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Autaptic excitation contributes to bistability and rhythmicity in the neural circuit for feeding in *Aplysia*

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The feeding circuit in *Aplysia* is a useful model system for studying the neuronal bases of cognitive functions such as sensory processing, generation of behavior, motivation, decision making, learning, and memory [1,2]. The goals of the present study are to develop a biologically-realistic model of the feeding circuit and to investigate the ways in which component processes contribute to circuit function. To begin, we developed a model of the central pattern generator (CPG) that mediates rhythmicity in the feeding circuit (Fig. 1A). Simulations indicated that two positive-feedback loops (the B31 autapse and the synaptic interactions between B31 and B63) introduced bistability into the membrane potential of the B31 soma (Figures 1B, 1C1). In addition, simulations indicated that this plateau-like potential was the 'deciding factor' for initiating rhythmic activity (Fig. 1C). Simulations also helped identify features of the model that warrant further empirical investigation; e.g.,

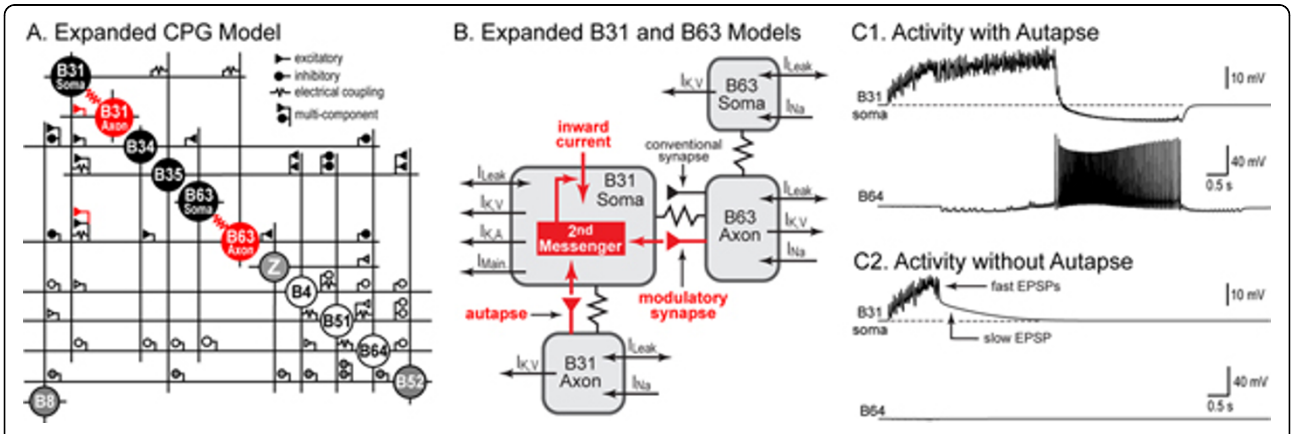

Figure 1 Bistability and rhythmicity in the feeding circuit. A: Circuit diagram of the feeding CPG. We expanded our previous ten-cell model [3] by representing B31 and B63 with two-compartments (soma and axon compartments), incorporating a modulatory synapse from B63 to B31, and implementing an autapse in B31 (new elements in red). See Panel B for additional details. The circuit was implemented in SNNAP [4]. Cellular and synaptic properties matched empirical data. Fill colors indicate cells that fire in phase. **B:** Hurwitz et al. [5] characterized and modeled membrane currents in the nonspiking soma of B31. We expanded that model by including a second-messenger system, which activated an inward current (new elements in red). **C1:** A 1-s depolarization of B63 (not shown) elicited a plateau-like potential in B31, which drove rhythmic activity (e.g., bursting in B64). **C2:** Without the autapse, B31 failed to manifest a plateau-like potential and rhythmic activity was blocked.

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the simulated amplitude of the plateau-like potential was less than empirical observations.

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