
Eye of Newt, Tongue of Carp, Ear of Cat, Paw of Monkey ...

Review By: NORMAN M. WEINBERGER

Review of: Sensory Coding: Selected Readings

By: William R. Uttal, Boston: Little, Brown, 1973. Pp. ix + 481. \$6.95 paper

HOW do we know what the world is like? By what means do the sensory systems receive and transmit information that can lead to appropriate behavior based upon the continual flux of stimuli that bombard them? William R. Uttal has provided a timely book of readings which attempts to give a "state of the art" progress report on attempts to answer these questions. As the author states, this book is not for everyone. It is comprised mainly of selected articles in the field of sensory neuro-physiology, most of which require at least a modicum of sophistication in neurophysiology and, in some instances, neuroanatomy. On the other hand there are several articles that deal with conceptual issues in sensory coding which should provide no difficulties for the nonspecialist. The book is divided into nine sections. Material of general interest is found in the Introduction (I), "The Dimensions of Sensory Coding" (III), "Conceptual Problems in Comparing Psychophysical and Neurophysiological Data" (IV), and in the final section, which contains papers by D. M. MacKay and by the author himself. The balance of the material includes sections on receptor transduction, the coding of quantity, spatial coding, temporal coding, and quality coding. Appropriate comments introduce each section.

Uttal has quite purposely, and I think with good reason, organized the material into different sections on the basis of the four major stimulus parameters that must be coded (intensity, place, time, and quality or modality), rather than according to the various sensory systems themselves. In this he attempts to emphasize the fundamental aspect of what it is that must be coded rather than the specializations of the sensory systems themselves. However, this organization also is used simultaneously to categorize not merely the stimulus parameters that must be coded but also the types of code used by the nervous system. As the author states in the Introduction, "Papers on the coding of stimulus quantity, space, time, and quality are intermixed with others in which these same metrics are used as the parameters of neural codes, to emphasize the importance of this sort of *taxonomy* in both the experiential and neurophysiological realms" (italics the reviewer's). This, I think, was an unfortunate choice which will be a source of confusion to many readers and indeed apparently has been a source of confusion to the editor as well. There seems to be no empirical basis for the position that each of the four stimulus parameters also reflects a particular type of coding used by the nervous system. Intensity and quality (modality) do not serve as codes nor are they so regarded in any of the experimental papers that are reproduced in this volume. Uttal does consider that space and time are codes. There is little question that temporal aspects of a spike train may be of critical importance. An excellent example of this is given in the paper by J. P. Segundo et al. who have demonstrated the sensitivity to the temporal patterning of presynaptic spike trains upon postsynaptic responses of neurons in the visceral ganglion of the sea slug (*Aplysia Californica*, Section VII). On the other hand, in the same section on temporal coding, the editor has placed a paper by Greenwood and Maruyama on the responses of auditory neurons in the cochlear nucleus of the cat. In his introduction to this section, Uttal justifies the placement of this paper "because it represents an example of how space [which neuron is activated] is used to encode a temporal dimension [frequency of acoustic stimulation]." What sense is there in considering the frequency of an acoustic stimulus as being mainly of interest because of its temporal characteristics rather than because of its quality? That such a categorization is arbitrary is made even more apparent by noting that papers by von Békésy and Woolsey on the coding of acoustic quality (stimulus frequency) are placed in Section VIII on quality coding. The editor cites Woolsey's paper as a good example of how "pitch" (stimulus frequency?) is coded by place at the auditory cortex. One can also question use of the term "place" as a code for sensory information within the context of a book that is largely concerned with the properties of spike trains. If a taxonomy of codes is desired, the editor could have used that which was provided by Perkel and Bullock in Section III.

There is one paper by the editor himself, "Evoked Brain Potentials: Signs or Codes?," which I feel is out of place. The subject itself is appropriate for, as Uttal points out, not all evoked electro-physiological responses may qualify as codes. That is, some of them may not represent information that is actually used by the organism as indexed by behavior. Uttal's emphasis upon behavioral validation of a presumptive or candidate neural code is also to be commended. However, this paper deals mainly with the question of whether or not evoked potentials taken from the scalp of humans represent neural codes. Most of the work referred to is concerned not with sensory processing in the usual sense but more with what might be termed cognitive processing, that is, problem-solving, cognition, attention, and the like. Here I think the editor has failed to note a rather critical distinction between two approaches to sensory system function. The traditional approach of sensory physiology and psychophysics has been to systematically manipulate parameters and to note systematic changes in electrophysiological or behavioral responses. On the other hand the cognitively oriented experiments specifically keep the physical parameters of a stimulus constant while varying stimulus meaning. In other words, these studies attempt to map what may be called the "cognitive field" rather than the sensory receptive field (E. Donchin, personal communication). Also, apparently the editor fails to realize that the long latency evoked potentials recorded from the human scalp do not represent the primary sensory cortex evoked activity.

DESPITE some of the problems mentioned above, this collection of readings should be of great interest to students of sensory physiology and sensory psychology. It provides no integrated answer to the questions posed in the first paragraph, nor does it clearly delineate the particular range of codes that have been validated. In this, the book reflects our current state of knowledge of its chosen topic.

Biographical Information for Authors: *William R. Uttal, the editor, is Professor of Psychology and Research Psychologist at the University of Michigan. A PhD of Ohio State University, Uttal's work deals mainly with relations between sensory psychophysics and neurophysiology. He is also author of five other books, including The Psychobiology of Sensory Coding and of Cellular Neurophysiology and Integration and An Autocorrelation Theory of Form Detection, in press.*

Reviewer Norman M. Weinberger is Professor of Psychobiology at the University of California, Irvine. Weinberger, who earned his PhD in experimental psychology at Western Reserve University, was a postdoctoral Fellow in neurobiology at the Brain Research Institute at UCLA. He is coeditor of The Neural Control of Behavior (with R. E. Whalen, R. F. Thompson, and M. Verzeano) and of Psychobiology (with J. L. McGaugh and R. E. Whalen).

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