Applied Neurophysics

A 21st Century Science of the Mind

(8 Hour Workshop)

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Applied Neurophysics is a label we apply to the interdisciplinary pursuit of an integrated understanding of the brain and mind. It incorporates a great deal of "old" science, but it is a new science for the future. This talk will describe the emerging concepts and paradigms, and provide a perspective for viewing the developments which may be expected during the next century. We seek to go beyond conventional psychophysics which merely quantifies perceptual processes, and avoids the realm of the mental. We thus seek to incorporate "hard" concepts such as consciousness, awareness, intention, and free well. Key aspects include information theory ("high-information" physics), self-organizing systems, multidimensional field potentials, and the breakdown of classical causality. We will definitely ask more questions than we answer.

For over 100 years, scientists studying any particular aspect of the brain or mind, when confronted with a particular question, might be prone to say "we'll leave that to the psychologists" or "we'll leave that to the philosophers" or "we'll leave that to the neurologists". It has been necessary to separate disciplines, to provide sufficient focus for progress to be made. We currently have highly developed areas including cognitive psychology, neurochemistry, cellular neurophysiology, clinical neurophysiology, and so on. It is now becoming possible as well as important to integrate various approaches into a consistent view that addresses broader questions. Neurophysics does not apply an arbitrary boundary to the method or structure of knowledge. It is a broad-based analysis of a set of particular questions, which share a common emphasis and perspective. Much as one can say "gravitation" is an area of study, or "astrophysics" is a discipline, neurophysics is itself a discipline. In the future, the neurophysicist will be recognized as a specialist and scholar, who understands and pursues knowledge of a particular area. It is not inconceivable that, for example, rather than calling a psychiatrist or neurologist into a trial for expert testimony, a neurophysicist will be called, to provide authoritative information regarding the individual's comprehensive physical/mental state.

Genetics used to be a group of collected studies that seemed unrelated, including studies of field genetics, experimental plant genetics, family genetics, molecular genetics, and so on. Studies ranged from basic biochemistry and biophysics all the way through population genetics, culture, society, and so on. A geneticist in the late 1960's was faced with a considerable range of studies, connected only by their shared focus on a set of questions. At this time, genetics is a highly focused and integrated field, encompassing all of the mentioned areas, but now including a highly precise molecular understanding, ability to discover and manipulate genes, and so on. It is currently a fully refined, integrated science. Neurophysics, however, is not.

Neurophysics considers consciousness and the mental realm as a branch of physics, one that can be quantified and applied. It endeavors to apply knowledge from a full range of disciplines, from theoretical physics and chemistry, through behavior and conditioning, cultural anthropology, philosophy, and language. Through a comprensive approach to these areas, it is possible to create a consistent understanding that includes elements of science from virtually all areas, and interrelationships between them.

Neurophysics will bring increasing understanding to EEG phenomena including evoked potentials, binding rhythms, activation patterns, and so on. It will study these phenomena in conjunction with increasingly precise models of brain and mind function, to put them into perspective. Increasing ability to predict will ensue. Already, work by Sterman, John, Thatcher, Gunkelman, and others have shed light on the an increasingly precise and clear overall view of EEG rhythms and patterns, and their functional significance. Recent results in hemispheric differences, asymmetries, and gamma binding, add to the overall understanding of the practical issues related to EEG interrelationships.

To articulate how classical and modern physics relate to the understanding of the brain and mind.

To describe how the connection between the mind and body, as classically understood, place a special challenge on physics, chemistry, and biology.

To describe how future developments in physics may impact our understanding of the mind, and the brain/mind connection

Among the questions that neurophysics addresses are:

What properties lead to a system that can be conscious?
Is it possible to create artificially conscious systems?
Can we grade consciousness into a quantifiable property?
Would an exact duplicate of an individual be identically conscious?
Why would nature devote the resources to create conscious beings?
What is the role of self-awareness in conscious experience?
What is the role of experience and history in coloring conscious experience?
How do emotion and desire interact with the mechanics of consciousness?
Does consciousness extend into other dimensions?
What are the physical properties of the conscious field?
Is it possible to measure consciousness directly?
What can EEG measure relative to navigating consciousness?
What is the role of the glia, and SCP potentials, in the brain and consciousness?
Can consciousness be shared between individuals?
What does quantum physics imply for consciousness?
What does M-theory (“string theory”) imply for consciousness?
Is consciousness a field?
Is there a field theory of consciousness?
What light can be shed on the philosopher’s “mind/brain problem”?
What are the mechanisms of clairvoyance, if it is possible?
What are the mechanisms of remote viewing, if it is possible?
Are there possible physical mechanisms underlying the experience of “ghosts”?
What is the physical basis of subjective conscious experience?
How do volition and intention interface with the physical world?
At which point do desire and will enter into the neuronal picture?
(Where does the free will “kick in”? Is it at the level of the mind?)
What is the nature of free will and choice?
In precisely what ways is a person “responsible” for their actions?

By considering any and all of these questions relevant, it is possible to begin to outline a general approach, and to structure consistent answers to some of the questions. What shall emerge is a

comprensive view that incorporates elements from fields as diverse (or similar?) as philosophy, religion, physics, and neurosurgery.

