Kelley M. Swanberg | 桑凱麗 | 손켈리

swanberg@post.harvard.edu | kelleyswanberg.com

EDUCATION

Doctor of Philosophy (Ph.D.) in Biomedical Engineering
Columbia University School of Engineering and Applied Science
(New York, New York, USA)
Dissertation: "Optimization of sensitivity to disease-associated cortical metabolic abnormality by evidence-based quantification of in vivo ^{1}H MRS data from 3 T and 7 T"
Bernard Jaffe Prize Nominee for Department of Biomedical Engineering

05.22
(m.y.)

Master of Science (M.Sc.) in Biomedical Engineering
Columbia University School of Engineering and Applied Science
(New York, New York, USA)
G.P.A.: 4.17/4.3 (A=4.0)

05.18

Master of Science (M.Sc.) in Korean Medicine (program in Korean)
Kyung Hee University Graduate School of East-West Medical Science
(Seoul, Republic of Korea)
G.P.A.: 4.3/4.3 (A=4.0)
Thesis: "Effect of moderate left parietal cortical contusion injury at 3 weeks of age on behavioral responses to addictive drugs in the adult male C57Bl/6 mouse"
Department of East-West Medicine Outstanding Thesis Award

03.15

Bachelor of Arts (B.A.) magna cum laude in Neurobiology, citation in French
Harvard University
(Cambridge, Massachusetts, USA)
G.P.A.: 3.92/4.0
Phi Beta Kappa

06.09

RESEARCH EXPERIENCE

Postdoctoral Researcher, Lund University Faculty of Medicine
Development of data acquisition, processing, modeling, hypothesis testing, and machine-learning pipelines for ultra-high-field preclinical and clinical magnetic resonance imaging and spectroscopy data and application to understanding brain metabolism in diverse conditions, including multiple sclerosis, Alzheimer's disease, and healthy aging.

01.09.23-
present
(d.m.y.)

Postdoctoral Research Scientist, Columbia University Department of Biomedical Engineering (MR-SCIENCE Laboratory)
Development of data processing, modeling, hypothesis testing, and machine-learning software pipelines for human cortical magnetic resonance spectroscopy data and application to understanding brain metabolism in diverse conditions, including multiple sclerosis and post-traumatic stress disorder.
Contact: Christoph Juchem, Ph.D., Associate Professor of Biomedical Engineering and Radiology, Columbia University School of Engineering and Applied Science and Columbia University Medical Center (cwj2112@columbia.edu)

01.06.22-
31.05.23

Doctoral Research Associate, Columbia University Department of Biomedical Engineering (MR-SCIENCE Laboratory)
Development of data processing, modeling, hypothesis testing, and machine-learning software pipelines for human cortical magnetic resonance spectroscopy data and application to understanding brain metabolism in diverse conditions, including multiple sclerosis and post-traumatic stress disorder. Preliminary methods development for establishment of ultra-high-field human magnetic resonance spectroscopy research program at Columbia.
Contact: Please see above.

01.09.16
-31.05.22

Postgraduate Associate, Yale School of Medicine Department of Radiology (Juchem Group)
Applying proton magnetic resonance spectroscopy at 7 Tesla to study multiple sclerosis pathophysiology in humans. Engaged in all aspects of the research process, from experimental design and data acquisition to analysis and manuscript composition.
Contact: Please see above.

21.08.15-
21.08.16

Collaborator, Kyung Hee University Department of East-West Medicine (Park Group)

Exploring the effects of unfocused pulsed ultrasonic stimulation as well as various pharmaceuticals on spontaneous and evoked hippocampal activity using 60-channel microelectrode array recordings from organotypic slice cultures. Supported experimental design and led efforts in data processing, statistical analysis and interpretation, manuscript writing, and submission procedures for multiple manuscripts, posters, and presentations, including two co-authored publications. Working language Korean.
Contact: Jiho Park, Ph.D., East-West Medical Science Department Director, Kyung Hee University Graduate School of East-West Medical Science (jihopark@khu.ac.kr)

Graduate Researcher, Kyung Hee University Medical Center Central Laboratory (Maeng Group)

Analyzed efficacy of small molecules in preclinical mouse models of affective disorders. Explored behavioral responses to addictive drugs in mice subject to developmental controlled cortical impact. Designed, implemented, analyzed, interpreted, and reported behavioral tests; executed controlled cortical impact surgery; extracted and stained mouse brain tissue; co-authored three publications. Managed laboratory finances for one semester; trained two new students in rodent handling, behavioral and data analysis, and laboratory best practice. Working language Korean.
Contact: Sungho Maeng, M.D., Ph.D., Assistant Professor of Integrative Medicine, Kyung Hee Medical Center (jethrot@khu.ac.kr)

Research Assistant, Walter Reed Army Medical Center Department of Neurology (Tsao Group)

Studied the effects of various behavioral regimens for phantom limb syndrome on dexterity and cognition and explored ways to improve current phantom pain therapies with medication, virtual reality, and application of the DARPA Proto 2 upper-limb neural prosthesis. Tested subjects on paper- and activity-based cognitive batteries; processed and interpreted statistics; composed several clinical experimental protocols; co-authored two research publications and two book reviews.
Contact: Captain Jack W. Tsao, M.D., D.Phil, US Navy Bureau of Medicine and Surgery Director of Traumatic Brain Injury (TBI) Programs (jtsao@uthsc.edu)

Research Assistant, Harvard Medical School Department of Psychiatry (Stickgold Group)

Studied the effects of sleep on the relationship between emotional valence and gist versus detail memory; investigated the effect of napping on gist memory. Tested subjects on computerized and paper-based batteries; administered electroencephalograms; co-authored one publication.
Contact: Jessica Payne, Ph.D., Collegiate Chair in Psychology, University of Notre Dame (jpayne7@nd.edu)

Pre-College and Undergraduate Laboratory Intern, Argonne National Laboratory (MacDonell Group)

Aided development of Environmental Protection Agency (EPA) Provisional Advisory Levels (PALs). Led development of draft PAL report for tetraethyl pyrophosphate (80+ pages; compiled dose-effect relationships from experimental and case reports and applied them to PAL derivations); expanded PAL reports for methanol, sarin, strychnine, and diacetylmorphine; analyzed primary literature to tabulate aquatic and atmospheric fate and exposure symptoms of 75+ toxic industrial chemicals and warfare agents.
Contact: Margaret MacDonell, Ph.D., Project Manager, ANL Environmental Assessment Division (macdonell@anl.gov)

Research Assistant, Harvard University Department of Psychology (Schacter Group)

Studied the effects of emotional valence on younger and older adults' reality-monitoring abilities. Tested subjects on computerized memory assays; calculated and interpreted statistics; composed draft methods and results sections for co-authored publication.
Contact: Elizabeth Kensinger, Ph.D., Assistant Professor of Psychology, Boston College (elizabeth.kensinger@bc.edu)

RESEARCH PUBLICATIONS

Juchem C., **K.M. Swanberg**, H. Prinsen, R.A. de Graaf, and D. Pelletier. (2023). In vivo cortical glutathione response to oral fumarate therapy in relapsing-remitting multiple sclerosis: A single-arm open-label phase IV trial using 7-Tesla ^{1}H MRS. *Neuroimage Clinical* 2023:39:103495.

