of the PRIDE study."

0 T. Radman, **Z.-D. Deng**, A. C. Nugent, E. M. Lo, M. J. Koval, B. Luber, A. D. Krystal, and S. H. Lisanby, "Peri-stimulus EEG power and coherence during paired associative stimulation predicts subsequent potentiation."

0 L.-Z. Yang, W. Zhang, W. Wang, Z. Yang, H. Wang, **Z.-D. Deng**, C. Li, B. Qiu, R. Cohen Kadosh, H. Li, and X. Zhang, "Cross-hemispheric communication predicts neuromodulation responsiveness."

Dissertation & Thesis

*2 **Z.-D. Deng**, "Electromagnetic Field Modeling of Transcranial Electric and Magnetic Stimulation: Targeting, Individualization, and Safety of Convulsive and Subconvulsive Applications," Ph.D. dissertation, Columbia University, Department of Electrical Engineering, New York, NY, 2013. Sponsor: K. L. Shepard. Available: Columbia University Academic Commons, http://hdl.handle.net/10022/AC:P:20557

*1 **Z.-D. Deng**, "Stochastic Chaos and Thermodynamic Phase Transitions: Theory and Bayesian Estimation Algorithms," M.Eng. thesis, Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA, 2007. Sponsor: C.-S. Poon. Available: DSpace@MIT, http://hdl.handle.net/1721.1/41649

Selected Abstracts (10/75)

*10 **Z.-D. Deng**, C. Liston, F. M. Gunning-Dixon, and M. J. Dubin, "Electric field induced by repetitive transcranial magnetic stimulation in patients depression," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2018.

*9 **Z.-D. Deng**, E. Axfjörð Fridgeirsson, J. Lilien, G. van Wingen, and J. van Waarde, "Electric field induced by electroconvulsive therapy in patients with depression," *Proceedings of the IEEE Engineering in Medicine and Biology Society*, 2018.

*8 **Z.-D. Deng**, E. M. Lo, L. Beynel, E. Fang, B. Luber, and A. D. Krystal, "Cortical excitability in patients with treatment resistant depression," *Biological Psychiatry*, vol. 81, no. 10, p. S242, 2017.

*7 **Z.-D. Deng**, S. W. Davis, G. Asturias, M. Glidewell, C. Liston, and M. J. Dubin, "Effect of repetitive transcranial magnetic stimulation on the structural connectome in patients with major depression," *Clinical Neurophysiology*, vol. 128, no. 3, p. e144–e145, 2017.

*6 **Z.-D. Deng**, W. Lim, L. M. Haugen, J. D. Port, and P. E. Croarkin, "Electric field induced by repetitive transcranial magnetic stimulation in adolescents with major depressive disorder: comparison of coil localization approaches," *Neuropsychopharmacology*, vol. 41, no. S1, p. S478, 2016.

*5 **Z.-D. Deng**, S. M. McClintock, T. Jones, and C. C. Abbott, "Engaging medial temporal lobes with ECT pulse amplitude to improve clinical outcomes," *Neuropsychopharmacology*, vol. 41, no. S1, p. S173–S174, 2016.

*4 **Z.-D. Deng**, S. M. McClintock, and S. H. Lisanby, "Connectivity analysis of resting EEG in depressed patients receiving electroconvulsive therapy and magnetic seizure therapy," *Neuropsychopharmacology*, vol. 40, no. S1, p. S486, 2015.

*3 **Z.-D. Deng**, S. M. McClintock, and S. H. Lisanby, "EEG-based graph theoretical measures as biomarkers of clinical outcome in electroconvulsive and magnetic seizure therapy," *The National Network of Depression Centers Annual Conference*, 2014. Innovative Poster Award

*2 **Z.-D. Deng**, S. H. Lisanby, and A. V. Peterchev, "Improving the focality of electroconvulsive therapy: the roles of current amplitude, and electrode size and spacing," *The Journal of ECT*, vol. 26, no. 2, p. 151, 2010. Best Abstract Award

*1 **Z.-D. Deng**, A. V. Peterchev, and S. H. Lisanby, "Focality of neural stimulation with magnetic seizure therapy and electroconvulsive therapy in humans and non-human primates," *Biological Psychiatry*, vol. 65, no. 8, pp. 219S–220S, 2009.

