Meetings

Neuronal Spike Trains

A group of 20 scientists, 10 from the United States and 10 from Japan, met at the Center for Cultural and Technical Interchange between East and West in Honolulu 4–8 December 1967 to discuss the analysis of neuronal spike trains and the processing of information within the nervous system. The conference was held under the auspices of the U.S.–Japan Cooperative Science Foundation, and was supported by the Japanese Society for the Promotion of Science and the National Science Foundation. Yasuji Katsuki (Tokyo Medical and Dental University, currently an East-West Center Senior Specialist) was elected Honorary Chairman. In his opening address Katsuki discussed the history of the U.S.–Japan Cooperative Science Program and the development of interest in analysis of interspike interval data. He emphasized the early work of Hagiwara, the later application of computer techniques to similar problems by Gerstein, and present problems.

The first formal session was devoted to an analysis of acoustical systems. Katsuki discussed the work which he and his colleagues have been doing on lateral-line organs, special mechanoreceptors, in certain aquatic vertebrates. The functional significance of both the efferent and afferent systems in the lateral-line organ was emphasized. Afferent-efferent interaction was studied in terms of cross-correlation analysis of simultaneously recorded impulse trains. Joseph Hind (University of Wisconsin) reported on the phase-locking of discharges in single auditory nerve fibers in squirrel monkeys during a restricted segment of the cycle of a sinusoidal stimulus. Statistical methods for describing phase-locking of the response of auditory neurons to low-frequency sinusoids was discussed by Jay Goldberg (University of Chicago). Phase-locking of discharge to a monaural sinusoid is influenced by the intensity of the stimulus and the presence of a second or masking stimulus. Binaural neurons which are sensitive to variations of interaural phase indicate that the discharge of such neurons is governed by the phase relations of the incoming activity related to the two ears. Thomas Goblick, currently working with Charles Molnar and Russell Pfeiffer at Washington University in St. Louis, discussed the problem of classifying interval histograms compiled from spontaneous unit activity recorded from single units in the anteroventral and posteroventral cochlear nuclei. Most of the spontaneous activity results directly from the spontaneous inputs of the cochlear nerve fibers. The different forms of activity appear to be due, in part, to different combinations of these numerous random inputs. Keichi Murata (Tokyo Medical and Dental University) presented the work which he has been doing with his colleagues on the classification of visual cerebral cortex neurons in terms of their responsiveness to various types of peripheral stimulation. Because the material presented in this session was straightforward, most of the discussion occurred early and the definition of terms and the standardization of nomenclature was emphasized.

An analysis of hypothalamic reciprocal mechanisms involved in eating and drinking in terms of unit activity was presented by Matthew Wayner (Syracuse University). Yutaka Oomura (Kanazawa University) presented a comparison of interspike interval distributions of spontaneously active units in light ether anesthetized preparations and unanesthetized cats during various behavioral states such as eating following food deprivation. Auto- and cross-correlation functions of independent and reciprocally related units were presented. Some of the requirements for a stochastic model were discussed. The amount of information per spike and channel capacity in terms of classical information theory was also presented. The significance of such calculations was challenged and provoked considerable group discussion. Although apparently correct, the usefulness of such calculations remained doubtful. Other difficulties in the application of information theory to spike train analysis, such as time bin length and sample mean and sample size, were discussed by Hiroshi Ooyama (Kanazawa University). A previously published possible solution to this problem by Hiroshi Nakahama (Tohoku University) and his co-workers was shown by further analysis to be inadequate.

A description of peripheral mechanisms underlying the sense of flutter vibration was presented by William Talbot (Johns Hopkins University). In the responses of the two classes of fibers subserving this sense, phase-locking of nerve impulses to a sinusoidal stimulus occurs at all supra-threshold stimulus intensities. At intensities matching psychophysical threshold for perception of vibration the spike train reproduces stimulus frequency with nearly perfect fidelity. B. L. Whitsel, in collaboration with Gerhard Werner (University of Pittsburgh), demonstrated the manner in which localization of cutaneous fields in the squirrel monkey is expressed in populations of cortical neurons. Additional information on central sensory systems was provided by Kichiya Iwama (Osaka University) in terms of a single unit analysis of the connections between lateral geniculate cells and fast and slow conducting optic tract fibers.

