

# Peter N. Steinmetz, M.D., Ph.D.

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**Office Address** Nakamoto Brain Research Institute  
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Tempe, AZ 85284

**Education** M.D. Johns Hopkins School of Medicine, May 1997.  
Ph.D. Johns Hopkins, Department of Biomedical Engineering, January 1996.  
B. S. Physics with honors. U. of Minnesota, Institute of Technology, 1987.

**Medical Licensure** None.

## Research Positions

**2015-present** **Director**

**Nakamoto Brain Research Institute, Tempe, AZ**

Founded the NBRI to continue research into human single neuron responses to memory and cognition.

Analyzing and publishing results from over 2 terabytes of prior single unit recordings in our laboratory and others laboratories around the world.

**2008-2015** **Director of Neuroengineering, Depts. Neurology & Neurosurgery, Barrow Neurological Institute, Phoenix, AZ**

Research in the laboratory focuses in three main areas:

Plasticity of single-unit neural responses in human cortex and how these may be exploited to control neuro-prosthetic devices. Lead investigator of program of recording single neurons from human epilepsy and hamartoma patients.

Biophysics of implanted electrodes and construction of models of deep-brain stimulation. As principal investigator, have established clinical collaborations to investigate the mechanisms of deep brain stimulation.

Synchronous neuronal firing and the neural representation of attention.

2010-2014 Research Associate Professor of Basic Medical Sciences, University of Arizona.

2010-2014 Adjunct Professor of Psychology, Arizona State University.

2008-2010 Clinical Professor of Neuroscience, Neuroscience Graduate Faculty, Arizona State University.

2007-2008 Member, Speech and Hearing Science Graduate Faculty, Arizona State University.

2006-2008 Adjunct Associate Research Scientist, Division of Neurology, Barrow Neurological Institute, Phoenix, AZ.

**2005-2008** **Assoc. Professor of Bioengineering, Arizona State University, Tempe, AZ.**

Established program of single neuron intracranial recording in human subjects in collaboration with the Barrow Neurological Institute.

Served on faculty search committee, college faculty senate, and university institutional review board.

**2001-2005** **Asst. Professor of Biomedical Engineering, University of Minnesota, Twin Cities Campus.**

Established the Brain Modeling Laboratory within the department.

Served on faculty search and graduate admission committees.

**1998-2001** **Postdoctoral Scholar at the California Institute of Technology, working with Christof Koch.**

Used stochastic ion channel models to examine the coding fraction for noisy neuronal spike encoders. Showed that typical noisy encoders have a higher coding fraction for low frequency signals, despite having lower timing precision.

Developed multi-compartmental models of cortical pyramidal cells with embedded stochastic channel and synaptic models. These are being used to quantitatively evaluate the impact of different noise sources on neuronal signal processing.

Developed linearized models of neuronal noise sources and examined the dependence of subthreshold voltage noise on membrane patch size, channel densities and temperature. Developed stochastic simulations of noise sources in both C++ and as Neuron models.

1997–1998

**Postdoctoral Fellow at the Krieger Mind/Brain Institute, working with Ken Johnson and Ernst Niebur.**

Adapted bootstrapping to statistically test correlations between pairs of neurons and developed C++ software to perform this test on experimental data sets. Determined that 70% of cell pairs in the second somatosensory area of awake behaving *Macaque* monkey are significantly correlated and that the degree of correlation varies with the attentional state of the monkey.

Designed, built and tested an amplifier for local field potential recording; this design used analog multiplexing and active filter circuits. Isolated noise sources in a separate headstage amplifier and redesigned it to eliminate them.

1987–1995

**Graduate student at Johns Hopkins University with Raimond Winslow and Eric Young.**

Derived optimal detectors of signals in the photoreceptor network. Used these detectors to quantify the importance of noise sources in limiting the detectability of visual stimuli and how this is affected by observation timing.

Designed and implemented ANSI C programs for computing these detectors on an SGI supercomputer; this code used 2 dimensional Fourier transforms, numerical integration and curve fitting techniques.

Performed intracellular recordings in the eyecup preparation of the tiger salamander retina.

Developed and assembled laboratory for intracellular recording.

Designed light bench for optical stimulation.