Intellectual Property

4 Electromagnetic apparatus for creating strong low-frequency circularly-polarized magnetic fields in a large volume. Co-inventors: S. N. Makarov, G. M. Noetscher, V. S. Makarov, G. Bogdanov, W. L. Appleyard; Assignee: NEVA Electromagnetics, LLC
- U.S. Provisional Patent application No. 15/868,038, Jan. 11, 2018

3 Systems and methods for detecting a physiological abnormality in a patient by using cardiac or other chaos in combination with a non-increasing parasympathetic modulation. Co-inventor: C.-S. Poon; Assignee: MIT
- US No. 9,737,258, Aug. 22, 2017, also published as WO 2014120353 A1

2 Transcranial magnetic stimulation coil with electronically switchable active and sham modes. Co-inventor: A. V. Peterchev; Assignee: Columbia University
- U.S. Provisional Patent application No. 61/525,922, Aug. 22, 2011

1 Methods, apparatus, and systems for magnetic stimulation. Co-inventors: A. V. Peterchev, S. H. Lisanby; Assignee: Columbia University
- US No. 9,295,853, Mar. 29, 2016
- US No. 8,801,589, Aug. 12, 2014
- PCT WO/2010/017249, US 2011/0184223 A1, US 2009/052768, Aug. 4, 2009

Research Support

Ongoing Research Support

June 2018–June 2020 **Individualized Low Amplitude Seizure Therapy (iLAST)**
NARSAD/Brain & Behavior Research Foundation
Role: PI
This study aims to develop a novel form of seizure therapy for depression that avoids the neurocognitive side effects of electroconvulsive therapy by using computational modeling to direct multi-electrode configurations that provide targeted and individualized dosing.

Sept. 2016–July 2020 **ECT Pulse Amplitude and Medial Temporal Lobe Engagement**
NIH/NINDS U01 MH111826 (PI: C. C. Abbott)
Role: Co-I
This study explores the impact of targeted hippocampal engagement with varying levels of electroconvulsive therapy current amplitude in elderly patients with clinical, neuropsychological and neuroimaging assessments.

Just in time **Efficacy of Biomarker-Guided rTMS for Treatment Resistant Depression**
NIH/NIMH R01 MH118388 (PIs: J. Downar, F. M. Gunning, C. M. Liston)
Role: Intramural NIH Collaborator
This study examines the efficacy of biotype-guided repetitive transcranial magnetic stimulation, a treatment selection strategy in which the site of neurostimulation is informed by biotypes derived from distinct resting state functional connectivity patterns.

Pending Research Support

Oct. 2018 **New Non-Contact Lower Body Subthreshold Neurostimulation Device with Flexible Operation Parameters Targeting Nonspecific Low Back Neuropathic Pain**
NIH/NIBIB R01 GRANT12722537 (PI: S. N. Makarov)
Role: Intramural NIH Collaborator

Oct. 2018 **Neuromodulation of Social Cognitive Circuitry in People with Schizophrenia Spectrum Disorders**
NIH/NIMH R33/R61 (PIs: A. N. Voineskos, Z. J. Daskalakis)
Role: Intramural NIH Collaborator

NIH Protocols

Safety and Feasibility of Individualized Low Amplitude Seizure Therapy
NIMH Protocol T-M-2191 (PI: S. H. Lisanby)
Role: Lead Associate Investigator

Concurrent fMRI-guided rTMS and Cognitive Therapy for the Treatment of Major Depressive Episodes
NIMH Protocol 17-M-0147 (PI: S. H. Lisanby)
Role: Associate Investigator

Non-Invasive Brain Stimulation Technique Development
NIMH Protocol 18-M-0015 (PI: S. H. Lisanby)
Role: Associate Investigator

Neuropharmacologic Imaging and Biomarker Assessments of Response to Acute and Repeated-Dosed Ketamine Infusions in Major Depressive Disorder
NIMH Protocol 17-M-0060 (PI: C. A. Zarate, Jr.)
Role: Associate Investigator

Evaluation of Patients with Mood and Anxiety Disorders and Healthy Volunteers
NIMH Protocol 01-M-0254 (PI: C. A. Zarate, Jr.)
Role: Associate Investigator

The Mechanism of Action Underlying Ketamine's Antidepressant Effects: An Investigation of the AMPA Throughput Theory in Patients with Treatment-Resistant Major Depression
NIMH Protocol T-M-2310 (PI: C. A. Zarate, Jr.)
Role: Associate Investigator

