Emergent Properties of Corollary Discharge, Neurotransmission, and a Morphing Neural Code

SYED (BASHIR) HYDARI, Se-Young (Myki) Lee, David Glanzman, Katsushi Arisaka on behalf of Elegant Mind Club

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Elegant Mind Club UCLA

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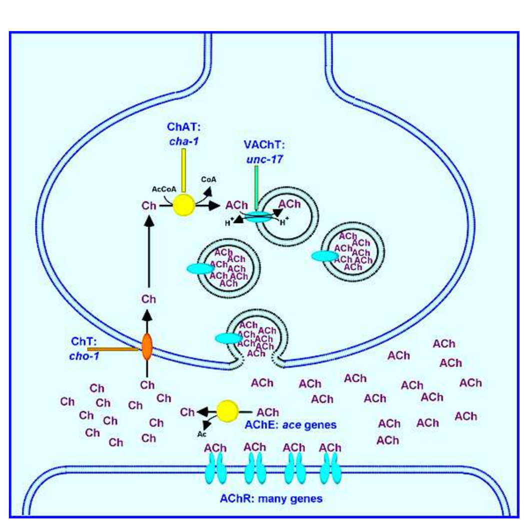
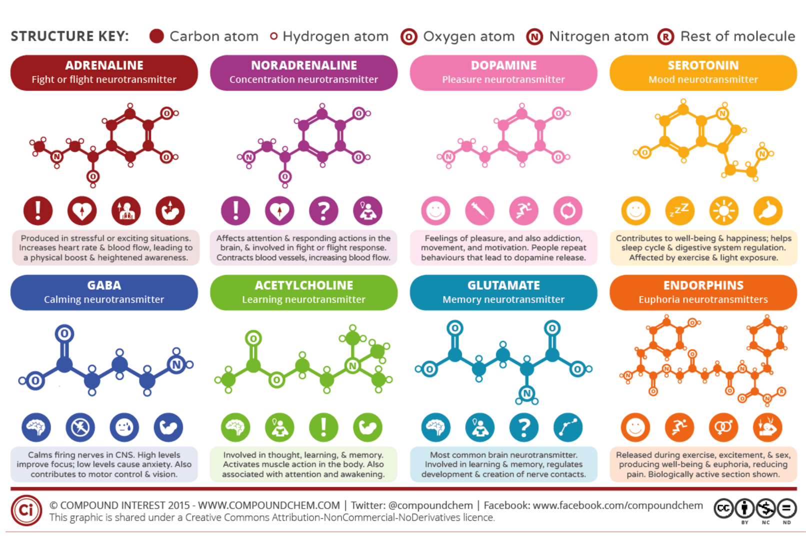
ABSTRACT

Central pattern generators, or CPGs, are intrinsic neural rhythms generated in the absence of sensory information. Framing the C. elegan as a revolutionary lens for unveiling the extensive versatility of the canonical CPG, we examine a) how the CPG is unconventionally capable of choreographing temporally chronological sensory and motor information for the purpose of phase locking, b) thus effectively establishing proprioception as the predecessor of emergent perception via utility of corollary discharge in sensorimotor integration. Afterwards, we investigate how the C. elegan's CPG emergence is mediated by espousing unusual ACC receptor species debuting neurotransmissional dichotomy and unique cyclic frequencies—extending implications to human nervous system and homologues. Then, we utilize the electrophysiological properties of the C. elegan CPG to catalogue a powerful trend of information morphology from a graded potential dominated to an action potential dominated neural system, enforced by increasingly complex biological designs for multimodality. By doing so we evince a necessity of modulating neurotransmission frequency to serve excellent candidacy for cross-inhibition, rhythm, and perception, such like the SMD neurons in C. elegans. To coalesce this information, we discuss highly "predictive," nature of neural systems in confronting novel environments via the idiosyncrasies of conserved graded potentials. And in finality, we elucidate the incredible illusory emergence of perception from proprioceptive information via corollary discharge and top-down processes—such as temporal information imparted by CPGs.

