BIOGRAPHICAL SKETCH

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NAME: Newsome, William T

eRA COMMONS USER NAME (credential, e.g., agency login): bnewsome

POSITION TITLE: Professor of Neurobiology, Stanford University School of Medicine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
Stetson University, Deland FL	BS	06/1974	Physics
California Institute of Technology	PHD	08/1979	Biology
National Eye Institute	Postdoctoral Fellow	09/1984	Neurophysiology

A. Personal Statement

My research concerns the neurophysiological mechanisms underlying decision-making and other forms of visually-based cognition. The overall goal of my research is to understand the neural processes that mediate visual perception and visually guided behavior. To this end, we conduct parallel behavioral and physiological experiments in animals that are trained to perform selected cognitive tasks. By recording the activity of neurons during performance of such tasks, we gain initial insights into the relationship of neuronal activity to behavior. We test hypotheses concerning this relationship by modifying neural activity within local cortical circuits using electrical microstimulation. Perturbation experiments of this nature allow us to determine whether the animal's behavior is affected in a manner that is predictable from the physiological properties of the stimulated neurons. Computer modeling techniques are then used to develop more refined hypotheses concerning the relationship of brain to behavior that are both rigorous and testable. This combination of techniques provides a realistic basis for neurophysiological investigation of cognitive functions such as emotion, perception, memory and motor planning.

Selected publications:

Newsome, WT and EB Paré. A selective impairment of motion perception following lesions of the middle temporal visual area (MT). *Journal of Neuroscience* 8: 2201-2211, 1988.

Salzman, CD and **WT Newsome**. Neural mechanisms for forming a perceptual decision. *Science* 264:231-237. 1994.

DeAngelis, GC, BG Cumming and **WT Newsome**. Cortical area MT and the perception of stereoscopic depth. *Nature* 394:677-680, 1998

Cohen, MR and **WT Newsome**. Context-dependent changes in functional circuitry in visual area MT. *Neuron*, 60:162-173, 2008

Kiani, R, CJ Cueva, JB Reppas and **WT Newsome**. Changes-of-mind during decision-making: neural correlates on single trials. *Current Biology* 24:1542-1547, 2014.

Yang, GR, HF Song, **WT Newsome**, XJ Wang. Task representations in neural networks trained to perform many cognitive tasks. *Nature Neuroscience, 22:297-306. 2019.*

B. Positions and Honors

Positions and Employment

1980-1984 Staff Research Fellow, Laboratory of Sensorimotor Research, National Eye Institute
1984-1988 Assistant Professor, Department of Neurobiology and Behavior, SUNY at Stony Brook
1988-1993 Associate Professor, Department of Neurobiology, Stanford University School of Medicine
1995-1996 McDonnell-Pew Visiting Fellow, University of Oxford
Senior Visiting Research Fellow, St. Johns College, Oxford
1993-present Professor, Department of Neurobiology, Stanford University School of Medicine
1997-2019 Investigator, Howard Hughes Medical Institute
2000-2005 Director, Neurosciences Graduate Program, Stanford University
2005-2008 Chair Department of Neurobiology, Stanford University School of Medicine
2008-2013 Director, BioX NeuroVentures, Stanford University
2013-present Director, Wu Tsai Neurosciences Institute
2013-present Harman Family Provostial Professor, Stanford University