Swanberg, K.M.[*], L. Campos[†], C.G. Abdallah, and C. Juchem. (2022). Proton magnetic resonance spectroscopy in post-traumatic stress disorder: Updated systematic review and meta-analysis. *Chronic Stress* 6.
* Corresponding author
† Undergraduate supervisee

Swanberg, K.M.[*], A.V. Kurada[†], H. Prinsen, K. Destefano, M. Bailey, D. Pitt, R.K. Fulbright, and C. Juchem. (2022). Multiple sclerosis diagnosis and phenotype identification by multivariate classification of in vivo frontal cortex metabolite profiles. *Scientific Reports* 12(1):13888.
* Corresponding author and shared first author
† Undergraduate supervisee

Swanberg, K.M.*, H. Prinsen, K. Destefano, M. Bailey, A.V. Kurada[†], D. Pitt, R.K. Fulbright, and C. Juchem. (2021). In vivo evidence of differential frontal cortex metabolism in relapsing-remitting and progressive multiple sclerosis. *NMR in Biomedicine* 34(11): e4590.
Featured cover image for NMR in Biomedicine 34(11)
* Corresponding author and shared first author
[†] Undergraduate supervisee

Gajdošík, M. K. Landheer, **K.M. Swanberg,** and C. Juchem. (2021). INSPECTOR: Free software for magnetic resonance spectroscopy data inspection, processing, simulation and analysis. *Scientific Reports* 11(1): 2094.

Gajdošík, M., K. Landheer, **K.M. Swanberg,** F. Adlparvar, G. Madelin, W. Bogner, C. Juchem, and I.I. Kirov. (2021). Hippocampal single-voxel MR spectroscopy with long echo time at 3 Tesla. *NMR in Biomedicine* 34(8): e4538.

Swanberg, K.M.*, K. Landheer, D. Pitt, and C. Juchem. (2019). Quantifying the metabolic signature of multiple sclerosis by in vivo proton magnetic resonance spectroscopy: Current challenges and future outlook in the translation from proton signal to diagnostic biomarker. *Frontiers in Neurology* 10.3389/fneur.2019.01173.
* Corresponding author

Landheer, K., **K.M. Swanberg**, and C. Juchem. (2019). Magnetic Resonance Spectrum Simulator (MARSS), a novel software package for fast and computationally efficient basis set simulation. *NMR in Biomedicine* 34(5): e4129.
Featured cover image for NMR in Biomedicine 34(5) Special Issue: Advanced methodology for in vivo magnetic resonance spectroscopy, based on data acquired in Swanberg, K.M. et al. Journal of Magnetic Resonance 290: 1-11.

Landheer, K., R.F. Schulte, M.S. Treacy, **K.M. Swanberg**, and C. Juchem. (2019). Theoretical description of modern ^{1}H in vivo magnetic resonance spectroscopic pulse sequences. *JMRI* 51(4): 1008-1029.

Swanberg, K.M.*, H. Prinsen, D. Coman, R.A. de Graaf, and C. Juchem. (2018). In vivo quantification of glutathione T_2 in the human brain at 7 Tesla. *Journal of Magnetic Resonance* 290: 1-11.
* Corresponding author

Shin, J.Y., J.W. Shin, S.K. Ha, Y.R. Kim, **K.M. Swanberg**, S. Lee, T.W. Kim, and S.H. Maeng. (2018). Radix Polygalae extract attenuates PTSD-like symptoms in a mouse model of single prolonged stress and conditioned fear possibly by reversing BAG1. *Experimental Neurobiology* 27(3): 200–209.

Kim, H.B., **K.M. Swanberg**, H.S. Han, J.C. Kim, J.W. Kim, S.O. Lee, C.J. Lee, S.H. Maeng, T.S. Kim, J.H. Park (2017). Prolonged stimulation with low-intensity ultrasound induces sustained increases in spontaneous hippocampal culture spiking activity. *Journal of Neuroscience Research* 95(3): 885-896.

Kim, H.B., T.I. Oh, **K.M. Swanberg**, M.B. Lee, T.W. Kim, E.J. Woo, J.H. Park, O.I. Kwon. (2016). Microelectrode array analysis of hippocampal network dynamics following theta-burst stimulation via current source density reconstruction by Gaussian interpolation. *Journal of Neuroscience Methods* 264: 1-10.

Kang, J., J.W. Shin, Y.R. Kim, **K.M. Swanberg**, Y. Kim, J.R. Bae, Y.K. Kim, J. Lee, S.Y. Kim, N.W. Sohn, S. Maeng. (2017). Nobiletin improves emotional and novelty recognition memory but not spatial referential memory. *Journal of Natural Medicines* 71(1): 181-189.

Shin, I.J., S.U. Son, H. Park, Y. Kim, S.H. Park, **K. Swanberg**, J.Y. Shin, S.K. Ha, Y. Cho, S.Y. Bang, J.H. Lew, S.H. Cho, S. Maeng. (2014). Preclinical evidence of rapid-onset antidepressant-like effect in Radix Polygalae extract. *PLoS One* 9(2): e88617.

Swanberg, K.M., A.M. Clark, J.E. Kline, I.R. Yurkiewicz, B.L. Chan, P.F. Pasquina, K.M. Hellman, J.W. Tsao. (2011). Enhanced left-finger deftness following dominant upper- and lower-limb amputation. *Neurorehabilitation and Neural Repair* 25(7): 680-684.

