

# 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

- Advisor: Prof. Julio C. Martinez-Trujillo, MD, PhD
- Area of specialization: Computational & systems cognitive neuroscience
- Dissertation Title: *Network properties underlying working memory in primate prefrontal cortex*

### McGill University

Montréal, Québec, Canada

BSC MAJOR IN NEUROSCIENCE, MINOR IN MUSICAL SCIENCE AND TECHNOLOGY

2006 - 2010

- **Honors:** Dean's Multidisciplinary Undergraduate Research List

## Experience

### Postdoctoral Researcher

London, Ontario, & Montréal,  
Québec, Canada

UNIVERSITY OF WESTERN ONTARIO - MARTINEZ-TRUJILLO COGNITIVE NEUROPHYSIOLOGY LAB

September 2017 - Present

- Leader of a research project examining the mechanisms of rule learning in networks of neurons in macaque prefrontal cortex.

### Member, Board of Advisors

Montréal, Québec, Canada

CANADIAN UNIVERSITY SOFTWARE ENGINEERING CONFERENCE (CUSEC)

2015-present

- CUSEC ([www.cusec.net](http://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).
- Oversaw hospitality for for 500 attendees, 18 speakers, and dozens of sponsor representatives.

### Teaching Assistant

Montréal, Québec, Canada

MCGILL UNIVERSITY

Fall 2010 - Spring 2013

- Oversaw the capstone course for final-year undergraduate neuroscience majors in which they had to write reports on scientific lectures by invited researchers.
- Provided guidance and evaluated student reports, generating feedback to improve comprehension and communication.

### 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 200k+ views; 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, neural data analysis, communicating results at conferences, and writing and editing grant proposals and manuscripts.

## Audio Recording Engineer

MLL STUDIOS

Alamo, California

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

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2012-2016	<b>McGill Physiology Internal Studentship Award</b> , Awarded to international students to defray the cost of non-resident tuition.	Montréal, QC
2016	<b>Student Travel Award</b> , Vision Sciences Society. Awarded to 20 student applicants of ~3000 attendees.	St. Pete's Beach, FL
2015	<b>1st Prize, Oral Presentations</b> , Physiology Research Day, McGill University. Placed 1st in a pool of ~15 talks.	Montréal, QC
2014	<b>Best Oral Presentation</b> , Canadian Association for Neuroscience Annual Meeting, Satellite Symposium on Primate Brain Circuits and Behavior. Awarded to 2 of ~20 talks.	Montréal, QC

## Skills & Capabilities

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### Quantitative

- Machine learning & analytical techniques for high-dimensional 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*).
- Multivariate statistics
- Modeling of neural and biological systems
- DSP for neural and audio signals
  - **Noteworthy example:** I wrote a program that changes the gender of a speaker's voice in recorded audio.

### Programming Languages

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

### Technical

- Oral, written, and graphic communication, with a particular passion for scientific and technical content
  - **Noteworthy examples (oral):** I have won awards for oral presentations to both general and neuroscience audiences, and delivered conference presentations and course lectures in place of my supervisor.
  - **Noteworthy example (written):** Since 2014, I have been asked to edit every manuscript and grant proposal produced by my lab.
- Experimental design for psychological, neuroscientific, and biomedical research
- Neurosurgical techniques in non-human primates and rodents
- Handling and training non-human primates for complex behavioral tasks
  - **Noteworthy example:** I was partnered with a macaque monkey naive to human interaction, and in 6 months trained it to perform a sophisticated computer-based rule-learning task.
- Audio recording 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*) and have written for and performed in numerous sketch and variety shows.
- Music composition and production
- 20 years experience playing drums in a variety of genres and contexts
- Digital, 35mm, and medium format photography
- Carpentry and woodworking

## Natural Languages

- Fluent: English
- Conversational: Spanish; Japanese

## Scientific peer-review (ad hoc)

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*Nature Neuroscience*

*Neuron*

*Proceedings of the National Academy of Sciences*

*Nature Communications*

*Cerebral Cortex*

*The Journal of Neuroscience*

*Experimental Brain Research*

## Publications & Conference Presentations

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I have published five peer-reviewed articles in, and served as a peer-reviewer for, top neuroscience and multidisciplinary journals. I have also given dozens of oral presentations at a range of scientific conferences and seminars. See [mleavitt.net](http://mleavitt.net) for a link to my Google Scholar profile and accessible publication summaries. The remainder of my CV details all my presentations and publications.

## Publications

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### 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* (submitted)

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 quadrant 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 Joobar, JC Martinez-Trujillo

## Conference Presentations

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### TALKS/LECTURES

2017	<b>Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles</b> , <a href="#">ML Leavitt</a> , AJ Sachs, JC Martinez-Trujillo. Workshop on Error-based learning in short-term and episodic memory	<i>Computational and Systems Neuroscience (COSYNE), Snowbird, UT</i>
2016	<b>Heterogeneous effects of neuronal ensemble size, tuning, and correlation structure on the decoding of spatial working memory in dorsolateral prefrontal cortex</b> , <a href="#">ML Leavitt</a> , AJ Sachs, JC Martinez-Trujillo. Session on Visual Memory: Neural Mechanisms	<i>Vision Sciences Society, St. Pete's Beach, FL</i>
2016	<b>Noise correlation structure shapes ensemble coding of working memory in prefrontal cortex</b> , <a href="#">ML Leavitt</a> , F Pieper, AJ Sachs, JC Martinez-Trujillo. Nanosymposium on Spatial Attention and Working Memory	<i>Society for Neuroscience, San Diego, CA</i>
2015	<b>Correlated variability and the fidelity of prefrontal working memory representations</b> , <a href="#">ML Leavitt</a> , AJ Sachs, JC Martinez-Trujillo. Nanosymposium on Learning and Memory	<i>Society for Neuroscience, Chicago, IL</i>
2014	<b>Noise correlations and coding during spatial working memory</b> , <a href="#">ML Leavitt</a> , JC Martinez-Trujillo. Satellite Symposium on Primate Brain Circuits and Behavior	<i>Canadian Association for Neuroscience, Montreal, QC</i>
2012	<b>The relation between local field potentials and single units across a microelectrode array implanted in macaque dorsolateral prefrontal cortex</b> , AJ Sachs, KJ Miller, F Pieper, <a href="#">ML Leavitt</a> , JC Martinez-Trujillo. Nanosymposium on Signal Propagation	<i>Society for Neuroscience, New Orleans, LA</i>