CPG emergence in C. elegans SMD neurons via ACC-receptor species of ACh: Inhibitory Motifs





Cyclic Frequencies and Dichotic Signaling in Neurotransmission—Modeled by SMD

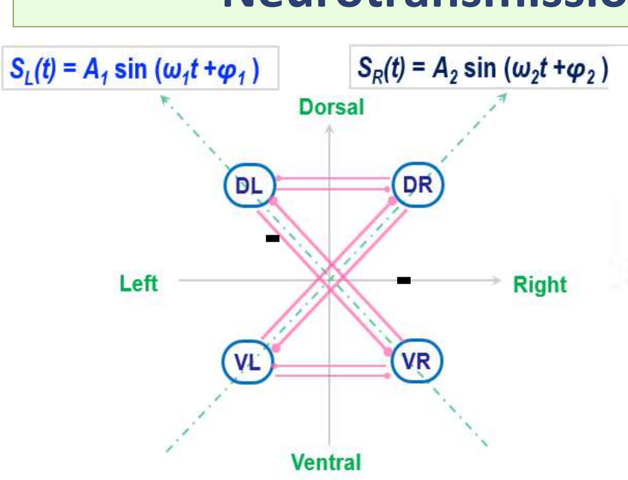
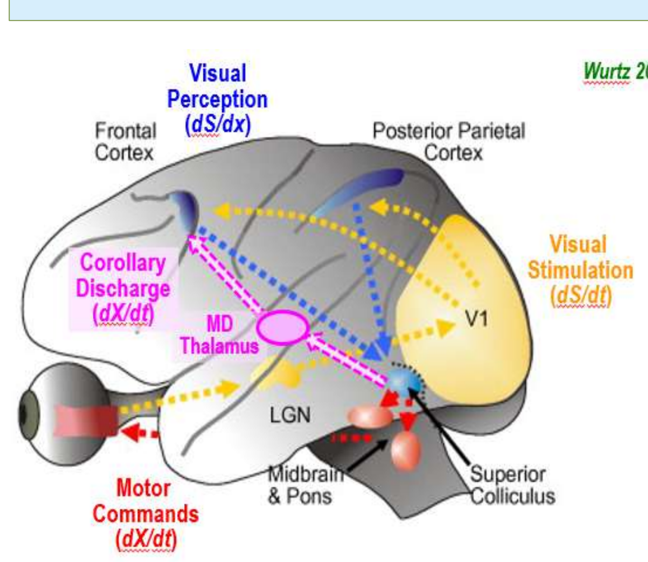
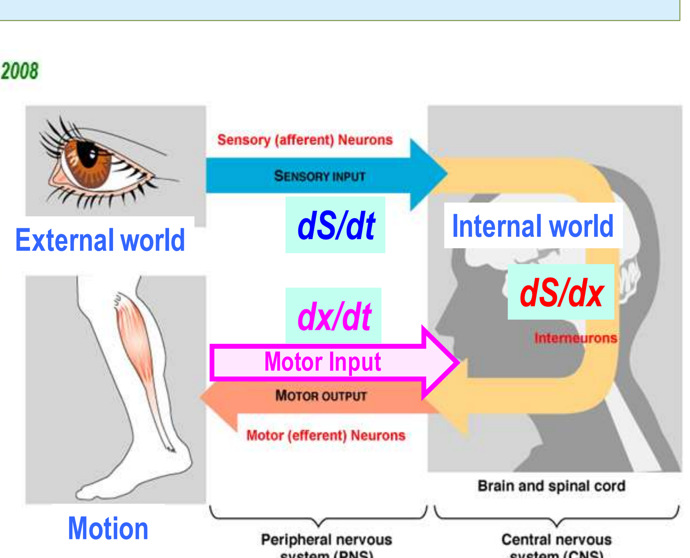


