Jude F. Mitchell

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Research interests

I am interested in how goal-directed behaviors alter information processing in the brain to improve performance. My laboratory links changes in the activity of neuronal cell classes and populations of neurons in primate visual cortex to behavioral performance. We use a novel animal model, the marmoset (*Callithrix Jacchus*), to investigate these questions. The marmoset offers unique advantages for probing neural circuitry at a detailed level in non-human primates.

Academic appointments

2015 - Assistant Professor, Dept. of Brain and Cognitive Sciences, University of Rochester

2010 - Staff Scientist, Systems Neuroscience, The Salk Institute, La Jolla, CA

2007 - Senior Research Associate, Systems Neuroscience, The Salk Institute, La Jolla, CA

2002 – Postdoctoral Research Fellow, Systems Neuroscience, The Salk Institute, La Jolla, CA

Education

Ph.D. Cognitive Science, University of California at San Diego, 2002
Dissertation: *Unity of Action: Coordination of Movement Plans Between Oculomotor Areas*
Committee members: David Zipser, Jeff Elman, Rich Krauzlis, Bill Kristan, Marty Sereno

B.S. Electrical Engineering, Harvard University, Cambridge, MA 1994

Research grants

2015-18: NIH, U01-NS094330, "Neural ensembles underlying natural tracking."
Co-PIs: Nicholas Priebe, Alex Huk, Ila Fiete (UT Austin)
$2,984,747 direct costs, over three years ($253,000 sub-award to U of R)

2014-16: NIH, R21-MH104756, "Optogenetic tools to distinguish neuronal class in behaving non-human primates."
Co-PI: Cory Miller (UCSD)
$275,000 direct costs, over two years (2nd year at University of Rochester)

Awards and small grants

2017 – Schmitt Program on Integrative Neuroscience (SPIN) Award,
"Investigating convergent strategies for population coding."
Co-PI: Krishnan Padmanabhan (U of R).
$50,000 direct costs, one year

2012 – Kavli Institute Innovative Research Award,
"Developing marmosets as a model for visual neuroscience."
Co-PIs: Cory Miller (UCSD), John Reynolds (The Salk Institute)
$30,000 direct costs, single year

Workshop grants

2016 – NSF, Center for Visual Science Symposia, "The Future of Attention."
Co-PI: Ben Hayden (U of R)
$10,000

2016 – NIH, R13EY026284, Center for Visual Science Symposia, "The Future of Attention."
Co-PI: Ben Hayden (U of R)
$25,000

Scholarship/Fellowship/Awards

2010-12: Swartz Foundation Research Fellowship, The Salk Institute, La Jolla, CA
"Normalization circuits and spiking models of attention."

2003-5: NIH Training Fellowship in Cognitive Neuroscience, UCSD
"Neuronal mechanisms of spatial attention in the macaque."

1996-99: NSF Graduate Student Fellowship, UCSD
"Neuronal models of saccade planning and working memory."

Academic Service

2016-18: Boynton Colloquium Organizer,
Center for Visual Science (CVS), University of Rochester

2015-18: Institutional Animal Care and Use Committee (IACUC),
University of Rochester Medical Center

2016-18: Neuroscience Search Committee,
Dept. of Brain and Cognitive Science (BCS), University of Rochester

2015-17: Organizing Committee, Marmoset Social Satellite Event,
Society for Neuroscience Meeting

2015-16: Co-Organizer of Bi-Annual Center for Visual Science (CVS) Symposium
"The Future of Attention", June 3-6, University of Rochester

2016-18: Executive Committee (rotating member),
Center for Visual Science (CVS), University of Rochester

2016-18: Graduate Admissions Committee,
Dept. of Brain and Cognitive Science (BCS), University of Rochester

2015: Organizer of "Comparative Neural Circuitry Meeting"
(Co-organizers: Cory Miller, David Leopold) Sept.16-18, Jackson Hole, WY

Invited Teaching

2017, Summer: Workshop on visual spatial attention and marmoset vision at
Vision: A Platform for Linking Circuits, Behavior, and Perception,
Cold Springs Harbor Laboratory summer course

2011, Summer: Workshop on neural mechanisms of spatial attention at
Telluride Neuromorphic Engineering Workshop
Telluride, Colorado

Teaching

2018, Spring: BCS/NSC 203: *Laboratory in Neurobiology*, Head Instructor
Co-instructors with David Kornack, Sarah McConnel, and Renee Miller
University of Rochester (+50 undergraduate students)

