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Freeman, Walter J.

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Comment

The use of codes to connect mental and material aspects of brain function

Comment on: “Natural world physical, brain operational, and mind phenomenal space–time” by A.A. Fingelkurts, A.A. Fingelkurts and C.F.H. Neves

Walter J. Freeman

Department of Molecular & Cell Biology, University of California at Berkeley, Berkeley, CA 94720-3206, USA

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The authors propose the hypothesis that the brain’s “operational space–time” connects “subjective space–time” to “physical space–time reality”. They pose the major challenge of explaining the neural mechanisms that so rapidly transpose stimulus energies to abstract concepts – from the specific to the generic, from the material to the mental. They describe and use three levels of explanations, which I conceive in terms of neural codes [1]. As neurobiologists they connect the microscopic properties of conditioned stimuli to intervals and frequencies in trains of action potentials evoked by stimuli and carried by topographically organized axons. As cognitivists they connect mesoscopic symbolic codes to bursts of action potentials from hierarchically organized feature-detector neurons that represent phonemes, lines, odorants, pressures, etc., which object-detector neurons bind into images of stimuli. As dynamacists they connect perceptions of the world to continuous spatial patterns of oscillatory fields of dendritic activity, which self-organize and evolve on trajectories through high-dimensional brain state spaces. This macroscopic code is expressed in landscapes of chaotic attractors.

Unlike other scientific codes such as those of DNA and the Periodic Table, these neural codes have no alphabets or syntaxes. They are epistemological metaphors that neurobiologists require to measure neural activity and that engineers use to design models of higher brain functions such as recognition, prediction, decision and intentional action (summarized with references in [1]).

Their hypothesis posits two sets of ‘connections’ between three states: that of the world (including the body), the brain activity, and thoughts. Thoughts take time and are shallow or deep, wide or narrow, so ‘connections’ can be posited without risk of getting mired in the Cartesian swamp or the ‘hard problem’ of qualia. My data show

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E-mail address: dfreeman@berkeley.edu.

that sensory cortices repeatedly generate mesoscopic spatiotemporal patterns that readily qualify as manifestations of on-going patterns of thought in the subjects' brains. The intentional process of perception begins when the limbic system directs the sensory systems to acquire information and send it by microscopic action potentials to the sensory cortices. Within a few milliseconds after arrival, the information triggers a burst of gamma oscillation in every sensory cortex, as seen in the epiphenomenal electrocorticogram (ECoG). Close examination of these bursts at high spectral, temporal and spatial resolution reveals textures of episodic patterns in mesoscopic neural activity. When expressed as multivariate feature vectors, the patterns connect not to microscopic sensory information. Instead they connect to the history, context, and significance of the information *for the subjects* – in a word, the mesoscopic meanings of the sensory stimuli for the individuals. About 300 milliseconds later a burst of beta oscillation emerges phase-locked over all the sensory systems and the entorhinal cortex. That macroscopic oscillation carries spatial patterns, which yield unified feature vectors that also relate to meanings of conditioned stimuli. In my opinion these global patterns are the best available candidates we have for connecting neural activity to thinking.

References

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