Anderson-Barnes, V.C., C. McAuliffe, **K.M. Swanberg,** J.W. Tsao. (2009). Phantom limb pain—a phenomenon of proprioceptive memory? *Medical Hypotheses* 73(4): 555-8.

Payne, J.D., R. Stickgold, **K. Swanberg**, and E. Kensinger. (2008). Sleep preferentially enhances memory for emotional components of scenes. *Psychological Science* 19(8): 781-788.

Kensinger, E.A., J. O'Brien, **K. Swanberg**, R. Garoff-Eaton, and D.L. Schacter. (2007). The effects of emotional content on reality-monitoring performance in young and older adults. *Psychology and Aging* 22(4): 752-754.

MANUSCRIPTS IN PROGRESS

Swanberg, K.M.*, M. Gajdošík, K. Landheer, M. Treacy, and C. Juchem. Spectral baseline modeling for precise and accurate metabolite quantification by in vivo proton magnetic resonance spectroscopy. Manuscript in review.
* Corresponding author

Swanberg, K.M.*, H. Prinsen, C. Averill, L. Campos†, A.V. Kurada, J.H. Krystal, I.L. Petrakis, L.A. Averill, C.G. Abdallah, and C. Juchem. Prefrontal neurotransmitter abnormalities in post-traumatic stress disorder with and without comorbidity to major depression. Manuscript in review.
* Corresponding author and shared first author
† Undergraduate supervisee

Campos, L.†, **K.M. Swanberg,** M. Gajdošík, K. Landheer, and C. Juchem. Using the full complex data of ^{1}H MR spectra improves spectral quantification precision relative to real fitting. Manuscript in review.
† Undergraduate supervisee

Medeiros, C.M.†, K.C. Igwe, H. Prinsen, A.V. Kurada, **K.M. Swanberg,** and C. Juchem. Influence of water- but not creatine-referenced proton magnetic resonance spectroscopy metabolite estimates by hidden lesions in cortex of individuals with multiple sclerosis. Manuscript in preparation.
† Undergraduate supervisee

OTHER ACADEMIC PUBLICATIONS

Swanberg, K.M. 2022. Optimization of sensitivity to disease-associated cortical metabolic abnormality by evidence-based quantification of in vivo proton magnetic resonance spectroscopy data from 3 Tesla and 7 Tesla. Columbia University Academic Commons dissertation repository. https://doi.org/10.7916/2nv4-q759.

손켈리 **(Kelley M. Swanberg)**. 2015. C57Bl/6 수컷 마우스의 3周次에 받은 中度의 왼쪽 頭頂葉 皮質 打撲傷이 成年期에 中毒性 藥物에 對한 行動的 反應에 미치는 影響 (Effect of moderate left parietal cortical contusion injury at 3 weeks of age on behavioral responses to addictive drugs in the adult male C57Bl/6 mouse). Kyung Hee University Library academic thesis repository. I804:11006-200000055599.

Chapman, Michael E. (2012). 《人文与社会科学学术论文写作指南》 (*Thesis Writer's Guide: Making an Argument in the Humanities and Social Sciences*). 桑凯丽 **(Kelley M. Swanberg)**, trans. into Chinese. Ed. Zou Haodan. Beijing: Peking University.

Campos, L.†, **K.M. Swanberg**, and C. Juchem. Evidence-based metabolic profiling with single-voxel proton magnetic resonance spectroscopy: A complete beginner's guide to spectral data quality assessment, processing, and quantification. Unpublished manual.
† Undergraduate supervisee

Swanberg, K.M. and J.W. Tsao. 2008. D. Dawbarn and S.J. Allen, Neurobiology of Alzheimer's Disease (3rd Ed.) [Book review]. *Journal of the Neurological Sciences* 266(1-2): 193-194.

Swanberg, K.M. and J.W. Tsao. 2008. S. Zeki and O. Goodenough, Law and the Brain [Book review]. *Journal of the Neurological Sciences* 263(1-2): 235-236.

SELECT ABSTRACTS AND POSTERS

K.M. Swanberg, H. Prinsen, D. Pelletier, and C. Juchem. 7-Tesla in vivo ^{1}H-MRS-measured prefrontal glutathione increases during oral fumarate therapy in relapsing-remitting multiple sclerosis. *Proc Int Soc Magn Reson Med* 2023, 2827.

Campos, L.†, **K.M. Swanberg,** and C. Juchem. Using the full complex data of ^{1}H MR spectra improves spectral quantification precision relative to real fitting. *Proc Int Soc Magn Reson Med* 2023, 3935.
† Undergraduate supervisee

Medeiros, C.†, K.C. Igwe, H. Prinsen, A.V. Kurada, **K.M. Swanberg,** and C. Juchem. Hidden lesions may confound ^{1}H-MRS metabolite quantification by internal water referencing in individuals with multiple sclerosis. *Proc Int Soc Magn Reson Med* 2023, 2837.
† Undergraduate supervisee

Zöllner H.J., **K.M. Swanberg**, J. LaMaster, A. Kaiser, J. Near, C. Fleischer, B.J. Soher, W.T. Clarke, and G. Oeltzschner. Towards a standardized file format for basis spectra and fitting results for linear-combination modeling. *Proc Int Soc Magn Reson Med* 2023, 5259.

K.M. Swanberg, H. Prinsen, C. Averill, L. Campos, A.V. Kurada[†], J.H. Krystal, I.L. Petrakis, L.A. Averill, C.G. Abdallah, and C. Juchem. Prefrontal cortex metabolites measured by 7-Tesla proton magnetic resonance spectroscopy distinguish posttraumatic stress disorder and major depression from control with high sensitivity and specificity [Virtual Poster Abstract]. *Proceedings of Magnetic Resonance Spectroscopy Workshop: Overcoming the Barriers to Clinical Use* 2022, 46.
[†] *Undergraduate supervisee*

Campos, L.[†], **K.M. Swanberg,** M. Gajdošík, K. Landheer, and C. Juchem. Linear combination modeling of complex relative to real ^{1}H MR spectra improves quantification precision [Poster Abstract]. *Proceedings of Magnetic Resonance Spectroscopy Workshop: Overcoming the Barriers to Clinical Use* 2022, 41.
[†] *Undergraduate supervisee*

Campos, L.[†], **K.M. Swanberg,** M. Gajdošík, K. Landheer, and C. Juchem. Linear combination modeling of complex relative to real ^{1}H MR spectra improves quantification precision [Poster Abstract]. Gordon Research Conference for In Vivo Magnetic Resonance, Andover, NH, USA. 2022.
[†] *Undergraduate supervisee*

