

Mark P. Brandon

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RESEARCH INTERESTS

Major psychiatric, neurological, and neurodegenerative diseases including schizophrenia, traumatic brain injury, temporal lobe epilepsy, and Alzheimer's disease, are associated with decreased size, metabolic dysfunction, and physiological pathology of the hippocampus and entorhinal cortex. Further, these circuits are essential for encoding and retrieval of episodic and spatial memories. My research aims to identify the logic by which these circuits operate in healthy and diseased states to understand the mechanisms that support hippocampal memory function and to guide efforts to restore entorhinal-hippocampal circuit function in neurodegenerative disease. For this, we employ a combination of in vivo electrophysiological recordings with reversible pharmacological and optogenetic manipulations in behaving animals.

ACADEMIC POSITIONS

Assistant Professor Department of Psychiatry McGill University Douglas Hospital Research Centre Montreal, QC, Canada	2015-
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EDUCATION

Graduate Program in Neuroscience Boston University Boston, MA	2006-2011
Ph.D. in Neuroscience	05/2011
University of Connecticut Storrs, CT	2002-2006
B.A. in Psychology and Minor in Neuroscience	05/2006

RESEARCH EXPERIENCE

Postdoctoral Research Center for Neural Circuits and Behavior, Division of Biological Sciences University of California, San Diego Advisor: Dr. Stefan Leutgeb	10/2011-2015
<ul style="list-style-type: none">• Developed optogenetic techniques to obtain precise control over the frequency of hippocampal theta oscillations.• Investigated the role of grid cells in the generation of orthogonal hippocampal place codes	
Postdoctoral Research Boston University	05/2011-10/2011

Advisors: Dr. Michael Hasselmo and Dr. Howard Eichenbaum

- Identified ‘timing versus distance’ qualities of grid cells during behavior on a treadmill task.

Graduate Student

2006-2011

Boston University

Advisor: Dr. Michael Hasselmo

- Examined the role of theta oscillations in the spatial coding of grid cells in the medial entorhinal cortex
- Identified a novel temporal organization of cortical head direction cell assemblies during behavior
- Developed novel approach for recording grid cells using a modified recording hyper-drive
- Quantified the activity of head direction cell ensembles during sleep

GRANTS AND AWARDS

- Brain and Behavior Research Foundation Young Investigator Award 2016-2018
- Scottish Rite Charitable Foundation Research Grant 2015-2018
- Canada Research Chair – Tier 2 2015-2020
- Postdoctoral Ruth L. Kirschstein National Research Service Award (NRSA) 2012-2015

PUBLICATIONS

Experimental papers

- 1) Kraus BJ, **Brandon MP**, Robinson RJ 2nd, Connerney MA, Hasselmo ME, Eichenbaum H. (2015) During running in place, grid cells integrate elapsed time and distance run. **Neuron**. Nov 4;88(3):578-89.
- 2) Schlesiger MI, Cannova CC, Boubilil BL, Hales JB, Mankin EA, **Brandon MP**, Leutgeb JK, Leibold C, Leutgeb S (*in press*) The medial entorhinal cortex is necessary for temporal organization of hippocampal neuronal activity. **Nature Neuroscience**.
- 3) Raudies F, **Brandon MP**, Chapman WG, Hasselmo ME (2015) Head direction is coded more strongly than movement direction in a population of entorhinal neurons. **Brain Research**, <http://dx.doi.org/10.1016/j.brainres.2014.10.053>
- 4) **Brandon MP**, Koenig J, Leutgeb JK, Leutgeb S. (2014) New and distinct hippocampal place codes are generated in a new environment during septal inactivation. **Neuron** May 21;82(4):789-96.
- 5) **Brandon MP**, Bogaard AR, Schultheiss NW, Hasselmo ME (2013) Segregation of cortical head direction cell assemblies on alternating theta cycles. **Nature Neuroscience** Jun;16(6):739-48.
- 6) **Brandon MP**, Bogaard AR, Libby CP, Connerney MA, Gupta K, Hasselmo ME (2011) Reduction of theta oscillations dissociates grid cell spatial periodicity from directional tuning. **Science** Apr 29;332(6029):595-9.
- 7) **Brandon MP**, Bogaard AR, Andrews CM, Hasselmo ME (2011) Head direction cells in the postsubiculum do not show replay of prior waking sequences during sleep. **Hippocampus** Mar;22(3):604-18.
- 8) Huang Y, **Brandon MP**, Griffin AL, Hasselmo ME, Eden UT. (2009) Decoding movement trajectories through a T-maze using point process filters applied to place field data from rat hippocampal region CA1. **Neural Computation** Dec;21(12):3305-34.

