ELSEVIER

Volume 18, issue 4 **August 2008**
ISSN 0959-4388

Current Opinion in Neurobiology

Tobias Bonhoeffer & Marc Tessier-Lavigne, Editors

August 2008

Sensory systems

Edited by David P Corey and J Anthony Movshon

October 2008 Neuronal and glial cell biology
December 2008 Motor systems • New technologies
February 2009 Development
April 2009 Cognitive neuroscience
June 2009 Signalling mechanisms

CURRENT OPINION
www.current-opinion.com

Available online at www.sciencedirect.com
ScienceDirect
Current Opinion in Neurobiology

Sensory systems: from molecules to percepts

Editorial overview

David P Corey and J Anthony Movshon

Current Opinion in Neurobiology 2008, **18**:355–356

Available online 23rd October 2008

0959-4388/$ – see front matter

DOI 10.1016/j.conb.2008.10.002

David P Corey

Harvard Medical School, Neurobiology, Boston, MA 02115, USA
e-mail: dcorey@hms.harvard.edu

David Corey is a professor of Neurobiology at Harvard Medical School and codirector of the Harvard Medical School Center for Hereditary Deafness. His laboratory explores the biophysics and cell biology of mechanotransduction by the hair cells of the inner ear.

J Anthony Movshon

New York University, Center for Neural Science, New York, NY 10003, USA
e-mail: movshon@nyu.edu

Anthony Movshon is Silver Professor and director of the Center for Neural Science at New York University. His work uses neurophysiology, psychophysics, and computation to study the way the brain represents and transforms visual information, and the mechanisms that put that information to use in the control of behavior.

For many decades, research on the senses has provided a window into the brain. Appropriate stimuli are relatively easy to generate, and the assays — at the level of a cell, a circuit, or a psychophysical percept — can be closely correlated with the stimuli. In recent years, sensory physiology has expanded both down and up: to the cell and molecular biology of receptor cells, and to an understanding of high-level coding and perception. In this issue, 17 papers explore a startling range of approaches to some of the fundamental questions of sensory physiology: How is the energy associated with events in the world transduced into neural signals? How are those signals processed by the nervous system? How does that processing give rise to perception and its behavioral consequences?

Molecular machinery of sensation

Modern molecular biology has had a great impact on sensory system research, most obviously by helping to uncover the molecular basis of sensory transduction. The effect of this has nowhere been more remarkable than in the chemical senses, where Benton gives an account of recent advances in studies of chemosensation in *Drosophila*. At the broader level of genetic analysis, Keller and Vosshall use the genomics of mammalian olfactory reception to uncover the way that smell has evolved to suit the needs of different species. Dallos, to explain the extraordinary sensitivity of the mammalian auditory system, considers the function of prestin, the voltage-driven motor protein of the cochlear outer hair cell. Also in hearing, Edge and Chen review recent studies suggesting how mammalian hair cells might be persuaded to regenerate after damage. Momin and Wood review recent evidence on the function of specific subtypes of the voltage-gated sodium channel, with a particular focus on their role in pain signaling.

Neural processing of sensory information

Transducing a sensory signal into a neural response solves the problem of energy conversion, but then presents the brain with the greater challenge of information conversion. How are brain circuits organized to deal with this challenge and rerepresent sensory information in a way that can be used to guide behavior? Glowatzki describes the remarkable ribbon synapse of inner ear hair cells, which enables both continuous and fast neurotransmitter release without action potentials. Shlens and Chichilnisky consider the nature of the information encoded by populations of retinal ganglion cells, with particular attention to synchronized activity. Briggs and Usrey consider recent evidence on an issue common to all mammalian sensory systems (save olfaction) — the way thalamic relays are influenced in feedback by cortical processing. The revolution in olfactory receptor biology has opened up new ways to ask questions about central olfactory processing, and Wilson reviews recent work on olfactory coding in mammals and insects. As in olfaction, peripheral representations of acoustic information are reorganized by the

CNS, and Nelken reviews recent work on the role of the primary auditory cortex in this reorganization. Somatic sensation and vision are different from the other senses in that they are concerned with the 3D shape of objects. Hsiao, and Bridge and Cumming review recent work on the central representations of 3D shape in these two systems, and suggest that somewhat divergent mechanisms may be at work in the two senses.

Converting sensations to perception, action, and memory

Defining a sensory representation and the computations that derive it from raw transduced signals does not by itself answer the question of how that representation is decoded and organized. Jazayeri reviews recent experimental and theoretical work that highlights the probabilistic nature of sensory signals and the way that nature constrains their use by downstream brain systems. In the olfactory system, studies of perceptual processing have been limited by our ignorance of the fundamental dimensions of olfactory space. Haddad *et al*. review recent work on the biological and chemical factors that determine this space. In visual perception, the organization of visual space and the segregation of objects is determined by high-level factors, and Pelli reviews recent work on the mechanisms that resolve objects and their elements. In hearing, one of the most rewarding separations of objects and elements for human listeners is the domain of music, and McDermott and Oxenham consider the way that fundamental features of the auditory system govern and contribute to our perception of music. Like music, pain has privileged access to the emotional systems of the brain. Apkarian reviews the work connecting the affective dimensions of pain with the systems responsible for emotional memory.

Taken together, these 17 contributions document the extraordinary range of work in sensory systems, taking us from basic molecular machinery to the domains of perceptual experience and memory. When we designed this issue, we started with a chart of the sensory systems and the levels at which they have been studied. Just as some of our authors are concerned with sensory spaces and dimensions, we were interested in looking at the space and dimensions of the sensory sciences. These papers illuminate a few particular regions of that space, and suggest the richness that resides throughout it.