The overflow model of the evolution of consciousness.
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There are continuing debates as to whether sensory overflow exists in a phenomenologically significant sense (e.g. Lau & Rosenthal 2011, Block 2011). There would be less argument, however, whether sensory overflow exists in the physical sense. Specifically, given the volume of sensory data coming into the brain from the environment, it is not in general possible to make a full use of it. Consequently, failures in cognitive process (exemplified in change blindness (Simons & Levin 1997) and inattentional blindness (Mack and Rock 1998)) would be incurred, posing significant constraints on what the brain could do computationally.

Independent of the stance one takes as to the nature of phenomenal overflow, there would always be overflow of sensory information in the physical sense. In general, there are more information than could be processed by the brain. The brain has adapted several strategies (e.g. redundancy reduction (Barlow 2001)) to cope with this situation.

Seen from the volume of information processed, consciousness can be regarded as a series of cognitive processes in which there will be gradually less information represented within the system. In the visual system, it is estimated that about $10^{10}$ bits/sec of information is registered at the retina, about $6 	imes 10^6$ bits/sec of information leaves the retina, and about $10^4$ bits/sec of information reaches the layer IV of area V1 (Raichle 2010). It has been estimated that information processed in consciousness is about 126 bits per second (Csikszentmihalyi 1956), while having a conversation alone takes about 40 bits per second. From the computational point of view, the main challenge for consciousness would appear to be the effective handling of information, as the bandwidth becomes narrow at the higher cognitive processes. The brain has apparently adapted several strategies, including redundancy reduction and gist perception (Oliva 2005, Cohen et al. 2011), to cope with the abundance of sensory information.

Here I present a model of the evolution of consciousness based on the idea that sensory overflow has been one of the key constraints in the emergence of consciousness. The overflow model of consciousness would provide a common basis for biological information processing from a single cell to the human brain. It is proposed that various life forms (e.g., paramecium, nematode, and vertebrates) are faced with the common problem of handling the abundance of information in a robust manner within a limited bandwidth. The conscious process serves as the last cognitive process prior to action, in which a robust gist representation of the outside world must be somehow formed from the sensory overflow. I argue that several properties of phenomenal consciousness (e.g. qualia, integrated parallelism) arose as a result of this adaptation to the overflow of sensory information.

From the overflow perspective, there is a continuous spectrum of consciousness from a single cell organism to a complex multicellular system like the human brain. Such a viewpoint would help elucidate the nature of consciousness as a ubiquitous property of biological systems, with several species-specific additions, e.g. the linguistic functions of the human consciousness.

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**EEG Attractor Dimensions. Why so many?**

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The attractor of a simple pendulum is a 1dimensional (1D) scale free circle described by a 0D moving point. Each incremental advance of the point represents a slight change in the balance of forces. The attractor...
portrays the dynamics, while its dimension is a measure of the systems’ complexity. Electroencephalographic (EEG) attractors may be reconstructed, measured, and observed in motion by 3D co-ordinate embedding. (1) We measured the EEG attractor dimension in 21 species acting as surrogates for their distant fossilized ancestors. From fish to human, the maximum correlation dimension increased from about 2D to 4.8 D during the past 500 my. (2,3) Animals demonstrated a range of EEG attractor dimensions from ~1D up to the species’ maximum. Advanced fauna had more dimensions available to them for neural processing. In humans, a meditating Zen Priest exhibited an EEG attractor dimension of 1.3D, focused mental arithmetic correlated with 2.2D, a multisensory experience 3.2D and multitasking 4.8D Why? The highest EEG attractor dimensions are associated with multitasking. Both hunters and prey could benefit from the ability to process multiple senses and actions simultaneously. How does this work? Our binding experiments suggest that the mechanism of a Gestalt, (a combined sensory experience), is the assignation of approximately one sense per dimension, thereby keeping data representing sensations both bound but distinct at the same time within multi-dimensional perceptual space. The proliferation of EEG attractor dimensions during evolution sidesteps the constraints imposed by 3D physical space by commandeering higher dimensional non-physical space, thereby allowing perceptual space to flourish.