Other Experience and Professional Memberships

Supercomputing Metacenter Advisory Board for Computational Neuroscience, NSF (1993-1994)
U.S. National Committee for the International Brain Research Organization (1993-1995)
Society for Neuroscience Nominating Committee (1995)
Zanvyl-Kreiger Mind/Brain Institute Advisory Council, Johns Hopkins University (1995-1999)
Chair, SAVP subpanel, National Eye Institute strategic planning committee, 1997.
Associate Member, Neurosciences Research Program (1994-2001)
Scientific Advisory Board, McGovern Institute for Brain Research, MIT (2001-2002)
Advisor, Neuroscience Program, Baylor College of Medicine (1998-2004)
Dean's Advisory Committee for the Center for Learning and Memory, MIT (1999-2002)
National Scientific Advisory Committee, Washington Regional Primate Research Ctr. (1999-2004)
Advisory Board, College of Arts and Sciences, Stetson University (2000-2004)
Director, Neurosciences Graduate Program, Stanford University (2001-2005)
Chair, Troland Research Awards Committee, National Academy of Sciences, 2005
Member, Troland Research Awards Committee, National Academy of Sciences, 2006
External Review Committee, Columbia University Graduate Program in Neuroscience, 2007
Councilor, Society for Neuroscience (2002-2006)
NAS Temporary Nominating Group, 2004
NAS Class II Membership Committee, 2005, 2007, 2009, 2010
Scientific Advisory Board, Riken Brain Sciences Institute, Japan (2003-2012, 2016)
McKnight Scholars Awards Selection Committee (2007-2013)
Correspondent, Committee on Human Rights, The National Academies of the USA (2001-present)
Scientific Advisory Board, Max Planck Institute for Biological Cybernetics, (2009-2015)
Committee on Committees, Society for Neuroscience (2010-2014)
Co-Chair, NIH BRAIN Working Group, Advisory Committee to the Director (2013-2014)
Group Leader Reviews, HHMI Janelia Farm Research Campus (2014, 2016)
Scientific Advisory Board, Safra Institute for Neuroscience, Hebrew University (2014-present)
International member, Brain Canada Scientific Advisory Forum (2015-present)
Scientific Advisory Board, Stanley Center for Psychiatric Research, The Broad Institute (2017-present)
Scientific Advisory Board, Wellcome Trust (2017-present)

Editorial Boards:
Visual Neuroscience (1990-1992), *The Journal of Neuroscience* (1989-1996), *Behavioral Neuroscience* (1990-1995), *Current Biology* (1995-2001), *Annual Review of Neuroscience* (1995-2006), *Current Opinion in Neurobiology (2000-present)*, *Faculty of 1000, Co-Head of the neuroscience faculty,* (2000-present)

Honors

1985 Sloan Research Fellowship
1987 McKnight Development Award

1991 Henry J. Kaiser Award for Excellence in Teaching, Stanford University
1992 The Rank Prize in Opto-electronics, The Rank Prize Funds, London
1992 The Golden Brain Award, Minerva Foundation, Berkeley, CA
1993 MERIT Award (R37), National Eye Institute
1994 W. Alden Spencer Award for highly original contributions to research in neurobiology, College of Physicians and Surgeons, Columbia University
1994 Sparks Award for excellence in systems neuroscience, University of Alabama at Birmingham
1994 Distinguished Psychologist Lecture Series, University of California, Los Angeles
1995 Guggenheim Fellowship
1995 The Seventh Annual W.S. Stiles Lecture, University College, London
1995 Fogarty International Senior Research Fellowship
1996 The King Solomon Lectures in Animal Behavior, Hebrew University, Jerusalem
1996 The Thirteenth Annual David Marr Memorial Lecture, University of Cambridge
1997 Investigator, Howard Hughes Medical Institute
1997 Henry J. Kaiser Award for Excellence in Teaching, Stanford University
1998 The Eighth Annual Einar Hille Memorial Lecture, University of Washington, Seattle
1999 The Overseas Lecture, Australian Neuroscience Society Annual Meeting, Hobart, Tasmania
1999 The Volker Henn Memorial Lecture, Center for Neuroscience, University of Zurich
2000 National Academy of Sciences, USA, Elected to membership,
2000 Distinguished Alumni Award, Stetson University, Deland, Florida
2001 7th Annual George Miller Distinguished Lectureship, Cognitive Neuroscience Society, New York
2002 Distinguished Scientific Contribution Award, American Psychological Association
2002 The Tenth Annual Vernon B. Mountcastle Lecture, Johns Hopkins University
2002 The Kuffler Lecture, Department of Neurobiology, Harvard Medical School
2003 Award for Outstanding Service to Graduate Students, Stanford University
2004 The Dan David Prize, Tel Aviv University
2004 Lyman Hooker Distinguished Visiting Professor, McMaster University, Canada
2006 The Ninth Brenda Milner Lecture in Cognitive Neuroscience, McGill University, Montreal
2010 The Champalimaud Vision Award, Lisbon
2010 The Karl Spencer Lashley Award, American Philosophical Society
2010 Max Birnstiel Lecture, Institute for Molecular Pathology, Vienna
2011 The American Philosophical Society, Elected to membership
2012 Honorary Doctor of Science degree, State University of New York, School of Optometry
2015 Pepose Award for the Study of Vision, Brandeis University
2016 19th Annual Stephen W. Kuffler Lectures, University of California at San Diego
2017 American Academy of Arts and Sciences, elected to membership
2017 7th Annual Dean of Science Lecture in Neuroeconomics, New York University