Swanberg, K.M., H. Prinsen, C. Averill, L. Campos[†], A.V. Kurada[†], J.H. Krystal, I.L. Petrakis, L.A. Averill, C.G. Abdallah, and C. Juchem. Abnormal glutamate metabolism in prefrontal cortex of post-traumatic stress disorder linked to comorbidity with major depression [Power Pitch Abstract]. *Proc Int Soc Magn Reson Med* 2022, 3344.
[†] *Undergraduate supervisee*

Campos, L.[†], **K.M. Swanberg**, M. Gajdošík, K. Landheer, and C. Juchem. Complex fitting of ^{1}H-MR spectra improves quantification precision independent of SNR and noise correlation [Talk Abstract]. *Proc Int Soc Magn Reson Med* 2022, 0430.
Magna cum laude award (top 15% of submitted abstracts for ISMRM Annual Meeting 2022)
[†] *Undergraduate supervisee*

Igwe K.C., P.J. Lao, D. Seblova, **K.M. Swanberg**, A. Rivera, A. Giudicessi, E. Tejeda, C. Juchem, R. Mayeux, J.J. Manly, A.M. Brickman. Hippocampal inflammation is associated with vascular dysfunction in middle aged Non-Latinx Black APOE-ε4 carriers [Poster Abstract]. *Proceedings of the Alzheimer's Association International Conference* 2022, 68178.

Swanberg, K.M., M. Gajdošík, K. Landheer, and C. Juchem. Computation of Cramér-Rao Lower Bounds (CRLB) for spectral baseline shapes [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2021, 2010.

Gajdošík, M., K. Landheer, **K.M. Swanberg**, L.S. Kegeles, C. de la Fuente-Sandoval, D.C. Shungu, and C. Juchem. The effects of basis sets on the analysis of in vivo brain MRS data obtained with standard PRESS sequences [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2021, 2013.

Gajdošík, M., K. Landheer, **K.M. Swanberg**, F. Adlparvar, G. Madelin, W. Bogner, C. Juchem, and I.I. Kirov. Hippocampal single-voxel MR spectroscopy with long echo time at 3 Tesla [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2021, 2230.

Swanberg, K.M., K. Landheer, M. Gajdošík, M.S. Treacy, and C. Juchem. Hunting the perfect spline: Baseline handling for accurate macromolecule estimation and metabolite quantification by in vivo ^{1}H MRS [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2020, 2856.

Swanberg, K.M., H. Prinsen, and C. Juchem. Spectral quality differentially affects apparent metabolite concentrations as estimated by linear combination modeling of in vivo magnetic resonance spectroscopy data at 7 Tesla [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2019, 4237.

Swanberg, K.M., H. Prinsen, K. Destefano, M. Bailey, A.V. Kurada[†], D. Pitt, R.K. Fulbright, and C. Juchem. In vivo evidence of differential glutathione metabolism in relapsing-remitting and progressive multiple sclerosis [Poster]. Columbia School of Engineering and Applied Science and Columbia University Medical Center Engineering in Biomedicine Symposium in New York, NY, USA. 2019.
[†] *Undergraduate supervisee*

Kurada A.V.[†], **K.M. Swanberg**, H. Prinsen, and C. Juchem. Diagnosis of multiple sclerosis subtype through machine learning analysis of frontal cortex metabolite profiles [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2019, 4871.
[†] *Undergraduate supervisee*

Landheer K, **K.M. Swanberg**, C. Juchem. Magnetic Resonance Spectrum Simulator (MARSS): Software for fast and reliable simulation of spin systems [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2019, 2289.

Kurada A.V.[†], **K.M. Swanberg**, H. Prinsen, and C. Juchem. Diagnosis of multiple sclerosis subtype through machine learning analysis of frontal cortex metabolite profiles [Talk]. Presented by A.V. Kurada at the New York Genome Center for the Center for Translational and Computational Neuroimmunology Annual Retreat in New York, NY, USA. 2019.
[†] *Undergraduate supervisee*

Swanberg, K.M., H. Prinsen, A.V. Kurada, R.K. Fulbright, D. Pitt, K. Destefano, M. Bailey, and C. Juchem. Towards in vivo neurochemical profiling of multiple sclerosis with MR spectroscopy at 7 Tesla: Apparent increase in frontal cortex water T_2 in aged individuals with progressive multiple sclerosis stabilizes in biexponential model constrained by tissue partial volumes [Talk Abstract]. *Proc Int Soc Magn Reson Med* 2018, 0161.
[†] *Undergraduate supervisee*

Swanberg, K.M., H. Prinsen, A.V. Kurada, R.K. Fulbright, D. Pitt, K. Destefano, M. Bailey, and C. Juchem. Apparent increases in frontal cortex water T_2 with progressive multiple sclerosis are attenuated by controlling for differences in voxel composition and age [Poster]. GEM-ASEE Doctoral Engineering Research Showcase, Washington, DC, USA. 2018; Gordon Research Conference for In Vivo Magnetic Resonance, Andover, NH, USA. 2018; 8th Annual Mount Sinai School of Medicine Translational and Molecular Imaging Institute Symposium, New York, NY, USA. 2018.
[†] *Undergraduate supervisee*

Swanberg, K.M., H. Prinsen, D. Coman, D.L. Rothman, R.A. de Graaf, and C. Juchem. 2017. Towards in vivo neurochemical profiling of multiple sclerosis with MR spectroscopy at 7 Tesla: Cross-sectional assessment of frontal-cortex glutathione, GABA, and glutamate in individuals with relapsing-remitting and progressive multiple sclerosis [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2017, 2970.

Swanberg, K.M., H. Prinsen, D. Coman, D.L. Rothman, R.A. de Graaf, and C. Juchem. 2017. In vivo quantification of glutathione T_2 in the human brain at 7 Tesla using echo time extension with variable refocusing selectivity and symmetry [Poster Abstract]. *Proc Int Soc Magn Reson Med* 2017, 3000.

Swanberg, K.M., H. Prinsen, D. Coman, R.A. de Graaf, C. Juchem. 2016. In vivo quantification of glutathione T_2 in the human brain at 7 Tesla [Poster]. National Multiple Sclerosis Society of Connecticut Annual Meeting, Hartford, Connecticut, United States.

