

**Arne Ekstrom, Ph.D.**  
**Department of Psychology**  
**Center For Neuroscience**  
**University of California, Davis**  
**1544 Newton Court, Davis, CA 95618**

**Education**

Jan. 2004, Ph.D. Neuroscience, Brandeis University (advisor: Michael Kahana).  
May 2001, M.S. Neuroscience, University of Arizona.  
May 1996, B.A. Biology and Psychology, Brandeis University.

**Professional Appointments**

present Associate Professor, Psychology, UC-Davis Center for. Neuroscience.  
March 2009 –2014 Assistant Professor, Psychology, UC-Davis Center For Neuroscience.  
June 2004 - 2009 Postdoctoral Fellow, UCLA Semel Institute for Neuroscience.  
August 1996 -1997 Research Assistant, Harvard University.

**Honors and Awards**

2012 Kavli Fellow – National Academy of Sciences Kavli Frontiers of Science.  
2011 Alfred P. Sloan Fellow.  
2011 Hellman Young Investigator Award.  
2008 The Brain Research Institute Distinguished Postdoctoral Fellow in Neuroscience.  
2005 Finalist for Lindsley Prize, Society for Neuroscience award for best thesis of the year.  
1998 Flinn Biomathematics Fellow, University of Arizona.  
1996 B.A., Brandeis University, *magna cum laude*, high honors in neuroscience.

**Reviewing/Editing**

Associate Editor, Frontiers in Human Neuroscience  
Ad-hoc reviewing: Neuron, Nature Neuroscience, Journal of Neuroscience, Journal of Cognitive Neuroscience, Brain, Neuroimage, Behavioral Brain Research, Cerebral Cortex, Experimental Psychology: Learning, Memory, and Cognition

**Grant Reviewer:**

Ad-hoc reviewer: NIH-LAM, NSF, Canadian New Research Grants, Human Frontier Science Program (Strasbourg, France), Netherlands Organisation for Scientific Research, Wellcome-Trust.

**Current Research Support**

3R01NS076856

Ekstrom (PI)

7/01/12 – 6/30/17

NIH/NINDS

Representation and binding of spatiotemporal episodic memories in the human hippocampus

The hippocampus is critical for episodic memory, particularly in coding where and when events occurred. Neurodegenerative diseases such as stroke, epilepsy, and schizophrenia often impact hippocampal function and result in impairments to spatiotemporal episodic memory. Determining how and in what manner the human hippocampus represents space and time will advance our understanding of how damage to this area affects episodic memory.

Role: PI

1R21NS087527  
NIH/NINDS

Ekstrom (PI)

9/30/14-9/20/16

A critical and unresolved issue regards how multiple brain regions interact as part of their roles in memory. Addressing this issue is important because the neural mechanisms necessary for episodic memory are not currently known. We will address this issue in humans by mapping the brain networks underlying episodic memory using graph theory, multilobular electrocorticographical recordings, and chronometric cortical stimulation.  
Role: PI (co-PI Tandon)

Emil Barth Award (Dept. of Neurosurgery)  
Neurosurgery Department

Ekstrom (PI)

5/1/2012-5/1/2013

In conjunction with neurosurgeon Dr. Kia Shahlaie at UC-Davis Medical Center, the purpose of this grant is to investigate the effects of traumatic brain injury on hippocampal structure and function.  
Role: PI

Faculty Senate Grant (UC-Davis)

Ekstrom (PI)

6/1/14-6/1/15

This grant provides seed funds for a collaborative project with Dr. Beth Ober in human development to study spatial navigation in young and elderly participants.

### **Completed Research Support**

Alfred P. Sloan Foundation Fellowship  
Alfred P. Sloan Foundation

Ekstrom (PI)

9/1/2011-9/1/2013

This grant provides pilot funding for the PIs work on episodic memory and spatial navigation.

Hellman Young Investigator Award

Ekstrom (PI)

7/1/2011-7/1/2012

UC-Davis Dean's Office

This grant provides pilot funding for the PIs work on episodic memory and spatial navigation.  
Role: PI

UC-Davis Faculty Research Grant

Ekstrom (PI)

8/1/2010-10/1/2011

UC-Davis Academic Senate

The purpose of this project is to understand the brain systems involved in human spatial navigation using functional magnetic resonance imaging of healthy volunteer subjects.  
Role: PI

NS050067-01A  
NRSA (postdoctoral)

Ekstrom (PI)

6/01/05-5/31/09

Correlating Human Electrophysiology and BOLD Activity

The goal of the study was to examine the relationship between changes in regional blood flow seen on fMRI and electrophysiological activity of single neurons by direct microelectrode recording in the human medial temporal lobe during visual cognitive tasks.