Development of Functional and Structural Magnetic Resonance Imaging Techniques for the Study of Mood and Anxiety Disorders
NIMH Protocol 07-M-0021 (PI: A. C. Nugent)
Role: Associate Investigator

fMRI-Guided Repetitive TMS in a Model of Anxiety with Healthy Individuals
NIMH Protocol 17-M-0042 (PI: C. Grillon)
Role: Associate Investigator

Modulation of the Parieto-Frontal Communication
NINDS Protocol T-N-3895 (PI: M. Hallett)
Role: Associate Investigator

Influence on Plasticity of Brain Temperature
NINDS Protocol 15-N-0066 (PI: M. Hallett)
Role: Associate Investigator

Identifying Neurobiological Mechanisms that Underlie Acute Nicotine Withdrawal and Drive Early Relapse in Smokers
NIDA Protocol 12-DA-N474 (PI: E. A. Stein)
Role: Associate Investigator

Uniform Services University–NIH Protocol

ADEPT: Adaptive Trial for the Treatment of Depression Associated with Concussion using Repetitive Transcranial Magnetic Stimulation Protocols
Center for Neuroscience and Regenerative Medicine Protocol (PI: L. M. Oberman)
Role: Associate Investigator

Completed Research Support

June 2016–Dec. 2017 **Fast-Fail Trials: Mood and Anxiety Spectrum Disorders (FAST-MAS)**
NIMH 271201200006I-3-27100003-1 (PI: A. D. Krystal)
Role: Data analyst
The goal of this project is to establish the kappa opiate receptor occupancy and mu opiate receptor effects after two weeks of daily dosing with the investigational agent JNJ-67953964, which has been demonstrated to be a selective kappa opiate receptor antagonist.

Apr. 2015–Jan. 2017 **Transcranial Direct Current Stimulation as a Treatment for Acute Fear**
NIH/NIMH R21 MH106772 (PI: A. D. Krystal)
Role: Co-I
This study investigates the utility of transcranial direct current stimulation to engage a target neural circuit, which could serve as the basis for developing better therapies for those suffering from acute fear related difficulties.

July 2014–June 2016 **Individualized Optimally-Targeted Seizure Therapy**
NIH/NCATS KL2 TR001115 (Training Grant PI: R. M. Califf)
Role: PI
This award from the Duke Translational Medicine Institute prepares the fellow for a successful career as a multidisciplinary independent investigator in the field of brain stimulation. The goal of the project is to develop a novel individualized neurotargeted seizure therapy.

Mar. 2015–June 2016 **Safety and Feasibility of Low Amplitude Electroconvulsive Therapy**
Duke University School of Medicine, Pilot fund
Role: PI
This study evaluates whether neurocognitive side effects of electroconvulsive therapy can be improved by reducing the current pulse amplitude.

Apr. 2009–Mar. 2016 **Prolonging Remission In Depressed Elderly (PRIDE)**
NIH/NIMH U01 MH084241 (PI: S. H. Lisanby)
Role: Data analyst
This study evaluates the efficacy and neurocognitive effects of combined electroconvulsive and pharmaco-therapy in prolonging remission in elderly patients with major depression.

Apr. 2015–June 2016 **Low Field Magnetic Stimulation Coil Design**
Tal Medical (PI: A. V. Peterchev)
Role: Co-I
This project develops a novel coil system for low field magnetic stimulation.

Nov. 2015–June 2016 **Concurrent Cognitive Behavioral Therapy and Transcranial Magnetic Stimulation in Obsessive-Compulsive Disorder**
American Psychiatric Association Research Scholarship (Grantee: Y. Hu)
Role: Acting PI
The purpose of this pilot study is to evaluate the feasibility of repetitive transcranial magnetic stimulation of the supplementary motor area concurrently with elements of exposure and response prevention in patients with obsessive-compulsive disorder.

Jan. 2014–Dec. 2015 **Evoked Potentials as Markers of Ketamine-Induced Cortical Plasticity in Patients with Major Depressive Disorder**
Janssen Research & Development, LLC (PI: A. D. Krystal)
Role: Co-I
This open-label trial evaluates the utility of somatosensory, motor, and transcranial magnetic stimulation-based evoked potentials as markers of cortical plasticity in response to a single intravenous infusion of ketamine in patients with depression.

Completed Research Support (continue)

July 2005–July 2011 **Magnetic Seizure Therapy for the Treatment of Depression**
Stanley Medical Research Institute (PI: S. H. Lisanby)
Role: Postdoctoral Fellow
This two-center, randomized, double-blind controlled trial compares the antidepressant efficacy and side effects of magnetic seizure therapy and electroconvulsive therapy.