Modeling and review papers

- 9) **Brandon MP**, Koenig J, Leutgeb S. (2013) Parallel and convergent processing in grid, head-direction, and place cell networks. **WIREs Cogn Sci**. doi 10.1002/wcs.1271

- 10) Hasselmo ME & **Brandon MP** (2012) A model combining oscillations and attractor dynamics for generation of grid cell firing. **Front Neural Circuits**. 6:30
- 11) Hasselmo ME, Giocomo LM, **Brandon MP**, Yoshida M. (2010) Cellular dynamical mechanisms for encoding the time and place of events along spatiotemporal trajectories in episodic memory. **Behav Brain Res**. Dec 31;215(2):261-74.
- 12) Hasselmo ME, **Brandon MP**, Yoshida Y, Fransen E, Giocomo LM, Heys J, Newman E, Zilli E. (2009) A phase code for memory could arise from circuit mechanisms in entorhinal cortex. **Neural Networks** Oct; 22(8):1129-38.
- 13) **Brandon MP** & Hasselmo ME (2009) Sources of the spatial code within the hippocampus. (2009) **F1000 Biology Reports**, 1:3.
- 14) Hasselmo ME, **Brandon MP**. (2008) Linking cellular mechanisms to behavior: Entorhinal persistent spiking and membrane potential oscillations may underlie path integration, grid cell firing and episodic memory. **Neural Plasticity** (658323).

Book Chapters

- Hasselmo ME, Giocomo LM, **Brandon MP**, Yoshida M. Mechanisms for memory-guided behaviour involving persistent firing and theta rhythm oscillations in the entorhinal cortex. Dynamic Brain – from Neural Spikes to Behaviors.

Abstracts for Conference Presentations

- **Brandon MP**, Donegan ML, Leutgeb JK, Leutgeb S. (2014) Optogenetic stimulation of parvalbumin-positive neurons provides an external pacemaker of hippocampal theta dynamics. Society for Neuroscience Abstracts (465.06)
- Boubilil BL, **Brandon MP**, Gallagher M, Leutgeb JK, Leutgeb S. (2014) Hippocampal spatial coding in aged rats is altered by septal inactivation. Society for Neuroscience Abstracts (465.02)
- Climer JR, Ditullo R, Hinman JR, Chapman G, **Brandon MP**, Hasselmo ME, Eden UT. (2014) Addressing theta rhythmicity in extracellularly recorded neurons in rat and bat. Society for Neuroscience Abstracts (465.06)
- **Brandon MP**, Donegan ML, Leutgeb JK, Leutgeb S. (2013) Optogenetic control of the hippocampal theta rhythm. Society for Neuroscience Abstracts (578.06)
- **Brandon MP**, Donegan ML, Leutgeb JK, Leutgeb S. (2013) Frequency-independent phase coding by hippocampal neurons during optogenetic pacing of the theta rhythm. The Networked Brain Meeting.
- Raudies F, **Brandon MP**, Chapman GW, Hasselmo ME (2013) Movement direction is not coded by the firing of most entorhinal cells but required by grid cell models. Society for Neuroscience Abstracts (696.11)
- Hinman JR, **Brandon MP**, Chapman GW, Hasselmo ME (2013) Speed modulation of medial entorhinal cortical neurons during medial septal inactivation. Society for Neuroscience Abstracts (769.01)
- Kraus BJ, **Brandon MP**, Robinson RJ, Connerney MA, Hasselmo ME, Eichenbaum H. (2013) Grid cells are time cells. Society for Neuroscience Abstracts (769.19)
- Chapman GW, Schultheiss NW, **Brandon MP**, Hasselmo ME (2013) Theta cycle skipping relationships in the medial entorhinal cortex are robust. Society for Neuroscience Abstracts (769.04)
- **Brandon MP**, Koenig J, Hasselmo ME, Leutgeb JK, Leutgeb S. (2012) Septal inactivation eliminated grid cell spatial periodicity and causes instability of hippocampal place cells in novel environments. Society for Neuroscience Abstracts (203.05).
- Kraus BJ, **Brandon MP**, Connerney MA, Robinson II RJ, Eriksson S, Libby CP, White JA, Hasselmo ME, Eichenbaum H. (2012) MEC neurons exhibit temporally-modulated firing during stationary treadmill running. Society for Neuroscience Abstracts (203.14).
- **Brandon MP**, Bogaard AR, Hasselmo ME. (2011) Grid cells, head direction cells, and theta oscillations: An analysis of theta cycle skipping and speed modulation. Society for Neuroscience Abstracts. (730.06).