Role: Postdoctoral Fellow

### **Student/Postdoctoral Supervision**

Hui Zhang, Ph.D., postdoctoral fellow, Center For Neuroscience, 9/1/2010-12/31/2012  
Andrew Watrous, Ph.D. Candidate, 5/1/2009-10/1/2013  
Jared Stokes, Ph.D. Candidate, 9/1/2011-  
Branden Kolarik, Ph.D. Candidate, 9/1/2011-  
Milagros Copara, Ph.D. Candidate, 9/1/2012-  
Amber Schedlbauer, Ph.D. Candidate, 9/1/2013-  
Lindsay Vass, postdoctoral fellow, 9/1/2014-

### **Refereed Journal Articles**

Stokes J.D., Kyle C. and **Ekstrom A.D.** (in press). Complementary Roles of Human Hippocampal Subfields in Differentiation and Integration of Spatial Context. Journal of Cognitive Neuroscience.

Watrous A.J., Fell J., **Ekstrom A.D.** and Axmacher N. (in press). More than spikes: common oscillatory mechanisms for content specific neural representations during perception and memory. Current Opinion in Neurobiology. PMID: 25129044

**Ekstrom A.D.**, Arnold A.E.G.F and Iaria G. (2014). A critical review of the allocentric spatial representation and its neural underpinnings: toward a network-based perspective. Frontiers in Human Neuroscience, 8(903), 1-15.

Schedlbauer A., Copara M.S., Watrous A.J. and **Ekstrom A.D.** (2014). Multiple interacting brain areas underlie successful spatiotemporal memory retrieval in humans. Scientific Reports, 4, 6431. PMID: 25234342.

Copara M.S., Hassan A., Kyle C., Libby L., Ranganath C., and **Ekstrom A.D.** (2014). Complementary roles of human hippocampal subregions during retrieval of spatiotemporal context. Journal of Neuroscience. 34(20): 6834-42. PMID: 24828637.

Zhang H., Zherdeva K. and **Ekstrom A.D.** (2014). Different "routes" to a cognitive map: Dissociable forms of spatial knowledge derived from route and cartographic map learning. Memory & Cognition. 42(7): 1106-1117. PMID: 24845757

Lee J.K., **Ekstrom A.D.**, and Ghetti S. (2014). Volume of hippocampal subfields and episodic memory in childhood and adolescence. Neuroimage. 94:162-171. PMID: 24642282.

Watrous A.J. and **Ekstrom A.D.** (2014). The Spectro-Contextual Encoding and Retrieval Theory of Episodic Memory. Frontiers in Human Neuroscience. 8(75): 1-14. PMID: 24600373.

**Ekstrom A.D.** and Watrous A.J. (2014). Multifaceted roles for low-frequency oscillations in bottom-up and top-down processing during navigation and memory. Neuroimage. 85:667-77.

PMID: 23792985.

**Ekstrom A.D.** (2014). Cognitive neuroscience: Navigating human verbal memory. Current Biology, 24(2): 167-168. PMID: 24556442.

Watrous A.J., Lee D.J., Izadi A., Gurkoff G.G., Shallice K., and **Ekstrom A.D.** (2013). A comparative study of human and rat hippocampal low frequency oscillations during spatial navigation. Hippocampus. 23(8):656-61. PMID: 23520039.

Watrous A.J., Tandon N., Connor C., Pieters T., and **Ekstrom A.D.** (2013). Frequency specific increases in network connectivity underlie successful spatiotemporal memory retrieval. Nature Neuroscience. 16(3): 349-356. PMID: 23354333.

Gruber M.J., Watrous A.J., **Ekstrom A.D.**, Ranganath C., Otten L.J. (2013). Expected reward modulated encoding-related theta activity before an event. Neuroimage. 64: 68-74. PMID: 22917987.

Zhang H. and **Ekstrom, A.D.** (2013). Human Neural Systems Underlying Rigid and Flexible Forms of Allocentric Spatial Representation. Human Brainmapping. 34(5):1070-87. PMID: 22786703.

Zhang H., Copara M., and **Ekstrom A.D.** (2012). Differential Recruitment of Brain Networks Following Route and Cartographic Map Learning of Spatial Environments. PLoS ONE. 7(9):e44886. PMID: 23028661.

Libby L.A., **Ekstrom A.D.**, Ragland, J.D., & Ranganath, C. (2012). Differential connectivity of perirhinal and parahippocampal cortices within human hippocampal subregions revealed by high-resolution functional imaging, Journal of Neuroscience. 32: 6550-60. PMID: 22573677.

