## BIOGRAPHICAL SKETCH

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NAME: Rosen, Burke

eRA COMMONS USER NAME (credential, e.g., agency login): BURKEROSEN

POSITION TITLE: Postdoctoral Research Associate

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Start Date MM/YYYY | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|---|
| University of California, Davis, Davis, California | BS | 09/2006 | 06/2010 | Neurobiology |
| University of California, San Diego La Jolla, California | PhD | 09/2015 | 02/2023 | Neuroscience |
| Washington University in St. Louis Saint Louis, Missouri | Postdoctoral Fellow | 03/2023 | present | Neuroscience |

### A. Personal Statement

*Know thyself.* Delphic maxim, c. 600 BCE

My overarching research goal is to advance our understanding of the human cerebral cortex, a structure whose exceptional size and complexity gives rise to our extraordinary capabilities and makes us vulnerable to some of our most dreaded diseases. I believe that a synthesis of structure, function, and genetics is necessary to better bridge description and mechanism.

I began my research career as neurobiology major at the University of California, Davis where I secured an assistantship in the lab of Dr. Petr Janata studying music perception. The scientific programing and human subjects research skills I developed in this role were invaluable to my future research. After graduating I joined the lab of Dr. Ksenija Marinkovic at the University of California, San Diego, and later San Diego State University where I studied the effects of acute alcohol intoxication on healthy adult humans with magneto- and electro-encephalography (M/EEG). In addition to augmenting my scientific skills and knowledge, this work solidified my interest in a research career and in neuroimaging specifically. During my graduate studies at the University of California, San Diego in the lab of Dr. Eric Halgren, I worked on characterizing whole-cortex structural and functional connectivity. I elucidated spatiotemporal patterns of spontaneous functional connectivity by leveraging the unique view offered by semi-chronic intracranial electrode implantations in epilepsy patients and mapped structural connectivity by taking advantage of the large, high quality diffusion MRI (dMRI) datasets made available by the Human Connectome Project (HCP). I found that both structural and spontaneous functional connectivity decay exponentially with respect to the fiber tract distance, but that the falloff in functional synchrony is less steep overall and is frequency dependent. One of the lessons these investigations instilled in me is that data aggregation can be a powerful force-multiplier. For example, the cortex-wide relationships I observed cannot be resolved in any individual patient due to sparse spatial sampling but are only revealed by the aggregation of many recordings from multiple surgical teams with differing preferred implantation trajectories.

Thus, I was pleased to join the lab of Drs. David Van Essen and Mathew Glasser at Washington University in St. Louis as a postdoctoral associate. The lab continues to be the heart of the HCP and is now part of an exciting new consortium, the Human and Mammalian Brain Atlas (HMBA), part of the BRAIN Initiative Cell Atlas Network (BICAN). The research I will be performing linking spatial transcriptomics to neuroanatomical and functional

features flows naturally from my research interests. I will be able to build on my knowledge of surface-based data manipulation and learn new bioinformatics and data science skills to interrogate the very high-dimensional gene expression data. Another way my scientific horizons will be broadened is the incorporation of non-human-primate (NHP) model organisms. A comparative approach is essential for understanding the recent evolution of the primate brain. In addition to the BICAN HMBA, the Van Essen and Glasser lab has fruitful, long-standing collaborations with the labs of Drs. Takuya Hayashi, Henry Kennedy, and Emma Robinson, among others, whose input will be invaluable for the proposed research and my professional development. Furthermore, Dr. Van Essen has a long history of mentoring postdoctoral fellows towards successful independent investigators.

In addition to acquiring new research experiences, I am continuing my professional development and academic service as a postdoctoral scholar. During my graduate tenure, I was elected to represent my fellow students on the Neurosciences Graduate Program executive faculty committee. In concert with the other student representative, I successfully introduced initiatives to restructure the program's qualifying exam to be more germane to the interests of both students and faculty and to end the use of the Graduate Record Exam in admissions. In addition to being a teaching assistant for an undergraduate course on neural oscillations and a graduate course on neural data analysis, I was also involved for several years with a student-led course teaching computational neuroscience techniques to students with non-computational backgrounds, where I developed curricula and lectured on digital signal processing. Within the lab, I co-mentored four undergraduate or master's students, one of whom is now a neuroscience PhD student. Upon arriving at Washington University, I joined the WU Postdoc Society executive council and was elected to serve as secretary. In this role I lead a successful effort to reform the organization's bylaws. I have served as an ad hoc peer reviewer or co-reviewer for the journals Cell, Cell Rep., Cereb. Cortex, Curr. Res. Physiol., Imaging Neuroscience, Nat. Rev. Neurosci., Neuroimage, PLOS Biol., and PNAS. I will continue to develop the skills required to thrive as an independent academic by taking advantage of networking events, teaching workshops, and professional development seminars at Washington University.


