

CORTICAL SYSTEMS AND BEHAVIOR LABORATORY

UNIVERSITY OF CALIFORNIA, SAN DIEGO

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Education & Training.

BA --- University of Colorado at Boulder [1994 - 1998]

PhD --- Harvard University [1999 - 2003]

Post-Doctoral Fellow --- Johns Hopkins University [2003 - 2009]

Academic Positions.

2009 - current --- *Assistant Professor*, Department of Psychology, UC San Diego

2009 - current --- Neurosciences Graduate Program, UC San Diego

Honors and Awards.

1998 - C.M.U. Young Scientist Travel Fellowship

1999 - NSF Graduate Fellowship - *Honorable Mention*

2001 - Harvard University Certificate of Distinguished Teaching

2001-2004 – NIH NIMH Individual Pre-Doctoral NRSA Fellowship (F31 MH63501)

2002 - Harvard University Certificate of Distinguished Teaching

2004-2006 – NIH NIDCD Individual Post-Doctoral NRSA Fellowship (F32 DC007022)

Extramural Grant Support.

Prior

2000 - Explorers Club

- *Role.* PI
- *Title.* Vocal communication in Ugandan vervet monkeys

2001-2004 - NIH - F31 MH63501

- *Role.* PI
- *Title.* Sources of variation in primate vocal behavior

2004-2006 - NIH - F32 DC007022

- *Role.* PI
- *Title.* Neuroethology of call recognition in primates.

2005 - National Organization for Hearing Research Foundation

- *Role.* PI
- *Title.* The functional anatomy of communication signal processing in primate neocortex.

2006-2009 - NIH - R03 DC008404

- *Role.* PI
- *Title.* The neural correlates of antiphonal calling

2007-2012 – NIH – K99 | R00 DC009007

- *Role.* PI
- *Title.* Cortical mechanisms underlying vocal signal recognition

2012-2013 – Kavli Innovative Research Grant

- *Role.* Co-PI [PI – Jude Mitchell]
- *Title.* Developing marmosets as a model for visual neuroscience and optogenetics research

Current

2012-2017 – NIH - R01 DC012087

- *Role.* PI
- *Title.* Neural basis of vocal signal recognition during natural communication
- *Summary.* The aim of this grant is to explore the neural basis of vocal communication in primate neocortex. We combine single-neuron recordings in freely moving marmosets with interactive playback software to effectively engage subjects in their natural communication behaviors while simultaneously recording the related neural activity. Our aim here is to examine the behavioral and neural basis of vocal signal recognition and categorization.

2013-2016 – NSF - IDBR 1254309

- *Role.* Co-PI [PI – Ross Snider]
- *Title.* A measurement system for behavioral and acoustic communication networks in wild vertebrates
- *Summary.* The aim of this grant is to develop a novel collar based recording system that enables the acquisition of multiple data types simultaneously (i.e. vocalizations, ambient sound, spatial position, velocity, height). The goal is to place collars on all animals in a social group in order to quantify their ongoing communication networks. In collaboration with Profs. Nicola Schiel and Antonio Souto, we will implement these collars on wild marmosets at the Tapacura Ecological Field Station (Recife, Brazil).

2014-2016 – NIH R21 MH104756

- *Role.* Co-PI [PI – Jude Mitchell]
- *Title.* Optogenetic tools to distinguish neuronal class in behaving nonhuman primates
- *Summary.* The aim of this grant is to develop a to establish new techniques to identify the class and laminar location of neurons in visual cortex using combinations of physiological and

optogenetic methods. These will also establish the methods in a new model system, the behaving marmoset, a small bodied New World monkey that offers many opportunities for the kinds of genetic manipulation that have been successful with mice.

