Quantifying the MacKay Hypothesis

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January 26, 2024

Abstract

In this paper the authors take up the hypothesis that electric field complexity is related to the richness of the conscious experience.

In this note we intend to quantify the complexity of the electric field of an axon. To set the stage, we quote MacKay [1]:

> Furthermore, it is extremely doubtful that action potentials are of much significance in the direct link to perception. They are far too fleeting. It is the more sustained membrane potentials that are likely to correlate the best. Discrete neuronal activity in the brain, however isolated it may appear, is simply a local distortion in an unbroken continuum of electrical flux. All cells produce membrane potentials, even if static, such that an electrical field encompasses the entire body. The "panexperientialism" view would also suggest that perceptual awareness is linked to something like an electrical field. This is the only obvious property that is shared by both the atom and the organism, and it is increasingly elaborated as one ascends to the organism. One might postulate that the higher the degree of complexity in the electrical field, the higher the level of consciousness experienced.

In the author's doctoral dissertation [2] a myelinated axon with 3 nodes was considered and it was argued that there is a rest −> injection −> exchange −> restoration cycle of the action potential at an axonal node. Now suppose action potential (AP) occurrence obeys the Bernoulli(p) law. Thus at the point $P(r, \theta, \phi)$ there is a field $E(r, \theta, \phi)$ with probability p and a null field with probability $1-p$. Thus a stochastic field is set-up as the Bernoulli variables enter the daisy-chain and are shuttled, as it were, down the chain of nodes. In one period, there are 8 possible electric-field levels generated. They occur with probabilities: $p^3, p^2(1-p), p(1-p)^2, (1-p)p^2, (1-p)^2p, (1-p)^3, p(1-p)p, (1-p)p(1-p)$ respectively. Knowing the mean electric field strength at P by measurement, one can delineate a list of possible Bernoulli processes compatible with that mean field strength.

The action potential input stochastic process is of entropy $H_b(p)$, the binary entropy formula that goes with a Bernoulli(p) process whereas the output entropy due to the field stochastic progression is $-p^3 logp^3 - 3p^2(1-p)logp^2(1-$

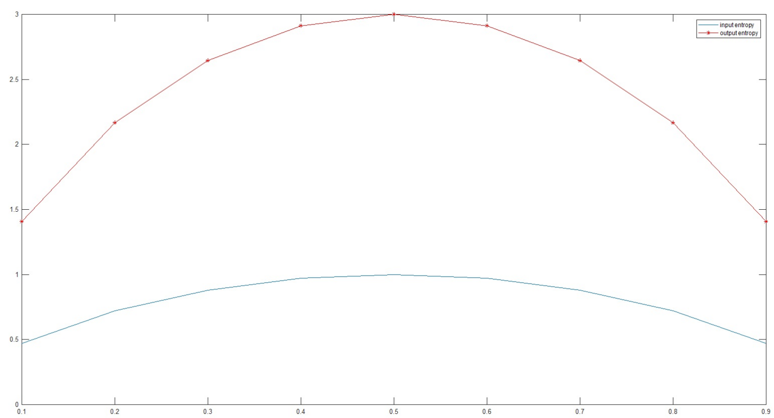

Figure 1: Input and output entropy at an axon.

$p) - 3p(1-p)^2 logp(1-p)^2 - (1-p)^3 log(1-p)^3$. These two formulae are plotted in Figure 1.

It has further been found that the greater the number of nodes, the greater is the entropy contained in the field strength. Thus myelination increases the entropic-richness of the field content. If we take the information-richness as an indicator of 'level of consciousness' then field complexity and level of consciousness are clearly linked, vindicating MacKay's stand.

References

[1] William A MacKay. The unified electrical field. *Behavioral and Brain Sciences*, 26(4):419–420, 2003.

[2] Aman Chawla. *On Axon-Axon Interaction via Currents and Fields*. PhD thesis, University of South Florida, 2017.