Joseph D. Monaco, Ph.D.

Mobile: 667.406.7398 • Email: joe@selfmotion.net • Web: jdmonaco.com
ORCID: 0000-0003-0792-8322 • GitHub: github.com/jdmonaco • Google Scholar: gceOLZEAAAAJ

Last updated: December 24, 2023

Education

- **Columbia University** — New York, NY
  Department of Neurobiology & Behavior — 2005–2009
  Center for Theoretical Neuroscience
  Degrees: Ph.D. (2009); M.Phil. (2008); M.A. (2006)
  Advisor: Larry Abbott (lfa2103@columbia.edu)

- **Brandeis University** — Waltham, MA
  Department of Biology — 2003–2005
  Volen Center for Complex Systems
  Graduate Program in Neuroscience, *Continued at Columbia University*
  Advisor: Michael Kahana (kahana@psych.upenn.edu)

- **University of Virginia** — Charlottesville, VA
  Laboratory of Computational Neurodynamics — 1999–2003
  Degrees: B.A. Mathematics; B.A. Cognitive Science; Minor, Philosophy
  Advisor: William ('Chip') Levy (wbl@virginia.edu)

Positions

- **National Institutes of Health** — Rockville, MD
  National Institute of Neurological Disorders and Stroke — 2023–present
  Office of the BRAIN Director
  Scientific Program Manager

- **SelfMotion Labs** (*stealth mode*) — Baltimore, MD
  Founder & Chief Scientist — 2022–present

- **Johns Hopkins University School of Medicine** — Baltimore, MD
  Research Associate (Faculty) — 2019–2022
  Postdoctoral Fellow — 2013–2019
  Department of Biomedical Engineering
  Sponsor: Kechen Zhang (kzhang4@jhmi.edu)

- **Johns Hopkins University** — Baltimore, MD
  Postdoctoral Fellow — 2009–2013
  Zanvyl Krieger Mind/Brain Institute
  PI: James J. Knierim (jknierim@jhu.edu)

Publications

Journal Articles

Hwang GM, Kulwatno J, Cruz TH, Chen D, Ajisafe T, **Monaco JD**, Nitkin R, George SM, Lucas C, Zehnder SM, and Zhang L. (*In press*). Transforming Modeling in Neurorehabilitation: Perspectives and Opportunities from US Funding Agencies. *Journal of Neural Engineering Research*

Levenstein D, Alvarez VA, Amarasingham A, Azab H, Zhe S. Chen, Gerkin RC, Hasenstaub A, Iyer R, Jolivet RB, Marzen S, **Monaco JD**, Prinz AA, Quraishi SA, Santamaria F, Shivkumar S, Singh MF, Traub R, Rotstein HG, Nadim F, and Redish AD. (2023). On the role of theory and modeling in neuroscience. *Journal of Neuroscience*, 43(7), 1074–88. doi: 10.1523/JNEUROSCI.1179-22.2022 [arxiv: 2003.13825]

Monaco JD and Hwang GM. (2022). Neurodynamical computing at the information boundaries of intelligent systems. *Cognitive Computation*. doi: 10.1007/s12559-022-10081-9

Hadzic A, Hwang GM, Zhang K, Schultz KM, and **Monaco JD**. (2022). Bayesian optimization of distributed neurodynamical controller models for spatial navigation. *Array*, 15, 100218. doi: 10.1016/j.array.2022.100218 [arxiv: 2111.00599]

Monaco JD, Hwang GM, Schultz KM, and Zhang K. (2020). Cognitive swarming in complex environments with attractor dynamics and oscillatory computing. *Biological Cybernetics*, 114, 269–284. doi: 10.1007/s00422-020-00823-z [arxiv: 1909.06711]

Wang CH, **Monaco JD**, and Knierim JJ. (2020). Hippocampal place cells encode local surface texture boundaries. *Current Biology*, 30, 1–13. doi: 10.1016/j.cub.2020.01.083 [biorxiv: 10.1101/764282]

Monaco JD, De Guzman RM, Blair HT, and Zhang K. (2019). Spatial synchronization codes from coupled rate-phase neurons. *PLOS Computational Biology*, 15(1), e1006741. doi: 10.1371/journal.pcbi.1006741 [biorxiv: 10.1101/211458]

Tabuchi M, **Monaco JD**, Duan G, Bell BJ, Liu S, Zhang K, and Wu MN. (2018). Clock-generated temporal codes determine synaptic plasticity to control sleep. *Cell*, 175(5), 1213–27. doi: 10.1016/j.cell.2018.09.016