Pending

2015-2020 – NIH - R01

- *Role.* PI
- *Title.* Neocortical circuitry underlying audition
- *Summary.* The aim of this grant is to examine the circuitry underlying aspects of auditory perception in marmoset auditory cortex. Utilizing a conditioned behavioral task for auditory discrimination in marmosets we will utilize our awake-behaving fMRI preparation to map the regions of interest in the auditory cortex core and belt areas. Subsequent recordings of single neuron recordings in these areas will identify the physiological properties of cells during the behavioral task. Finally, we will use optogenetic techniques to modulate neural activity in these regions of interest to test their functional contributions to audition.

Field Work .

1995 - La Suerte Biological Field Station, Costa Rica : Capuchins : *Cebus capucinus*
1996 - Betumonga Research Station, Indonesia : Simakobu Monkeys : *Simias concolor*
1997-2003 - Cayo Santiago, Puerto Rico : Rhesus Monkeys : *Macaca mulatta*
2000 - Farley Hills, Barbados : Vervet Monkeys : *Cercopithecus aethiops*
2000 - Lake Nabugabo, Uganda : Vervet Monkeys : *Cercopithecus aethiops*
2000 - Kousseri, Cameroon : Vervet Monkeys : *Cercopithecus aethiops*
2002 - Soberania National Park, Panama : Cotton-top Tamarins : *Saguinus oedipus*
2010 – ongoing – Recife, Brazil: Common Marmosets : *Callithrix jacchus*

Teaching .

University of Colorado at Boulder

- Undergraduate Teaching Assistant – “Animal Behavior” (1998)

Harvard University

- Teaching Fellow – “Human Behavioral Biology” (2000); “Perception: Taste, Touch and Sound” (2001); “Cognitive Psychology” (2001); “Animal Cognition Laboratory” (2002)

Assistant Head Teaching Fellow – “Evolution of Human Nature” (2002)

- Instructor – “Neuroethology” (2003)

University of California, San Diego

PSY103 ‘Principles of Behavior’ (2010-present)

Neuro200c ‘Cognitive Neuroscience’ (2013-present)

PSY240 ‘The Primate Brain’ (2009,2012)

PSY234 ‘Evolution of Language’ (2011)

Invited Talks.

2001 - Japanese Primate Research Institute (Inuyama, Japan)

2002 - Yale University, Dept of Psychology (New Haven, CT)

2002 - Johns Hopkins University, Dept of Biomedical Engineering (Baltimore, MD)

2004 - National Institute of Health (Poolesville, MD)

2005 - Max Planck Institute (Leipzig, Germany)
2005 – Advances and Perspectives in Auditory Neurophysiology (Washington, DC)
2006 - Gordon Conf: Sensory Coding and the Natural Environment (Big Sky Resort, MT)
2007 - Dartmouth College, Dept of Psychology (New Hanover, NH)
2007 - Emory University, Dept of Psychology (Atlanta, GA)
2008 - Rutgers University, Dept of Psychology (New Brunswick, NJ)
2008 - University of California, San Diego, Dept of Psychology (La Jolla, CA)
2009 – University of Oslo, ‘Darwin Day Symposium’ (Oslo, Norway)
2010 – The NeuroCog Collective (Bocas del Toro, Panama)
2011 – Princeton University, Face to Face, Brain to Brain Workshop (Princeton, NJ)
2012 – The NeuroCog Collective (Nosara, Costa Rica)
2012 – University of California, San Diego; Neuroscience Seminar Series (La Jolla, CA)
2013 – University of Texas at Austin; Center for Perceptual Systems Seminar (Austin, TX)
2014 – University of Pittsburgh; Dept of Neurobiology (Pittsburgh, PA)
2014 - The NeuroCog Collective (Coffs Coast, Australia)
2015 – University of Oregon; Institute of Neuroscience (Eugene, OR)
2015 – ‘Marmoset as a Transgenic Model of the Human Brain’ Workshop; Janelia Farm (Ashburn, VA)
2015 – Comparative Neural Circuits Workshop (Jackson Hole, WY)

Conference Presentations.