Kern K., **Ekstrom A.D.**, Suthana N.A., Giesse, B.S., Montag M.S., Arshanapalli A., Bookheimer S., Sicotte N. (2012). Fornix Damage Limits Verbal Memory Functional Compensation in Multiple Sclerosis. Neuroimage. 59(3):2932-40. PMID: 22001266.

Staba R.J., **Ekstrom, A.D.**, Suthana N.A., Burggren A., Fried I., Engel J. Jr, Bookheimer S.Y. (2012). Gray matter loss correlates with mesial temporal lobe neuronal hyper-excitability inside the human seizure-onset zone. Epilepsia. 53(1):25-34. PMID: 22126325.

Lee D.J., Gurkoff G.G., Izadi A., Berman R.F., **Ekstrom A.D.**, Mulzelaar P., Lyeth B., Shallice K. (2012). Medial septal nucleus theta frequency deep brain stimulation improves spatial working memory following traumatic brain injury. Journal of Neurotrauma. Epub. PMID: 23016534.

Watrous, A., Fried, I., & **Ekstrom, A.D.** (2011). Behavioral correlates of human hippocampal delta and theta oscillations during navigation. Journal of Neurophysiology. 105:1747-55. PMID: 21289136.

**Ekstrom, A.D.**, Copara, M.S., Isham, E.A., Wang, W., and Yonelinas, A.P. (2011). Dissociable networks involved in spatial and temporal order source retrieval. Neuroimage. 56: 1803-1813. PMID: 21334445.

Mukamel, R., **Ekstrom, A.D.**, Kaplan, J., Iacoboni, M., Fried, I. (2011). Single-neuron responses in humans during execution and observation of actions. Current Biology. 2010:7. PMID: 20381353.

Suthana, N., **Ekstrom, A.D.**, Moshirvaziri, S., Knowlton, B., & Bookheimer, S. (2011). Dissociations within human hippocampal subregions during encoding and retrieval of episodic spatial information. Hippocampus. 21. 694-701. PMID: 20882543.

Isham, E.A., **Ekstrom, A.D.**, & Banks, W.P. Effects of youth authorship on the appraisal of paintings. (2011). Psychology of Aesthetics, Creativity, and the Arts.

Isham EA, Banks WP, **Ekstrom AD**, Stern JA. (2011). Deceived and distorted: game outcome retrospectively determines the reported time of action. Journal of Experimental Psychology: Human Perception and Performance. 37: 1458-69.

Hsieh, L.T., **Ekstrom, A.D.**, and Ranganath, C. (2011). Neural oscillations associated with item and temporal order maintenance in working memory. Journal of Neuroscience. 31: 10803-10. PMID: 21795532.

Addante, R., Watrous, A.J., Yonelinas, A.P., **Ekstrom, A.D.**, and Ranganath, C. (2011). Pre-stimulus theta activity predicts correct source memory retrieval. Proceedings of the National Academy of Sciences. 108: 10702-7. PMID: 21670287.

Jacobs, J., Kahana, M.J., **Ekstrom, A.D.**, Mollison, M.V., & Fried, I. (2011). A sense of direction in human entorhinal Cortex. Proceedings of the National Academy of Sciences. 107, 6487-6492. PMID: 20308554.

**Ekstrom, A.D. (2010)**. How and when the fMRI BOLD signal relates to underlying neural activity: The danger in dissociation. Brain Research Reviews, 62(2):233-44. PMID: 20026191.

Jacobs, J., Korolev, I., Caplan, J.B., **Ekstrom, A.D.**, Litt, B., Baltuch, G., Fried, I., Schulze-Bonhage, A., Madsen, J., & Kahana, M.J. (2010). Right-lateralized brain oscillations in human spatial navigation. Journal of Cognitive Neuroscience. 22, 824-836. PMID: 19400683.

Suthana, N.A., Krupa, A., Donix, M., Burggren, A., **Ekstrom, A.D.**, Jones, M., Ercoli, L.M, Miller, K.J., Siddart, P., Small, G.W., & Bookheimer, S.Y. (2010). Reduced Hippocampal CA2, CA3 and Dentate Gyrus Activity in Asymptomatic People at Genetic Risk For Alzheimer's Disease. Neuroimage. 53, 1077-1084. PMID:20005961.

Donix M, Burggren AC, Suthana NA, Siddarth P, **Ekstrom AD**, Krupa AK, Jones M, Martin-Harris L, Ercoli LM, Miller KJ, Small GW, Bookheimer SY. (2010). Family history of Alzheimer's disease and hippocampal structure in healthy people. The American Journal of Psychiatry, 167, 1399-1406. PMID: 20686185.