Monaco JD, Rao G, Roth ED, and Knierim JJ. (2014). Attentive scanning behavior drives one-trial potentiation of hippocampal place fields. *Nature Neuroscience*, 17(5), 725–731. doi: 10.1038/nn.3687 [pdf] [supp]

Monaco JD, Knierim JJ, and Zhang K. (2011). Sensory feedback, error correction, and remapping in a multiple oscillator model of place cell activity. *Frontiers in Computational Neuroscience*, 5:39. doi: 10.3389/fncom.2011.00039

Monaco JD and Abbott LF. (2011). Modular realignment of entorhinal grid cell activity as a basis for hippocampal remapping. *Journal of Neuroscience*, 31(25), 9414–25. doi: 10.1523/jneurosci.1433-11.2011

Muzzio IA, Levita L, Kulkarni J, **Monaco J**, Kentros CG, Stead M, Abbott LF, and Kandel ER. (2009). Attention enhances the retrieval and stability of visuospatial and olfactory representations in the dorsal hippocampus. *PLOS Biology*, 7(6), e1000140. doi: 10.1371/journal.pbio.1000140

Monaco JD, Abbott LF, and Kahana MJ. (2007). Lexico-semantic structure and the recognition word-frequency effect. *Learning & Memory*, 14(3), 204–213. doi: 10.1101/lm.363207

Conference Papers

Buckley E, **Monaco JD**, Schultz KM, Chalmers R, Hadzic A, Zhang K, Hwang GM, and Carr MD. (2022). An interdisciplinary approach to high school curriculum development: Swarming Powered by Neuroscience. *Proceedings of 2022 IEEE Integrated STEM Education Conference (ISEC'22)*. [arxiv: 2109.05545]

Hwang GM, Schultz KM, **Monaco JD**, and Zhang K. (2021). Neuro-Inspired Dynamic Replanning in Swarms—Theoretical Neuroscience Extends Swarming in Complex Environments. *Johns Hopkins APL Technical Digest*, 35, 443–447.

Monaco JD, Hwang GM, Schultz KM, and Zhang K. (2019). Cognitive swarming: An approach from the theoretical neuroscience of hippocampal function. *Proceedings of SPIE (International society for optics and photonics) Defense & Commercial Sensing*. Micro- and Nanotechnology Sensors, Systems, and Applications XI, 109822D, 1–10. doi: 10.1117/12.2518966 [pdf]

Monaco JD and Levy WB. (2003). T-maze training of a recurrent CA3 model reveals the necessity of novelty-based modulation of LTP in hippocampal region CA3. *Proceedings of 2003 IEEE/INNS International Joint Conference on Neural Networks (IJCNN'03)*, 1655–1660. doi: 10.1109/IJCNN.2003.1223655 [pdf]

Preprints

Monaco JD, Rajan K, and Hwang GM. (2021). A brain basis of dynamical intelligence for AI and computational neuroscience. *ArXiv Preprint*. arxiv: 2105.07284

Thesis

Monaco JD. (2009). Models and mechanisms for integrating cortical feature spaces. Doctoral Dissertation, Columbia University, New York. ProQuest Publication No. AAT 3393609 [fullcolor]

Websites

"Joseph Monaco, Ph.D. – Scientific Program Manager, NIH BRAIN Initiative." Website.
https://www.ninds.nih.gov/about-ninds/who-we-are/staff-directory/joseph-monaco

"Briefly Balanced: Theoretical neuroscience of behavior in space and time." Website.
https://jdmonaco.com/

PubMed Listing. Website.
https://www.ncbi.nlm.nih.gov/pubmed/?term=monaco_jd+OR+(monaco_j+AND+muzzio_ia)

Google Scholar. Website. https://scholar.google.com/citations?hl=en&user=gceOLZEAAAAJ&view_op=list_works&sortby=pubdate

GitHub Overview. Website. https://github.com/jdmonaco

Twitter Feed. Social Media. https://twitter.com/j_d_monaco

Funding Awards

- NCS-FO: Spatial intelligence for swarms based on hippocampal dynamics 2018–2021
  - NSF/NCS FOUNDATIONS (BRAIN Initiative) Award No. 1835279: $862K/$997K (Direct/Total)
  - **Lead PI:** Kechen Zhang
  - **Co-PIs, JHUAPL**: Grace Hwang, Robert W. Chalmers, Kevin Schultz, and M. Dwight Carr
  - **Research Associate (FY19)/Co-PI (FY20–FY21): Joseph D. Monaco**

  → *I co-developed this project and co-wrote the proposal with a JHUAPL colleague (see* Leadership & Team Coordination *on p.10). As a Research Associate faculty at JHU as of FY20, my project role was promoted to co-PI.*

  → *This project was the basis for JHUAPL's 2020 ranking as a top workplace for innovation: "Johns Hopkins University APL is one of Fast Company's Best Workplaces for Innovators." (July 29, 2020).* Fast Company.