2016-17, Spring: BCS/NSC 203: *Laboratory in Neurobiology*, Co-taught with Kathy Nordeen (Lead Instructor), David Kornack, and Renee Miller
University of Rochester (+60 undergraduate students)

2015-17, Fall: NSC 301: *Senior Seminar in Neuroscience*
University of Rochester (+20 undergraduate students)

2015,17, Fall: BCS 504: *Sensory Systems, Co-Instructor*
Co-taught with Greg DeAngelis (Lead Instructor)
University of Rochester (+5 graduate students)

2017-present: Weekly literature reviews in *Visual Neuroscience,*
University of Rochester (2 graduate and 3-5 undergraduate students)

2002, Spring: *Neural Networks and Models of Cognition*, Head Instructor
Cognitive Science Department, University of California at San Diego

2000, Spring: *Introduction to Probability and Statistics*, Head Instructor
Cognitive Science Department, University of California at San Diego

Advising

Post-Doctoral:	2016-present:	Jacob Yates (CVS/BCS, University of Rochester)
	2016-present:	Shaun Cloherty (Monash University)
	2014-2016:	Samuel Nummela (UCSD)
	2011-2015:	Anirvan Nandy (Salk Institute)

Graduate Students:

Current:	2015-present:	Shanna Coop (BCS, University of Rochester)
	2015-present:	Sunwoo Kwon (BCS, University of Rochester)
Graduated:	2010-2013:	Emily Anderson (UCSD/Salk Institute)

Undergraduates Students/Honors Thesis:

Graduated:	2015:	Garrett Bunce (BCS/NSC, University of Rochester)
	2016:	Casey Bishop (BCS/NSC, University of Rochester)

Ad-hoc Refereeing

Grant agencies: *NIH SREA* (2017: 1), *Wisconsin National Primate Center Project Review* (2017:1), *Canada Foundation for Innovation* (2017:1)

Journals: *Science* (2016:1), *Nature* (2013:1), *Neuron* (2016:1), *Nature Communications* (2017:1), *Elife* (2015:1), *PLOS Biology* (2014:1), *Molecular Psychiatry* (2015:1), *Journal of Neuroscience* (2015-17:3), *Journal of Neurophysiology* (2015-17:3), *Cerebral Cortex* (2015-17:4), *NeuroImage* (2015:1), *Scientific Reports* (2017:1), *Developmental Neurobiology* (2016:1), *PLOS One* (2015:1), *Behavioral Brain Research* (2015:1), *Frontiers in Neural Circuits* (2017:1)

Patents

2013: Patent No. 61/727,599. *Electrode and method of use.* Filed November 17, 2013.

Consulting

2017: Janssen, Inc., Tamara Berdyyeva San Diego, CA
Establishment of a marmoset breeding colony.

2011: Brain Corporation, Inc., Eugene Izhikevich San Diego, CA
Development of biologically realistic models of vision.

Research Articles in preparation (* equal contribution)

1. Cloherty SL*, Yates JL*, DeAngelis GC, **Mitchell JF**. 'Motion perception in the common marmoset.' [in preparation for J. Neuroscience].

2. Yates JL*, Cloherty SL*, DeAngelis GC, **Mitchell JF**. 'Multiplicative interaction between perceptual biases and sensory input in motion estimation.' [working title, intended for Current Biology].

3. Coop SH, Bunce GW, **Mitchell JF**. 'Spatial cueing and planned saccade tasks in the marmoset.' [working title, intended for J. Neurophysiology].

4. Kwon S, Rolfs M, **Mitchell JF**. 'Pre-saccadic integration of motion information in smooth pursuit eye movements.' [working title, intended for Journal of Vision].

Peer-reviewed Review Articles

5. Miller CT, Friewald W, Leopold DA, **Mitchell JF**, Silva AC, Wang XJ (2016). 'Marmosets: A Neuroscientific Model of Human Social Behavior.' *Neuron,* 90(2), 219-233.

6. **Mitchell, JF**, Leopold, DA (2015). 'The marmoset monkey as a model for visual neuroscience.' *Neuroscience Research*, *93*, 20-46.

7. Belmonte, J.C.I., Callaway, E.M., Churchland, P., Caddick, S.J., Feng, G., Homanics, G.E., Lee, K.F., Leopold, D.A., Miller, C.T., **Mitchell, J.F.** and Mitalipov, S. (2015). 'Brains, genes, and primates.' *Neuron*, *86*(3), pp.617-631.

8. Stoner GR, **Mitchell JF**, Fallah M and Reynolds JH (2005). 'Interacting competitive selection in attention and binocular rivalry.' *Progress in Brain Research*, 14:227-34.