### Teaching Experience

Analytic and Diagnostic Instrumentation, BME 598. Developed rigorous course in engineering fundamentals. Delivered once in fall 2006.

Undergraduate instrumentation course, BME 3201, Bioelectricity and Instrumentation. Developed the course and accompanying laboratory. Have taught this course for four years.

Entry graduate level bioelectricity and instrumentation course, BME 5101. Taught in collaboration with Bin He in the department.

Undergraduate physiology laboratory. Teach a module on electroencephalography and one on the electro-oculogram.

Graduate level lab course. Itasca Neurobiology Laboratory. Teach intracellular recording techniques and Hodgkin–Huxley neural theory. Wrote a 20 page coursebook on electronic instrumentation and recording.

Graduate level lab course. Biochemical Sensors I. Practical design and implementation of numerous sensors including glucose and urea sensors using matrix encapsulation and fiber-optic fluorescence.

Mentored 11 graduate students: A. Roy, G. Miyazawa, S. Lu, C. Baker, C. Thorp, S. Sotiropoulos, F. Da Silva, L. Squire, E. Isham, T. Fischer, Y. Drolet, S. Bellinger. Have collaborated with and mentored 15 undergraduate students.

### Other Professional Experience

2012-2014

**President, The Medical Memory.**

Developed startup business to provide video recordings of doctor-patient interactions. Interest in company sold to other partners.

1995-1997

**Medical student at the Johns Hopkins Hospital.**

Elective clerkships in neurology, neuropsychiatry and neurosurgery.

1983–1987

**Founder and President of Steinmetz & Brown, Ltd.**

Designed, tested, and produced floppy disk drive controllers for the HP-IL interface; this design, based on a Z-80 microprocessor, used interrupt driven hardware control. Directly responsible for all phases of the product, from conception to launch and national marketing.

Designed, tested and produced satellite communications controller for satellite news gathering vans; this design, based on an 8086 microprocessor, entailed real-time interrupt driven processing. Directly responsible for product design, testing and production.

Designed and implemented business database systems using the Macintosh platform.

As President, supervised 10 employees of the company. Interest in the company sold to other principals.

### 1980–1983

#### **Systems analyst, Hubbard Broadcasting, Inc.**

Designed, tested and implemented microcomputer based system which allowed transfer of schedule information to switching equipment.

### **Awards**

Medical Scientist Training Program, 1987-1995, academic scholarship.

Honorable mention, National Defense Science and Engineering Fellowship competition, 1992.

National Merit Scholar, Boston University.

### **Society Memberships**

Society for Neuroscience.

Biophysical Society.

Biomedical Engineering Society.

### **Refereed Journal Articles & Book Chapters**

Race Selective Neurons in the Human Brain. Valdez AB, Treiman DM, Smith KA, Papesch MH, Goldinger SD, Steinmetz PN. (2013). *Proceedings of the National Academy of Sciences, being revised for resubmission*.

Newhoff, M., D. Treiman, KA. Smith, and PN. Steinmetz. (2015). Gender Differences in Human Single Neuron Responses to Emotional Faces. *Processings of the National Academy of Sciences, in review*.

Distributed Representation of Visual Objects by Single Neurons in the Human Brain. Valdez AB, Papesch MH, Treiman DM, Smith KA, Goldinger SD, Steinmetz PN. (2015). *Journal of Neuroscience, in press*.

Wixted, JT, LR Squire, J Yoonhee, MH Papesch, SD Goldinger, JR Kuhn, KA Smith, DM Treiman, and PN Steinmetz. (2014). Sparse and distributed coding of episodic memory in neurons of the human hippocampus. *Proceedings of the National Academy of Sciences 111, no. 26: 9621-9626*.

Steinmetz PN, Thorp CK (2013) Testing for effects of different stimuli on neuronal firing relative to background activity. *Journal of Neural Engineering, 10: 056019*.

A Statistical Method for Predicting Seizure Onset Zones from Human Single-Neuron Recordings. Valdez AB, Hickman EN, Treiman DM, Smith KA, Steinmetz PN (2013). *Journal of Neural Engineering, 10:016001*.