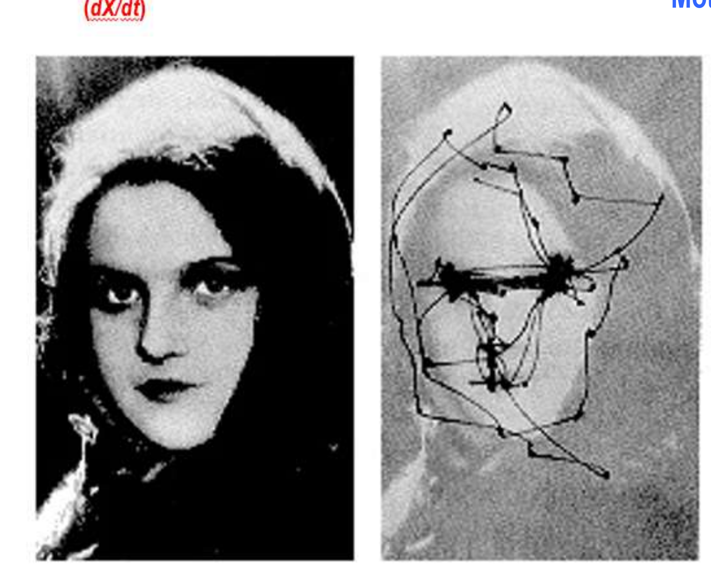
Figure 1. Cross-Inhibitory Connection Mediated via unusual dichotic signaling of Acetylcholine in acc-1 species of channel receptors on SMD Neurons

Figure 2. Cys-loop ligand-gated ion channels family: Acetylcholine Chloride-Gated Channels uniquely found in C. elegan nervous system. Mediates the cross inhibition necessary for CPG emergence and is found particularly in the SMD neurons—which have originally served focal candidacy for the location of the C. elegans CPG, as a function of rhythmic head motion

