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BRAIN DYNAMICS OF NORMAL AND ABNORMAL LEARNING, MEMORY AND COGNITION WITH APPLICATION TO ALZHEIMER'S DISEASE, AMNESIA, AUTISM AND NEGLECT

Adaptive resonance theory or ART explains how normal and abnormal brains may learn to categorize and recognize objects and events in a changing world and how these learned categories may be remembered for a long time. This article uses ART to propose and unify the explanation of diverse data about normal and abnormal modulation of learning and memory by acetylcholine (ACh). In ART, vigilance control determines whether learned categories will be general and abstract or specific and concrete. ART models how vigilance may be regulated by ACh release in layer 5 neocortical cells by influencing after-hyperpolarization (AHP) currents. This phasic ACh release is mediated by cells in the nucleus basalis (NB) of Meynert that are activated by unexpected events. The article additionally discusses data about ACh-mediated tonic control of vigilance. ART proposes that there are often dynamic breakdowns of tonic control in mental disorders such as autism, where vigilance remains high and medial temporal amnesia, where vigilance remains low. Tonic control also occurs during sleep-wake cycles. Properties of up and down states during slow wave sleep arise in ACh-modulated laminar cortical ART circuits that carry out important perceptual and cognitive processes in awaken individuals. These slow wave sleep circuits interact with circuits that control circadian rhythms and memory consolidation. Tonic and phasic vigilance control may also clarify how, in response to the formation of beta-amyloid plaque and neurofibrillary tangles, ACh dynamics of vigilance control are undermined. This collapse may help to explain various Alzheimer's disease symptoms. Sleep disruptions before and during Alzheimer's disease and how they contribute to a vicious cycle of plaque formation in layers 3 and 5 are also clarified from this perspective.

Biography

Stephen Grossberg is a Principal Founder and current Research Leader in computational neuroscience, theoretical psychology and cognitive science and biologically-inspired technology. In the 1960s, he introduced foundational nonlinear equations for short-term memory, medium-term memory and long-term memory that are used throughout the biological neural modeling community, as well as the paradigm of modelling how individuals, or machines can adapt autonomously in real time to unexpected events. His Google Scholar reports have more than 72,000 citations and h-index of 124 of his over 550 publications. He is the Founder of the journal *Neural Networks* and the International Neural Network Society, and has been an Editor of other 30 journals. He is a Fellow of APA, APS, INNS, IEEE, SEP, MDRS and the Psychonomics Society. He was awarded the 2015 Norman Anderson Lifetime Achievement Award of the Society of Experimental Psychologists and the 2017 Frank Rosenblatt award of the Institute for Electrical and Electronics Engineers.

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