Freeman Lecture
Neuroscience & Experience

Mesoscopic neurodynamics

History

There is a long, fascinating history of humans' attempts to understand their own minds

In UC Berkeley, we focussed on EEG data

Types of data

At this stage of development of Neuroscience,we believe that EEG data will reveal more than other techniques like fmri. In particular, many recent fmri findings have been debunked by sophisticated statistical reasoning.
In fact, EEG – and its relative ECOG – may provide a better key to localization of neural function through analysis of extremely high-energy gamma oscillations.

An Ironic distance:Walter Freeman Jr

We should thus keep perspective, even in view of the undoubtedly extraordinary work about to be described Walter is son of the lobotomist of the same name, a third generation neuroscientist, and all data used here have been subjected to bioethic review and passed.

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FM transmission; both the signal and the transmission frequency can be retrieved. Izhek. and Freeman both stress this.
Sensory activity gives rise to activity patterns in the brain that lead to original information being discarded.
C occupies the whole cortex
AM of the carrier wave is how meaning is implemented

Representations – formed by motor system through outward flow of neural activity.
We can talk of the phase state of the brain, and trajectories of discrete steps marked by phase transitions
Gamma coherence is ubiquitous in cortical functioning, even in the non-thalamocortical olfactory cortex.

Gamma patterns are not invariant wrt the stimuli; they change with reinforcement, and are meaning-related. We can call them wave packets.
The input from action potentials undergoes a state transition; this places the cortex in the basin of an attractor selected by the stimulus.
Time scales; sensory cortex is destabilised by a micro-saccade, and in 3-7msec it changes states

25-35 msec later there is 100msec of amplitude modulation (meaning) of a carrier wave. These meaning states occupy the whole brain
Note that meaning is assumed consensual, rather than “objective”
Efference copies are crucial for selective attention; feedback catered to.
In the limbic system, as in the sensory cortices, there are global attractors accessed by nonlinear phase transitions

Motor commands place the motor system in appropriate basins of attraction. Representations emerge as spatiotemporal patterns of activity in the effectors of the body.
Barnham; we should think of meaning in terms of non-equilibrium thermodynamics and the nonlinear dynamics of coupled oscillators in phase space.
Living systems can be thought of as generalised non-linear oscillators, stabilised through phase transitions by the world.

Modelling done by ordinary differential equations is adequate. Note that staining disproportionately shows up large neurons, that most connections are intracerebral, that there are small world effects, that a move to a statistical mechanics approach is appropriate. Meaning is to be viewed in terms of the nonlinear dynamics of large groups of neurons
FM radio; interspike intervals about the main frequency

EEG reveal high coherence in the gamma range on the presentation of sensory stimuli. These coherent “Wave packets” are produced in a manner analogous to the transition from gas to liquid.
Size: 10-30 mm. In rabbits. Axonally conducted.
Dendrites receive signals through chemical transmitter molecules from other neurons at synapses, and convert them to loop currents

Summary

EEG data indicate that neural patterns of meaning in the brain are mesoscopic wave packets that follow trajectories in discrete steps. Each step is demarcated by a first-order phase transition that enables the formation of chaotic spatiotemporal oscillations in the gamma range. AM of carrier wave is method of expressing meaning, the result of interaction with the environment

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