July 2010–Jan. 2015 **Translational Research Evaluating Neurocognitive Memory Processes**
NIH/NIMH K23 MH087739 (PI: S. M. McClintock)
Role: Postdoctoral Fellow
This study informs the cognitive component processes underlying memory impairment after electroconvulsive therapy.

July 2010–Dec. 2015 **Rational Dosing for Electric and Magnetic Seizure Therapy**
NIH/NIMH R01 MH091083 (PI: S. H. Lisanby)
Role: Graduate Research Associate, contributed to grant writing
This study lays a foundation for optimizing stimulus parameters of electric and magnetic seizure therapy through computational modeling and preclinical studies of seizure induction.

Sept. 2010–June 2011 **Field Shaping and Coil Design for Transcranial Magnetic Stimulation**
NIH/NCRR TL1 RR024158 (Training Grant PI: H. N. Ginsberg)
Role: Predoctoral Fellow
This award from the Columbia University Irving Institute for Clinical and Translational Research supports clinical research training for predoctoral students in the basic sciences. The goal of the project is to develop novel coil design for deep transcranial magnetic stimulation.

Aug. 2007–July 2009 **Development of a Novel TMS Device with Controllable Pulse Shape**
NIH/NIBIB R21 EB006855 (PI: A. V. Peterchev)
Role: Graduate Research Associate
This project develops an efficient transcranial magnetic stimulation device that produces nearly rectangular pulses with adjustable amplitude, width, and directionality.

Sept. 2005–June 2009 **Nonlinear Analysis of Heart Rate Variability**
NIH/NHLBI R01 HL079503 (PI: C.-S. Poon)
Role: Graduate Research Associate
This project develops advanced nonlinear estimation and adaptive control algorithms for the modeling and analysis of the cardiovascular system.

Scholarships, Fellowships, & Honors

2018 **Richard J. Wyatt Memorial Fellowship Award for Translational Research**, NIMH

2018 **New Investigator Award**, American Society of Clinical Psychopharmacology

2018 **Travel Fellowship Award**, Society of Biological Psychiatry

2018 **Research Colloquium for Junior Investigators**, American Psychiatric Association

2018 **Alies Muskin Career Development Leadership Program**, Anxiety & Depression Association of America

2017 **NARSAD Young Investigator Award**, Brain & Behavior Research Foundation

2017 **Career Development Institute for Psychiatry**, Stanford University

2017 **New Investigator Award**, International Society for CNS Clinical Trials and Methodology

Scholarships, Fellowships, & Honors

2016 **Certificate for Highly Cited Research**, Brain Stimulation, Elsevier

2015 **Young Investigator Memorial Travel Award**, American College of Neuropsychopharmacology

2015 **Summer Research Institute in Geriatric Mental Health**, Weill Cornell Medical College

2015 **Chair's Choice Award**, Society of Biological Psychiatry

2014 **Innovative Poster Award, Young Investigator Award Finalist**, National Network of Depression Centers

2010 **Best Abstract Award**, International Society for Neurostimulation

2010 **Presidential Teaching Award Finalist**, Columbia University

2006 **Student Paper Competition Finalist**, IEEE Engineering in Medicine and Biology Society

2002 **New York Times College Scholarship**, New York Times Company Foundation

Talks & Colloquia

Grand Rounds

2018 Clinical TMS Society Grand Rounds Webinar
Transcranial magnetic stimulation: physics, devices, and modeling

2017 University of New Mexico School of Medicine, Psychiatry & Behavioral Sciences
Toward individualized electroconvulsive therapy for treatment of depression

2015 Duke University School of Medicine, Department of Psychiatry & Behavioral Sciences
Toward next generation seizure therapy

2015 Central Regional Hospital, Butner, NC
Individualized seizure therapy

Invited Talks, Seminars, Worskops, & Panels

2018 NIMH Intramural Research Program Investigators' Seminar Series
Computational neurostimulation: engineering better noninvasive brain stimulation therapies

2018 UCLA Brain Mapping Center
Computational neurostimulation: engineering better brain stimulation therapies

Semel Institute for Neuroscience and Human Behavior, Neuromodulation Division
Modeling and design for magnetic stimulation

2018 USC Mark and Mary Stevens Neuroimaging and Informatics Institute
Computational neurostimulation

2018 2nd Bergen Workshop of the Global ECT–MRI Collaboration
Electric field modeling for electroconvulsive therapy