Corollary discharge MODEL: Saccadic Eye Movement

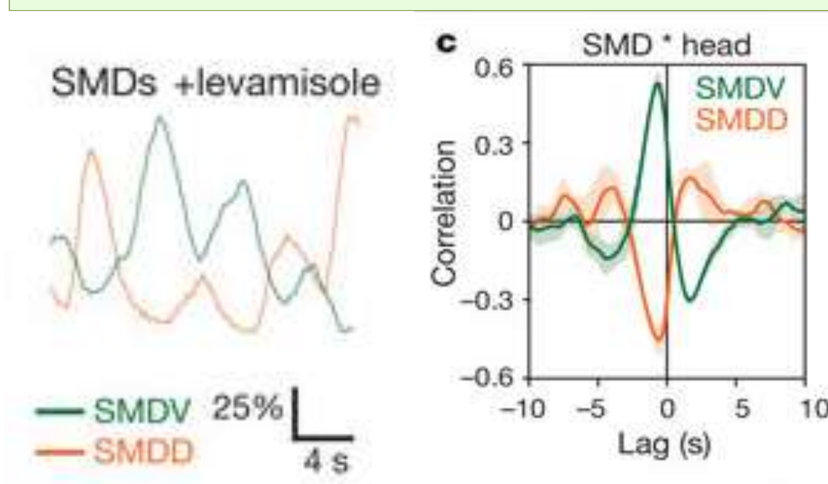


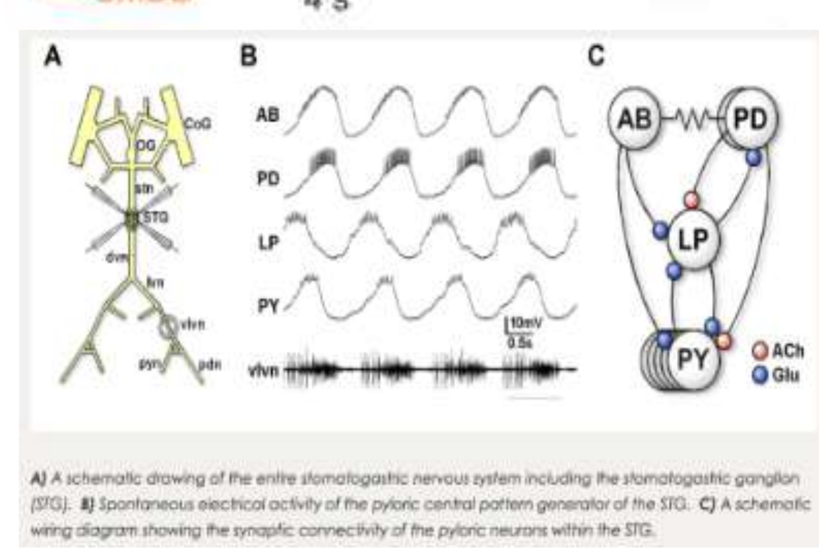




Figures. Oculomotor proprioception, mediated by corollary discharge involved in human saccades (2-4 times per a second), relays a motor copy of the impending motion to higher cortical