Neurons in the Human Hippocampus and Amygdala Respond to Both Low and High Level Image Properties. Steinmetz, P. N., Cabrales, E., Wilson, M. S., Baker, C. P., Thorp, C. K., Smith, K. A., Treiman, D.M. (2011). *Journal of Neurophysiology, 105:2874-2884*.

Modeling Action Potential Generation During Single and Dual Electrical Stimulation of CA3 Axons in Hippocampal Slice. Steven Bellinger, Jong Rho, P. N. Steinmetz, (2010). *Computers in Medicine and Biology, 40: 487-497*.

In situ Single Unit Recording of Hypothalamic Hamartomas under Endoscopic Direct Visualization. Gregory P Lekovic, Kerrigan, J. F., Wait, S., ReKate, H. L., & Steinmetz, P. N. (2009). *Neurosurgery, 65(6): E1195-E1196*.

Task Switch Inhibits Single Neuron Category Selective Responses in the Human Hippocampus While Preserving Selectivity in the Amygdala. P. N. Steinmetz, (2009). *Journal of Cognitive Neuroscience, 21(2): 347-358*.

External Noise Interference in Human Intracranial Microwire Recordings. C.K. Thorp, P.N. Steinmetz, (2009). *IEEE Transactions on Biomedical Engineering, 56 (1): 30-36*.

A Model of Submyelin Potassium Ion Accumulation Causing Axonal Conduction Failure During Deep Brain Stimulation. Bellinger, S, G. Miyazawa, and P. N. Steinmetz, (2008). *Journal of Neural Engineering, 5: 263-274*.

Synchrony: a Neural Correlate of Somatosensory Attention. A. Roy, P.N. Steinmetz, S.S. Hsiao, K.O. Johnson, E. Niebur, (2007) *Journal of Neurophysiology, 98: 1645-1661*.

Assessing the Effects of Deep Brain Stimulation Using Embedded Axon Models. S.N. Sotiropoulos, P.N. Steinmetz, (2007). *Journal of Neural Engineering 4:107-119*.

Differences in Mnemonic Processing by Neurons in the Human Hippocampus and Parahippocampal Region. I.V. Viskontas, B. J. Knowlton, P. N. Steinmetz, & I. Fried, (2006). *Journal of Cognitive Neuroscience, 18: 1654-1662*.

Calculation of Stereotaxically Registered Brain Conductivities and Anisotropies Using Diffusion Tensor MR Imaging. S.N. Sotiropoulos, B. Mueller, K.O. Lim, P.N. Steinmetz, (2005). *International Journal of Bioelectromagnetism, 15:146-149*.

Robust Micromechanical Neurite Elicitation in Synapse-Competent Neurons via Magnetic Bead Force Application. Fischer, T. M., Steinmetz, P. N., & Odde, D. J. (2005). *Annals of Biomedical Engineering*, 33:1229-1237.

Attention to Tactile Stimuli Increases Neural Synchrony in Somatosensory Cortex. Steinmetz, P. N., Hsiao, S. S., Johnson, K. O., & Niebur, E. (2005). In *Neurobiology of Attention*. Eds: Itti, L., Rees, G., & Tsotsos, J. New York: Academic Press/Elsevier, pp 534-37.

The Impact Of Spike Timing Variability On The Efficiency Of Neural Encoding Models. A. Manwani, P. N. Steinmetz and C. Koch. (2002). *Neural Computation*, 14(2).

Variability and Coding Efficiency of Noisy Neural Spike Encoders. P. N. Steinmetz, A. Manwani and C. Koch. *Biosystems*, 2002, 62 (1-3): 87 – 97.

Attention Modulates Synchronized Neuronal Firing in Primate Somatosensory Cortex. P. N. Steinmetz, A. Roy, P. Fitzgerald, S.S. Hsiao, E. Niebur, K. O. Johnson. (2000). *Nature*, 404:187 - 190.

Channel Noise in Excitable Neuronal Membranes. A. Manwani, P. N. Steinmetz and C. Koch, (2000). *Advances in Neural Information Processing Systems*, 12.

Subthreshold Voltage Noise due to Channel Fluctuations in Active Neuronal Membranes. Peter N. Steinmetz, Amit Manwani, Michael London, Idan Segev, Christof Koch. (2000). *Journal of Computational Neuroscience*, 9 (2):133-148.