- Spiking network models of sharp-wave ripple sequences with gamma-locked attractor dynamics 2018–2020
  - NIH/NINDS R03 Award No. NS109923: $50K/$82K (Direct/Total)
  - **PI:** Kechen Zhang
  - **Research Associate: Joseph D. Monaco**

  → *I conceived this project, generated preliminary data, and wrote the proposal (see* Leadership & Team Coordination *on p.10). As a Postdoctoral Fellow, JHU policy precluded a PI role.*

- Learning to explore paths through space 2016–2018
  - JHU/Science of Learning Institute (SLI) Award: $150K
  - **PI:** Kechen Zhang
  - **Co-PI:** David J. Foster (now at UC Berkeley)
  - **Research Associate: Joseph D. Monaco**

  → *I conceived this project, initiated the collaboration between the Zhang and Foster labs, and wrote the proposal (see* Leadership & Team Coordination *on p.9). As a Postdoctoral Fellow, JHU policy precluded a PI role.*

Community Coverage of My Work

News & Views

- Place R, Nitz DA. (2020). Cognitive Maps: Distortions of the Hippocampal Space Map Define Neighborhoods. *Current Biology*, 30(8): R340–R342.
- Colwell CS, Donlea J. (2018). Temporal coding of sleep. *Cell*, 175(5): 1177–9.
- Dupret D, Csicsvari J. (2014). Turning heads to remember places. *Nature Neuroscience*, 17(5): 643–44.

Post-Publication Reviews

- Moser E, Rowland D. (May 12, 2014). "This exciting study finds an unexpected relationship between exploratory head scanning behavior and the development of new place fields in the rat hippocampus..." *F1000/Faculty Opinions*.
- Maler L. (April 10, 2014). "This elegant and original study has demonstrated a strong link between the neural activity of hippocampal pyramidal neurons (PNs) during head scanning behavior and their subsequent acquisition of a new place field..." *F1000/Faculty Opinions*.
- Giocomo L, Moser E. (June 29, 2011) "This paper presents an interesting computational model which utilizes grid-cell modularity to generate robust remapping..." *F1000/Faculty Opinions*.

Media Releases

"Novel Teaching Tool Earns Hopkins Collaborators International Conference Honors." JHUAPL Press Office. Sept 19, 2022. https://www.jhuapl.edu/NewsStory/220919-stem-teaching-tool-recognized-ieee-isec-2022

"Can robotic swarms navigate using learning rules devised for brain dynamics?" JHU/Kavli Neuroscience Discovery Insitute. May 3, 2020. https://kavlijhu.org/news/32

"Swarmalators." JHUAPL Press Office. May 9, 2019. https://www.youtube.com/watch?v=ic4zEgVMSsA

"What do animal brains have in common with swarms of robots? Maybe more than you think." Geoff Brown/JHU Office of Communications. Oct 2, 2018. https://hub.jhu.edu/2018/10/02/brain-robot-swarms-study/

"Do Robot Swarms Work Like Brains?" JHUAPL Press Office. October 1, 2018. https://www.jhuapl.edu/PressRelease/181001

"Where does a memory begin? Johns Hopkins neuroscientists think they know." Latarsha Gatlin/JHU Office of Communications. April 14, 2014. https://hub.jhu.edu/2014/04/14/memory-brain-place-cells/

"Johns Hopkins Researchers Probe Mysteries of the Brain." JHU Office of Communications. April 14, 2014. https://www.youtube.com/watch?v=Jm8OiLJqKJQ

Recognition

2022	IEEE/ISEC Best Paper Award, First Place
2003	International Joint Conference on Neural Networks (IJCNN) Student Paper Award, First Place
2002	U.Va. John A. Harrison III Undergraduate Research Award
1999–2003	U.Va. Echols Scholar
1999	State of Maryland Merit Scholastic Award
1999	AP Scholar with Distinction
1999	National Merit Scholarship Commended Student
1999	Johns Hopkins Mathematics Competition (2nd Place, Individual Calculus)
1999	Maryland Distinguished Scholar

Professional Service & Scientific Review

Journals — Editorial Boards

2023–present	Frontiers in Computational Neuroscience
2023–present	Frontiers in Neural Circuits