Peer-reviewed Research Articles (* equal contribution)

1. Nummela SU, Coop S, Cloherty SL, Boisvert CJ, Leblanc M, **Mitchell JF** (2017). 'Psychophysical measurement of marmoset acuity and myopia.' *Developmental Neurobiology,* 77(3), 300-13.

2. Nandy A**, Mitchell JF**, and Reynolds JH (2016). **'**Neurons in macaque Area V4 are tuned for complex spatio-temporal patterns.' *Neuron,* 91(4), 920-930.

3. Divincenti, J., Miller, AD, Knoedl, DJ, **Mitchell, JF (2016)**. 'Uterine Rupture in a Common Marmoset (Callithrix jacchus).' *Comparative Medicine*, 66(3), 254-258

4. MacDougall M, Nummela S, Coop S, Disney A, **Mitchell J**, and Miller T (2016). 'Viral expression and optogenetic manipulation of neural circuits in marmosets'. *J. Neurophysiology,* 116(3), 1286-94.

5. **Mitchell, JF**, Priebe, NJ, & Miller, CT (2015). Motion dependence of smooth pursuit eye movements in the marmoset. *Journal of neurophysiology*, *113*(10), 3954-3960.

6. Chow, CP*****, **Mitchell, JF***, and Miller, CT (2015). Vocal turn-taking in a non-human primate is learned during ontogeny. *Proceedings of the Royal Society of London B: Biological Sciences*, *282*(1807), 20150069.

7. **Mitchell JF**, Boisvert CR, Reuter JD, Reynolds JH, Leblanc M (2014). 'Correction of refractive errors in rhesus macaques (Macaca mulatta) involved in visual research.' *Comparative Med.* 64(4):300-8.

8. **Mitchell JF**, Reynolds JH, and Miller CT (2014). 'Active vision in marmosets: a model system for visual neuroscience.' *J Neuroscience*, 34(4): 1184-93.

9. Anderson EB, **Mitchell JF** and Reynolds JH (2013). 'Attention-dependent reductions in burstiness and action potential height in macaque area V4'. *Nature Neuroscience*, 16(8):1125-31.

10. Nandy AS, Sharpee T, Reynolds JH, and **Mitchell JF** (2013). 'The fine structure of shape tuning in area V4'. *Neuron* 78(6):1102-15.

11. Sundberg KA, **Mitchell JF**, Gawne TJ and Reynolds JH (2012). 'Attention influences single unit and local field potential response latencies in visual cortical area V4'. *J Neuroscience*, 32:16040-50.

12. Anderson EB, **Mitchell JF**, and Reynolds JH (2011). 'Attentional modulation of firing rate varies with burstiness across putative pyramidal neurons in macaque visual area V4'. *J. Neuroscience*, 31:10983-92.

13. Ciaramitaro VM, **Mitchell JF**, Stoner GR, Reynolds JH, and Boynton GM (2010). 'Object-based attention to one of two superimposed surfaces alters responses in human early visual cortex'. *J. Neurophysiology*, 105: 1258-65.

14. **Mitchell JF**, Sundberg KA, and Reynolds JH (2009). 'Spatial attention decorrelates intrinsic activity fluctuations in macaque area V4'. *Neuron*, 63:879-888.

15. Sundberg KA, **Mitchell JF**, and Reynolds JH (2009). 'Spatial attention modulates center-surround interactions in macaque visual area V4'. *Neuron*, 61:1-12.

16. Khoe W, **Mitchell JF**, Reynolds JH and Hillyard, SA (2008). 'ERP evidence that surface-based attention biases interocular competition during rivalry'. *Journal of Vision*, 8(3):18.1-11.

17. **Mitchell JF**, Sundberg KA, and Reynolds JH (2007). 'Differential attention-dependent response modulation across cell classes in macaque visual area V4'. *Neuron,* 55: 131-141.

18. Khoe W, **Mitchell JF**, Reynolds JH and Hillyard, SA (2005) 'Exogenous attentional selection of transparent superimposed surfaces modulates early event-related potentials'. *Vision Research,* 45(24):3004-14

19. **Mitchell JF**, Stoner GR and Reynolds JH (2004) 'Object-based attention in binocular rivalry'. *Nature,* Vol 429:410-413.

20. **Mitchell JF**, Stoner GR, Fallah M, and Reynolds JH (2003) 'Attentional selection of superimposed surfaces cannot be explained by modulation of the gain of color channels.' *Vision Research,* 43(12):1323-8.

21. **Mitchell JF**, Zipser D (2003) 'Sequential memory-guided saccades and target selection: A neural model of the frontal eye fields.' *Vision Research,* 43:2669-95.