Rate Limitations of Unitary Event Analysis. A. Roy, P. N. Steinmetz, E. Niebur. (2000). *Neural Computation*, 12(9).

Model-free Detection of Synchrony in Neuronal Spike Trains, With an Application to Primate Somatosensory Cortex. Arup Roy, P.N. Steinmetz, Ken Johnson and Ernst Niebur. (2000). *Neurocomputing*, 32-33: 1103-1108.

Optimal Detection of Flash Intensity Differences Using Rod Photocurrent Observations. Steinmetz, P.N. and Winslow R. L. (1999) *Neural Computation* 11(5): 1097-1111.

#### **Other Publications**

Animal Models: Some Empirical Worries. Peter N. Steinmetz and Stephen I. Helms Tillery. 1999. *Public Affairs Quarterly*, 8(3), pp. 287-298.

#### **Presentations & Abstracts**

Steinmetz, PN, and Thorp, CK. (2014). Recording human intracranial single neuron activity in electrically noisy clinical environments. Society for Neuroscience 853.06.

Kuhn, J, Wixted, JT, Squire, LR, Jang, Y, Papesh, MH, Goldinger, SD, and Steinmetz, PN. (2014). Behavioral confidence during recognition memory is correlated with single unit and multi-unit activity across multiple brain regions. Society for Neuroscience 354.26.

Newhoff, M, Goldinger, SD, Valdez, AB, Papesh, MH, and Steinmetz, PN. (2013). Gender differences in single-neuron responses to emotional faces. Society for Neuroscience 869.08/LLL43.

Wixted, JT, Squire, LR, Jang, Y, Papesh, M, Goldinger, SD, and Steinmetz, PN. (2013). A broadly distributed memory signal in neurons of the human hippocampus. Society for Neuroscience 385.19/KKK62.

Steinmetz, PN, and Thorp, CK. (2012). Testing for effects of stimulus categories relative to background firing. Soc. Neurosci. Abst. 506.02.

Steinmetz, PN, Wait, W, Lekovic, GP, ReKate, HL, and Kerrigan, JF. (2012). Synchronous firing in two populations of neurons in human epileptic hypothalamic hamartomas. American Epilepsy Society Meeting 3.337.

Goldinger, S, Valdez, AB, Papesh, MH, and Steinmetz, PN. (2012). Single-neuron responses to emotional expressions in the human brain. Soc. Neurosci. Abst. 391.05/CCC70.

Wixted, JT, Papesh, M, Goldinger, SD, and Steinmetz, PN. (2012). Representation of episodic memory strength by single neurons in the human hippocampus. Soc. Neurosci. Abst. 18.02.

Wixted, JT, Papesh, MH, Goldinger, SD, Jang, Y, and Steinmetz, PN. (2012). Representation of episodic memory strength by single neurons in the human hippocampus. Psychonomics 264.

Papesh, M, Valdez, A, Treiman, DM, Smith, KA, Goldinger, SD, and Steinmetz, PN. (2012). Race selective neurons in the human brain. Soc. Neurosci. Abst. 285.26.

Hussaina Y., Steinmetz P.N., Treiman D.M. (2011). Juvenile myoclonic epilepsy (JME) is pharmaco-resistant in 2/3 of patients. American Epilepsy Society, 1.187.

Valdez A., Papesh M., Treiman D., Smith K., Goldinger S., Steinmetz P. (2011). Distributed visual representation of objects by single neurons in the human brain. Society for Neuroscience, 125.05.

Cabrales E.F., Treiman D.M., Steinmetz P.N. (2011). Representation of basic psychological categories of visual objects by single neurons in the human brain. Society for Neuroscience, 125.07.

Steinmetz P.N., Papesh M., Valdez A.B., Treiman D.M., Goldinger, S. (2011). Single neuron activity reflects source of memory in human medial temporal lobe. Society for Neuroscience, 752.03.

Vorobjev G., Mihalas S., Steinmetz P., Niebur E (2011). Theta and alpha oscillations throughout the human brain are suppressed following visual stimulation. Society for Neuroscience, 661.03/D66.

