Meetings

Information and Control Processes in Living Systems

Transmission, transaction, and storage of information in living systems was the theme at the first of a projected series of conferences on information and control processes in living systems held in Princeton, New Jersey, 28 February–3 March 1965. Participants represented biophysics, biology, molecular chemistry, neurophysiology, psychology, computer and communication sciences, electrical engineering, and applied mathematics.

W. Ross Adey (University of California, Los Angeles) traced the development of models of information processing in living systems from the simple concept of the telephone switchboard to stochastic models of parallel and redundant transmission and storage of information. Allen Newell (Carnegie Institute of Technology) dealt with the nature of information in living systems. The conference participants addressed themselves to the task of enumerating ways that complex, integrated behavior might arise in natural automata. In particular, heuristic computer programs that simulate problem-solving by humans (such as chess playing) were discussed as models of sequential decision making. Lawrence Stark (University of Illinois, Chicago) described a pattern-recognition computer program capable of classifying electrocardiograms; he compared the classification logic used by the computer program with that used by humans in processing visual patterns.

Discussions on coding in macromolecular systems were led by Melvin Calvin (University of California, Berkeley). These talks began with a description of information processing behavior in the intact organism; they progressed from the organs, tissues, cells, intracellular organelles, and macromolecules to the molecular substrates. How information is stored and coded in macromolecular substrates was then considered. The structural features of the four polymers (the nucleic acids, the proteins, the lipids, and the polysaccharides) which macromolecules can produce were examined next. Informational content as it may relate to structure was also considered; it was pointed out that all structural changes are ultimately the result of enzyme specificity both in space and time. DNA replication was cited as an example of coding and transmission of information necessary for cellular differentiation. Control of the synthetic operations involved in the functioning of the cell may be achieved by enzyme induction.

Discussions of the mechanisms for transmitting, transacting, and storing information were led by Julian H. Bigelow (Institute for Advanced Study, Princeton). Rafael Elul (University of California, Los Angeles, and Hebrew University, Jerusalem) described a series of microelectrode studies on various kinds of cells; he attempted to discover mechanisms for learning and remembering. A change in the zeta potential of the protein on the cell membrane, along with the diffusion rate of the transmitter substance, was suggested as a possible mechanism for synaptic facilitation and inhibition. Mary A. B. Brazier (University of California, Los Angeles) described her studies of brain function; she used drugs and deep electrodes on human subjects and cats. Results indicate that the hippocampus is directly involved in a temporary loss of short-term memory, but not involved in long-term memory or immediate recall. The role of the center median in the brain in detecting stimulus novelty was also suggested. Donald O. Walter (University of California, Los Angeles) then reported on the results of a computer analysis of electroencephalograms recorded simultaneously from a series of scalp leads in the human brain. The analysis indicates that wave phenomena, in response to alerting stimuli recorded from one side of the brain, are highly correlated with waves on the other side of the brain in their longitudinal organization on the cortical surface. Waves, however, are not correlated transversely. Lawrence Stark (University of Illinois, Chicago) suggested that Shannon's concept of information rate could be used as a measure of the complexity of a pattern of nervous impulses. He described studies in which the crayfish responded to a light stimulus at the rate of 100 information bits per second. He concluded that this same concept could be applied to the mammalian nervous system, with an information rate probably on the order of 1000 bits per second. Frank Rosenblatt (Cornell University) concluded the discussion by presenting several models of neural function in the context of perceptron theory. He attempted to show that reinforcement algorithms for determining connectivity between neural analogs in a perceptron network are based on physiological evidence of mechanisms for synaptic facilitation and inhibition.

The recurring theme of the discussion of this conference involved possible mechanisms by which storage of information might have a molecular basis in living systems. Here, the contributions by Calvin to the conference provided fascinating material on the hierarchic arrangements of molecular coding schemes, and on aspects of their possible vulnerability to decay with time. In the relative impregnability of information storage in neural structures lies one of the most challenging of all biological problems; these stores may endure across three score years and ten in the face of ceaseless dynamic metabolic exchanges, each one seemingly capable of sweeping away the carefully graven image of our engrams.

The conference was supported by a grant from the Human Ecology Fund, New York City. A complete transcript of the proceedings is scheduled for publication prior to next year's meeting. The topics of discussion over the next 4 years include man-machine symbiosis, communication in social groups, the pathology and therapy of control processes in living systems, and new vistas in biological information processing.

DIANE RAMSEY
Astropower Laboratory,
Douglas Aircraft Company, Inc.,
Newport Beach, California