### POSTERS

2018	<b>Learning-related modulation of rule representation in primate prefrontal cortex ensembles</b> , <a href="#">Leavitt ML</a> , Boulay C, Gulli RA, Duong LR, Sachs A, Martinez-Trujillo JC	<i>Neuroinformatics, Montréal, QC</i>
2017	<b>Prefrontal cortex ensemble activity during during associative visuomotor rule learning in primates</b> , <a href="#">Leavitt ML</a> , Boulay C, Gulli RA, Duong LR, Sachs A, Martinez-Trujillo JC	<i>Society for Neuroscience, Washington, DC</i>
2017	<b>Lateral prefrontal cortex single neuron and ensemble activity during associative learning in virtually navigating monkeys</b> , Duong LR, Gulli RA, Corrigan BW, <a href="#">Leavitt ML</a> , Doucet G, Martinez-Trujillo JC	<i>Society for Neuroscience, Washington, DC</i>
2017	<b>Hippocampal single neuron and ensemble activity during associative learning in virtually navigating primates</b> , Gulli RA, Duong LR, Corrigan BW, Doucet G, <a href="#">Leavitt ML</a> , Williams S, Martinez-Trujillo JC	<i>Society for Neuroscience, Washington, DC</i>
2017	<b>Correlated variability modifies working memory fidelity in primate prefrontal neuronal ensembles</b> , <a href="#">Leavitt ML</a> , Sachs AJ, Martinez-Trujillo JC	<i>Canadian Association for Neuroscience, Montréal, QC</i>
2016	<b>Beyond the single neuron: Ensemble coding of working memory in primate prefrontal cortex</b> , <a href="#">Leavitt ML</a> , Sachs AJ, Martinez-Trujillo JC	<i>The Future of Visual Attention, Rochester, NY</i>

2016	<b>Non-selective neurons contribute information to neuronal ensembles by modifying noise correlation structure,</b> <a href="#">Leavitt ML</a> , Sachs AJ, Martinez-Trujillo JC	Canadian Association for Neuroscience, Toronto, ON
2015	<b>Predicting decision outcomes from single realizations of lateral prefrontal cortex neuronal activity,</b> Boulay C, <a href="#">Leavitt ML</a> , Pieper F, Martinez-Trujillo JC, Sachs A	Society for Neuroscience, Chicago, IL
2015	<b>Neural representation of spatial working memory is divided into quadrants in primate prefrontal cortex,</b> <a href="#">Leavitt ML</a> , Sachs AJ, Martinez-Trujillo JC	Canadian Association for Neuroscience, Vancouver, BC
2014	<b>Neural tuning affects spike-rate correlations during a spatial working memory task,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Society for Neuroscience, Washington, DC
2014	<b>Single-trial dorsolateral prefrontal cortex neural trajectories predict intended saccade direction,</b> Boulay C, Pieper F, <a href="#">Leavitt ML</a> , Martinez-Trujillo JC, Sachs AJ	Society for Neuroscience, Washington, DC
2014	<b>Correlated spiking during during spatial working memory in macaque prefrontal area 8a,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Canadian Association for Neuroscience, Montreal, QC
2013	<b>Anti-correlated spike rates associated with working memory activity in macaque dorsolateral prefrontal cortex,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Society for Neuroscience, San Diego, CA
2013	<b>Spike count correlation variability in visual, presaccadic, and visuopresaccadic neurons of macaque dorsolateral prefrontal cortex during a working memory task,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Canadian Association for Neuroscience, Toronto, ON
2012	<b>Spike rate correlations in visual, presaccadic, and visuopresaccadic neurons in area 8a of macaque prefrontal cortex during a spatial working memory task,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Society for Neuroscience, New Orleans, LA
2012	<b>Spike rate correlations vary by neuron response type during working memory in macaque prefrontal area 8A,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Canadian Association for Neuroscience, Vancouver, BC
2012	<b>Spike count correlations in visual, visuomotor, and motor neurons of macaque prefrontal area 8A during working memory maintenance,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Vision Science Society, Naples, FL
2011	<b>Correlated activity of dorsolateral prefrontal cortex neurons during spatial working memory maintenance,</b> <a href="#">Leavitt ML</a> , Pieper F, Sachs AJ, Martinez-Trujillo JC	Society for Neuroscience, Washington, DC
2011	<b>Spike rate correlations between primate dorsolateral prefrontal cortex neurons during a spatial working memory task,</b> <a href="#">Leavitt ML</a> , Schneiderman M, Martinez-Trujillo JC	Canadian Association for Neuroscience, Quebec, QC
2011	<b>Spike count correlations between primate dorsolateral prefrontal cortex neurons during a spatial working memory task,</b> Martinez-Trujillo JC, <a href="#">Leavitt ML</a> , Schneiderman M	Vision Sciences Society, Naples, FL