Matthew L. **Leavitt, PhD**

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Passionate about understanding and explaining biological and synthetic intelligence.

Education

McGill University
Montréal, Québec, Canada

PhD in Physiology
2011 - 2017

- **Area of specialization:** Computational & systems cognitive neuroscience
- **Advisor:** Prof. Julio C. Martinez-Trujillo, MD, PhD
- **Dissertation Title:** *Network properties underlying working memory in primate prefrontal cortex*
- **Dissertation Summary:** An examination of how networks of neurons coordinate to generate cognitive behaviors, focusing on visuospatial working memory, through the collection and analysis of large-scale multi-neuron recordings from the prefrontal cortex of macaque monkeys.

McGill University
Montréal, Québec, Canada

BSc Major in Neuroscience, Minor in Musical Science and Technology
2006 - 2010

- **Focus:** Cognitive and behavioral neuroscience (Major); Digital Signal Processing, synthesis, and sampling (Minor)

Skills

Quantitative

- **Machine learning & statistical techniques for high-dimensional neural data**
  - *Noteworthy example:* Decoding the contents of working memory from large networks of simultaneously-recorded neurons in prefrontal cortex in macaque monkeys (Leavitt et al. (2017) *PNAS* & Leavitt et al. (2017) *Cerebral Cortex*).
- **Modeling of neural, biological, and behavioral systems**
  - *Noteworthy examples:* I modeled the learning process of macaques performing a visuospatial rule-learning task (Leavitt et al. (2018) *Neuroinformatics*), and neural circuit mechanisms of spatial attention (Duong et al. (in press) *eNeuro*).
- **DSP for neural and audio signals**
  - *Noteworthy example:* I developed a MATLAB program that changes the sex of a speaker's voice in recorded audio.

Technical

- **Oral, written, and graphic communication, with a particular passion for scientific and technical content**
  - *Noteworthy examples (oral):* I received awards for oral presentations given to both general audiences and other neuroscientists (see **Honors & Awards**), and I delivered conference presentations and course lectures on behalf of my supervisor.
  - *Noteworthy example (written):* Since 2014 I have been uniquely tasked with editing every manuscript and grant proposal produced by my lab.
- **Experimental design for neuroscientific, psychological, and psychophysical research**
- **Formal scientific literature review**
  - *Noteworthy example:* Leavitt et al. (2017, *Trends in Neurosciences*) reviews the evidence for working memory-related neural activity across different brain regions.
- **Assembling and troubleshooting bespoke systems for neurophysiological research in behaving non-human primates**
- **Neurosurgical techniques for research in non-human primates and rodents**
- **Teaching across diverse fields (neuroscience, music production, mathematics) and pupils (elementary through university-age students, macaque monkeys)**
- **Audio production and engineering for music and radio**

Creative

- **Writing and editing for comedy on stage and in print**
  - *Noteworthy examples:* I spent three years as an editor for McGill University's humor magazine (The Red Herring), working with a dedicated staff and coordinating contributor submissions. As part of a comedy troupe, I have written for and performed in numerous Montréal-area sketch and variety shows.
- **17 years experience in music production, engineering, and composition**
- **20 years experience playing drums in a variety of genres and contexts**
- **Digital, 35mm, and medium format photography**
- **Carpentry and woodworking**

Programming Languages & Tools

- **Fluent: MATLAB; Max/MSP**
  - *Noteworthy examples (MATLAB):* I performed computational neuroscientific data analysis yielding a doctoral dissertation and five peer-reviewed publications.
  - *Noteworthy examples (Max/MSP):* I built software for generating synthetic bird calls and multi-track audio looping.
- **Conversational: Python; Javascript & d3**
  - *Noteworthy example (Javascript & d3):* I made an interactive brain map visualizing evidence for working memory-related neural activity in different brain regions (see **mleavitt.net**), to accompany a review article on the same topic (Leavitt et al. (2017) *Trends in Neurosciences*).
- **Familiar: Ruby; Java; C++; Perl**

Natural Languages

- **Fluent: English**
- **Conversational: Spanish; Japanese**

Professional Experience

Postdoctoral Research Fellow — *London, Ontario, & Montréal, Québec, Canada*

University of Western Ontario - Martinez-Trujillo Cognitive Neurophsyiology Lab — *September 2017 - Present*

- Leading a research project examining the neuronal mechanisms of rule learning in prefrontal cortex in macaque monkeys.

