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Comment

Critique of pure free energy principle Comment on "Answering Schrödinger's question: A free-energy formulation" by Maxwell James Désormeau Ramstead et al.

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The paper by Ramstead et al. [1] [in this issue] reminds us the efforts of eminent scientists such as Whitehead and Godel. After having produced influential manuscripts, they turned to more philosophical issues, understanding the need for a larger formalization of their bounteous scientific results [2,3]. In a similar way, the successful free-energy principle has been generalized, in order to encompass not only the brain activity of the original formulation, but also the whole spectrum of life [1]. The final result is of prominent importance, because, in touch with Quine's naturalized epistemology [4] and Badiou's account of set theory [5], provides philosophical significance to otherwise purely scientific matters. The free energy principle becomes a novel paradigm that attempts to explain general physical/biological mechanisms in the light of a novel scientific ontology, the "variational neuroethology". The latter, seemingly grounded in a recursive multilevel reductionistic/emergentistic approach à la Bechtel [6], has also its roots in a rationalistic top-down approach that, starting from mathematical/physical general concepts (von Helmholtz's free energy), formulates experimentally testable (and falsifiable) theories.

Philosophical issues. One of the main concerns raised by generalizations of the free-energy principle is that it coped with individuals and evolution in rather vague and abstract terms. Is such a claim true? In order to tackle this problem, here we ask: what is meant by different organisms with peculiar systems features? The crux of Ramstead et al.'s argument is that organisms can be described in terms of (high dimensional) phase space induced by hierarchically nested Markov blankets. Then we ask: if different living beings display the common features of Markov blankets, might it be stated that they are "identical"? Has the free energy principle's notion of organisms anything to do with "identity"? Are biological systems (as described in a free energy principle context) identical? Do they stand for the same feature, or for two different features with something in common?

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We recall Heidegger's account of the "principle of identity" [7]. It states that A = A. The formula expresses that one A is equal to another A. Hence, A is the same of A, because "identical" (from Greek) means: "the same".

However, in another possible version, the formula A = A speaks of "equality". A is A. It does not say that A is the same, but that every A is itself the same. Or, in other words, each thing itself is the same for itself with itself.

However, it could also be stated that A "belongs to" an identity with A. In this case, sameness is interpreted as a "belonging together". In "belonging together", the world "together" means: to be assigned and placed into the order of a together, to be established in the unity of a manifold, to be combined into the unity of a system. Such an assignment and placing occur thanks to connexions of the one with the other. Two interpretations are feasible: a) biological systems are determined by an identity as a feature of that identity; b) identity is represented as a feature of biological systems.

However, "belonging together" could also mean: the together is now determined by the belonging.

Therefore, the possibilities here are two: a) representing belonging in terms of the unit of together; b) experiencing this together in terms of belonging. The issue b) leads us to the psychological standpoint of the observer, i.e., to the original formulation of the free energy principle for brain activity. Indeed, the two features termed "brain" and "biological system" can also be thought as the same, so that both belong together in the same environmental milieu, and by virtue of the same milieu. If we attempt to represent together both the features as a coordination of perspectives, we can establish and explain this coordination either in terms of "brain" or "biological system". If the two features belong to each other, "biological system" belongs with "brain" in an identity, whose active assembly (amalgam) stems from that "letting belong together" which we might call "mental representation". Identity becomes, in this version, a functional property of the event of mental representation.

In sum, identity can be presupposed either as a feature of biological systems, or a spring that flows from them. In this second account, the principle of identity becomes a watershed for the psychological origin of identity. We can therefore assess "brain" and "biological system" in terms of that which joins the two, by virtue of the event of mental representation. Thus, the term "biological system" displays the widest range of possible uses. In particular, it does not assess just "the same" thing, but also things that are "different". For example, the curvature shoreline of Vietri (southern Italy) and the edge of a bowl of water with similar curvature are components in feature vectors that supply the basis for common description. This implementation makes the free energy principle not just a launching platform for a novel interpretation of almost all the biological (and physical) phenomena, but also a suitable tool in order to evaluate the slight (objective and subjective) differences that make our world an astonishing realm of rich heterogeneity.

Physical and biological issues. The free energy principle is successful enough to justify its engagement in the assessment of a wide range of biological, physical, and also social, nonlinear systems. However, we want to draw the attention on less-explored issues, that might help to further investigate its powerful apparatus.

Pandemonium is a hierarchical, parallel processing, self-improving model, where "computational demons" perform non-trivial binary functions on two variables [8]. This architecture has been proposed also in order to elucidate brain functions, such as pattern recognition. The processing resembles a kind of natural evolution, by selecting outputs from the "best" processing demons. Indeed, Pandemonium introduces a "the winner-take-all" mechanism, in keeping with neural darwinism [9–12]: cognitive demons' selection generates new subdemons for trial and eliminates inefficient and weak ones, every time reweighting the assembly. The same concept might be extended to variational neuroethology, because competition among hierarchical nested Markov blankets might occur in every one of the four Tinbergen's levels of inquiry.

A role for non-stationary local fluctuations of temperature in Markov blankets merits exploring. For example, contrary to the common belief, the cortical temperature is not a stable parameter, rather the brain displays thermal gradients observed at many spatiotemporal scales [13]. Local changes in thermal properties may act as a dynamic variable, modulating presynaptic and postsynaptic events, sensory stimuli, behavioral changes, memory encoding and fine-tune activity-dependent processes [14,15]. Arguments concerning thermodynamics point towards a correlation between changes in temperature and message content. Indeed, modifications in temperature can be associated with variations in both thermodynamic and information entropies [16,17]. Temperatures encompass information about how large-scale biological outcomes arise from the interactions of many small-scale processes, so that thermal variations may lead to different probability outcomes. Ongoing fluctuations with complex thermal properties that vary across

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