Swanberg, K.M., H. Prinsen, R. Fulbright, C. Juchem. 2015. Cortical metabolic signatures of multiple sclerosis as investigated by 7-Tesla ^{1}H-MRS in humans [Poster]. Yale School of Medicine Department of Radiology and Biomedical Imaging Bioimaging Sciences Annual Retreat. Southbury, Connecticut, United States.

Swanberg, K.M., J.Y. Kang, S. Lee, S.H. Maeng. 2015. Attenuated locomotion without abnormal anxiety-like behavior, novelty preference, or memory performance following acute decursinol administration in adult male C57Bl/6 mice [Poster Abstract]. The 23rd Federation Meeting of Korean Basic Medical Scientists, Kyeongju, Republic of Korea.

Kim, H.B., H.S. Han, **K.M. Swanberg**, J.C. Kim, J.W. Kim, E.S. Hwang, G.Y. Choi, S.O. Lee, C.J. Lee, S.H. Maeng, T.S. Kim, J.H. Park. 2014. Prolonged stimulation with low-intensity ultrasound induces delayed increases in hippocampal culture spike activity [Poster Abstract]. Korean Society of Brain and Neural Science, 3rd Congress of the Asian Society of Neuropathology, and Korean Society for Neurodegenerative Disease Joint Conference 2014, Seoul, Republic of Korea.

Swanberg, K.M., S.Y. Bang, S.H. Maeng. 2014. Enhanced baseline locomotor response to cocaine without alteration in drug-specific conditioned place preference or behavioral sensitization in adult male C57Bl/6 mice subjected to left parietal cortical impact injury during adolescence [Poster Abstract]. Korean Society of Brain and Neural Science, 3rd Congress of the Asian Society of Neuropathology, and Korean Society for Neurodegenerative Disease Joint Conference 2014, Seoul, Republic of Korea.
Best Poster Award

Liu, N., J. Hua, **K. Swanberg**, J.W. Tsao. 2008. Development of a military neurology telemedicine system [Talk Abstract]. Presented by J.W. Tsao at 13th annual American Telemedicine Association International Meeting and Exposition, Seattle, Washington, United States.

SELECT ACADEMIC TALKS AND DISCUSSIONS

The Proton Magnetic Resonance Spectroscopy Validation Effort Resource Initiative (^{1}H-MRS VERI)
International Society for Magnetic Resonance in Medicine Virtual Meeting "Update on the Proton Magnetic Resonance Spectroscopy Validation Effort Resource Initiative (^{1}H-MRS VERI) and Synthetic Data Consensus Efforts"

21.04.23
(d.m.y.)

High-throughput numeric simulation for improving the precision and accuracy of metabolite quantification by in vivo proton magnetic resonance spectroscopy
Works in Progress, Columbia Magnetic Resonance Research Center (virtual meeting)

11.11.22

Multivariate supervised identification of brain disease by cortical small molecules visible to magnetic resonance
Zuckerman Institute for Mind, Brain, and Behavior Postdoctoral Seminar Series (virtual seminar)

28.10.22

Meet the experts in magnetic resonance spectroscopy
Session moderator for MRS workshop 2022 (virtual discussion)

23.08.22

^{1}H MRS-visible diagnostic biomarkers for progressive multiple sclerosis
Works in Progress, Columbia Magnetic Resonance Research Center Group Meeting (virtual meeting)

04.02.22

Exploratory data analysis in R
Workshop leader, MR SCIENCE Laboratory Programming Monthly (virtual tutorial)

07.03.22,
10.01.22

There is no "I" in "spectroscopy": How should we distinguish our research in an increasingly collaborative world?
Panel discussion moderator, 5th Annual INSPECTOR MR Spectroscopy Workshop 2021 (virtual workshop)

19.11.21

Development of ^{1}H MRS-visible diagnostic biomarkers for progressive multiple sclerosis
Webinar: Emerging Research and Trial Strategies for Progressive Multiple Sclerosis, New York Academy of Sciences

04.10.21

7-Tesla proton magnetic resonance spectroscopy of post-traumatic stress disorder and major depressive disorder: Data processing and statistical considerations
Inaugural Works-in-Progress series kickoff, Graduate Organization for Biomedical Engineers, Columbia University (virtual seminar)

20.08.21

What can ^{1}H MR spectroscopy tell us about brain disease? In vivo insights on post-traumatic stress disorder and multiple sclerosis from 7 Tesla
Johns Hopkins University School of Medicine Division of Cancer Imaging Research (virtual seminar)

21.05.21

Evidence-based quantification of in vivo proton magnetic resonance spectroscopy data from 3 T and 7 T: Towards optimized identification of disease-associated cortical metabolic abnormality
Johns Hopkins University School of Medicine Department of Radiology and Radiological Science (virtual seminar)

19.02.21

Validating linear combination models for ^{1}H MRS quantification
4th Annual INSPECTOR MR Spectroscopy Workshop 2020 (virtual workshop)

20.11.20

Hunting the perfect spline: Baseline handling for accurate macromolecule estimation and metabolite quantification by in vivo ^{1}H MRS
International Society for Magnetic Resonance in Medicine Spectroscopy Study Group (virtual power pitch)
Voted 3rd-place abstract among all trainee posters in spectroscopy at International Society for Magnetic Resonance in Medicine 28th Annual Meeting

25.08.20

How open should our science be?
Panelist for discussion by Reproducible Research Study Group at International Society for Magnetic Resonance in Medicine 28th Annual Meeting (virtual symposium)

14.08.20

Baseline definition tool for accurate metabolite quantification via ^{1}H MRS processing and quantification software INSPECTOR
International Society for Magnetic Resonance in Medicine Reproducible Research Study Group (virtual power pitch)

17.07.20

Evidence-based in vivo proton magnetic resonance spectroscopy for neuroscience applications
Engineering Graduate Student Council Research Seminar Series, Columbia University (virtual seminar)

05.08.20

In vivo proton magnetic resonance spectroscopy: Potential and recommendations for neuroscience applications
Chan-Zuckerberg Initiative Neurodegeneration Community Project (virtual seminar)

07.04.20

Evidence-based neurochemical profiling by in vivo proton magnetic resonance spectroscopy at ultra-high field: Application to multiple sclerosis
Lund University Department of Experimental Medical Science; Lund, Skåne, Sweden