Member, Board of Advisors — *Montréal, Québec, Canada*

Canadian University Software Engineering Conference (CUSEC) — *2015-present*

- CUSEC (www.cusec.net) is an annual, three-day, student-run software engineering and computer science conference.
- Provide guidance and mentorship to the Conference Chairs and staff.
- Collaborate to shape the priorities of CUSEC: ensuring the longevity and integrity of the organization and its mission.

Conference Co-Chair — *Montréal, Québec, Canada*

Canadian University Software Engineering Conference (CUSEC) — *2014*

- Recruited and managed a student volunteer staff of 23 across 7 teams (logistics, sponsorship, speakers, design, promotions, events, and A/V).
- Coordinated hospitality for ~600 attendees (500 students, 18 speakers, dozens of sponsor representatives, and staff).

Director of Speakers — *Montréal, Québec, Canada*

Canadian University Software Engineering Conference (CUSEC) — *2012 - 2013*

- I set the programming, and recruited and hosted the ~18 speakers for two consecutive conferences.
- Included notable speakers such as Alexis Ohanian, co-founder of Reddit; Bret Victor, interface designer, whose invited talk, *Inventing On Principle*, has 800k+ views on Vimeo and YouTube; and Benjamin Black, who co-authored the white paper on what would eventually become Amazon Web Services.

Research Assistant — *Montréal, Québec, Canada*

McGill University - Martinez-Trujillo Cognitive Neurophysiology Lab — *Winter 2009 - Summer 2011*

- Scope of duties included research design, non-human primate training, assisting in neurosurgeries, electrophysiological recording in awake behaving primates, neuronal data analysis, communicating results at conferences, and writing and editing grant proposals and manuscripts.

Audio Recording Engineer — *Alamo, California*

MLL Studios — *2004 - 2010*

- I assembled and operated a small, private recording studio. MLL studios engineered and produced dozens of songs for local bands and musicians, and served as a base of operations for my own recording projects.

Honors & Awards

2012-2016 — **McGill Physiology Internal Studentship Award**, Awarded to outstanding international graduate students. — *Montréal, QC*

2016	**Student Travel Award**, Vision Sciences Society. Awarded to top 20 student applicants of ~3000 attendees.	*St. Pete's Beach, FL*
2016	**1st Prize, Oral Presentations**, Physiology Research Day, McGill University. Placed 1st in a pool of ~15 talks.	*Montréal, QC*
2014	**Best Oral Presentation**, Canadian Association for Neuroscience Annual Meeting, Satellite Symposium on Primate Brain Circuits and Behavior. Awarded to top 2 of ~20 talks.	*Montréal, QC*

Press

This neuroscientist's poster showed how US travel bans stifle groundbreaking research
Quartz (2018)

US travel ban blocking students from presenting their research
Ars Technica (2018)

Publications, Conference Presentations, and Peer-review

I have worked on both the peer-review and submission sides of top neuroscience and multidisciplinary journals, publishing five peer-reviewed articles (including one review article) and serving as a peer-reviewer for other contributors. I have also given dozens of oral presentations at a range of scientific conferences and seminars. See **mleavitt.net** for a link to my Google Scholar profile and accessible publication summaries. The remainder of my CV details my peer-review experience, publications, and presentations.