2018 Joint NYC Neuromodulation Conference & NANS Summer Series
Preconference workshop director: *Computational modeling in neuromodulation: tools for engineers, clinicians, and researchers*
Contributed talk: *Optimizing stimulation arrays and high-density EEG for brain targeting*

2018 Neuropsychiatric Drug Development Summit
Targeted intermittent device delivered interventions will ultimately prove superior to maintenance treatment with drugs for brain disorders

2018 International Conference of the IEEE Engineering in Medicine and Biology Society
Chair: *Computational human models for brain stimulation*

2018 APA Annual Conference Presidential Symposium
ECT in the era of new brain stimulation treatments: road map of future enhancements

2018 ADAA Axiety and Depression Conference
Individualized electroconvulsive therapy for treatment of depression

2017 NIMH Non-Invasive Brain Stimulation Electric Field Modeling Workshop
Use of individual electric field models in clinical research

2017 NYC Neuromodulation Conference
Low field magnetic stimulation

2016 NIDA, Neuroimaging Research Branch
Advances in transcranial magnetic stimulation technology

2016 NIMH Workshop on Trancranial Electrical Stimulation: Mechanisms, Technology, and Therapeutic Applications
Effect of anatomical variability on electric field characteristics of tES

2016 Mayo Clinic College of Medicine, Department of Molecular Pharmacology, Neurobiology of Alcoholism and Drug Addition Lab
Transcranial magnetic stimulation technology development

Department of Neurosurgery Research, Neural Engineering Lab
Optimizing transcranial magnetic stimulation

2016 NIMH, Experimental Therapeutics & Pathophysiology Branch
Engineering better electromagnetic brain stimulation therapies

2015 International Society for ECT and Neurostimulation Annual Meeting
Workshop: *Spatial targeting with transcranial magnetic stimulation*

2015 Duke University School of Medicine, Department of Psychiatry & Behavioral Sciences
Chair's round: *Fundamentals of transcranial electric and magnetic stimulation dosing*

2015 Weill Cornell Medical College, Department of Biomedical Engineering
Transcranial magnetic stimulation: pulse source, coil design, & concurrent neuroimaging

2014 Duke University, Department of Biomedical Engineering
Modeling and coil design considerations for transcranial magnetic stimulation

Teaching & Mentoring

Appointments

2018–2019 **Research Mentor**, Fischell Department of Bioengineering, University of Maryland, College Park, A. James Clark School of Engineering
Capstone Design Competition

2017 **Lecturer**, NINDS
Clinical Neuroscience Program Lecture Series

2017 **Lecturer**, NIMH
fMRI Course

2016 **Instructor**, Department of Neuroscience, Duke University
Research Independent Study

2014–2016 **Faculty**, Department of Psychiatry and Behavioral Sciences, Duke University School of Medicine
Visiting Fellowship in Transcranial Magnetic Stimulation & Electroconvulsive Therapy Fellowship (Continuing Medical Education)

2015–2016 **Research Mentor**, Matching Undergraduates to Science and Engineering Research Program, Duke University

2015–2016 **Faculty**, Biosciences Collaborative for Research Engagement, Duke University

Spring 2010 **Teaching Assistant, Columbia Video Network Course Assistant**, Department of Electrical Engineering, Columbia University Fu Foundation School of Engineering and Applied Science
Analog Systems in VLSI (graduate level)

Fall 2009 **Teaching Assistant**, Department of Electrical Engineering, Columbia University Fu Foundation School of Engineering and Applied Science
The Digital Information Age

Fall 2009 **Recitation Instructor**, Department of Biostatistics, Columbia University Mailman School of Public Health
Biostatistics (graduate level)

2003–2007 **Teaching Assistant**, Department of Mathematics, MIT
Multivariable Calculus (Fall '03–'06), *Differential Equations* (Spring '04–'07)

Fall 2004 **Grader**, Department of Electrical Engineering and Computer Science, MIT
Signals and Systems

Thesis Committee

2017 G. Asturias, "Effect of Repetitive Transcranial Magnetic Stimulation on the Structural and Functional Connectome in Patients with Major Depressive Disorder," Undergraduate Honors Thesis, Duke University, Department of Psychology and Neuroscience, Durham, NC, 2017. Sponsor: Z.-D. Deng. Available: DukeSpace, http://hdl.handle.net/10161/14299