09.01.20

Evidence-based ^{1}H MRS spectral fitting and quantification: Application to multiple sclerosis
Columbia University Medical Center; 3rd Annual INSPECTOR MR Spectroscopy Workshop 2019 in New York, NY, USA

22.11.19

In vivo evidence of differential glutathione metabolism in relapsing-remitting and progressive multiple sclerosis
New York Genome Center; Center for Translational and Computational Neuroimmunology Annual Retreat in New York, NY, USA

07.03.19

In vivo magnetic resonance proton spectroscopy data processing and quantification
Columbia University Medical Center; 2nd Annual INSPECTOR MR Spectroscopy Workshop 2018 in New York, NY, USA

26.11.18

Measuring brain metabolites with in vivo proton MR spectroscopy: Applications to multiple sclerosis
Columbia University School of Engineering and Applied Science; Columbia Biomedical Engineering Annual Retreat in New York, NY

06.09.18

Towards in vivo neurochemical profiling of multiple sclerosis with MR spectroscopy at 7 Tesla: Apparent increase in frontal cortex water T_2 in aged individuals with progressive multiple sclerosis stabilizes in biexponential model constrained by tissue partial volumes
International Society for Magnetic Resonance in Medicine; Annual Meeting 2018 in Paris, France

18.06.18

Magnetic resonance spectroscopy of multiple sclerosis pathology
Columbia University Medical Center; 1st Annual INSPECTOR MR Spectroscopy Workshop 2017 in New York, NY, USA

08.12.17

In vivo quantification of glutathione T_2 in the human brain at 7 Tesla
Yale School of Medicine; Magnetic Resonance Research Center Works in Progress Series in New Haven, CT, USA

30.06.16

Animal experimentation in the neurosciences: Helping us understand ourselves?
Kyung Hee University Department of East-West Medical Science; Korean-language guest lecture for undergraduate Introduction to Neuroscience course in Suwon, Republic of Korea

04.05.15

Prolonged stimulation with low-intensity ultrasound induces delayed NMDA-dependent increases in spontaneous hippocampal culture spike activity
Kyung Hee University; The 12th Korea-Japan Joint Symposium of Brain, Cardiac, and Smooth Muscle Sciences in Suwon, Republic of Korea
1st place Graduate Student and Postdoctoral Fellow Presentation Award

01.22.15

Task-specific self-efficacy and short-term memory performance
Southern Illinois University; Illinois Junior Science and Humanities Symposium in Carbondale, IL, USA

04.04.05

PROFESSIONAL SOCIETY MEMBERSHIPS

International Society for Magnetic Resonance in Medicine (ISMRM) (2017-present)
ISMRM High Field Systems & Applications (01/2018-present)
ISMRM MR Spectroscopy (01/2018-present)
ISMRM Reproducible Research (01/2019-present)
ISMRM Current Issues in Brain Function (01/2018-present)
Society for Industrial and Applied Mathematics SIAM (2017-22)

ISMRM Psychiatric MR Spectroscopy & Imaging (01/2018-present)
ISMRM White Matter (01/2019-present)
ISMRM Quantitative MRI (01/2019-present)
ISMRM Detection and Correction of Motion in MRI & MRS (01/2019-20)
ISMRM Molecular and Cellular Imaging (01/2019-20)
New York Academy of Sciences (NYAS) (2019-present)
Institute of Electrical and Electronics Engineers IEEE (2017-19)

PUBLICATIONS REFEREED

NMR in Biomedicine (2023-20); *Brain and Behavior* (2023-22); *BMJ Open* (2023-22); *Phytotherapy Research* (2023-22); *Psychiatry Research* (2023)*; European Journal of Psychotraumatology* (2023); *Journal of Neurochemistry* (2023); *Multiple Sclerosis Journal* (2022); *Frontiers in Neuroscience* (2022); *Acta Neurologica Belgica* (2022, 20); *Frontiers in Neurology* (2021); *Journal of International Medical Research* (2021-20); *npj Digital Medicine* (2020); *Neuroscience Letters* (2020)

CONFERENCE ABSTRACT REVIEW

International Society for Magnetic Resonance in Medicine Annual Meeting (2019-2022)
Gordon Research Seminar for In Vivo Magnetic Resonance (2022)

GRANT REVIEW

Invited external grant reviewer for Precision Medicine Alliance Scotland (2021)

SOFTWARE

Batch LCModel Analysis Toolkit (2023). Written in MATLAB 2018a. Modular functions facilitating batch linear combination modeling of proton magnetic resonance spectral data in Linux-based program LCModel. Open-source under BSD-2-clause license; available at https://github.com/kswanberg/Batch_LCModel_Analysis_Toolkit.

INSPECTOR (C. Juchem, 2016). MATLAB-based spectral processing and analysis tool by C. Juchem. Contributed functions for batch simulation and spectral quantification (*Proc Int Soc Magn Reson Med* 2019, 4237; 2020, 2856; 2021, 2010; 2022, 0430; 2023, 3935), regularized spline baseline handling for linear combination modeling (*Proc Int Soc Magn Reson Med* 2020, 2856; 2021, 2010; 2022, 0430; 2023, 3935), and Cramér-Rao Lower Bound calculation for baseline shapes (*Proc Int Soc Magn Reson Med* 2021, 2010).

MATLAB Fig to JPEG Converter (2017). Written in MATLAB; compiled for Windows. A simple solution to a frustrating problem for those with no MATLAB license: Converting a directory of MATLAB .fig files to easily viewable .jpg image files. Available at www.kelleyswanberg.com/other/.

Varian Raw Data Deidentifier (2015). Written in MATLAB 2013b; updated for MATLAB 2018a. Deidentifies directories of Varian magnetic resonance scanner data and saves results with a key for easy re-identification. Open-source under BSD-2-clause license; available at https://github.com/kswanberg/Varian_Raw_Data_Deidentifier.

Multi-Channel Stopwatch. (2013). Written in Processing; compiled for Linux, Mac, and Windows. Records the times and durations of up to 499 instances each of five different channels of events; automatically sums each channel of data by minute. Data optionally exported as text file after each session. Available at www.kelleyswanberg.com/other/.