Workshop Outline

Foundations – 2 Hours

Philosophy of Science and Neurophysics
Physical Reductionism and Emergent Properties
The Three Brains – Electrical, Electrotonic, and Chemical
Neurophysiologic Basis of Brain Rhythms
The Role of Lateral Inhibition in the Brain
Inhibition as a Key Control Mechanism in the Brain
The role of the glia in brain function
Synchrony and higher functions – "The throwing Madonna"

Structure and Function in the Brain – 2 Hours

Control of Activation and the Ascending Reticular Activating System
Still Vision Demonstration – What is the scope of our vision?
The Importance of Change – The Man and the Train
Information Concentration – The retina and the optic nerve
The Function of Language in Information – The Words Get in the Way
Perceptual Binding and the Meaning in the Message
The Importance of Temporal Binding – Trading Time for Space
DC Potentials and Consciousness
Levels of Consciousness – From Worm to Man
The Heirarchy of Brain Function – Microthoughts, Macrothoughts, Thoughts, and Megathoughts.
Automatic Behavior – Do we need to think in order to act?

Break – 1 Hour

Overarching Issues in the Brain and Perceiving "Reality" – 2 Hours

The Brain in a Vat Problem – What does it mean to be in the universe?
The Transporter Problem – What does it mean to have a body?
The Microscope Problem – What does it mean to have free will?
The Chinese Room Problem – What does it mean to process information?
The Pencil Problem – How do we recognize and classify things?
The Chair Problem (the words get in the way) – Labeling versus experiencing
The Dog Problem – Does behavior imply understanding?
The Color Problem – Can science access the subjective world?
The Binding Rhythms – The limitlessness of understanding
The Fourier Transform and Reality – Point Processes and Universality
The Holographic Principle – Is the Universe a Hologram of What We Think We Know?
The Brain has a Mind of its Own (don't think of chocolate cake) – Who is in charge?
Physics and the Brain – Is there anything out there?
Science versus Art – The role of classification in understanding and misunderstanding
High Information Physics, Multiple Dimensions, and Consciousness
We are the Wallpaper – Multidimensions and Reality

Qi, Chakras, and Biofeedback - What can we learn?
Psi Phenomena and Physics – Can we Quantify the Unquantifiable?

The Big Picture – The Brain in the Universe – 2 Hour

If I Lived on Mars, I'd Speak Martian – The Importance of Universals
How Many Words for Snow? – The Role of Orthogonality
Brain and Experience – Can We Ever Understand the Bible?
Determinism, Indeterminism, Compulsion, and Free Will
Can a Computer ever have Free Will – Choice in a Deterministic World
Can a Computer ever be Conscious – Computation and Consciousness
What is the role of Quantum Physics?
What is the future of psi phenomenology?
What is the role of Neurofeedback?
Promising directions: Alpha Coherence, Gamma Synchrony, and Alpha/Theta Training

Shared Consciousness – The Hundredth Monkey
What about Ghosts?
Can we ever comprehend our own existence?
Will the planet ever become conscious?
Can We Write a User's Manual for the Brain?

Quiz Questions:

1) The primary role(s) of lateral inhibition in the brain is(are) to:

A) Sharpen perceptual boundaries
B) Provide stability of responses to stimuli
C) Make us aware of colors
D) A and B
E) A and B and C

2) The range of vision in the still eyeball is approximately:

A) 1 degree
B) 2 degrees
C) 6 degrees
D) 30 degrees

3) The ratio between the number of neurons and glia in the human cortex is approximately

A) 1/1
B) 1/2
C) 1/8
D) 1/20
E) 1/100

4) The role(s) of the glia in the human cortex is/are now believed to

A) provide nourishment
B) process sensory information
C) regulate local neuronal activation
D) A and B
E) A and C
F) A and B and C

5) Which of the following may generally be said of a system that processes information

A) It cannot increase the amount of information in a signal
B) It can increase the amount of information in a signal
C) The amount of learning is enhanced by the orthogonality of the input
D) A and B
E) A and B and C
F) A and C

6) The understanding of human consciousness properly involves which of the following:

A) The physical Brain
B) The physical Body
C) The physical Universe
D) The extraordinary Universe
E) All of the above

7) The value of language in science is that it:

A) Allows us to communicate with each other
B) Provides the ability to be precise and consistent
C) Gets us closer to the underlying truth about experience
D) Is how the brain primarily processes information
E) A and B
F) A and C
G) A and B and C

7) Which of the following can reduce an individual's potential for free will?

A) Fear
B) Incorrect or misleading Information
C) The failure to believe in free will
D) Cultural or political bias
E) Language as a barrier to pure understanding
F) All of the above

References:

Abbott ( ) Flatland

Bohm, D. (1980) Wholeness and the Implicate Order. London: Routledge & Kegan Paul Ltd.

Ferguson, M ( ) The Holographic Universe

Greene, B. (1999) The Elegant Universe. New York: Vintage Books.

Greene, B. ( ) The Fabric of the Universe. New York: Vintage Books.

Maltz, M. ( ) Psychocybernetics

Nunez, P.L. (1995) Neocortical Dynamics and Human EEG Rhythms. New York: Oxford University Press.

Pribram, K. H. (1991) Brain and Perception – Holonomy and Structure in Figural Processing. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Sterman, M.B. ( ) Origin of Neocortical Rhythms

Thatcher, R.W. ( ) Neural Coherence and the Contents of Consciousness

Walker, E.H. (2000) The Physics of Consciousness. New York: Basic Books.

Weiner, N. ( ) Cybernetics or Control and Communication in Animal and Machine