Mentees

Medical Student

2018 A. V. Sathappan, UCSD

Graduate Student

2012 M. Kshirsagar, Biomedical Engineering, Duke University

Postbaccalaureate IRTAs (NIH)

2018–present M. Noh, Bioengineering, MIT
2016–present M. Velez Afanador, Microbiology, University of Puerto Rico

Undergraduate Students

2014–2017 G. Asturias, Neuroscience & Psychology, Duke University (Distinction)
Z. Feng, Biomedical Engineering and Biology, Duke University
M. Glidewell, Biomedical Engineering, Duke University

S. Lee, Biomedical Engineering, Duke University
J. R. Lilien, Electrical & Computer Engineering, Duke University (Walter J. Seeley Award)
W. Lim, Biomedical Engineering, Duke University
F. M. Mercer, Women's Studies, Duke University
E. Salgado, Neuroscience & Psychology, Duke University (Distinction)
R. Shah, Biology, Duke University
E. Shinder, Biology, Duke University
E. P. Vienneau, Biomedical Engineering, Duke University (Howard G. Clark Award)
D. T. Weaver, Biology, Duke University

Summer Interns

2018 M. Dib, Biomedical Engineering, University of Maryland, College Park
2017 E. Chung, Psychology, University of Maryland, College Park
A. L. Halberstadt, Biology and Psychology, Carnegie Mellon University
2015 C. M. Prevost, Biomedical Engineering, Clemson University
2013 J. V. McCall, Biomedical Engineering, North Carolina State University

Professional Affiliations & Services

Professional Society Membership

2004–present **Institute of Electrical and Electronics Engineers**, Engineering in Medicine and Biology Society, member

2014–present **Organization for Human Brain Mapping**, member

2017–2018 **Anxiety and Depression Association of America**, member

2017–2018 **International Society for CNS Clinical Trials and Methodology**, member

2008–2012 **Society for Industrial and Applied Mathematics**, student member

2005–2012 **Society for Neuroscience**, student member

2004–2009 **American Physical Society**, student member

Public Education & Outreach

2018 University of Pennsylvania, Wharton Undergraduate Health Care Club
Public seminar: *Technology and the future of mental health treatment*

2017–2018 Judge, Postbac Poster Day, NIH

2016 Innovation Leader, Psychiatry Innovation Lab, American Psychiatric Association

2016 Duke Psychiatry, Mood Disorders Support and Education Group
Public lecture: *Brain stimulation treatments for severe mood disorders*

2016 Duke Translational Medicine Institute, Undergraduate Research Society
Public seminar: *Engineering meets psychiatry*

2015 Duke Psychiatry, Mood Disorders Support and Education Group
Public lecture: *New frontiers in treatments for mood disorders*

Editorial & Grant Review Services

Peer Review Journals

review editor — Frontiers in Psychiatry: Neuroimaging and Stimulation

ad hoc reviewer — AIP Advances
American Journal of Psychiatry
Australasian Physical and Engineering Sciences in Medicine
BioMedical Engineering OnLine
Brain Stimulation
Cerebral Cortex
Clinical EEG and Neuroscience
Computational and Mathematical Methods in Medicine
Computer Methods and Programs in Biomedicine
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Neural Systems and Rehabilitation Engineering
IEEE Transactions on Magnetics
Journal of ECT
Journal of Neural Engineering
Journal of Neuroscience Methods
JoVE
Medical & Biological Engineering & Computing
Medical Hypotheses
NeuroImage Clinical
Neuromodulation: Technology at the Neural Interface
Neuroscience Letters
PLoS One
Translational Psychiatry

Conference Proceedings Review

International Conference of the IEEE Engineering in Medicine and Biology Society
IEEE/EMBS International Conference on Neural Engineering
IEEE/EMBS International Conference on Biomedical and Health Informatics

Grant Review Panels

Duke Institute for Brain Sciences, Research Incubator Awards

Certifications

2015–2016 Health Disparities Research Curriculum, Duke Translational Medicine Institute CTSA

2015 Tackling the Challenges of Big Data, MIT Professional Education Program

renewed 2016 Collaborative Institutional Training Initiative certified

2013 IRB/IACUC/HIPAA trained for clinical and preclinical research, Duke Medicine

2009 Transcranial magnetic stimulation administration certified, Columbia University Medical Center/New York State Psychiatric Institute

renewed 2016 Basic Life Support, American Heart Association