Steinmetz P.N., Wait S., Lekovic G.P., ReKate H.L., Kerrigan J.F. (2010). In Situ Single-Unit Microelectrode Recordings from Hypothalamic Hamartomas Demonstrate Bimodal Neuron Firing Rates. American Epilepsy Society, 2.005.

Steinmetz P.N., Goldinger S., Papesch M., Treiman D.M. (2010). Repetition Enhances Single Neuron Responses to Word Recognition In Human Anterior Cingulate Cortex. Society for Neuroscience, 534.9.

Valdez, A.B., Hickman, E.N., Treiman, D., Smith, K. Steinmetz, P. N. (2010). Correlation of Human Intracranial Microwire Recording with Clinical Factors and Outcomes. American Epilepsy Society, 1.202.

Zwart, C. M., Debbins, J. P., Moguel-Cobos, G. D., Steinmetz, P. N. (2009). Cross subject variability of internal capsule axon angles in DBS candidates: potential impact on stimulation effects. Society for Neuroscience, 326.21/F25.

Steinmetz, P. N., Wilson, M. S., Baker, C. P., & Thorp, C. K. (2009). Single neuron responses reflect image brightness and contrast in the human medial temporal lobe. Society for Neuroscience, 306.8.

Bellinger, S. C., Rho, J. M., Steinmetz, P. N. (2009). Modeling action potential generation during electrical stimulation of CA3 axons in hippocampal slice. Biomedical Engineering Society, Pittsburgh, PS 9A-178.

Zwart, C. M., Debbins, J. P., Moguel-Cobos, G. D., Steinmetz, P. N. (2009). Using diffusion tensor imaging to highlight white matter relevant to deep brain stimulation. Biomedical Engineering Society, PS98-153A.

Zwart, C., Debbins, J., Moguel-Cabos, G., P. N. Steinmetz (2009). Using Diffusion Tensor Imaging to Highlight White Matter Relevant to Deep Brain Stimulation, University of California Systemwide Bioengineering Symposium, Merced, CA, University of California Merced.

S. Bellinger, P. N. Steinmetz (2008). Submyelin Potassium Accumulation May Functionally Block Subsets of Local Axons During Deep Brain Stimulation: A Modeling Study. Society for Neuroscience, 517.

E. Hickman, P. N. Steinmetz (2008). Cellular Yield During Human Intracranial Microwire Recording: Effects of Brain Area, Subsequent Resection Status, and Days After Surgery. Society for Neuroscience, 101.8/VV3.

S. Bellinger, T. A. Simeone, J. M. Rho, P. N. Steinmetz (2008). Stimulating Schaffer collaterals Using Two Electrodes in a Microelectrode Array Improves Fiber Volley Signal Magnitude. Society for Neuroscience, 101.21/VV16.

Bellinger, S, and P.N. Steinmetz (2007). Submyelin Potassium Ion Accumulation and Axonal Conduction Failure During Deep Brain Stimulation. Biomedical Engineering Society. Los Angeles, CA. P4.111.

Isham, E., CP Baker, CK Thorp, WS Banks, P.N. Steinmetz (2007). Separate Image Durations Activate Distinct Neuronal Populations in the Human Medial Temporal Lobe. Computational and Systems Neuroscience, 306.

C.K. Thorp and P.N. Steinmetz (2007). Pre-selection and Multiple Testing Contaminates Neural Response Analysis. Computational and Systems Neuroscience, 252

P.N. Steinmetz (2007). Separate image durations activate distinct neuronal populations in the human medial temporal lobe. Bodian Seminar, Zanvyl Krieger Mind/Brain Institute, invited talk.

S.N. Sotiropoulos, P.N. Steinmetz (2006). Assessing the direct effects of brain electrical stimulation using short axon segment models. Society for Neuroscience Abstract, #469.3.

Isham, EA, CP Baker, CK Thorp, WP Banks, and P.N. Steinmetz (2006). Temporal dependence of single unit responses in human subjects during object categorization. Society for Neuroscience Abstract 504.

F. DaSilva, P.N. Steinmetz (2006). Blurred Image Categorization. Vision Sciences Society.

P.N. Steinmetz (2005). Cognitive correlates of single unit activity in the human medial temporal lobe. Invited talk Psychology Colloquium, North Dakota State University.