Journals — Peer Review

2023	Nature Communications
2021	PLOS Computational Biology
2021	Nature Machine Intelligence
2020	Neuroscience and Biobehavioral Reviews
2020	Scientific Reports
2019	eLife
2019	Hippocampus
2018–2019	Neuron
2018	Neural Computation (including as 'Communicator')
2018	PLOS ONE
2017	PeerJ
2015	IEEE Transactions in Biomedical Engineering
2012–2020	IEEE Neural Networks
2012	Biological Cybernetics
2012	Neurocomputing
2012	Neuroscience

Funding Agencies

2022	NSF CAREER Ad-Hoc Reviewer
2022	NSF Emerging Frontiers in Research and Innovation (EFRI) Preliminary Review (3 Panels)
2022–2023	NSF EFRI Final-Round Review (1 Panel, 1 Ad Hoc)
2020–2022	NSF EFRI Program Development, Extramural Contributor
2014	IARPA Program Development, Extramural Contributor

Conferences

2020–2021	Cosyne, Review Committee
2016	Cosyne, Review Committee

Societies

2022–2024	American Physical Society, Regular Member
2011–2022	Society for Neuroscience, Postdoc/Regular Member

Workshops, Seminars, and Talks

International

10/13/2023	"Cognitive-narrative dynamics of self-perspective control across the lifespan." *Invited Talk*. 33rd Annual International Association for Perceptual Control Theory (IAPCT) Conference, Session 7 on *Consciousness and the Self*, Virtual [pdf]
10/12/2023	"Beyond 'FAIR': What does sustainable protocolization of open data in neuroscience look like?" *Invited Panelist & Keynote Speaker*. Open Data in Neuroscience (ODIN) Symposium, Massachusetts Institute of Technology, Boston, MA
3/8/2023	"Neurodynamical computing at the information boundaries of intelligent systems." *Contributed Talk*. American Physical Society (APS) March Meeting, Las Vegas, NV [pdf]
2/1/2022	"Theory-Driven Data Science to Understand the Neural Dynamics of Memory and Behavior." *Invited Talk*. Department of Cell & Systems Biology, University of Toronto, Canada, Virtual

12/1/2021 "Learning as swarming: Cognitive flexibility from the neural dynamics of phase-coupled attractor maps." *Contributed Talk*. Neuromatch 4.0 Conference, Virtual

10/29/2020 "Spatial theta-phase coding in the lateral septum: A theory of allocentric feedback during navigation." *Contributed Talk*. Neuromatch 3.0 Conference, Virtual

10/7/2020 "Computing path integration with oscillatory phase codes in biological and artificial systems." *Data Blitz*. iNAV Symposium 2020, Virtual

7/1/2010 "Medial versus lateral modes for reconfiguring hippocampal representations." *Invited Talk*. Grid Cell Meeting, Gatsby Computational Neuroscience Unit, UCL, UK

National

9/26–28/2023 BRAIN Initiative Cell Atlas Network (BICAN) Knowledge Base Workshop. *BRAIN Liaison & Invited Participant*. Allen Institute for Brain Sciences, Seattle, WA

7/17–18/2023 Workshop on Ethics of Sharing Individual Level Human Brain Data Collected in Biomedical Research. *Co-Organizer, Breakout Moderator/Reporter*. BRAIN Initiative Neuroethics Working Group (NEWG), NIH, Bethesda, MD & Hybrid

5/9/2023 "Theory of theory: On the role of theory and modeling in neuroscience." *Invited Extramural Seminar*. NIH, Virtual [pdf]

4/28/2023 "Neurodynamical Articulation: Decoupling Intelligence from the Experiencing Self." *Invited Public Seminar*. QuEST, Air Force Research Lab/Autonomous Capabilities Team 3 (AFRL/ACT3), Virtual [pdf]

12/21/2022 "Finding Causal Paths Across Scales: Embodied Control, Ethological Interaction, and Theory-Driven Neural Data Science." *Invited Talk*. Division of Neuroscience and Behavior, NIH/NIDA, Virtual

11/17/2022 "Finding Causal Paths Across Scales: Embodied Control, Ethological Interaction, and Theory-Driven Neural Data Science." *Invited Talk*. Division of Neuroscience and Basic Behavioral Science, NIH/NIMH, Virtual

8/26/2022 "Brain oscillations: From cortical computing to the existential nonduality of conscious agents." *Invited Public Seminar*. Qualia Exploitation for Sensor Technology (QuEST), Air Force Research Lab/Autonomous Capabilities Team 3 (AFRL/ACT3), Virtual [pdf]