SELECT AWARDS

Bernard Jaffe Prize Nominee for Biomedical Engineering *Departmental nominee for Biomedical Engineering, Columbia University School of Engineering and Applied Science*	2022
3rd Place Trainee Poster and Virtual Power Pitch in Spectroscopy at ISMRM 28th Annual Meeting *International Society for Magnetic Resonance in Medicine MR Spectroscopy Study Group*	2020
Professional Development Scholarship *Engineering Graduate Student Council, Columbia University School of Engineering and Applied Science*	2019, 2018
Educational Stipend *International Society for Magnetic Resonance in Medicine Annual Meeting*	2019, 2018, 2017
Liu Ping Fellowship *Columbia University Fu Foundation School of Engineering and Applied Science*	2017
Outstanding Thesis Award *Kyung Hee University Graduate School of East-West Medical Sciences Department of East-West Medicine*	2015
1st Place Graduate Student and Postdoctoral Fellow Presentation Award *12th Korea-Japan Joint Symposium of Brain, Cardiac, and Smooth Muscle Sciences*	2015
Best Poster Award *Korean Society of Brain and Neural Science, 3rd Congress of the Asian Society of Neuropathology, and Korean Society for Neurodegenerative Disease Joint Conference 2014*	2014
Phi Beta Kappa (selection based on G.P.A. and professor recommendations)	2009
John Harvard Scholar (top 5% of the Harvard Class of 2009)	2007, 2006
Detur Book Prize (top 50 students of the Harvard Class of 2009)	2006

TEACHING AND OUTREACH

Research associates mentored:
Catherine M. Medeiros (undergraduate), Columbia University School of Engineering and Applied Science — 2021-present
Leonardo Campos (undergraduate), Columbia University School of Engineering and Applied Science — 2020-present
Gabriela Gonzalez (undergraduate), Columbia University School of Engineering and Applied Science — winter 2020
Abhinav Kurada (undergraduate), Columbia University School of Engineering and Applied Science — 2016-2020
Cathy Choo (high school), Townshend Harris High School — summer 2019
Isabel Abonitalla (undergraduate), Hunter College — summer 2017
Jiyun Kang (Masters), Kyung Hee University School of East-West Medical Science — spring 2014
Suck Lee (Masters), Kyung Hee University School of East-West Medical Science — spring 2014

Co-Director, Swedish Trans-Atlantic Researchers and Scholars (STARS) Network — 2022-present
Member of four-person executive board and event chair for international organization of North American and Swedish academics and professionals interested in trans-Atlantic mobility and collaboration. (0 to 2 hours/week)

Member, International Society for Magnetic Resonance in Medicine (ISMRM) Education Committee — summer 2023-present
Committee for driving the educational initiatives of the International Society for Magnetic Resonance in Medicine (ISMRM) through 2023-24.

Executive Board Member, International Society for Magnetic Resonance in Medicine (ISMRM) Spectroscopy Study Group Code and Data Sharing — summer 2021-2023
Six-member collaboration through the International Society for Magnetic Resonance in Medicine for driving field-wide initiatives toward raw data sharing and open-source toolkits. Current manager of project for building a repository of freely available datasets for standardized validation of spectral processing and quantification procedures. (0 to 5 hours/week)

Interviewer for Undergraduate Admissions, Harvard University Faculty of Arts and Sciences — 2022-23
Interview prospective undergraduates; report to admissions committee for Harvard College Class of 2026, 7. (0 to 3 hours/week)

Seminar Host, Columbia Neuroscience Seminar Talk Series — 04.22 (m.y.)
Hosted Columbia Neuroscience Seminar talk and two-day virtual university visit by Dr. Jessica Payne, Professor of Psychology at the University of Notre Dame. (0 to 5 hours/week)

Teaching Fellow, Principles and Practices of In Vivo Magnetic Resonance Spectroscopy — fall 2019, 2020, 2021
Columbia University School of Engineering and Applied Science graduate-level laboratory course on in vivo MRS. (5 to 20 hours/week)

Teaching Fellow, Principles of Magnetic Resonance Imaging — spring 2018
Columbia University School of Engineering and Applied Science graduate-level course in MRI. (5 to 20 hours/week)

Member, Columbia Neuroscience Seminars Selection Committee (Subcommittee for Brain Disease) — 2019-2021
Selection committee comprising faculty and trainee members for Columbia Neuroscience Seminar speakers. (0 to 4 hours/week)

Workshop Leader for Coding in Python and Reading a Scientific Paper, New York Bioforce — summer 2019
Developed and led two sessions within intensive summer bootcamp for high school students interested in STEM. (0 to 4 hours/week)

Department Representative for Biomedical Engineering, Women in Science at Columbia — 09.16-08.19
Organization for campus programming and outreach focused on women in STEM. (0 to 2 hours/week)

Alumnus Mentor, Give Something Back Foundation — 11.16-present
Professional development coaching for outstanding low-income high school students in Illinois. (0 to 1 hour/week)

Course Proctor, Brain Education Day, Yale University Department of Neuroscience — 03.15
Co-taught seminar on magnetic resonance neuroimaging methods to New Haven junior high and high school students.

Graduate Coach, InGenius Prep — 07.15-07.16
One-on-one weekend tutoring in standardized testing and high school math and science for high-achieving students from the United States and Asia. (0 to 5 hours/week)

Instructor, AP Biology   06.15-16
Proctored accelerated virtual summer course encompassing two semesters of AP Biology for rising high school junior; comprehensive weekend tutoring throughout academic year. Student scored 5/5. (2 to 8 hours/week)

Writing Instructor   winter 2012 to
One-on-one online coaching in college analytical writing techniques. (10 to 15 hours/month)   fall 2013

Course Preceptor and Teaching Assistant, Peking University Department of History   fall 2009 to fall
Designed and lead advanced undergraduate history seminar on historical research methods entitled "Methods in Historical   2010
Research and Exposition: A Process-Based Approach to World History." Sole teaching assistant and discussion leader of world
history course for first- and second-year undergraduate students entitled "Readings in World History I." (10+ hours/week)

Award Peer Tutor in Multivariable Calculus, Harvard University Bureau of Study Counsel fall 2007
Tutored two Harvard undergraduates in multivariable calculus. (3 to 4 hours/week)

SAT Coach and Educational Consultant, Strategy Alpha International
Designed and taught four classes daily of SAT mathematics and writing to Chinese high school students; held several daily   07.07
office hours for perfecting personal statements, interviewing strategies, and college choices during two-week college-preparatory
boot camp. (40+ hours/week)

SAT Coach   summer 2008
Intensive one-on-one tutoring of American, British, and Chinese students in all sections of the SAT. (4 to 20 hours/week)   to fall 2011

Non-Academic Work Experience

Content Production Manager, I Dig Culture   05.14-05.15
Managed a team of writers across four different countries to produce content for an international media channel promoting the   (m.y.)
critical analysis of cultural difference. (3 to 10 hours/week)

Staff Writer, The Silk Road   06.13-05.14
Researched and composed brief articles published alongside short documentaries on topics in Korean culture, including traditional
music, food, and martial arts, for international audiences. (3 to 5 hours/week)

Chinese-Korean-English Tour Guide, Korail Travel   10.13
Trilingual guide for predominantly Chinese tourists at the 2013 Medical and Agricultural Exhibitions in Jeollanam-do, Republic of
Korea. Responsibilities included maintaining the safety and morale of foreign guests, calculating and implementing lodging, dining,
and transportation logistics, and responsibly handling emergencies and other unforeseen externalities (including illness, lost
personal items, and multiple traffic accidents).