C.K. Thorp, P.N. Steinmetz (2005). Noise Sources in Human Intracranial Microwire Recording. Biomedical Engineering Society Meeting (BMES), 2005.

S.N. Sotiropoulos, P.N. Steinmetz (2005). Modeling the Effects of DBS using Anatomically Consistent Multi-compartment Axon Models., Biomedical Engineering Society Meeting (BMES), 2005.

S.N. Sotiropoulos, B. Mueller, K.O. Lim, P.N. Steinmetz (2005) Calculation of Stereotaxically Registered Brain Conductivities and Anisotropies Using Diffusion Tensor MR Imaging. 5th International conference on Bioelectromagnetism and Noninvasive Functional Source Imaging (BEMNFSI), 2005.

P.N. Steinmetz (2005). Testing Synchronous Firing: A Framework of Methods.. Computational and Systems Neuroscience 2005, #252.

S.N. Lu, B.J. Hunt. I. Fried, P.N. Steinmetz. (2004). Identifying sources of visually responsive high frequency activities in human medial temporal lobe. Society for Neuroscience Meeting, #884.19.

S. Sotiropoulos, P.N. Steinmetz. (2004). A biophysical model of deep brain stimulation of the subthalamic nucleus. Society for Neuroscience Meeting, #1011.5.

G. Miyazawa, P.N. Steinmetz (2004). Perinodal Potassium Accumulation Blocks Output of Model Subthalamic Neurons. Society for Neuroscience Meeting, #903.7.

T. Fisher, D. Odde, P.N. Steinmetz (2004) Robustness of tensile-force mediated neurite elicitation in synapse-competent neurons. Biomedical Engineering Society meeting.

I.V. Viskontas, Knowlton, B. J., Steinmetz, P. N., & Fried, I. (2004). Activity of individual hippocampal neurons during recollection in humans. Cognitive Neuroscience Meeting, 2004.

Lu, S. N., Ekstrom, A., Isham, E., Fried, I., & Steinmetz, P. N. (2003). A comparison of unsupervised automatic and manual cluster analysis for classifying human single unit data. Neuroscience Abstract, #430.15.

Steinmetz, P. N. (2002). Attentional shift abolishes response selectivity of single neurons in the human hippocampus but not in the amygdala. Bodian Seminar, Zanvyl Krieger Mind-Brain Institute.

Steinmetz, P. N., L. Reddy, C. Koch and I. Fried (2001). Task demand changes the visual category selectivity of single neurons in the human medial temporal lobe. Neuroscience Abstracts 10.12.

E Niebur, A Roy, P.N Steinmetz, S S Hsiao and K O Johnson (2001). Attention Modulated Synchrony in Primate Cortex. 4<sup>th</sup> International Neural Coding Workshop, Plymouth, UK.

P. N. Steinmetz, A. Manwani, and C. Koch (2000). Spike Timing Imprecision May Represent Signal or Noise in Stochastic Neural Encoders. Society for Neuroscience Abstract.

In Vivo, In Vitro And In Computo Evidence That Membrane Potential Fluctuations Enhance The Computational Efficiency Of Neocortical Neurons. Panel participant at the Winter Conference on Brain Research, 2000 with A. Destexhe, F. Amzica, and S. Hestrin.

Causes and effects of Irregularity in Neural Firing. Panel at the Winter Conference on Brain Research, 2000 with C. Canavier, H. Braun, and C. Chow.

P. Steinmetz, A Manwani, M. London and C. Koch. (1999). Channel Noise in Excitable Neuronal Membranes. Society for Neuroscience, 289.8.

Attention-induced Changes of Synchronous Firing in Somatosensory Cortex Differ Between the First and Second Primate Somatosensory Areas. E. Niebur, A. Roy, P.N. Steinmetz, P. Fitzgerald, S.S. Hsiao, K.O. Johnson. Soc. Neurosci. Abst., 1999.

Categories of Correlations Between Neurons in SII Cortex of the Awake Behaving Monkey Performing an Attentional Task. A. Roy, P.N. Steinmetz, E. Niebur. Soc. Neurosci. Abst., 1999.