22. **Mitchell JF**, Zipser D (2001) 'A model of visual-spatial memory across saccades.' *Vision Research,* 41:1575-92.

23. Czeisler CA, Duffy JF, Shanahan TL, Brown EN, **Mitchell JF**, Rimmer DW, Ronda JM, Silva EJ, Allan JS, Emens JS, Dijk DJ, Kronauer RE (1999) 'Age-independent stability, precision, and near-24-hour period of the human circadian pacemaker.' *Science,* 284:1-5.

24. Vassilev PM, **Mitchel JF**, Vassilev M, Kanazirska M, Brown EM (1997) 'Assessment of frequency-dependent alterations in the level of extracellular Ca^{2+} in the synaptic cleft.' *Biophysical Journal,* 72:2103-6.

Invited Book Chapters

1. Leopold DA, Mitchell JF, Freiwald WA (2017). '*Evolved Mechanisms of High-Level Visual Perception in Primates.*' In Evolution of Nervous Systems, 2nd Edition, edited by Jon H. Kass, Elsevier, Inc.

Invited Talks, Colloquiums, and Tutorials

2017 - Marmoset Social Event, Society for Neuroscience, Washington, DC
Challenges in establishing a marmoset research program

Vision Course Seminar, Banbury Center, Cold Springs Harbor, NY
Neural mechanisms of attention and the marmoset as a model system

Center for Perceptual Systems (CPS) Seminar, Austin, TX
Neural mechanisms of attention and the marmoset as a model system

2016 - Neurosciences Graduate Program Seminar, Rochester, NY
Neural mechanisms of attention and the marmoset as a model system

2015 - Neuroscience Seminar, University of Western Ontario, Canada
Active vision in marmosets: a model for visual neuroscience.

The Common Marmoset as a Transgenic Model of the Human Brain in Health, Janelia Farm, Washington, DC.
Active vision in marmosets: a model for visual neuroscience.

Japanese Meeting on Marmoset Neuroscience, Inuyama, Japan
Active vision in marmosets: a model for visual neuroscience.

Special Seminar, Center for Visual Sciences, Rochester, NY
Active vision in marmosets: a model for visual neuroscience.

2014 - Marmoset social, The Society for Neuroscience, Washington, DC
Visual behavioral experiments in awake marmosets.

Neuroscience Search Seminar, Cambridge University, England
Active vision in marmosets: a New World for visual neuroscience

Laboratory of Sensorimotor Research, NIH, Bethesda, MD
Active vision in marmosets: a New World for visual neuroscience

Krieger Brain & Mind Institute Seminar, Johns Hopkins, Baltimore, MD
Active vision in marmosets: a New World for visual neuroscience

Physiology Search Seminar, University of Arizona, Tucson, AZ
Active vision in marmosets: a New World for visual neuroscience

Neuroscience Seminar, Pittsburgh University, Pittsburgh, PA
Active vision in marmosets: a New World for visual neuroscience

Neuroscience Search Seminar, Baylor University, Houston, TX
Active vision in marmosets: a New World for visual neuroscience

Neuroscience Search Seminar, Brain and Cognitive Sciences, Rochester, NY
Active vision in marmosets: a New World for visual neuroscience

2013 - Transgenic models of the human brain. Cricks-Jacobs Symposium, La Jolla, CA
Active vision in marmosets: a New World for visual neuroscience.

Invited seminar: Dr. Erika Sasaki and Hideyuki Okano, Keio University, Japan
Mechanisms of attention and the marmoset as a model for visual neuroscience.

Attention and Learning Neuroscience Satellite Meeting, La Jolla, CA
Neural mechanisms of spatial attention: reductions of ongoing cortical activity.

Physiology Dept. Seminar, Monash University, Melbourne, Australia
Active vision in marmosets: a New World for visual neuroscience.

Gordon Research Conference, Stonehill College, Easton, MA
The role of attention feedback in sensory processing.

Psychology Seminar, University of Arizona, Tucson, AZ.
Neural mechanisms of attention.

Psychology Seminar, Psychology Dept, UCSD, La Jolla, CA.
The marmoset as a primate model for visual neuroscience.

Neuroscience Special Seminar, Psychology Dept, Vanderbilt U., Nashville, TN.
The role of attention feedback in sensory processing.

Neurobiology Seminar Series, Zilke Institute, USC, Los Angeles, CA.
The role of attention feedback in sensory processing.

2012 - Swartz Foundation Research Retreat, La Jolla, CA.
A network model of attention-dependent reductions of correlated noise.