tissue so that an index for "predicting one's own intent," is made available for top-down processes (such as Bayesian inferences) to produce cohesive vision.

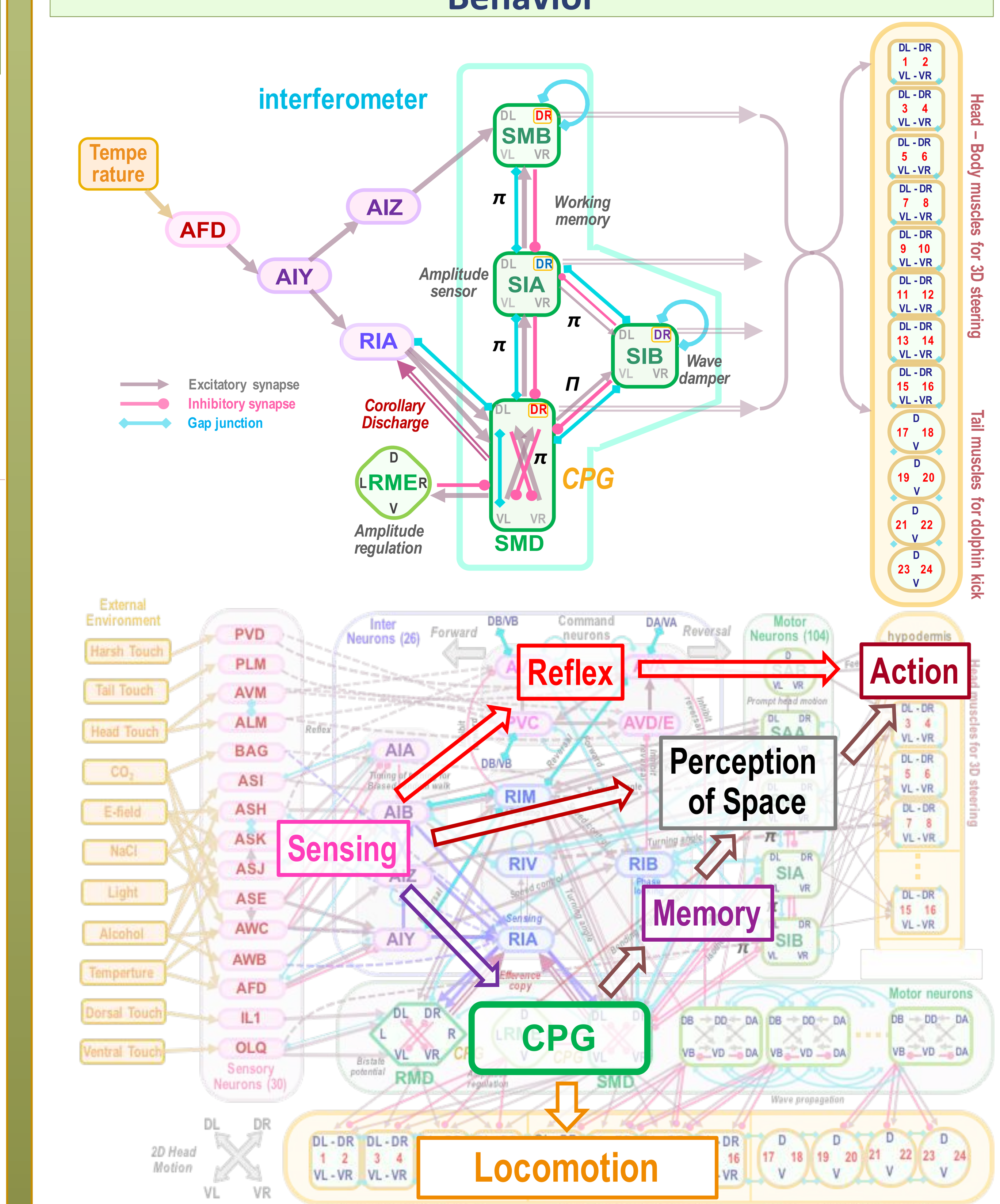
Amplitude to Frequency Encoding: Evolutionary transition in Neural Code from Graded Potentials to Action Potentials