- **Brandon MP**, Libby C, Connerney M, Bogaard A, Hasselmo ME. (2010) Grid cell spiking depends on intact activity in the medial septum. Society for Neuroscience Abstracts. (101.19).
- Hasselmo ME, **Brandon MP**. (2010) Grid cell, border cell, and place cell spiking on a spiral maze. Society for Neuroscience Abstracts (101.20)
- **Brandon MP**, Bogaard A, Hasselmo ME. (2010) Grid cell firing in the medial entorhinal cortex altered by direct pharmacological infusions into the medial septum. FENS Forum of European Neuroscience Abstracts (025.7)
- **Brandon MP**, Andrews CM, Hasselmo ME. (2009) Analysis of replay of neural activity in rat postsubiculum during REM sleep. Society for Neuroscience Abstracts. (193.12).
- **Brandon MP**, Andrews CM, Hasselmo ME. (2008) Postsubiculum data during REM sleep in the rat shows replay of head direction activity experienced during waking. Society for Neuroscience Abstracts. (94.14).
- Hasselmo ME, **Brandon MP**. (2008) A model of place cell replay during REM sleep predicts temporally structured replay of head direction activity in postsubiculum. Society for Neuroscience Abstracts (94.15).
- Huang Y, **Brandon MP**, Griffin AL, Hasselmo ME, Eden UT. (2008) Decoding movement trajectories through a T-maze using point process filters applied to place field data from rat hippocampal region CA1. Society for Neuroscience Abstracts (690.17).
- **Brandon MP**, Griffin AL, Eichenbaum H, Hasselmo ME. (2008) Uniform spatial representation between task phases of dorsal CA1 neurons in a continuous non-match to position task on the T-maze. IJCNS
- Griffin AL, **Brandon MP**, Eichenbaum H, Hasselmo ME (2007) Characterization of single unit activity in dorsal CA1 during a nonmatch-to-position spatial memory task, Society for Neuroscience Abstracts (427.1).
- Hinman JR, **Brandon MP**, Sava S, Markus EJ (2006) Examining the orthogonality of hippocampal place cells across environments, Society for Neuroscience Abstracts (371.2).

INVITED LECTURES AND PRESENTATIONS

- 2015 Chair and Speaker, Spring Hippocampal Research Conference. Taormina, Italy.
- 2015 Speaker, 9th Annual Neural Microcircuits Symposium, UCLA, Los Angeles, CA.
- 2014 Speaker, McGill University, Douglas Research Hospital, Montreal, Quebec
- 2014 Speaker, University of California, Irvine, Department of Anatomy and Neurobiology
- 2014 Speaker, Boston University, Department of Biology
- 2013 Speaker, Spring Hippocampal Research Conference. Taormina, Italy.
- 2013 Chair and Speaker, 37th Annual Winter Conference: Learning and Memory. Park City, UT.
- 2012 Speaker, 36th Annual Winter Conference: Learning and Memory. Park City, UT.
- 2012 Speaker, University of California, Irvine, Department of Neurobiology and Behavior
- 2011 Speaker, SUNY Downstate, Department of Cell Biology
- 2011 Speaker, University of Delaware. Department of Psychology
- 2011 Speaker, Johns Hopkins University, Department of Neuroscience
- 2011 Speaker, Miami University, Department of Psychology
- 2011 Speaker, University of Minnesota, Department of Neuroscience
- 2011 Speaker, University of Lethbridge, Alberta, Canada, Department of Brain Dynamics
- 2011 Speaker, University of Washington, Department of Psychology
- 2011 Speaker, University of California, Los Angeles, Department of Psychology
- 2011 Speaker, University of Connecticut, Department of Psychology
- 2011 Speaker, Spring Hippocampal Research Conference. Verona, Italy.
- 2010 Speaker, Gatsby Unit: Grid cell workshop. University College London, London, UK
- 2010 Speaker, 14th Annual International Conference on Cognitive and Neural Systems, Boston, MA

STUDENT RESEARCH AND MENTORSHIP

Graduate students

Hyun Choong Yong	9/15-current
Zaki Abaji	9/15-current
Isabelle Shank	1/16-current

Research Staff

Raphael Lavoie	8/15-current
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Undergraduate students

Johnson Ying (McGill)	9/15-current	
Oleksandr Pozdnyakov (McGill)	8/15-current	
Gecelle De Guia (UCSD)	5/14-6/15	
Vesta Yazdani (UCSD)	5/14-6/15	
Luca Debs (UCSD)	7/13-1/14	
Julianne Davis (UCSD)	5/13-6/14	
Mallory Martinez (UCSD)	5/13-1/14	
Christopher Hyde (UCSD)	1/13-6/14	Calit2 Undergraduate Summer Research Scholarship, 2013
Sahab Danesh (UCSD)	11/11-5/13	
Bradley Steuble (UCSD)	1/12-1/13	
Christopher Libby (BU)	1/09-5/11	Summer Undergraduate Research Fellowship, 2009, 2010
Michael Connerney (BU)	9/09-5/11	Summer Undergraduate Research Fellowship, 2010
Sven Eriksson (BU)	9/10-5/11	Summer Undergraduate Research Fellowship, 2010
Winthrop Gillis (BU)	11/10-5/11	
Sultan Muhammad (BU)	9/07-9/08	

OTHER PROFESSIONAL HIGHLIGHTS

- **Invited reviewer for:**
 - Cerebral Cortex
 - Current Biology
 - eLife
 - Hippocampus
 - Journal of Neuroscience
 - Journal of Neurophysiology
 - Journal of Physiology
 - Learning and Memory
 - Nature Neuroscience
 - Science
- **Member**
 - Society for Neuroscience