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CONSCIOUSNESS AND COMPLEXITY

OR

CONSCIOUSNESS AND RESONANCE?

by

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Tononi and Edelman (1) suggest that “conscious experience is integrated ... and at the same time it is highly differentiated”, that “integration [occurs] ... through reentrant interactions”, and that “attention may increase ... conscious salience”. They also note that “cortical regions ... for controlling action ... may not contribute significantly to conscious experience”.

An alternative theory unifies these several hypotheses into a single hypothesis: “All conscious states are resonant states” (2), and suggests how resonant states enable brains to learn about a changing world throughout life (3). Resonance arises when bottom-up and top-down, or “reentrant”, processes reach an attentive consensus between what is expected and what is in the world. Because resonance dynamically regulates learning of sensory and cognitive representations, this theory is called adaptive resonance theory, or ART.

ART implies all the properties noted by Tononi and Edelman, but also clarifies their critical link to learning, and explains why only a certain type of excitatory top-down matching can stabilize learning (4): When top-down attentional signals match bottom-up sensory input, their mutual excitation strengthens and maintains existing neural activity long enough for synaptic changes to occur. Thus, attentionally relevant stimuli are learned, while irrelevant stimuli are suppressed and hence prevented from destabilizing existing memories. Recent experiments support these predictions during vision (5), audition (6), and learning (7).

Why dorsal cortical circuits that control action do not support consciousness now follows easily: Such circuits use inhibitory matching. For example, after moving your arm to an expected position, movement stops (viz., is inhibited) because “where you want to move” matches “where you are” (8). Inhibitory matches do not resonate, hence are not conscious.

A detailed model of how the laminar circuits of neocortex use resonance to control cortical development, learning, attention, and grouping of information has recently been proposed (9), and suggests new experiments to test the predicted linkages between learning, attention, and consciousness.
References