Consciousness as representation formation from a neural Darwinian perspective

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The claim that consciousness facilitates adaptive behavior is fairly uncontroversial. Responsiveness to exogenous stimuli is inexorably dependent on learning. Reinforced learning is a basic mechanism that allows organisms to learn from experience in a trial and error manner. The relation between consciousness and learning is a much debated topic. In line with other authors (Cleeremans 2007, Edelman 1993) we present an understanding of consciousness in terms of representation formation accomplished through memory and learning. Edelman (1978) puts forward an account of the underlying biological and psychological functioning of the brain which he labeled „neural Darwinism“. The bold hypothesis of his approach is that neurons in the brain are organized in groups whose interaction can be likened to natural selection. In this framework, survival of the fittest means that the „strongest“ representation is the one that has the largest influence on overall mental processing. More recently Izhikevich (2005) developed this approach further using polychronous computation and spike-timing dependent plasticity (STDP). He was able to demonstrate the formation of neuronal groups and their STDP-driven behavior on a model neural network of 1000 randomly connected excitatory and inhibitory neurons. In this model, inhibitory interneurons facilitated rate to spike-time conversion. The activation of each neuronal group produces a small oscillation in the local field potential (LFP). When groups activate in a polychronous manner, the changes in their LFP add up resulting in increased synchrony. How does the question of synchronization translate to the problems of learning and consciousness? We suggest two possible lines of investigation. Firstly, the influence of noradrenergic fluctuations on learning capacities. There is accumulating evidence that NE release from locus coeruelus boosts thalamocortical processing which in turn heightens bottom-up sensory input processing and facilitates learning (Nieuwenhuis, 2011). Secondly, the function of dopaminergic modulation in the cortex. Dopamine release is the biological mechanism by which STDP takes place (Izhikevich, 2007) allowing for selection of neuronal groups, updating of mental maps and representation formation. We suggest that this is the process by which, through increased synchronization, the single object of perception gets filtrated from the neuronal noise in the background. From this perspective, consciousness amounts to neuronal activity in which some groups have heightened expressions compared to other electrochemical signaling taking place at the same time.

Memory access across states of consciousness

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We present a quantitative linguistic tool to measure memory access in mentation reports from different states of consciousness. In our study, four independent, blind native speaker judges analysed a database of physiologically monitored mentation reports from REM sleep, non-REM sleep, hypnagogia and waking. The grammatical-semantic tool for the analysis bases on a modification of our linguistic tool for the analysis of simulated motor movement and auditory verbal hallucinations. Our results confirm strong evidence at the level of brain function suggesting that access to retrospective episodic memory and prospective memory is limited especially in REM sleep, followed by non-REM sleep. Sleep onset mentation showed a higher degree of memory access, although still significantly lower than waking mentation. Our preliminary data

support the prevailing physiological hypothesis that memory access is a function of the physiologically distinct states of consciousness.