Donix M, Burggren AC, Suthana NA, Siddarth P, **Ekstrom AD**, Krupa AK, Jones M, Rao A, Martin-Harris L, Ercoli LM, Miller KJ, Small GW, Bookheimer SY. (2010). Longitudinal changes in medial temporal cortical thickness in normal subjects with the APOE-4 polymorphism. Neuroimage, 53, 37-43. PMID: 20541611.

**Ekstrom, A.D.**, Bazih, A.J., Suthana, N.A., Al-Hakim, R., Ogura, K., Zeineh, M., & Bookheimer, S.Y. (2009). Advances in high-resolution imaging and computational unfolding of the human hippocampus. Neuroimage, 47, 42-49. PMID: 19303448.

Suthana, N.A., **Ekstrom, A.D.**, Moshirvaziri, S., Knowlton, B., & Bookheimer, S.Y. (2009). Human Hippocampal CA1 involvement during allocentric encoding of spatial information. Journal of Neuroscience, 26, 10512-10519. PMID: 19710304.

**Ekstrom, A.D.**, Suthana, N.A., Behnke, E., Salamon, N., Bookheimer, S.Y., & Fried, I. (2008). High-Resolution depth electrode localization and imaging in patients with pharmacologically intractable epilepsy. Technical Note. Journal of Neurosurgery, 108, 812-5. PMID: 18377264.

Burggren, A.C., Zeineh, M.M., **Ekstrom, A.D.**, Braskie, M.N., Thompson, P.M., Small, G.W., & Bookheimer, S.Y. (2008). Reduced cortical thickness in hippocampal subregions among cognitively normal apolipoprotein E e4 carriers. Neuroimage, 41, 1177-83. PMID: 18486492.

**Ekstrom, A.D.**, Viskontas, I., Kahana, M.J., Jacobs, J., Upchurch, K., Bookheimer, S.Y., & Fried I. (2007). Contrasting roles of neural firing rate and local field potentials in human memory. Hippocampus, 17, 606-617. PMID: 17546683

**Ekstrom, A.D.**, & Bookheimer, S.Y. (2007). Spatial and temporal episodic memory retrieval recruit dissociable functional networks in the human brain. Learning and Memory, 14, 645-654. PMID: 17893237.

Jacobs, J., Kahana, M., **Ekstrom, A.D.**, & Fried, I. (2007). Brain oscillations control timing of single-neuron activity in humans. Journal of Neuroscience, 27, 3839-3844. PMID: 17409248

Viskontas, I., **Ekstrom, A.D.**, Wilson, C.L., & Fried, I. (2007). Characterizing interneuron and pyramidal cells in the human medial temporal lobe *in vivo* using extracellular recordings. Hippocampus, 17:49:57. PMID: 17143903

**Ekstrom, A.D.**, Caplan, J.B., Ho, E., Shattuck, K., Fried, I., & Kahana, M.J. (2005). Human hippocampal theta activity during virtual navigation. Hippocampus, 15, 881-889. PMID: 16114040.

**Ekstrom, A.D.**, Kahana, M.J., Caplan, J.B., Fields, T.A., Isham, E.A., Newman, E., & Fried, I. (2003). Cellular networks underlying human spatial navigation. Nature, 425, 184-188. PMID: 12968182.

**Ekstrom, A.D.**, Meltzer, J., McNaughton, B.L., & Barnes, C.A. (2001). NMDA receptor antagonism blocks experience-dependent expansion of hippocampal "place fields." Neuron, 31, 631-638. PMID: 11545721.

Redish, A.D., Battaglia, F.P., Chawla, M.K., **Ekstrom, A.D.**, Gerrard, J.L., Lipa, P., Rosenzweig, E.S., Worley, P.F., Guzowski, J.F., McNaughton, B.L., & Barnes, C.A. (2001). Independence of firing correlates of anatomically proximate hippocampal pyramidal cells. Journal of Neuroscience, 21, 1-6. PMID:11222672.

## **Book Chapters**

McNaughton, B.L., Barnes, C.A., Battaglia, F.P., Bower, M.R., Cowen, S.L., **Ekstrom, A.D.**, Hoffman, K.L., Houston, F.P., Karten, Y., Lipa, P., Pennartz, C.M.A., & Sutherland, G.R. (2001). On-line reprocessing of recent memory and its role in memory consolidation: A progress report. In Maquet, Stickgold, Smith: Sleep and Brain Plasticity (eds. Maquet, P., Stickgold, B. & Smith, C.)

**Ekstrom, A.D.** (2010). Navigation in virtual space: Psychological and neural Aspects. In Encyclopedia of Behavioral Neuroscience (eds. Koob, Thompson and Le Moal).

Redish AD and **Ekstrom AD.** (in press). Hippocampus and related areas: What the place cell literature tells us about cognitive maps in rats and humans. In Handbook of Spatial Cognition. (eds. Waller & Nadel).