1. **Rosen BQ**, Krishnan GP, Sanda P, Komarov M, et al. Simulating human sleep spindle MEG and EEG from ion channel and circuit level dynamics. J Neurosci Methods. 2019 Mar 15;316:46-57. PMCID: PMC6380919.
2. **Rosen BQ**, Halgren E. A Whole-Cortex Probabilistic Diffusion Tractography Connectome. eNeuro. 2021 Jan-Feb;8(1). PMCID: PMC7920542.
3. **Rosen BQ**, Halgren E. An estimation of the absolute number of axons indicates that human cortical areas are sparsely connected. PLoS Biol. 2022 Mar;20(3):e3001575. PMCID: PMC8947121.
4. **Rosen BQ** On corticocortical connectivity and its contribution to extracranial potentials. 2023. UC San Diego. ProQuest ID: Rosen_ucsd_0033D_22105. Merritt ID: ark:/13030/m5453906.


**B. Positions, Scientific Appointments and Honors**

**Positions and Scientific Appointments**

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|---|---|
| 2023 – Present | Secretary, Washington University Postdoc Society |
| 2023 – Present | Member, Organization for Human Brain Mapping |
| 2023 – Present | Postdoctoral Research Associate, Washington University in St. Louis |
| 2017 – 2019 | Student Representative, Neurosciences Grad. Prgm. Executive Committee, UC San Diego |
| 2015 – 2023 | Graduate Student Researcher, University of California, San Diego |
| 2014 – 2015 | Research Specialist II, San Diego State University |
| 2013 – Present | Member, Society for Neuroscience |
| 2010 – 2014 | Staff Research Associate II, University of California, San Diego |
| 2007 – 2010 | Student Research Assistant, University of California, Davis |

**Honors**

| | |
|---|---|
| 2019 – 2020 | Co-PI, Innovative Research Grant, Kavli Institute for Brain and Mind ($50,000) |
| 2018 – 2019 | Predoctoral fellowship in Cognitive Neuroscience, Inst. for Neural Computation, UC San Diego |
| 2010 | B.S. awarded with honors, University of California, Davis |
| 2010 | Departmental citation for outstanding academic achievement & independent research, UC Davis |
| 2007, 2009 | Dean's List, Biological Sciences, University of California, Davis |
| 2006 | Joseph H. and Helen C. Henderson Scholarship |

**C. Contributions to Science**

Complete list of published work:
https://www.ncbi.nlm.nih.gov/myncbi/burke.rosen.1/bibliography/public/
https://scholar.google.com/citations?user=PA81tSIAAAAJ
https://bqrosen.com

1. Early Career: Effects of alcohol on brain oscillations

While staff researcher for Dr. Marinkovic, I developed spatiotemporal time-frequency domain M/EEG analysis pipelines and led a multi-modal human data collection team. MEG is a particularly useful tool for studying neuropharmacology because it avoids the physiological confound that vasodilators (e.g., alcohol) have on fMRI BOLD while having better spatial resolution than EEG because the cranial tissues are transparent to the magnetic signal. Alcohol is known to be deleterious to executive function, but the systems-level neural mechanisms are poorly understood. I found that the neural oscillations of the anterior cingulate (ACC) are particularly affected by alcohol during both resting state and executive tasks. Alcohol intoxication increases ACC alpha band power at rest and reduces theta band power in sufficiently difficult executive tasks, suggesting global high-level neuromodulation over specific discrete dysregulation. We further found that alcohol reduces functional connectivity between ACC and other cortical areas during decision conflict, suggesting that one mechanism of alcohol's action is reducing neural coordination via desynchronization. These findings improve our understanding of how the most commonly used recreational intoxicant affects human cortical processing. I co-authored seven peer-reviewed publications derived from this work, including two first-author publications. Separately, I wrote analysis code for artifact rejection, spectral decomposition, and sleep graphoelement detection in intracranial EEG in collaboration with my future thesis advisor, Dr. Eric Halgren, which resulted in the co-authorship of two additional publications.

a. Marinkovic K, **Rosen BQ**, Cox B, Kovacevic S. Event-Related Theta Power during Lexical-Semantic Retrieval and Decision Conflict is Modulated by Alcohol Intoxication: Anatomically Constrained MEG. Front Psychol. 2012;3:121. PMCID: PMC3334511.
b. **Rosen BQ**, O'Hara R, Kovacevic S, Schulman A, et al. Oscillatory spatial profile of alcohol's effects on the resting state: anatomically-constrained MEG. Alcohol. 2014 Mar;48(2):89-97. PMCID: PMC3959272.
c. **Rosen BQ,** Padovan N, Marinkovic K. Alcohol Hits You When It Is Hard: Intoxication, Task Difficulty, and Theta Brain Oscillations. Alcohol Clin Exp Res. 2016 Apr;40(4):743-52. PMCID: PMC4820362.
d. Marinkovic K, Beaton LE, **Rosen BQ**, Happer JP, Wagner LC. Disruption of Frontal Lobe Neural Synchrony During Cognitive Control by Alcohol Intoxication. J Vis Exp. 2019 Feb 6;(144). PMCID: PMC6677147.