In the discussion of control systems and information theory the appropriateness of the calculations by Lawrence Stark (University of Illinois, Chicago) in the determination of channel capacity for the light-sensitive abdominal tail ganglia in the crayfish was questioned. The consensus of opinion appeared to be that although information theory has played an important role in the development of modern communication techniques, it presently has very limited application to biological systems. The major difficulty is that the interpretation of such information theoretic quantities as channel capacity has not yet been established in the problems at hand. Further development of the theory may yet lead to results useful in biological systems. Very interesting control systems of insect flight muscles and movements were discussed by Donald Wilson (Stanford University). A relatively complete analysis of interspike interval sequences in terms of serial correlation coefficients for cells from different parts of the brain during sleep and arousal was presented by Hiroshi Nakahama. The significance

of apparent time dependencies between intervals was determined by comparisons with the same type of analyses of the data after they have been randomly shuffled. Random shuffling of interval data as a means of determining the significance of time dependencies within the data was also emphasized by Donald Perkel (Rand Corporation) in the generalized treatment of autocorrelation and cross-correlation analyses in the simulation of various types of interaction between nerve cells.

After a description of three types of axons in the optic nerve of the frog by Keiji Tasaki (Tohoku University) and a discussion of the possible functional significance of each type, some special problems of lateral interaction in the retina were discussed. Masayasu Sato (Kumamoto University) discussed single fiber gustatory nerve responses and taste quality. Although a majority of taste units respond to a variety of chemical stimuli, they can be statistically classified into categories and the discrimination of taste quality depends on differences in the relative amounts of activity of these categories of units. The relation between stimulus strength and nervous activity appears to follow a power function. The results of Don Tucker working in collaboration with Lloyd Beidler (Florida State University) on the olfactory system indicate a variety of response patterns in olfactory units which are not only difficult to interpret but incomprehensible in terms of the tremendous number of possible combinations if one assumes an "across fiber pattern" theory of quality coding similar to that in taste. If a "holistic" theory is advanced for olfactory quality coding, then what fraction of the millions of receptors in an animal represents an adequate sample? Chemical sensitivities of hypothalamic neurons probably involved in eating and drinking behavior were presented by Yutaka Oomura. Both osmo- and gluco-sensitive cells were found in the lateral hypothalamic region. In the study of single nerve cells and their response patterns one is forced to employ statistical methods not only because there exists the constant background activity of many of the cells but also because it is difficult to know, under many conditions, if and when an experimentally induced change in the external environment of the cell becomes an effective stimulus for that particular cell.

Computer simulation of particular spike discharge patterns appears to present no serious difficulty. Problems arise in the development of a model that exhibits the variety of discharge patterns that a single neuron does under different conditions. Models were presented by Donald Perkel, Donald Wilson, Keichi Murata, Ryoji Suzuki (Tokyo Medical and Dental University), Charles Molnar, Yasuji Iso (Kyushu Institute of Technology), and Shogo Kano (Kagoshima University). Special instrumentation such as high input impedance preamplifiers, the use of small computers to program experiments, equipment to measure interspike intervals automatically, magnetic tape systems to record and store data, and the use of large general-purpose computers to reduce and analyze data were also discussed.

