Towards Solving the Hard Problem of Consciousness: The Varieties of Brain Resonances and the Conscious Experiences that they Support

Stephen Grossberg
Center for Adaptive Systems, Graduate Program in Cognitive and Neural Systems,
Center for Computational Neuroscience and Neural Technology,
Departments of Mathematics, Psychology, and Biomedical Engineering,
Boston University, Boston, MA 02215
steve@bu.edu, http;/cns.bu.edu/~steve

The hard problem of consciousness is the problem of explaining how we experience qualia or phenomenal experiences, such as seeing, hearing, and feeling, and knowing what they are. To solve this problem, a theory of consciousness needs to link brain to mind by modeling how brain mechanisms give rise to conscious psychological experiences, notably how emergent properties of several brain mechanisms interacting together embody parametric properties of conscious psychological experiences. This lecture summarizes evidence that Adaptive Resonance Theory, or ART, accomplishes this goal. ART is currently the most advanced cognitive and neural theory, with the broadest explanatory and predictive range, of how advanced brains autonomously learn to attend, recognize, and predict objects and events in a changing world. In particular, ART can incrementally learn, fast or slow, unsupervised or supervised, in a self-stabilizing way in response to a complex non-stationary world filled with unexpected events. It also provides functional and mechanistic explanations of data ranging from individual spikes and their synchronization to the dynamics of conscious perceptual, cognitive, and cognitive-emotional experiences.

ART has predicted that "all conscious states are resonant states" as part of its specification of mechanistic links between processes of consciousness, learning, expectation, attention, resonance, and synchrony. The theory has reached sufficient maturity to begin classifying the brain resonances that support conscious experiences of seeing, hearing, feeling, and knowing. Psychological and neurobiological data about conscious experiences in normal individuals and clinical patients are clarified by this classification. This analysis also explains why not all resonances are conscious, and why not all brain dynamics are resonant. Two revolutionary computational paradigms that describe different aspects of brain computing figure prominently in these explanations of conscious and unconscious processing; namely, Complementary Computing: the global organization of the brain into computationally complementary pairs of cortical processing streams, whose interactions overcome computational deficiencies of individual cortical streams; and Laminar Computing: the organization of the cerebral cortex into laminar circuits whose specializations can support multiple types of biological intelligence, to date including laminar models of vision, audition, and cognition.