Eberhard E. Fetz, Ph.D.

Professor of Physiology and Biophysics

University of Washington, Seattle

Born in 1940 in Zwenkau, Germany

Studied Physics at the Rensselaer Polytechnic Institute, Troy, NY and at the Massachusetts Institute of Technology, Cambridge, MA

FOCUS

PROJECT

Graphical Representation of Brain Function

My project will use graphic and multimedia techniques to represent the operation of the brain in performing a variety of behavioral and cognitive functions. For part of the project, I will use Photoshop to create collages of images that will illustrate the creative activities of other Wiko Fellows and will combine these images with representations of the neural mechanisms that may mediate their intellectual activities. This will involve discussions with volunteering Fellows to identify the thinking processes used in their profession and to collect representative images of their work. In a second portion of the project, I hope to create some multimedia pieces that will explore the relationship between neural mechanisms and conscious behavior. These will use, for example, layers of transparent images, specially prepared mirrors, and video projection to represent the interactive relationships between mind, brain, and the world. The overall goal will be to exploit the evocative power of graphic techniques to illuminate the remarkable operations of the brain in generating cognitive behavior.

Recommended Reading

Fetz, E. E. and D. V. Finocchio. "Correlations Between Activity of Motor Cortex Cells and Arm Muscles During Operantly Conditioned Response Patterns."

Experimental Brain Research 23 (1975): 217-240.

Fetz, E. E. "Are Movement Parameters Recognizably Coded in Activity of Single Neurons?" Behavioral and Brain Sciences 15 (1992): 679-690.

Fetz, E. E. "Real-Time Control of a Robotic Arm by Neuronal Ensembles." Nature Neuroscience 2 (1999): 583-584.

Fetz, E. E., S. I. Perlmutter, Y. Prut, K. Seki and S. Votaw. "Roles of Primate Spinal Interneurons in Preparation and Execution of Voluntary Hand Movement."

Brain Research Reviews 40 (2002): 53-65.

COLLOQUIUM, 09.11.2004

Images of and in the Brain

The neurons in our brains effortlessly perform common miracles of perceiving the world, making appropriate movements and generating higher cognitive functions like speech and thought. Exactly how the brain works remains a tantalizing puzzle, one that has so far eluded an increasing array of experimental strategies.

The behavioral capacities of the brain are derived from the interactions of large populations of neurons. These activities generate recordable signals like the EEG, and so-called "functional images" [e.g., fMRI, PET & MEG], which can provide crude images of activation patterns during behavior, but which are hopelessly inadequate for elucidating the underlying mechanisms. The crucial computations are performed at the cellular level. The participation of individual neurons can be investigated by recording their activity with microelectrodes in behaving animals performing tasks designed to test the cells' function. Examples from the primate motor system illustrate the search for the movement parameters [e.g., limb displacement or force] that may be coded in cortical cell activity. These studies lead to the conclusion that multiple parameters are multiplexed in populations of cells, a conclusion that pertains to sensory and associative systems as well. As a consequence individual neurons may change their relationship to particular parameters, depending on the task, and many cells without an obvious relationship may still contribute to movement.

A relevant model of such parallel multiplexed processing is the hologram, which stores images by interference patterns and provides a natural mechanism for elaborating associations. Such holographic mechanisms are implicitly captured in the operation of neural network models. Artificial neural networks provide powerful tools for investigating neural computation in complex networks since they can be derived from examples of the behavior and completely specify the necessary connectivity and activity of the component units.

The task-dependent nature of responses in single neurons has practical advantages in the current field of brain-machine interfaces, whose agenda is to convert activity of cortical cells to control signals for robotic arms or computer cursors. The neurons fortuitously sampled by the recording electrodes may have arbitrary response properties as classically defined, so the success of this approach depends on the subject's ability to volitionally modify cell activity, a capacity demonstrated in early biofeedback experiments.

My WIKO project will explore new ways to represent the operations of the brain through graphical and multimedia techniques. These will exploit the associative power of collaged images to represent neural mechanisms mediating behavioral and cognitive functions. Interested WIKO fellows are invited to participate in the collage project by considering the sort of mental operations that their brains perform in their work and by providing interesting images that represent their professional endeavors. These images would be collaged through Photoshop with illustrations from the neuroscience literature concerning the relevant brain mechanisms. These prints and the multimedia pieces would aim to circumvent experimental limitations and illuminate graphically the remarkable relationships between mind, brain and the world.

PUBLICATIONS FROM THE FELLOW LIBRARY

Fetz, Eberhard E. (Lausanne,2012)

Artistic explorations of the brain

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1687131821

Fetz, Eberhard E. (2009)

Functional classes of primate corticomotoneuronal cells and their relation to active force

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=877895201

Fetz, Eberhard E. (2003)

Recurrent neural networks of integrate-and-fire cells simulating short-term memory and wrist movement tasks derived from continuous dynamic networks

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=877885311

Fetz, Eberhard E. (2003)

Sensory input to primate spinal cord is presynaptically inhibited during voluntary movement

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=770477992

Fetz, Eberhard E. (2002)

Roles of primate spinal interneurons in preparation and execution of voluntary hand movement

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=770477216

Fetz, Eberhard E. (2000)

Synaptic interactions mediating synchrony and oscillations in primate sensorimotor cortex

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=770481558

Fetz, Eberhard E. (2000)

Functions of mammalian spinal interneurons during movement

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=770463304

Fetz, Eberhard E. (1999)

Primate spinal interneurons : muscle fields and response properties during voluntary movement

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=877876428

Fetz, Eberhard E. (1999)

Real-time control of a robotic arm by neuronal ensembles

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=770466249

Fetz, Eberhard E. (1999)

Primate spinal interneurons show pre-movement instructed delay activity

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=770465749