Translator and Market Analyst, Netelusion Beijing   09.10-09.11
Chief Chinese-English translator for browser-based strategy game 帝国文明 (Imperial Warfare). Conducted market research,
formulated budget reports, developed strategies for marketing Chinese webgames to Chinese-speaking audiences in Singapore,
Malaysia, and Taiwan. Developed proficiency in a variety of Internet marketing tools, including Facebook ads, applications, and
fan pages; Google ads; Twitter; blogging; and leverage of third-party forums and gaming websites through paid banner ads and
solicited reviews. Working language Mandarin Chinese. (40+ hours/week)

Executive Board Member, Harvard Wushu   winter 2006-
Managed all aspects of a contemporary kung fu and performance team of up to twenty-five Harvard, MIT, and Wellesley   spring 2009
undergraduates, graduate students, faculty, and Cambridge community members; responsibilities included running weekly board
meetings with two to four other directors, drafting and presenting semesterly grant proposals, balancing budgets, leading
practices, choreographing performances, ordering uniforms and equipment, planning social events, maintaining campus visibility,
and recruiting new members. (2 to 3 hours/week)

CEO and Co-Founder, IMUSE Foundation
Co-founded 501(c)(3) national nonprofit organization designed to facilitate networking among exceptional students from the United   09.08-09.09
States and China; our 2009 program focused on a two-week conference of over fifty people in Beijing in August. Oversaw the
activities of a binational board and staff of twenty-one and managed the transition from startup project to lasting charitable
foundation. (10 to 40+ hours/week)

Executive Director, Initiating Mutual Understanding through Student Exchange (IMUSE) 2008

Managed cultural exchange program with $300,000 budget designed to present an objective and multifaceted view of modern China and the Beijing Olympics to North American college students; included a tour by fourteen student delegates from Tsinghua and Peking Universities of eleven North American tertiary schools to facilitate public panel discussions, dinners, and speaker events; a continent-wide essay and photo competition; and a fourteen-day fellowship at the 2008 Beijing Olympics. I sat on the seven-member executive board overseeing the whole project and acted as one of four managing directors for the Beijing Olympic Fellowship Program. (10 to 35 hours/week)

Product Analyst, MySpace China

Interned for product department in Beijing headquarters of MySpace.cn; gave presentations in English and Mandarin Chinese analyzing the relative benefits and disadvantages of competing websites; composed a 21-page research report in Mandarin Chinese and English on the demographics and needs of MySpace photography album tool users. (40+ hours/week)

LANGUAGES

English: Native speaker

Korean: Advanced working proficiency
Master of Science with perfect G.P.A. in Korean-language graduate program (spring 2015)

Mandarin Chinese: Advanced working proficiency (simplified >> traditional)
New HSK Level 6/6 certification (fall 2011)

French: Advanced working proficiency
French Chamber of Commerce First Degree Diplôme of Business French with highest mention of excellence (spring 2008)

Swedish: Estimated B1/2-level proficiency in speaking, listening, reading, and writing
Duolingo Events leader for monthly Swedish-only conversation group Svenska i New York (2019-2023; 33 events rated 4.9/5 by 122 learners)

OTHER TRAINING

EPIC Sequence Development Environment Programming, GE Healthcare, New York, NY, USA

Magnetic resonance scan sequence development in GE EPIC/Orchestra SDE. Certificate awarded.

IDEA Sequence Development Environment Programming, Siemens Healthcare, Cary, NC, USA

Magnetic resonance scan sequence development in C++-based Siemens IDEA SDE. Certificate awarded.

Collaboratory@Columbia University Data Science Boot Camp, New York, NY, USA

Columbia Data Science Institute. Dimension reduction, modeling, neural networks in Python. Certificate awarded.

Data Analysis, Johns Hopkins University through Coursera.org

Prof. Jeff Leek. Weekly quizzes and two peer-graded analysis reports. Final grade 98.7%.

Computational Neuroscience, Washington University through Coursera.org

Profs. Adrienne Fairhall and Rajesh Rao. Weekly problem sets. Final grade 97.7%.

Yonsei University Korean Language Institute, Seoul, Republic of Korea

Intermediate Korean (Levels 3 and 4 of 6). Level 5 audited. Composite grade 92%.

Tsinghua University International Chinese Language and Culture Center Mandarin Program, Beijing, China

Intermediate and Advanced Mandarin Chinese. Composite grade 96.7%.

OTHER SKILLS

Laboratory: 7T and 3T MR safety; in vivo proton magnetic resonance imaging (MRI) and spectroscopy (MRS) scanning in human participants (Siemens syngo.MR and Varian VnmrJ); mouse care, handling, and behavioral testing (open field test, elevated plus maze, light-dark box test, passive avoidance, conditioned fear, rotarod, pole test, novel object test, water plus maze, Morris water maze, conditioned place preference, Y-maze, behavioral sensitization); intraperitoneal injection (mouse); decapitation and brain extraction (mouse); controlled cortical impact survival surgery (mouse); triphenyl tetrazolium chloride staining; elementary 10-20 polysomnography implementation (human)

Programming and analysis:
MATLAB, R, Python, Processing, ActionScript 3, SPSS 17-21
Elementary: JavaScript, Jekyll, AWS ec2, PHP, HTML, SQL, C, C++, IDEA (Siemens), EPIC (GE)

Design: CorelDraw X8-2018, Adobe Flash CS4, Photoshop/Photoshop Elements, PaintShop Pro, freehand projection drawing