6/1/2020 "Can Transitory Neurodynamics Unify Learning Theories for Brains and Machines?" *Invited Talk & Panel Discussion*. 6th Annual BRAIN Initiative Investigators Meeting, Symposium 1 on *How Can Dynamical Systems Neuroscience Reciprocally Advance Machine Learning?*, NIH, Virtual [**YouTube**]

5/18/2020 "Computational Approaches to the Neural Dynamics of Time, Memory, and Behavior." *Invited Talk*. Department of Neuroscience, Medical Discovery Team for Optical Imaging, University of Minnesota, Virtual

2/24/2020 "Computational Mechanisms of Memory: Linking Behavior, Space, & Time." *Invited Talk*. Department of Psychology, University of Nevada, Las Vegas, NV

1/31/2020 "Attractors, memory, and oscillations: Computational motifs of spatial learning." *Invited Talk*. Department of Biological Sciences, University of Texas at El Paso, El Paso, TX

4/17/2019 "Emergent dynamics of hippocampal circuitry as a basis for robust self-organized planning in mobile swarms." *Invited Talk*. International Society for Optics and Photonics (SPIE) Defense & Commercial Sensing 2019 Conference, Baltimore, MD

4/10/2019 NSF/Neural & Cognitive Systems (NCS) PI Workshop. *Invited Participant*. Marriott Wardman Park Hotel, Washington, D.C.

2/3–7/2019 NSF/BRAIN Initiative Workshop: Present and Future Frameworks of Theoretical Neuroscience. *Invited Participant*. University of Texas, San Antonio, TX

1/3/2014 "Head scans drive the formation and potentiation of place fields during exploration." *Data Blitz*. 38th Winter Conference on Neurobiology of Learning & Memory, Park City, UT

4/10/2009 "Rapid spatial map formation and remapping by competing over grid cell inputs." *Thesis Seminar*. Department of Neurobiology & Behavior, Columbia University, New York, NY [Keynote Movie Export (mp4)]

Regional

10/2/2019 "Oscillations, attractors, and sequences: Extending hippocampal computations to artificial systems." *Invited Talk*. Kavli Neuroscience Discovery Institute, Johns Hopkins University, Baltimore, MD

1/22/2016 "Hippocampal circuits for space, memory, and navigation: From minimal models to biologically inferred networks." *Invited Talk*. Department of Pharmacology, University of Maryland, Baltimore, MD

9/6/2014 "Stopping to look: How attentive scanning behavior reveals the formation of new memories." *Department Retreat Seminar*. Department of Neuroscience, Johns Hopkins University, Baltimore, MD

4/21/2014 "Landmark influence: How attention to sensory cues stabilizes and updates the hippocampal cognitive representation of space." *Advanced Researcher Seminar*. Zanvyl Krieger Mind/Brain Institute, Johns Hopkins University, Baltimore, MD

4/1/2014 "Hippocampus and declarative memory: Head scanning." *Department 'Lab Lunch' Seminar*. Department of Neuroscience, Johns Hopkins University, Baltimore, MD

Scientific Conference Presentations

Monaco JD, Hwang GM, Schultz K, Zhang K. (2020). Cognitive swarming in complex environments with attractor dynamics and oscillatory computing. *6th Annual BRAIN Initiative Investigators Meeting*. Virtual, with audio narration. June 2020.

Monaco JD, Hwang GM, De Guzman RM, Blair HT, Zhang K. (2019). Spatial rate-phase coding in lateral septal 'phaser cells': single-unit data and theta-bursting models. *FENS (Federation of European Neuroscience Societies) Dynamics of the brain: Temporal aspects of computation*. North Copenhagen, Denmark. June 2019.

Monaco JD. (2019). Decoding septohippocampal theta cells during exploration reveals unbiased environmental cues in firing phase. Kavli Neuroscience Discovery Institute, Baltimore, MD. October 2019.

Monaco JD, Hwang GM, Schultz K, Zhang K. (2019). Self-organized swarm control using neural principles of spatial phase coding. *5th Annual BRAIN Initiative Investigators Meeting*. Washington, D.C. April 2019.

Hwang GM, Schultz K, **Monaco JD**, Chalmers RW, Lau SW, Yeh BY, Zhang K. (2018). Self-organized swarm control using neural principles of spatial phase coding. *Society for Neuroscience*. San Diego, CA. November 2018.

Monaco J, Blair HT, Zhang K. (2017). Decoding septohippocampal theta cells during exploration reveals unbiased environmental cues in firing phase. *Society for Neuroscience*. Washington, D.C. November 2017.