1998 - American Society of Physical Anthropology (Salt Lake City, Utah)
1999 - Evolution of Mind Symposium (London, England)
2001 - International Ethological Society Meeting (Tuebingen, Germany)
2001 - SAGA4 (Okayama, Japan)
2003 - 1st Conference on Acoustic Communication in Animals (College Park, MD)
2005 – Advances and Perspectives in Auditory Neurophysiology (Washington, DC)
2005 - Society for Neuroscience (Washington, DC)
2006 - Advances and Perspectives in Auditory Neurophysiology (Atlanta, GA)
2006 - Society for Neuroscience (Atlanta, GA)
2007 - Advances and Perspectives in Auditory Neurophysiology (San Diego, CA)
2007 - Society for Neuroscience (San Diego, CA)
2008 - Advances and Perspectives in Auditory Neurophysiology (Washington, DC)
2008 - Society for Neuroscience (Washington, DC)
2009 – Association for Research in Otolaryngology (Baltimore, MD)
2009 – CoSyne (Salt Lake City, UT)
2009 - Advances and Perspectives in Auditory Neurophysiology (Chicago, IL)
2009 - Society for Neuroscience (Chicago, IL)
2010 – SoCal Hearing Conference (Irvine, CA)
2011 - Advances and Perspectives in Auditory Neurophysiology (Washington, DC)
2011 - Society for Neuroscience (Washington, DC)
2012 – Annual Interdisciplinary Conference (Breckenridge, CO)
2012 - Advances and Perspectives in Auditory Neurophysiology (New Orleans, LA)
2012 - Society for Neuroscience (New Orleans, LA)
2013 - Annual Interdisciplinary Conference (Jackson Hole, WY)
2013 - Advances and Perspectives in Auditory Neurophysiology (San Diego, CA)
2013 - Society for Neuroscience (San Diego, CA)
2014 - Annual Interdisciplinary Conference (Jackson Hole, WY)
2014 - Advances and Perspectives in Auditory Neurophysiology (Washington, DC)
2014 - Society for Neuroscience (Washington, DC)

2015 - Annual Interdisciplinary Conference (Jackson Hole, WY)
2015 – Animal Behaviour Society (Anchorage, AK)
2015 - Advances and Perspectives in Auditory Neurophysiology (Chicago, IL)
2015 - Society for Neuroscience (Chicago, IL)

Professional Service.

Ad Hoc Reviewer: Journals.

American Journal of Primatology; Animal Behaviour; Animal Cognition; Behaviour; Bioacoustics; Brain, Behavior and Evolution; Cerebral Cortex; Ethology; Experimental Brain Research; European Journal of Neuroscience; Infancy; Interaction Studies: Social Behaviour and Communication in Biological and Artificial Systems; Journal of the Acoustical Society of America; Journal of Ethology; Journal of Zoology, Nature Neuroscience; Primates; Proceedings of the Royal Society, B

Ad Hoc Reviewer: Grants.

Binational Science Foundation

Conferences

2010 - *NeuroCog Collective* – Bocas del Toro, Panama

- Organizer (w/Laurie Santos)

2012 - *NeuroCog Collective* – Nosara, Costa Rica

- Organizer (w/John Serences)

2013-2015 - *Advances and Perspectives in Auditory Neuroscience* [APAN] SFN Presymposium

- Programming Committee

2014 - *NeuroCog Collective* – Coffs Coast, Australia

- Organizer (w/John Serences)

2015 – *Comparative Neural Circuits*– Jackson Hole, WY

- Co-Organizer (w/Jude Mitchell & David Leopold)

Publications.

In Prep.

1. Toarmino C; Itthipuripat S; Serences J & **Miller, CT**. In Prep. Discrimination of frequency-modulated sweeps in common marmosets.
2. MacDougal, M; Numella, S; Coop, S; Mitchell, J; & **Miller, CT**. In Prep. Optogenetic control of marmoset cortical neurons.
3. Numella, SU; Jovanovich, V; & **Miller, CT**. In Prep. Single primate frontal cortex neurons predict naturally occurring behavior.

