Pure State Consciousness And Its Local Reduction To Neuronal Space

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Abstract. Using a mathematical formalism borrowed from quantum mechanics, the single neuronal state can be represented as a vector in a complex space, spanned by an orthonormal basis of integer 'action potential' states (here an 'action potential' is not the depolarisation event itself but the propensity for a neuron eventually to produce a single spike). These basis states are eigenvectors of a hermitian number operator N, an inevitable n spikes belonging to the n-action potential state $|\, n \,\rangle$. The more general normalised neural state $|\, \psi \,\rangle$ is resolved onto each basis vector to give a complex amplitude $\langle\, n \,|\, \psi \,\rangle$. The squared modulus of this amplitude is the prior probability of n spikes, the expected spike count $\langle\, \psi \,|\, N \,|\, \psi \,\rangle$ being the sum of spike counts weighted by such probabilities. An assumption that neural firing is 'memoryless', consistent with the exponential decay of evoked responses to brief sensory stimuli, implies that the expected spike count of an initial single neuronal state vector must be proportional to the initial instantaneous firing rate. In this model a scalar element of experience called a 'perception value' is associated with the instantaneous firing rate of a single sensory neuron over repeated stimulus presentations. In that the experience attributable to a single sensory neuron can only be quantified within statistical limits from the incidence of spikes across multiple presentations of a stimulus, consciousness remains inaccessible to direct measurement on a single trial. In this way, the model disambiguates subjective experience from objective neural properties. Here the model is extended to composite neural systems that are tensor products of single neuronal vector spaces. Depiction of the mental state as a vector on this tensor product space is intended to capture the unity of consciousness. The density operator is introduced as its local reduction to the single neuron level, from which the firing rate can again be derived as the objective correlate of a subjective element. However, the relational structure of perceptual experience only emerges when the non-local mental state is considered. A metric of phenomenal proximity between neuronal elements of experience is proposed, based on the cross-correlation function of neurophysiology, but constrained by the association of theoretical extremes of correlation / anticorrelation in inseparable 2-neuron states with identical and opponent elements respectively.

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