Scientific peer-review (ad hoc)

Nature Neuroscience
Neuron
Proceedings of the National Academy of Sciences
Nature Communications
Cerebral Cortex
The Journal of Neuroscience
Experimental Brain Research

Publications

Codes for working memory in the brain: why so many?
Trends in Cognitive Sciences (in preparation)
ML Leavitt, JC Martinez-Trujillo

A normalization circuit underlying coding of spatial attention in primate lateral prefrontal cortex
eNeuro (under revision)
LR Duong, ML Leavitt, F Pieper, A Sachs, JC Martinez-Trujillo

Sustained activity encoding working memories: not fully distributed
Trends in Neurosciences (2017)
ML Leavitt, D Mendoza-Halliday, JC Martinez-Trujillo

Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles
Proceedings of the National Academy of Sciences (2017)
ML Leavitt, F Pieper, AJ Sachs, JC Martinez-Trujillo

A quadrantic bias in prefrontal representation of visual-mnemonic space
Cerebral Cortex (2017)
ML Leavitt, F Pieper, AJ Sachs, JC Martinez-Trujillo

Single-trial decoding of intended eye movement goals from lateral prefrontal cortex neural ensembles
Journal of Neurophysiology (2015)
CB Boulay, F Pieper, M Leavitt, J Martinez-Trujillo, AJ Sachs

Structure of spike count correlations reveals functional interactions between neurons in dorsolateral prefrontal cortex area 8a of behaving primates
PLoS ONE (2013)
ML Leavitt, F Pieper F, A Sachs, R Joober, JC Martinez-Trujillo

Conference Presentations

Talks/Lectures

2019	**Network properties underlying cognition in macaque LPFC**, ML Leavitt Blake Richards lab visit	*University of Toronto, Toronto, ON*
2018	**Ensemble mechanisms of rule learning in primate prefrontal cortex**, ML Leavitt, C Boulay, LR Duong, RA Gulli, AJ Sachs, JC Martinez-Trujillo. Nanosymposium on Decision Making: Circuits and Computations	*Society for Neuroscience, San Diego, CA*
2018	**Ensemble mechanisms of rule learning in primate prefrontal cortex**, ML Leavitt Xiao-Jing Wang lab visit	*New York University, New York, NY*
2018	**Network properties underlying cognition in LPFC**, ML Leavitt Roozbeh Kiani lab visit	*New York University, New York, NY*
2017	**Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles**, ML Leavitt Neuroscience and Biology Group	*MILA, Montréal, QC*
2017	**Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles**, ML Leavitt, AJ Sachs, JC Martinez-Trujillo. Workshop on Error-based learning in short-term and episodic memory	*Computational and Systems Neuroscience (COSYNE), Snowbird, UT*
2016	**Heterogeneous effects of neuronal ensemble size, tuning, and correlation structure on the decoding of spatial working memory in dorsolateral prefrontal cortex**, ML Leavitt, AJ Sachs, JC Martinez-Trujillo. Session on Visual Memory: Neural Mechanisms	*Vision Sciences Society, St. Pete's Beach, FL*
2016	**Noise correlation structure shapes ensemble coding of working memory in prefrontal cortex**, ML Leavitt, F Pieper, AJ Sachs, JC Martinez-Trujillo. Nanosymposium on Spatial Attention and Working Memory	*Society for Neuroscience, San Diego, CA*
2015	**Correlated variability and the fidelity of prefrontal working memory representations**, ML Leavitt, AJ Sachs, JC Martinez-Trujillo. Nanosymposium on Learning and Memory	*Society for Neuroscience, Chicago, IL*
2014	**Noise correlations and coding during spatial working memory**, ML Leavitt, JC Martinez-Trujillo. Satellite Symposium on Primate Brain Circuits and Behavior	*Canadian Association for Neuroscience, Montreal, QC*
2012	**The relation between local field potentials and single units across a microelectrode array implanted in macaque dorsolateral prefrontal cortex**, AJ Sachs, KJ Miller, F Pieper, ML Leavitt, JC Martinez-Trujillo. Nanosymposium on Signal Propagation	*Society for Neuroscience, New Orleans, LA*