Monaco JD. (2016). Spatial rate/phase correlations in theta cells can stabilize randomly drifting path integrators. *Greater Baltimore SfN Meeting*, Baltimore, MD. October 2016

Monaco JD, Blair HT, Zhang K. (2015). Spatial rate/phase correlations in theta cells can stabilize randomly drifting path integrators. *Cosyne*. Salt Lake City, UT. March 2015.

Monaco J, Blair HT, Zhang K. (2014). Spatial rate/phase codes provide landmark-based error correction in a temporal model of theta cells. *Society for Neuroscience*. Washington, D.C. November 2014.

Wang CH, Rao G, **Monaco JD**, Deshmukh SS, Knierim JJ. (2014). Potentiation of place fields along the CA1 transverse axis by investigatory head-scanning behavior. *Society for Neuroscience*. Washington, D.C. November 2014.

Monaco J, Rao G, Knierim JJ. (2013). Scanning behavior in novel environments promotes *de novo* formation of hippocampal place fields in rats. *Society for Neuroscience*. San Diego, CA. November 2013.

Monaco J, Rao G, Knierim JJ. (2012). Hippocampal LFP during rodent head-scanning behavior: Theta and sharp-wave ripples. *Society for Neuroscience*. New Orleans, LA. October 2012.

Monaco J, Rao G, Knierim JJ. (2011). Hippocampal place cell firing during head-scanning movements is associated with the formation of new place fields. *Society for Neuroscience*. Washington, D.C. November 2011.

Rao G, **Monaco J**, Knierim JJ. (2011). Environmental novelty promotes rodent head-scanning behavior linked to enhanced entorhinal activity. *Society for Neuroscience*. Washington, D.C. November 2011.

Monaco JD, Zhang K, Blair HT, Knierim JJ. (2010). Cue-based feedback enables remapping in a multiple oscillator model of place cell activity. *Cosyne*. Salt Lake City, UT. February 2010.

Monaco JD, Abbott LF. (2009). Dynamic hippocampal remapping using recurrent inhibition on realigning grid cell inputs. *Cosyne*. Salt Lake City, UT. February 2009.

Monaco JD, Muzzio IA, Levita L, Abbott LF. (2006). Entorhinal input and global remapping of hippocampal place fields. *CNS*. Edinburgh, UK. July 2006.

Monaco JD, Abbott LF. (2006). Entorhinal input and the remapping of hippocampal place fields. *Cosyne*. Salt Lake City, UT. March 2006.

Monaco JD, Levy WB. (2003). T-maze training of a recurrent CA3 model reveals the necessity of novelty-based modulation of LTP in hippocampal region CA3. *IJCNN*. Portland, OR. July 2003.

Monaco JD, Perlstein RP. (1997). Monte-Carlo analysis of deoxyhypusine synthase inhibitor ligand conformations. *NIH Poster Day*. Bethesda, MD. August 1997.

Teaching & Mentoring

Educational Programming

2018–2021 My NSF project with JHUAPL (see *Funding Awards* on p.3 and *Leadership & Team Coordination* on p.10) was successfully funded with a substantial STEM component for high-school students involving the development of both a 12-week course and an intense 2-day seminar called “Swarming Powered by Neuroscience.” I worked with our STEM education collaborators at JHUAPL to develop computational resources required for the curricula. Additionally, I participated in and delivered two zoom lectures about our research for the virtual 4-day STEM workshop (developed due to Covid requirements) with 40+ students that was held Jan 2021.

Mentoring & Supervision

Spring 2021 Darius Carr, STEM high school student; I mentored Darius as part of a local high school program that facilitates research internships for underrepresented students. I developed a computational research project with him that deepened his current interests in neuroscience, python programming, and scientific research.

2020–2022 Armin Hadzic, junior machine learning engineer at JHUAPL; I supervised Armin in translating computational neuroscience models into the domain of reinforcement learning and Bayesian optimization to investigate autonomous swarming with neural control. Our project led to a first author peer-reviewed research publication for Armin in Array (see *Journal Articles* on p.2). In 2022, I provided letters of recommendation in support of Armin's applications to Ph.D. programs in computer science.

2019–2023 Sreelakshmi Rajendrakumar, master's student in JHU/Biomedical Engineering (BME); I mentored Sreelakshmi in hippocampal physiology and single-unit data analysis. In 2023, I provided letters of recommendation in support of Sree's applications to Ph.D. programs in operations research and causal inference.

2014 Manning Zhang, M.S., graduate student in JHU/BME; I mentored Manning through an exchange program with Shanghai Jiao Tong University and submitted a letter of recommendation supporting her admission to the JHU/BME master's program.