2. Graduate Career: Functional connectivity of the cortex during sleep and wake

Building on my prior experiences, I was interested in studying functional connectivity in the cortex as a neurosciences graduate student at the University of California, San Diego, and this was the focus of each of my laboratory rotations. I joined the lab of Dr. Eric Halgren with whom I had previously collaborated. The source localization of M/EEG, which greatly enhances the scientific and clinical utility of these techniques, makes assumptions about the fall-off with distance of covariance between neural elements for which there is little ground truth. The central aim of my dissertation was to elucidate the frequency-specific covariability patterns of spontaneous brain activity during non-REM sleep (NREM) and wake. This was achieved by compositing intracranial stereo-EEG (sEEG) recordings from over 230 patients undergoing surgery for drug-resistant focal epilepsy. Many recordings are needed because the spatial sampling of any single patient is quite sparse. While I was accumulating and curating data for these analyses, I became interested in using diffusion-MRI (dMRI) based structural connectivity to estimate the underlying anatomical connectivity, and importantly, the fiber-tract distance between the cortical areas being sampled with sEEG. Upon successfully curating and compositing the spontaneous intracranial data, I discovered that functional correlativity rapidly decays with interelectrode distance and oscillatory frequency with higher frequencies decaying over shorter distances, except for the characteristic frequencies of NREM graphoelements which are disproportionately synchronous. For a given frequency, the distance relationship is described by an exponential function for areas connected by fibers less than 100 mm in length. Lastly, I showed that the source localization of spontaneous M/EEG is materially affected by these empirical frequency-specific fall-off rates.

a. **Rosen BQ** On corticocortical connectivity and its contribution to extracranial potentials. 2023. UC San Diego. ProQuest ID: Rosen_ucsd_0033D_22105. Merritt ID: ark:/13030/m5453906.
b. Marsh BM, Navas-Zuloaga MG, **Rosen BQ**, Sokolov Y, et al. Emergent effects of synaptic connectivity on cortical sleep slow wave amplitude, density and propagation in a large-scale thalamocortical network model of the human brain. 2023 bioRxiv. doi: 10.1101/2023.10.15.562408

3. Graduate Career: Structural connectivity of the cortex

Finding existing dMRI distance and connectivity matrices in the literature lacking, I performed fiber tractography on the preprocessed dMRI made available by the WU-Minn Human Connectome Project (HCP). I found that white-matter connectivity closely hews to an exponential function of fiber distance, a finding consistent with histological tracing studies in macaques. We also found that while hierarchy, as indexed by myelination, influenced white matter connectivity the effect of distance was much stronger, which is evidence against the cytoarchitectonic model of cortical connectivity. Distance and connectivity matrices were made available as a public resource. The dMRI-derived connectivity was also critical for my co-development of a corticothalamic model capable of simulating whole-head M/EEG while still being sensitive to subcellular synaptic properties. Because the units of dMRI connectivity are arbitrary, I sought a way to scale these values into physical units. By leveraging estimates of neuron density in the corpus callosum, I translated the dMRI streamline counts into an estimate of interareal axon counts, finding that distant areas are connected by surprisingly few axons in absolute terms. The dMRI-derived distances were used as part of a whole brain simulation of M/EEG and as the abscissa for estimating sEEG coherence-distance relationships. My dissertation's work is presented in four first-author publications, including one in preparation released as a dissertation chapter and one additional co-authored preprint.

a. **Rosen BQ**, Krishnan GP, Sanda P, Komarov M, et al. Simulating human sleep spindle MEG and EEG from ion channel and circuit level dynamics. J Neurosci Methods. 2019 Mar 15;316:46-57. PMCID: PMC6380919.
b. **Rosen BQ**, Halgren E. A Whole-Cortex Probabilistic Diffusion Tractography Connectome. eNeuro. 2021 Jan-Feb;8(1). PMCID: PMC7920542.
c. **Rosen BQ**, Halgren E. An estimation of the absolute number of axons indicates that human cortical areas are sparsely connected. PLoS Biol. 2022 Mar;20(3):e3001575. PMCID: PMC8947121.
d. **Rosen BQ** On corticocortical connectivity and its contribution to extracranial potentials. 2023. UC San Diego. ProQuest ID: Rosen_ucsd_0033D_22105. Merritt ID: ark:/13030/m5453906.

