

INTERNATIONAL CONFERENCE
ON
THEORETICAL NEUROBIOLOGY

February 24 – 26, 2003

National Brain Research Centre

(Deemed University)

Manesar, Haryana, India

VENUE

AMALTAS & KADAMBA HALL
INDIA HABITAT CENTRE
LODHI ROAD, NEW DELHI

Organized by

National Brain Research Centre, Manesar, India

AGENDA

Enormous progress has been made in experimentally explicating the neural processes underlying various brain functions such as conscious perception, conceptual thinking, and emotional feelings. Unraveling the mathematical content of these experimental findings can help us impart the precision of engineering design to the therapeutic treatment of dementia, schizophrenia, depression and many other debilitating neuropsychiatric disorders. But building models of brain that accord with data, especially the contextual quintessence of cognitive neuroscience, is particularly challenging. Theoreticians have been trying to extend the reductionist elementism that has hitherto been extremely successful in physical sciences to encompass neurocognitive phenomena only to discover its limitations. Is the current state-of-affairs indicative of the limitations of science and mathematics or do we have more sophisticated methods at our disposal?

Mathematical experience has shown that set-theoretic elementism fails to accurately model geometry also, which led to the development of category theory. The relevance of category theory for brain sciences can be readily discerned by noting that in category theory objects are described not in terms of their constituent elements but in terms of their relations to other objects reminiscent of the contextual influences in cognitive neuroscience. Category theory can be thought of as a marriage of holism with reductionism; it incorporates the insights of holism while furthering the reductionist program of calculation with certainty. This takes on added significance in the light of Thomas Albright and colleagues' keen observation that the advancement of neuroscience depends on methods that combine holistic insights with reductionist concreteness: "the issue is whether we can succeed in developing new strategies for

combining reductionist and holistic approaches in order to provide a meaningful bridge between molecular mechanism and mental processes: a true molecular biology of cognition” [Neuron 25:S1, 2000]. Category theory provides a means to ‘put together’ –an antidote to reductionist breaking down– which has also been ranked high on neuroscience agenda. In the words of Carla Shatz, “the challenge now is to put the molecules back into the cells, and the cells back into the [neural] systems and the systems back into [the brain trying to really understand behaviour and perception” [Nature 414:4, 2001]. Realizing the import of the considered assessments of Albright and Shatz, National Brain Research Centre, New Delhi, India has taken the initiative to exploit the philosophically profound and methodologically concrete category theory to catalyze the maturation of neural science into brain science.

Acknowledging the primacy of experimental data, the conference sessions begin with lectures on experimental findings, followed by computational neuroscience talks, and conclude with expositions of category theory. This format is designed to see how far the methods of computational neuroscience go to meet the demands of data, and to see how category theory relates to the specific concerns of the brain sciences. Each session is followed by an hour-long triangular debate with experimental and computational neuroscientists and category theoreticians to bring to sharp focus the strengths and limitations of these approaches, which in turn can help us see how they can complement one another.

PROGRAMME

24 February (Monday)

08:00 – 09:00 Registration

09:00 – 09:30 Inaugural Session

Prof. Vijayalakshmi Ravindranath Welcome Address & (Director, NBRC)
Conference Objectives

Dr. (Mrs.) Manju Sharma Inaugural Address
(Secretary, Department of Biotechnology)

Prof. P. N. Tandon Presidential Address
(President, NBRC Society)

Session I: Contextual Processing (Chair, V. Ravindranath)

09:30 – 10:00 **Thomas Albright** (Salk Institute / HHMI, USA)
More than Meets the Eye: Contextual Influences on Visual Processing

10:10 – 10:40 **Ennio Mingolla** (Boston University, USA)
The Units of Visual Form Perception

10:50 – 11:20 **Posina Venkata Rayudu** (NBRC, India)
Higher Dimensional Algebraic Study of Brain Functions

12:00 – 13:00 Discussion (Leaders: S. H. Koslow & R. K. Shyamasundar)

Session II: Modularity and Integration (Chair, T. Albright)

14:00 – 14:30 **Lisa Stefanacci** (Salk Institute, USA)
Clues to Emotion: Studies of the Amygdala

14:40 – 15:10 **Kevin O'Regan** (CNRS, France)
A Sensorimotor Approach to Consciousness, and the Genesis of the Notion of Space

15:20 – 15:50 **Ronald Brown** (University of Wales, UK)
Higher Dimensional Algebra: A New Tool for the Mathematical Study of Local to Global Problems

16:30 – 17:30 Discussion (Leaders: G. Longo & S. L. Rao)

25 February (Tuesday)

09:00 – 09:15 Summary of Day 1 (N. C. Singh, NBRC)

Session III: Neuronal Information (Chair, S. H. Koslow)

09:15 – 09:45 **Edward Callaway** (Salk Institute, USA)
Cell Type Specificity of Neural Circuits in Visual Cortex

09:55 – 10:25 **Shiro Usui** (Riken, Japan)
VISIOME Platform: Neuroinformatics in Vision Science

10:35 – 11:05 **Giuseppe Longo** (Ecole Normale Supérieure, France)
A Conceptual Framework for Complexity, Information and Causality

11:45 – 12:45 Discussion (Leaders: T. Albright & G. Baskaran)