Posters

2018	**Learning-related modulation of rule representation in primate prefrontal cortex ensembles**, Leavitt ML, Boulay C, Gulli RA, Duong LR, Sachs A, Martinez-Trujillo JC	*Neuroinformatics, Montréal, QC*
2017	**Prefrontal cortex ensemble activity during during associative visuomotor rule learning in primates**, Leavitt ML, Boulay C, Gulli RA, Duong LR, Sachs A, Martinez-Trujillo JC	*Society for Neuroscience, Washington, DC*
2017	**Lateral prefrontal cortex single neuron and ensemble activity during associative learning in virtually navigating monkeys**, Duong LR, Gulli RA, Corrigan BW, Leavitt ML, Doucet G, Martinez-Trujillo JC	*Society for Neuroscience, Washington, DC*
2017	**Hippocampal single neuron and ensemble activity during associative learning in virtually navigating primates**, Gulli RA, Duong LR, Corrigan BW, Doucet G, Leavitt ML, Williams S, Martinez-Trujillo JC	*Society for Neuroscience, Washington, DC*
2017	**Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles**, Leavitt ML, Sachs AJ, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Montréal, QC*
2016	**Beyond the single neuron: Ensemble coding of working memory in primate prefrontal cortex**, Leavitt ML, Sachs AJ, Martinez-Trujillo JC	*The Future of Visual Attention, Rochester, NY*
2016	**Non-selective neurons contribute information to neuronal ensembles by modifying noise correlation structure**, Leavitt ML, Sachs AJ, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Toronto, ON*
2015	**Predicting decision outcomes from single realizations of lateral prefrontal cortex neuronal activity**, Boulay C, Leavitt ML, Pieper F, Martinez-Trujillo JC, Sachs A	*Society for Neuroscience, Chicago, IL*
2015	**Neural representation of spatial working memory is divided into quadrants in primate prefrontal cortex**, Leavitt ML, Sachs AJ, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Vancouver, BC*
2014	**Neural tuning affects spike-rate correlations during a spatial working memory task**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Society for Neuroscience, Washington, DC*
2014	**Single-trial dorsolateral prefrontal cortex neural trajectories predict intended saccade direction**, Boulay C, Pieper F, Leavitt ML, Martinez-Trujillo JC, Sachs AJ	*Society for Neuroscience, Washington, DC*
2014	**Correlated spiking during during spatial working memory in macaque prefrontal area 8a**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Montreal, QC*
2013	**Anti-correlated spike rates associated with working memory activity in macaque dorsolateral prefrontal cortex**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Society for Neuroscience, San Diego, CA*
2013	**Spike count correlation variability in visual, presaccadic, and visuopresaccadic neurons of macaque dorsolateral prefrontal cortex during a working memory task**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Toronto, ON*
2012	**Spike rate correlations in visual, presaccadic, and visuopresaccadic neurons in area 8a of macaque prefrontal cortex during a spatial working memory task**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Society for Neuroscience, New Orleans, LA*
2012	**Spike rate correlations vary by neuron response type during working memory in macaque prefrontal area 8A**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Vancouver, BC*
2012	**Spike count correlations in visual, visuomotor, and motor neurons of macaque prefrontal area 8A during working memory maintenance**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Vision Science Society, Naples, FL*

2011	**Correlated activity of dorsolateral prefrontal cortex neurons during spatial working memory maintenance**, Leavitt ML, Pieper F, Sachs AJ, Martinez-Trujillo JC	*Society for Neuroscience, Washington, DC*
2011	**Spike rate correlations between primate dorsolateral prefrontal cortex neurons during a spatial working memory task**, Leavitt ML, Schneiderman M, Martinez-Trujillo JC	*Canadian Association for Neuroscience, Quebec, QC*
2011	**Spike count correlations between primate dorsolateral prefrontal cortex neurons during a spatial working memory task**, Martinez-Trujillo JC, Leavitt ML, Schneiderman M	*Vision Sciences Society, Naples, FL*