MATTHEW J. WAYNER
Brain Research Laboratory, Syracuse University, Syracuse, New York
YUTAKA OOMURA
Department of Physiology, Kanazawa Kanazawa, Japan

Calendar of Events

Courses

Built-in Test Equipment for the Maintenance of Complex Electronic Systems, New York, 22–26 July. The subject matter will encompass devices such as in-circuit, micro-circuit, nondestructive, and noncontact types of electronic and optical sensors; computers for processing the sensor-derived data; and techniques for recording and display of the processed test data. Fee: $245. (Miss Mari Fields, School of Engineering and Science, New York University, 401 W. 205 St., New York 10034)

Composite Materials: Fundamentals and Utilization, Berkeley, Calif., 24–28 June. The course will cover advances in composite materials and structures technology and will explore the potential structural applications of composites. Aspects of research and technology to be discussed will include micro and macro mechanisms, nonlinear elasticity, structural design, anisotropy of fracture and strength, experimental techniques employed in fracture studies, and directional solidified metals and ceramics. Fee: $260. (Engineering Extension, University of California, 2223 Fulton St., Berkeley 94720)

Workshops in the Rorschach Method, Cleveland, Ohio. *Workshop 1, Basic Principles*, 17–21 June. Includes technique of administration, fundamentals of scoring, psychological significance of test variables, and introduction to interpretation. *Workshop 2, Advanced Clinical Interpretation*, 24–28 June. Includes analysis of cases presenting a wide variety of disorders, review of newer developments in test interpretation. The workshops are open to qualified psychologists, psychiatrists, research workers, psychiatric social workers, counselors, and graduate students in clinical psychology having at least 1 year of academic study or its equivalent. Enrollment is limited. Fee: Each 5-day workshop is $60. (Case Western Reserve University–Cleveland College, Newton D. Baker Bldg 110, Cleveland, Ohio 44106)

Management of Research and Development, Cambridge, Mass., 19–30 August. This course is based on studies conducted during the past 10 years which have produced new insights into the behavioral and human organizational aspects of scientific-technical performance as well as new systems analytic methods of planning and controlling R&D undertakings. Is intended for those directing scientific and engineering organizations in government, industry, and universities. Fee: $800. (Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge 02139)

Fluorescence and Phosphorescence Spectrometry, Hopatcong, N.J., 12–16 August. A thorough training in the basic principles and applications of every type of luminescence—fluorescence, phosphorescence, fluorescence spectroscopy, chemiluminescence, electrogenerated luminescence, x-ray fluorescence and fluorescence polarization, and analytical and biochemical applications. Fee: $200. (Dr. Saul Gordon, Center for Professional Advancement, P.O. Box 66, Hopatcong, 07843)

Conventional and Direct Energy Conversion, Ithaca, N.Y., 16–26 July. General treatment of the subject based on a classification of systems and the development of performance criteria for each classification. Topics include thermoelectric and thermionic generators, MHD generators, solar cells, fuel cells, and some conventional dynamic systems. Fee: $350. (Director of Continuing Education, College Engineering, 251 Carpenter Hall, Cornell University, Ithaca 14850)

Seminars in Rocky Mountain National Park. *Mountain Geology*, 17–22 June. Will concentrate on basic geologic principles and phenomena as they appear in the landscape features of Rocky Mountain National Park and the adjoining area. Considerable emphasis will be placed on glacial geology and related phenomena. *Field Identification of Plants*, 24–29 June. Will deal primarily with field identification techniques and characters of the important families of the local flora. *Advanced Field Identification of Plants*, 1–6 July. *Mountain Ecology*, 1–6 July. Emphasis will be placed on the basic concepts of ecology, primarily succession and climax as they can be demonstrated in the mountain landscape. *Alpine Tundra Ecology*, 8–13 July. Topics of discussion will be alpine environment, biological adaptation of life forms and physiology to this extreme environment, and the ecological description and distribution of plant communities within the tundra. *Animal Ecology*, 15–20 July. Adaptation, ecological niche, food web and population dynamics will be studied by means of observation of the smaller birds and mammals. Registration is limited for each seminar. The University of Colorado will award credit of one semester hour per seminar week. Fee: $30 per week. (Executive Secretary, Rocky Mountain Nature Association. P.O. Box 147, Estes Park, Colo. 80517)