2013–2015 Chia-Hsuan Wang, Ph.D., graduate student at the JHU/MBI; I worked extensively with Chia-Hsuan to take over my previous studies of behavior and place cells in the Knierim lab, leading to a Society for Neuroscience conference poster in 2014. I supported her subsequent thesis research based on my analytics and informatics software, resulting in a paper in Current Biology (see *Journal Articles* on p.2).

Classroom Instruction

Fall 2004 Teaching Assistant for undergraduate "Introduction to Neuroscience" course, Brandeis University; I assisted Prof. Eve Marder by supervising classes, grading examinations, and giving review lectures.

Spring 2005 Teaching Assistant for undergraduate "Biology Laboratory" course, Brandeis University

Research Program Development

Leadership & Team Coordination

April 2010/2011 **Fellowship Proposal (NIH/NINDS F32 NRSA):** "Behavioral Coordination of Entorhinal-Hippocampal Activity for Real-Time Sensory Updating of Spatial Memory"

In collaboration with my posdoctoral sponsor Jim Knierim, I conceived and developed a postdoctoral fellowship training proposal as a NIH F32 NRSA application. The proposal integrated computational modeling with spatial navigation experiments based on behavioral data from position-tracking sensors and neural data from multiregional hippocampal–entorhinal single-unit ensemble recordings. The application received a 21st percentile rank; I followed up the 2010 application with a 2011 resubmission following discussions with NINDS PO Jim Gnadt.

Mar. 2016–2018 **Grant Award (JHU/SLI):** "Learning to explore paths through space"

This internal JHU award (2016–2018; see *Funding Awards* on p.3) resulted from a collaboration with David J. Foster (now at UC Berkeley) that I initiated to conduct modeling studies informed by his lab's hippocampal reactivation data. By integrating Prof. Zhang's mathematical theories of spatial cognitive maps, I wrote and submitted a proposal for a $200K/2-year project to the JHU Science of Learning Institute. The proposal was awarded at the $150K level and research outcomes included (1) novel theories of temporal synchronization coding that inspired the 2017 NSF proposal effort, and (2) preliminary dynamical models of sharp-wave reactivation that provided the foundation for the 2018 NIH R03 award.

April–June 2016 **Grant Proposal (DARPA/BTO):** "Noninvasive Gastrovagal Stimulation for Enhanced Neuroplasticity of Cortical and Hippocampal Networks during Cognitive Training (GEN-C)"

In response to DARPA announcement BAA-16-24 of the "Targeted Neuroplasticity Training (TNT)" program, I worked with colleagues from JHUAPL and JHU/SoM Center for Neurogastroenterology to develop a collaborative program involving 3 PIs and 5 co-Is (8 labs) across divisions, departments, and fields. I recruited experimental labs from JHU/MBI and coordinated proposed contributions to maximize scientific impact with a budget of $9.8M/5 years. I coordinated the 40-page research narrative, including writing, editing, and/or integrating each lab's contributions and worked with ORA to submit the proposal. While not funded in total, DARPA/BTO PM Doug Weber funded select components, leading to JHUAPL Work Agreement No. 145563 "BCI (Brain Computer Interface) Technologies" in 2018.

Nov. 2017–2021 **Grant Award (NSF/NCS):** "NCS-FO: Spatial intelligence for swarms based on hippocampal dynamics"

This NSF-awarded project (2018–2021; see *Funding Awards* on p.3) was the result of 6 months of collaboration, brain-storming, and team-building between the Zhang lab at JHU/SOM and a group of JHUAPL engineers, mathematicians, and scientists. The project was initially inspired by results that I presented at my Society for Neuroscience 2017 meeting poster. I wrote Aim 1 and integrated the full research narrative with inputs from our collaborators for the proposal of this $997K/2-year project to develop those initial ideas into technological applications (e.g., robotics, autonomous control, AI) that reciprocally inform neuroscience. The project has so far produced three posters, a conference talk & proceedings publication, three patent applications, a preprint, a research article in Biological Cybernetics, a NIH BRAIN Investigators Meeting symposium talk, and a substantial STEM program. We received a no-cost extension through FY21 to complete the final phase of the project.

Jan. 2018–2020 **Grant Award (NIH/NINDS):** "Spiking network models of sharp-wave ripple sequences with gamma-locked attractor dynamics"

To continue with the collaboration that I initiated with David J. Foster (UC Berkeley) on the basis of the internal SLI award (see above), I wrote a small modeling proposal that integrated preliminary results from the SLI project and recent research developments in the memory reactivation field. This proposal was awarded (2018–2020; see *Funding Awards* on p.3) through the NIH/NINDS R03 mechanism and I am currently utilizing this support to build a foundation for future efforts along this research track.