2010 - Special Seminar, Neurosciences Institute, La Jolla, CA
Spatial attention decorrelates intrinsic noise fluctuations

2009 - COSYNE Workshop, 'Modulation of cortical response by brain state', Snowbird, UT
Spatial attention decorrelates intrinsic noise fluctuations

Conference Oral Presentations (within 5 years)

1. *Yates JL, Cloherty SL, DeAngelis GC, Mitchell JF. Motion estimation in the common marmoset. The 13th Asia Pacific Conference on Vision (2017).
2. *Coop SH, Nummela SU, Mitchell JF. Psychophysical measurement of marmoset acuity and myopia. OSA Fall Vision Meeting (2016), Rochester, NY.
3. *Mitchell JF. The marmoset as a model organism for active vision and visual neuroscience. Minisymposium, "Transgenic Primate Models of the Human Brain". Program No. 668.02.2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2014.
4. *Mitchell JF, Reynolds JH. A network model of attention-dependent reductions of noise correlations in macaque V4. Program No. 724.03.2012 Neuroscience Meeting Planner. New Orleans, LA: Society for Neuroscience, 2012.

5. *Anderson EB, Mitchell JF, Reynolds JH. Attention-dependent reduction in burstiness and action potential height in macaque V4. Program No. 724.01.2012 Neuroscience Meeting Planner. New Orleans, LA: Society for Neuroscience, 2012.

Conference Poster Presentations (within 5 years)

1. Coop SH, Bunce GW, Mitchell JF. Spatial cueing and planned saccade tasks in the marmoset. Program No. 60.16.2017 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2017.
2. Cloherty SL, Yates JL, DeAngelis GC, Mitchell JF. Motion perception in the common marmoset. Program No. 146.04.2017 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2017.
3. Yates JL, Cloherty SL, DeAngelis GC, Mitchell JF. Motion estimation in the common marmoset. Sunposium 2017, Max Plank Institute, West Palm Beach, FL
4. Mitchell JF, Nummela SU, Miller CT. Natural viewing and pursuit behavior in marmosets performing forarging tasks. Program No. 61.13.2015 Neuroscience Meeting Planner. Chicago, IL: Society for Neuroscience, 2015.
5. Nummela SU, Miller CT, Mitchell JF. Psychophysical measurement of marmoset visual acuity as a function of eccentricity. Program No. 330.09.2015 Neuroscience Meeting Planner. Chicago, IL: Society for Neuroscience, 2015.
6. MacDougall M, Coop SH, Nummela SU, Mitchell JF, Miller CT. Optogenetic control of marmoset cortical neurons. Program No. 413.11.2015 Neuroscience Meeting Planner. Chicago, IL: Society for Neuroscience, 2015.
7. Mitchell JF, Priebe NJ, Miller CT. Smooth pursuit eye movements in the common marmoset. Program No. 626.18.2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2014.
8. Mitchell JF, Reynolds JH. Spatial attention may regulate noise correlations through increases in local inhibition. Program No. 435.03.2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2014.
9. Nandy AS, Reynolds JH, Mitchell JF. Spatio-temporal structure of shape-tuning in V4 receptive fields. Program No. 236.18.2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2014.
10. Casale AE, Hansen BJ, Mitchell JF, Reynolds JH, Callaway EM. Cell-type specific differences in high and low frequency synchronization during behavior in the awake mouse. Program No. 60.16.2014 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2014.
11. Mitchell JF, Reynolds JH, Miller CT. Developing awake behaving marmosets as a model for visual neuroscience. Program No. 262.18.2013 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2013.

12. Chow CP, Reynolds JH, Miller CT, Mitchell JF. Head-restrained marmosets discriminate find differences in orientation. Program No. 262.17.2013 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2013.
13. Nandy AS, Sharpee TO, Reynolds JH, Mitchell JF. The fine structure of V4 receptive fields. Program No. 465.15.2012 Neuroscience Meeting Planner. New Orleans, LA: Society for Neuroscience, 2012.

Research and Work-Related Experiences

1994-95: Scientific Programmer, Brigham Women's Hospital, Harvard University
Analysis of semi-periodic signals in noisy time-series
Supervisors: Richard Kronauer and Emery Brown

1993-94: Senior Undergraduate Thesis, Electrical Engineering, Harvard University
Differential equations and multi-compartment models of single neurons
Advisor: Richard Kronauer

1992: Scientific Programmer and Research Assistant, NOAA, Asheville, NC
Analysis of geographic information data and precipitation patterns
Advisor: Alan McNab