C. Contribution to Science

1. **Fusion of sensory physiology with visual psychophysics.** For decades sensory physiology and sensory psychophysics were parallel fields with little interaction between them even though perception (the domain of psychophysics) was widely thought to emerge from underlying neural mechanisms (the domain of physiology). My most significant contribution to science was merging these two scientific traditions into seamless whole by making individual animals—rhesus monkeys—the subject of simultaneous psychophysical and physiological study. By quantitatively characterizing the animal's performance on rigorously controlled perceptual tasks while at the same time recording electrophysiological signals from the putative neural substrates, we were able to draw unprecedently tight links between physiology and behavior. These studies culminated in electrical microstimulation experiment in which we demonstrated conclusively that columns of direction selective cells in extrastriate visual area MT provide signals that govern perception of motion direction. These studies paved the way for a generation of researchers to analyze the neural substrates of perception in numerous sensory modalities.

   a. Newsome, WT, KH Britten and JA Movshon. Neuronal correlates of a perceptual decision. *Nature* 341: 52-54, 1989.

b. Salzman, CD, KH Britten and **WT Newsome**. Cortical microstimulation influences perceptual judgements of motion direction. *Nature* 346:174-177, 1990

c. Britten, KH, MN Shadlen, **WT Newsome** and JA Movshon. The analysis of visual motion: a comparison of neuronal and psychophysical performance. *Journal of Neuroscience* 12:4745-4765. 1992.

d. Zohary, E, MN Shadlen and **WT Newsome**. Correlated neuronal discharge rate and its implications for psychophysical performance. *Nature* 370:140-143. 1994.

e. Shadlen, MN, KH Britten, **WT Newsome** and JA Movshon. A computational analysis of the relationship between neuronal and behavioral responses to visual motion. *Journal of Neuroscience*, 16:1486-1510. 1996.

2. **Pioneered cellular level analysis of perceptual decision-making.** Decision-making is the key cognitive link between perception and action. Although psychology and economics have long been interested in how humans make decisions, there were no cellular level, mechanistic studies of decision-making prior to our first paper on this topic in 1996 (Shadlen and Newsome, 1996). Building on our studies of the neural mechanisms underlying motion perception (above), we then asked how sensory evidence about motion in the world was converted into a binary decision in traditional psychophysical studies. Since saccadic eye movements were the operant motor response in our psychophysical studies, we make electrophysiological measurements in several brain areas that linked visual area MT to saccade generating motor circuits. We identified neural signals in the parietal and frontal lobes, as well as in the superior colliculus (a midbrain structure) whose activity was correlated to visual decisions in manner expected from theory (drift-diffusion models) and human psychophysics. Now, more than 20 years later, it is common for major neuroscience scientific meetings to feature multiple sessions on the neural mechanisms of decision-making.

   a. Shadlen, MN and **WT Newsome**. Motion perception: seeing and deciding. *Proceedings of the National Academy of Sciences, USA* 93:628-633. 1996.

   b. Horwitz, GD and **WT Newsome**. Separate signals for target selection and movement specification in the superior colliculus. *Science* 284:158-161, 1999.

   c. Shadlen, MN and **WT Newsome**. Neural basis of a perceptual decision in the parietal cortex (Area LIP) of the rhesus monkey. *Journal of Neurophysiology*, 86:1916-1936, 2001.

   d. Horwitz, GD, AP Batista and **WT Newsome**. Representation of an abstract perceptual decision in macaque superior colliculus. *Journal of Neurophysiology*, 91:2281-2296, 2004.