In Review.

1. Toarmino, C.; Wong, L. & **Miller, CT**. In Review. Decisions for vocal interactions in a simulated primate communication network.
2. **Miller, CT**; Thomas, AW; Numella, SU; & de la Mothe, L. In Review. Responses of primate frontal cortex neurons during natural vocal communication.

Peer-Reviewed.

1. Mitchell, J; Priebe, N & **Miller CT**. 2015. Motion dependence of smooth eye movements in the marmoset. *Journal of Neurophysiology*, In Press
2. Chow, C.; Mitchell, J. & **Miller, CT**. 2015. Vocal turn-taking in a nonhuman primate is learned during ontogeny. *Proceedings of the Royal Society, B*. In Press
3. Mitchell, J; Reynolds, J & **Miller, CT**. 2014. Active vision in marmosets: A model for visual neuroscience. *Journal of Neuroscience*, 34,1183-1194.
4. Morrill, R; Thomas, AW; Schiel, N.; Souto, A; **Miller, CT**. 2013. The effect of habitat acoustics on common marmoset vocal signal transmission. *American Journal of Primatology*, 75, 904-916.
5. **Miller, CT** & AW Thomas. 2012. Individual recognition during bouts of antiphonal calling in common marmosets. *Journal of Comparative Physiology, A*. 198, 337-346
6. **Miller, CT**; Bee, MA. 2012. Receiver psychology turns 20: Should we broaden the scope? *Animal Behaviour*, 83, 331-343
7. Roy, S; **Miller, CT**; Gottsch, D; Wang, X. 2011. Vocal control by common marmosets in the presence of interfering noise. *Journal of Experimental Biology*, 214, 3619-3629
8. **Miller, CT**; DiMauro, A; Pistorio, A; Hendry, S; Wang, X. 2010. Vocalization induced cFos expression in marmoset cortex. *Frontiers in Integrative Neuroscience*, 4 (128) 1-15
9. **Miller, CT**; Mandel, K; Wang, X. 2010. The communicative content of the common marmoset phee call during antiphonal calling. *American Journal of Primatology* 72, 974-980.

10. **Miller, CT**; Eliades, SJ; Wang, X. 2009. Motor planning for vocal production in common marmosets. *Animal Behaviour*. 78, 1195-1203.
11. **Miller, CT**; Beck, K; Meade, B. Wang, X. 2009 Antiphonal call timing in marmosets is behaviorally significant: Interactive playback experiments. *Journal of Comparative Physiology, A*. 195, 783-789
12. **Miller, CT**; Wang, X. 2006. Sensory-motor interactions modulate a primate vocal behavior: antiphonal calling in common marmosets. *Journal of Comparative Physiology, A.*, 192, 27-38.
13. **Miller, CT**; Iguina, C; Hauser, MD. 2005. Processing vocal signals for recognition during antiphonal calling. *Animal Behaviour*, 69, 1387-1398.
14. Palleroni, A.; **Miller, C.T.** Hauser, M.D.; Marler, P. 2005. Prey plumage adaptation against falcon attack. *Nature*, 434, 973 – 974.
15. **Miller, CT**; Scarl, JS, Hauser, MD. 2004. Sex-specific sensory biases underlie sex differences in tamarin long call structure. *Animal Behaviour*, 68, 713-720.
16. **Miller, CT**; Hauser, MD. 2004. Multiple acoustic cues underlie vocal signal recognition in tamarins: antiphonal calling experiments. *Journal of Comparative Physiology, A.*, 190, 7-19.
17. Santos, LR; **Miller, CT**; Hauser, M.D. 2003. The features that guide them: distinguishing between functionally relevant and irrelevant features of artifacts in cotton-top tamarins and rhesus macaques. *Animal Cognition*, 6, 269-281.
18. **Miller, CT**; Flusberg, S, Hauser, MD. 2003. Interruptibility of long call production in tamarins: implications for vocal control. *Journal of Experimental Biology*, 206, 2629-2639.
19. **Miller, CT**; Paciulli, LM. 2002. Patterns of lateralized hand use in an arboreal primate (*Simias concolor*). *American Journal of Primatology*, 56, 231-236.
20. **Miller, CT**; Miller, J; Gil de Costa, R; Hauser, MD. 2001. Selective phonotaxis by cotton-top tamarins. *Behaviour*, 138, 811-826.
21. **Miller, CT**; Dibble, E; Hauser, MD. 2001. Amodal completion of acoustic signals by a nonhuman primate. *Nature Neuroscience*, 4, 783-784.
22. Hauser, MD, **Miller, CT**; Liu, KD; Gupta, R. 2001. Cotton-top tamarins fail to recognize their mirror image: within- & between-species differences. *American Journal of Primatology*, 53, 131-137.
23. Ghazanfar, AA; Flombaum, J; **Miller, CT**; Hauser, MD. 2001. The units of perception in cotton-top tamarin (*Saguinus oedipus oedipus*) vocal communication: Playback experiments with long calls. *Journal of Comparative Physiology, A.*, 187, 27-35.
24. Ramus, F; Hauser, MD; **Miller, CT**; Morris, D; Mehler, J. 2000. Language discrimination by human newborns and cotton-top tamarin monkeys. *Science*, 288, 349-351.