Figures. We observe the C. elegans nervous system to be the only one of its kind in the animal kingdom—a solely graded potential nervous system that does not utilize action potentials. These graded potentials provide a global hypersensitivity that allow for "prediction of intent," in more complex vertebras. The C.elegan, based on our research and synthesis, represents a transition point in the evolution o the neural code from a graded potential to an action potential dominated systems. This demand for action potentials was enforced by the increasingly complex multimodality of larger organisms and allows for choreographing multiple sensory modalities in a desynchronized, and non-overlapping manner. But graded potentials are still conserved, as demonstrated by their retention of the waveform and amplitude coding, to permit "global slight depolarization," that prepares the neural system in the form of a "dream state," for incoming novel stimuli

C. elegans: Corollary discharge MODEL: Isothermal Behavior



Connecting both models: Perception is an "Emergent Property" of Proprioception

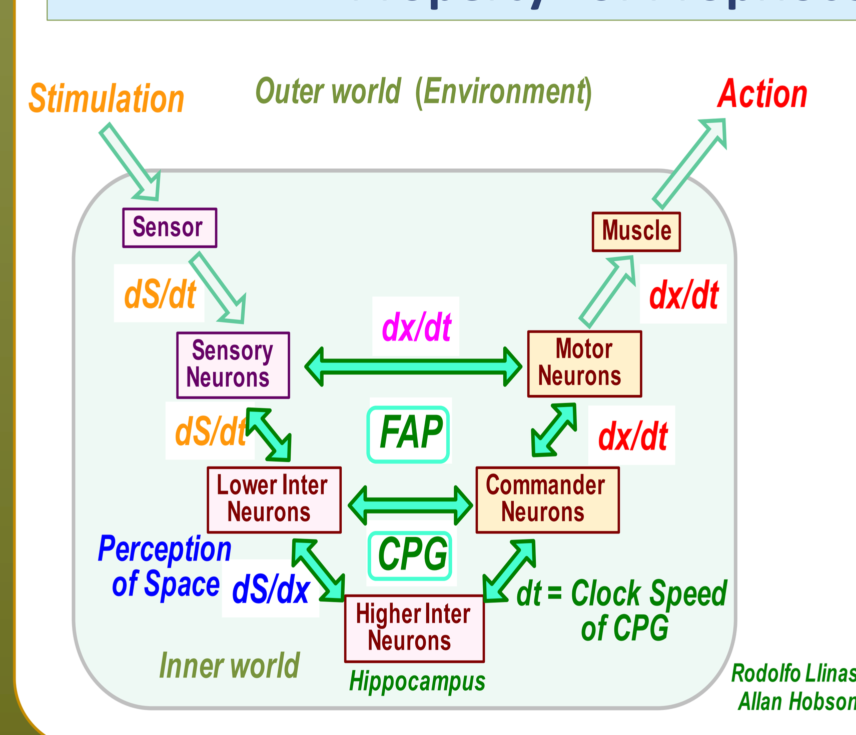
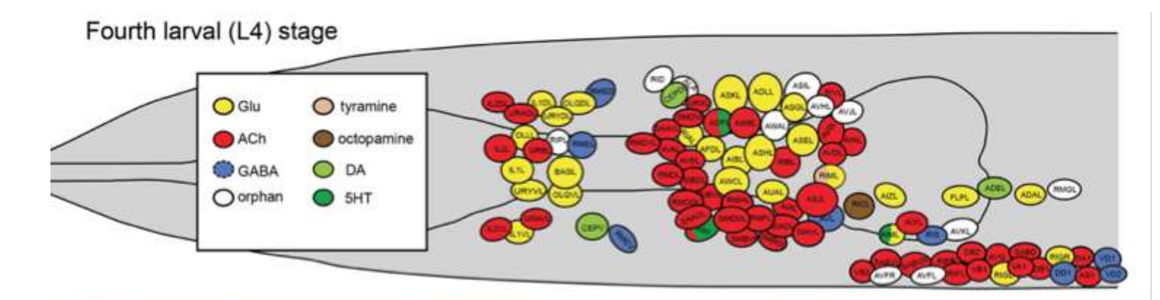
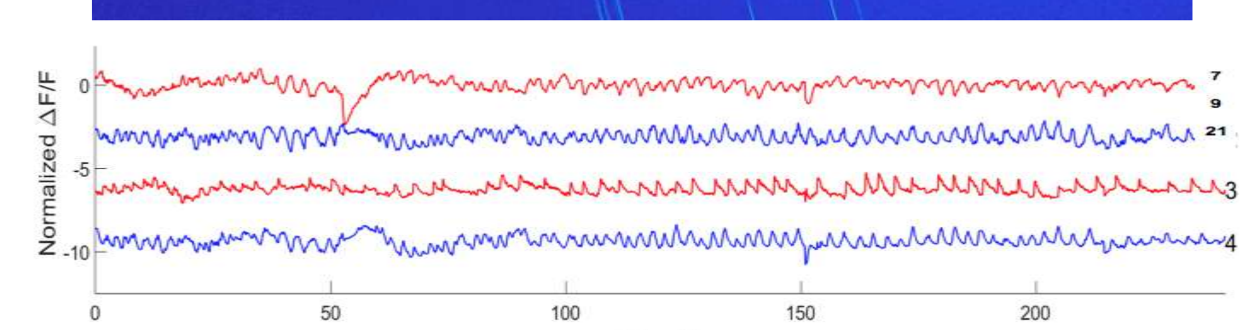


Figure 1. A CPG tethers temporal information (dt) to proprioceptive information (dx) conveyed to the nervous system via corollary discharge. Effectively, our sensory cognizance of the anatomical location of a bodily appendage (proprioception) is over-scribed by top-down inferences supplied via Bayesian inferences (higher cortical processing) or temporal information (Central Pattern Generator) to produce a cohesive perception, and THUS memory, of the external environment. In other words, perception of the external environment is mediated by proprioception of an internal environment's locomotive/spatial properties..

CONCLUSIONS

It is evident that the basic functionality of the CPG has been monumentally underestimated in traditional neuroscience. As first portrayed with C. elegans as our model organism, we frame an entirely new lens through which we appreciate central pattern generators: not merely with respect to conducting vital motorized behavioral functions while minimizing energy investment, but equally, to the realm of sensorimotor integration and the emergence of perception and consequently, memory. After steadily examining the panorama of neural code morphology in basic CPG patterns and the emergence of the C. elegan CPG with respect to ACC neurotransmission, dichotic signaling, and modulation of cyclic frequency, we revitalize the perception of how biologically intelligent the most unsuspecting and simple of species may pose to be. But with more ado, we provide an entirely new strata to appreciate the central and versatile nature of the CPG, a token we first scaffold after intimate inspection of the model organism, C. elegans with an accessible 302 neurons- the only organism to have its entire transcriptome completely mapped. Hopefully, these distinctions further elucidate the greater shortcomings in a scientific culture that seeks to immediately footprint itself in the nervous systems of more complex species, without fundamentally understanding the more primitive. Point in case, before we document the unruly nature of the brain, we must examine our species from the prism of those same 302 neurons





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