Free energy principle

The free energy principle tries to explain how (biological) systems maintain their order (non-equilibrium steady-state) by restricting themselves to a limited number of states.

It says that biological systems minimise a free energy functional of their internal states, which entail beliefs about hidden states in their environment. The implicit minimisation of variational free energy is formally related to variational Bayesian methods and was originally introduced by Karl Friston as an explanation for embodied perception in neuroscience, where it is also known as active inference.

The free-energy principle states that the brain must minimize its Shannonian free-energy, i.e. must reduce by the process of perception its uncertainty (its prediction errors) about its environment. As completely predictable stimuli do not reduce uncertainty, they are not worthwhile of conscious processing. Unpredictable things on the other hand are not to be ignored, because it is crucial to experience them to update our understanding of the environment. Deafferentation leads to topographically restricted prediction errors based on temporal or spatial incongruity. This leads to an increase in topographically restricted uncertainty, which should be adaptively addressed by plastic repair mechanisms in the respective sensory cortex or via (para)hippocampal involvement. Neuroanatomically, filling in as a compensation for missing information also activates the anterior cingulate and insula, areas also involved in salience, stress and essential for stimulus detection. Associated with sensory cortex hyperactivity and decreased inhibition or map plasticity this will result in the perception of the false information created by the deafferented sensory areas, as a way to reduce increased topographically restricted uncertainty associated with the deafferentation. In conclusion, the Bayesian updating of knowledge via active sensory exploration of the environment, driven by the Shannonian free-energy principle, provides an explanation for the generation of phantom percepts, as a way to reduce uncertainty, to make sense of the world [1)].

1)

De Ridder D, Vanneste S, Freeman W. The Bayesian brain: phantom percepts resolve sensory uncertainty. Neurosci Biobehav Rev. 2014 Jul;44:4-15. doi: 10.1016/j.neubiorev.2012.04.001. Epub 2012 Apr 11. Review. PubMed PMID: 22516669.