Book Chapters.

1. Toarmino, CT; Jovanovich, V; **Miller CT**. In Press. Decision-making in primate communication. IN MA Bee & CT Miller (eds) *Perception and Cognition in Animal Communication*. Springer Verlag.
2. **Miller, CT**; Cohen, YE. 2010. Vocalizations as auditory objects: behavior and neurophysiology. IN M. Platt & A.A. Ghazanfar (eds) *Primate Neuroethology*. Oxford University Press. pp 237-255
3. Egnor, RE; **Miller, CT**, Hauser, MD. 2006. Primate vocal communication. IN M. Naguib (ed) *The Encyclopedia of Language and Linguistics*. Elsevier Publishers.
4. Ghazanfar, AA; **Miller, CT**. 2004. Audition. IN M. Bekoff (ed) *Encyclopedia of Animal Behavior*. Greenwood Press: Westport, CT. Pgs. 334-343
5. **Miller, CT**; Weiss, D; Hauser, MD. 2003. Mechanisms of acoustic perception in cotton-top tamarins. IN. A.A. Ghazanfar (ed) *Primate Audition: Behavior to Neurobiology*. CRC Press: Boca Raton, FL. Pgs. 43-60.
6. **Miller, CT**; Ghazanfar, AA. 2002. Meaningful acoustic units in nonhuman primate vocal behavior. IN M.Bekoff, C.Allen, G.Burghardt (eds) *The Cognitive Animal*. MIT Press: Cambridge, MA. Pgs. 265-274.
7. Weiss, DJ; Ghazanfar, AA; **Miller, CT**; Hauser, MD. 2002. Specialized processing of primate facial and vocal expressions: evidence for cerebral asymmetries. IN L.Rogers; R. Andrew (eds) *Comparative vertebrate lateralization*. Cambridge University Press: Cambridge, UK.

Commentaries & Book Reviews.

1. Reynolds, J. **Miller, CT**. et al. In Press. Brains, Genes and Primates. *Neuron*
2. **Miller, CT** & Osmanski, M. 2009. Review of D.K. Oller, U. Griebel (eds) 'Evolution of Communicative Flexibility', MIT Press: Cambridge, MA. *Integrative and Comparative Biology*, 49, 720-722.
3. Ghazanfar, AA & **Miller, CT**. 2006. Language evolution: Loquacious monkey brains? *Current Biology*, 16, R879-R881

Book.

1. Bee, MA. & **Miller, CT** (eds). In Press. *Perception and Cognition in Animal Communication*. Springer Verlag.

Updated April 2015