3. **Pioneered cellular level analysis of value-based decision-making.** In perceptual decision-making, there is typically a correct answer. The motion was rightward or leftward. The letters on the last line on the Snellen eye chart have an objectively correct answer. Value-based decision making is a different beast. Internal models of economic value (e.g. reward value) are typically built up gradually through trial-and-error experience with the world, and the internal value model may (should!) change as the world around us changes. We developed a behavioral paradigm based on Hernnstein's matching law that allowed us to measure quantitatively the value associated with particular visual icons by a foraging monkey. We then created and validated a model for the putative internal decision variable that guided the monkeys' choices, and in electrophysiological experiments we identified neural signals in the parietal and frontal lobes that correlated well with this hypothesized internal decision variable. We also showed that the same parietal circuits that reflected decision-related computations in perceptual choice reflected decision-related computations in value-based choice as well. Since these humble beginnings in a few labs in the period of 1999-2004, value-based decision-making has emerged as a major focus of neuroscientists world-wide.

   a. Sugrue, LP, GS Corrado and **WT Newsome**. Matching behavior and the encoding of value in parietal cortex. *Science*, 304:1782-1787, 2004.

   b. Sugrue, LP, GS Corrado and **WT Newsome**. Choosing the greater of two goods: neural currencies for value and decision-making. *Nature Reviews Neuroscience*, 6:363-375, 2005.

c. Corrado, GS, LP Sugrue and **WT Newsome**. Linear-nonlinear-Poisson models of primate choice. *Journal of the Experimental Analysis of Behavior*, 84:581-617, 2005.

d. Rorie, AE, J Gao, JL McClelland and **WT Newsome**. Integration of sensory and reward information during perceptual decision-making in lateral intraparietal cortex. *PLoS One*, 5(2):e9308, 2010.

4. **Dynamical systems analysis of decision mechanisms.** Neural systems within the brain exhibit several key properties of dynamical systems: massively parallel processing, ubiquitous feedback signals at virtually all levels of the system, and complex dynamical motifs that can be detected in the coordinated activity of simultaneously recorded units. In the early 2000's, pioneering work in the laboratory of Prof. Krishna Shenoy at Stanford began to show the entire field how dynamical systems analysis could be insightfully applied to the analysis of neural systems in the brain. In collaboration with the Shenoy lab, we extended this approach to the analysis of decision mechanisms. In particular we tackled the problem of contextually sensitive decision mechanisms, in which decision rules and the flow of sensory information through the circuit must change from one behavioral task to the next. The first paper from this collaboration (Mante et al, 2013) identified a novel network mechanism for contextually sensitive gating of sensory information within decision-making circuits, and has inspired numerous research groups to pursue neural population studies within this conceptual framework (>500 citations thus far). We continue to pursue these topics currently.

   a. Mante, V, D Sussillo, KV Shenoy and **WT Newsome**. Selective integration of sensory evidence by recurrent dynamics in prefrontal cortex. *Nature*, 503:78-84, 2013.

   b. Chandrasekaran, C, D Peixoto, **WT Newsome**, KV Shenoy. Laminar differences in decision-related neural activity in dorsal premotor cortex. *Nature Communications*, 8:614. 2017.

   c. Peixoto, D, R Kiani, C Chandrasekaran, SI Ryu, KV Shenoy, **WT Newsome**. Population dynamics of choice representation in dorsal premotor and primary motor cortex. bioRxiv, **doi:** https://doi.org/10.1101/283960, 2019.

D. Additional Information: Research Support and/or Scholastic Performance

Current/Pending Research Support

Provostial Research Funds, Stanford University Newsome (PI) 2014 – 2021
This is discretionary funding ($200K per year) to Dr. Newsome that can be used to support any aspect of his research, including the K99 work proposed by Dr. Golub.