4. Graduate Career: Other contributions

In addition to the research directly forming my dissertation, I lead an interdisciplinary pilot project comparing human vs chimpanzee cortical expansion and human cortical gene expression which preliminarily associated *CNTNAP2* and *PCTP*, two genes previously implicated in language and autism spectrum disorder, with interspecies cortical expansion. I was awarded an Innovative Research Grant by the Kavli Institute for Brain and Mind to support this exploratory work. In addition, the corpus of curated sleep and waking sEEG and M/EEG data I created facilitated my colleagues in investigating the thalamo-cortical-hippocampal circuits that give rise to memory consolidation and perceptual binding. The findings of these projects included that thalamo-cortical connectivity drives sleep spindle properties, the discovery of theta bursts as a distinct sleep graphoelement, and the characterization of cortical ripples during sleep and wake. As part of these studies, I co-authored four publications, including one preprint. Separately, working with my rotation advisors Dr. Bradley Voytek and Dr. Terrance Sejnowski, I found evidence that the spectral slope of scalp EEG is altered by schizophrenia, and helped develop novel differential covariance-based methods of functional connectivity estimation, which each resulted in a co-authored publication. I also continued to collect MEG and maintain analysis pipelines in a consulting capacity for Dr. Marinkovic, and these efforts gave rise to four co-authored publications. Collectively, the research I performed during my graduate career is presented in 16 publications or preprints.

a. Gonzalez CE, Mak-McCully RA**, Rosen BQ**, Cash SS, Chauvel PY, Bastuji H, Rey M, Halgren E. Theta Bursts Precede, and Spindles Follow, Cortical and Thalamic Downstates in Human NREM Sleep. J Neurosci. 2018 Nov 14;38(46):9989-10001. PMCID: PMC6234298.
b. Chen Y, **Rosen BQ**, Sejnowski TJ. Dynamical differential covariance recovers directional network structure in multiscale neural systems. Proc Natl Acad Sci U S A. 2022 Jun 14;119(24):e2117234119. PMCID: PMC9214501.

c. Dickey CW, Verzhbinsky IA, Jiang X, **Rosen BQ**, et al. Widespread ripples synchronize human cortical activity during sleep, waking, and memory recall. Proc Natl Acad Sci USA. 2022 Jul 12;119(28):e2107797119. PMCID: PMC9282280.
d. Peterson EJ, **Rosen BQ,** Belger A, Voytek B, et al. Aperiodic Neural Activity is a Better Predictor of Schizophrenia than Neural Oscillations. Clin EEG Neurosci. 2023 Jul;54(4):434-445. PMID: 37287239.

5. Postdoctoral Career: Transcriptional correlates of evolutionary cortical expansion

Upon defending my dissertation, I secured a postdoctoral position in the lab of Drs. David Van Essen and Matthew Glasser at Washington University in St. Louis where I am investigating cortical evolution by examining homologies between humans and macaques and patterns of gene expression and cell type density. Previous attempts at registering human and macaque cortices have relied on optimization of the spherically inflated surface which introduces bias based on folding patterns. I have implemented a landmark-based approach optimized on the anatomical surface, greatly reducing this bias. This registration enables the creation of detailed maps of evolutionary cortical expansion. Further, I have mapped publicly available macaque spatial transcriptomics data to the surface, allowing comparisons of transcription with neuroimaging measures, including cortical expansion. I have preliminarily found that cell type gradients map onto cortical myelination better than gene expression gradients which reinforces the importance of single-cell resolution transcriptomics. I will apply these analyses to human cortical spatial transcriptomics data when it becomes available. Together, this work will shed light on the transcriptional origins of the greatly expanded and remarkably capable human neocortex.

**a.** **Rosen BQ**, Donahue, CJ, Coalson TS, Harwell J et al. Cell type correlates of evolutionary cortical expansion. 2023 Nov. poster, BICAN consortium meeting. Laurel MD.
**b.** **Rosen BQ**, Hayashi T, Van Essen DC, Glasser MF. Macaque cell type and gene expression correlates of neuroanatomy. 2024 June. Poster, Organization for Human Brain Mapping. Seoul, South Korea.
**c.** **Rosen BQ**, Donahue CJ, Coalson TS, Harwell, J, et al. Mapping evolutionary cortical expansion with anatomical MSM. 2024 June. Poster, Organization for Human Brain Mapping. Seoul, South Korea.