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Network model for visually mediated ciliary locomotion in *Hermissenda*

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The overall goal of this study is to investigate the ways in which learning modifies behavior. A combination of computational and empirical studies is being used to address this issue. Empirical studies investigate learning from a cellular and synaptic perspective in the relatively simple nervous system of the nudibranch mollusk *Hermissenda* [1-3]. Pavlovian conditioning produces light-elicited inhibition of normal positive phototaxis in *Hermissenda*. Learning changes both cellular excitability and synaptic strength in the neural circuit that supports phototaxis. In the present study, a model of the circuit that supports visually mediated locomotion (Fig. 1A) was developed. Consistent with empirical observations, simulated responses to light increased the level of VP_1 spike activity (Fig. 1B1), which is equivalent to positive phototaxis. Simulations indicated that phototaxis resulted from disinhibition of VP_1. Light increased activity in I_e and decreased activity in I_i (Fig. 1B2). The net result was less activity in III_i and disinhibition of VP_1 (Fig. 1B2). Simulations also indicated that disinhibition produced phototaxis only if VP_1 had a high level of tonic firing. The model is being refined and expanded, and will be used to investigate the generation of other behaviors (e.g., foot contraction), the responses to other

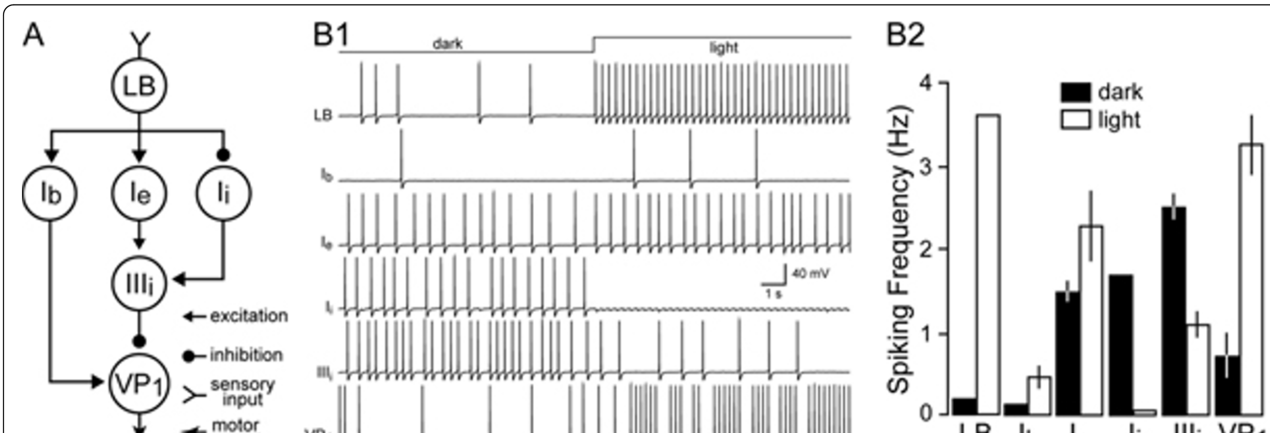

Figure 1 Network model for visually mediated ciliary locomotion. A: The model had six cells: LB, lateral B-type photoreceptor; I_b, I_e, I_i and III_i, interneurons; VP_1, ciliary motor neuron. The cells were Hodgkin-Huxley-like neurons. Membrane conductances also included noise. The match between empirical data and model properties was qualitative. For example, all synaptic connections were modeled as monosynaptic, which reflected 'functional' connections. The circuit was implemented in SNNAP [4]. **B1:** The model responded to light, which was simulated by depolarizing LB, with increased VP_1 activity. **B2:** The mean (+/- SD; n = 7) spiking frequency (Hz) of each cell before (dark) and during the light stimulus (light). Noise produced variability among simulations. In some cases, the error bars were not visible.

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sensory inputs (e.g., gravity), and the influence of learning-induced plasticity (e.g., increased I_e excitability and decreased VP_1 tonic firing). Simulations also will help identify features of the model that warrant further empirical investigation.

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