Modelling Selective Attention. E. Niebur, C. Koch, L. Itti, P. N. Steinmetz, A. Roy, P. Fitzgerald, K.O. Johnson, S.S. Hsiao. In "From Molecular Neurobiology to Clinical Neuroscience", proceedings of the German Neuroscience Society meeting, Goettingen. 1999. Editors: Elsner, N. and Eysel, U.

Model-free detection of synchrony in neuronal spike trains, with an application to primate somatosensory cortex. A. Roy, P. N. Steinmetz, E. Niebur. CNS\*99.

Biophysics of Information Transmission in Single Neurons. Amit Manwani, P. N. Steinmetz, Mickey London, and Christof Koch. Neural Information and Coding Workshop, 1999.

Attention Modulates Synchronized Neuronal Firing in Somatosensory Area II. P.N. Steinmetz, A. Roy, P. Fitzgerald, S.S. Hsiao, E. Niebur, K.O. Johnson Hebrew University of Jerusalem, Jan. 1999. Invited talk.

Synchronous firing in the second somatosensory cortex covaries with the attentional state of alert monkey. Steinmetz PN, Roy A, Hsiao SS, Niebur E, Johnson KO. Journal of Cognitive Neuroscience: 56-56, Suppl. S 1999.

Synchronous Firing in the Second Somatosensory Cortex (SII) Covaries with the Attentional State of Alert Monkey. P.N. Steinmetz, A. Roy, P. Fitzgerald, S.S. Hsiao, E. Niebur, K.O. Johnson. Soc. Neurosci. Abst., 1998.

Rate Dependence of Unitary Event Analysis. A. Roy, P.N. Steinmetz, E. Niebur. Soc. Neurosci. Abst., 1998.

Steinmetz, P.N. and R. L. Winslow (1995). Ideal Observers of Signals in the Rod Network. *ARVO Abstracts*, 1284.

Ideal Observers of Neural Signals in Phototransduction and the Noise Characteristics of a Phototransduction Model. Steinmetz, P.N. and R.L. Winslow. *Society for Neuroscience Abstracts* 397.5, 1994.

Impulse initiation in retinal ganglion cells. Steinmetz, P.N., Fohlmeister, J.F., and Miller, R.F. *Society of Neuroscience Abstract*, 1989.

Impulse entrainment at trigger zones with non-uniform excitation and geometric structures. Steinmetz, P.N. and Fohlmeister, J.F. *Society of Neuroscience Abstract*, 1988.

### **Grant Support**

The Representation of Episodic and Semantic Memory in Single Neurons of the Human Hippocampus. (McKnight Endowment Fund for Neuroscience to J. Wixted as PI, subcontract to P. Steinmetz; February 2014-January 2017).

Memory systems of the mammalian brain. (NIH to L. Squire as PI, subcontract to P. Steinmetz; June 2012-May 2013).

Representation of low and high-level image properties by single neurons in the human medial temporal lobe. (Moore Foundation to R. Adolphs at PI, support to P. Steinmetz as co-investigator; July 2011-June 2013).

Optimizing Placement of Deep Brain Stimulation Electrodes Using Magnetic Resonance and Diffusion Tensor Imaging. (Medtronic Navigation; to Dr. Steinmetz as PI; April 2010-April 2012).

Representation of Memory for Spoken Words and Voice Detail by Single Neurons in the Human Hippocampus. (NIH, NIDCD, 1R21DC009871-0; to Dr. Steinmetz as PI; June 2009-May 2011).

Representation of memory for spoken words and voice detail by single neurons in the human hippocampus. (Arizona Biomedical Research Commission #8-043; to Dr. Steinmetz as PI; July 2008-June 2010).

Multidisciplinary hypothalamic hamartoma research project. (Barrow Neurological Institute Foundation to John F. Kerrigan, M.D. as P.I.; support to P.N. Steinmetz as co-investigator; through June 2007).

Real-time Neural Control by Human Subjects. (Whitaker Foundation; to Dr. Steinmetz as PI; through Oct. 2005).

Recording Visual Responses in the Human Medial Temporal Lobe. (James S. McDonnell Foundation; to Dr. Steinmetz as PI; through Sept. 2004).

Micro-mechanical Engineering of Connectivity in Living Neural Networks. (National Science Foundation to Prof. David Odde, support to P.N. Steinmetz as co-investigator ; through Mar 2004.)