Feb.–Mar. 2018 **White Paper:** Schultz K, Zhang K, and **Monaco J**. "BrainSWARRMM: Brain-like Sharp-Waves for Autonomous Replanning & Reconnaissance on Matrix Manifolds"

In response to the Office of Naval Research (ONR) Special Notice N00014-18-R-SN05, Topic 3, I helped organize a series of collaborative meetings to design a $2M/4-year project between JHUAPL and JHU/SoM. I co-authored the resulting white paper that was submitted for consideration to ONR.

May–June 2018 **White Paper:** Zhang K, **Monaco JD**, Hwang GM, Schultz KM, Kobilarov M, Foster DJ, Jacobs J, and Itti L. "An Integrative Theoretical Framework of the Neural Self-Organization of Active Perception for Autonomous Spatial Navigation"

In response to ONR MURI Announcement N00014-18-S-F006 and with the help of JHUAPL, I coordinated a series of meetings with 5 PIs across 4 universities (Columbia, UC Berkeley, USC, JHU) to design an innovative research program that targeted reciprocal advances in experimental & theoretical neuroscience and robotics & AI across species and scales. The resulting $7.5M/5-year project that I outlined in the white paper was not invited for a full submission. We debriefed with the sponsor, ONR PM Marc Steinberg, who revealed that ONR was impressed with the project but that they were seeking a different balance of elements with respect to neuroscience and AI.

August 2019 **White Paper: Monaco J**, Zhang K, and Schultz K.. "SW2Mem: Graph Spectral Decoding of Hippocampal-Cortical Loops for Artificial Consolidation and Dreaming"

In response to ONR Special Notice N00014-19-S-SN08, Topic 5.1 I conceived this project, created the preliminary model and datasets, guided the preliminary analyses with JHUAPL collaborators, and wrote & submitted the white paper to ONR outlining a potential $1.05M/3-year project. ONR declined to invite us to submit a full proposal.

August 2019 **White Paper:** Schultz K, Agarwala S, Zhang K, and **Monaco J**. "Brain-like Distributed Surveillance using Heterogeneous Agents for integRated Perception, and Planning (BD-SHARPP)"

In response to ONR Special Notice N00014-18-R-SN05, Topic 3, we submitted a revised version of the March 2018 white paper that was specifically invited by ONR PM Tom McKenna.

Sept. 11, 2019 **NSF Project Review:** "Annual advisory board review symposium"

I delivered a seminar on Aim 1 progress at a JHUAPL-hosted symposium for our project's yearly review, attended by DARPA/I2O PM Hava Siegelmann and other outside experts.

Feb. 26, 2020 **Grant Proposal (NSF/NCS) :** "NCS-FO: Neuroeconomics as a biomimetic control theory for mobile robotic decision making"

This FY21 proposal was submitted to the NSF/NCS FOUNDATIONS program; while it was discussed and received high scores, the application was declined. I co-developed this project in collaboration with colleagues at the University of Pittsburgh Medical Center (UPMC), JHU Whiting School of Engineering (JHU/WSE), and JHUAPL. Our interdisciplinary project brought together multiscale human electrophysiological recordings (UPMC), latent state-space models (JHU/WSE), control- and game-theoretic analysis (JHUAPL), and mechanistic neural models (JHU/BME, for which I would have been co-PI). We proposed to investigate and characterize the neural bases of metacognitive brain states that influence decision-making during social & economic games. As a high-risk/high-reward element, we proposed to algorithmicize our results to advance human-robot interaction.

Jan. 14, 2022 **Grant Proposal (JHU/Discovery Award) :** "Algorithms of flexible navigation in mice and robots"

This intramural FY23 proposal for a JHU Discovery Award resulted from a new collaboration with Patricia Janak (PI; JHU/PBS) and Céline Drieu (postdoctoral fellow), in which we seek to integrate advanced large-scale neural recording technologies with my theoretical modeling of neural systems as a distributed control problem. Fundamental questions of neural systems communication will be addressed using convergent data-driven and theory-driven approaches to understanding the cognitive dynamics that enable mice to perform spatial goal-directed memory tasks.

Inventions & Patents

7/5/2022	Inventor, Autonomous Navigation Technology, US patent issued, 11,378,975
1/3/2020	Inventor, Autonomous Navigation Technology, US patent application, 16,734,294
5/10/2019	Inventor, Neuroinspired Algorithms for Swarming Applications, provisional patent, 62/845,957
1/3/2019	Inventor, Neuroinspired Algorithms for Swarming Applications, provisional patent, 62/787,891