Computational model of a modulatory cell type in the feeding network of the snail, Lymnaea stagnalis

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The ionic basis of action potentials in an identified modulatory cell type in the feeding network of the snail, *Lymnaea stagnalis*: a computational study

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Introduction
Realistic mathematical models of single neurons are significant in assessing the contribution of specific ionic conductances to neuronal excitability. This study presents a detailed computational model of the Cerebral Giant Cells (CGCs), a pair of serotonergic neurons in the feeding network of *Lymnaea stagnalis*, which are critical for the expression of motor behaviour (feeding) and the formation of long-term memory.

Methods
First, we fitted a single-compartment, Hodgkin-Huxley model of the CGCs to two-electrode voltage- and current-clamp data [1] using a combination of linear and non-linear least-square fitting techniques. Then, we selectively blocked each ionic current to assess its role in the model, thus mimicking the application of pharmacological agents in the biological neuron.

Results
The model replicates accurately the shape of the action potentials and the tonic firing (~0.74 Hz) of the biological neuron (Fig. 1A). A persistent sodium current I_{NaP} and a transient low-threshold calcium current I_{LVA} keep the neuron spontaneously active (Fig. 1Bi,ii). A transient potassium current I_A regulates the interspike interval, while a transient high-threshold calcium current I_{HVA} increases the duration of each spike (Fig. 1Biii,iv). Transient sodium and delayed rectifier potassium currents are responsible for the depolarizing and repolarizing phases of the action potential, as in the classical Hodgkin-Huxley model. The available experimental data [1] are in agreement with these conclusions.

Conclusions
The model we have developed here provides an accurate description of the CGCs at the biophysical level and it is a useful tool for studying the electrical properties of these important modulatory neurons.

Acknowledgments
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References
1. K. Staras, J. Gyori & G. Kemenes: **Voltage-gated ionic currents in an identified modulatory cell type controlling molluscan feeding.** *Eur J Neurosci* 2002, **15:** 109-119

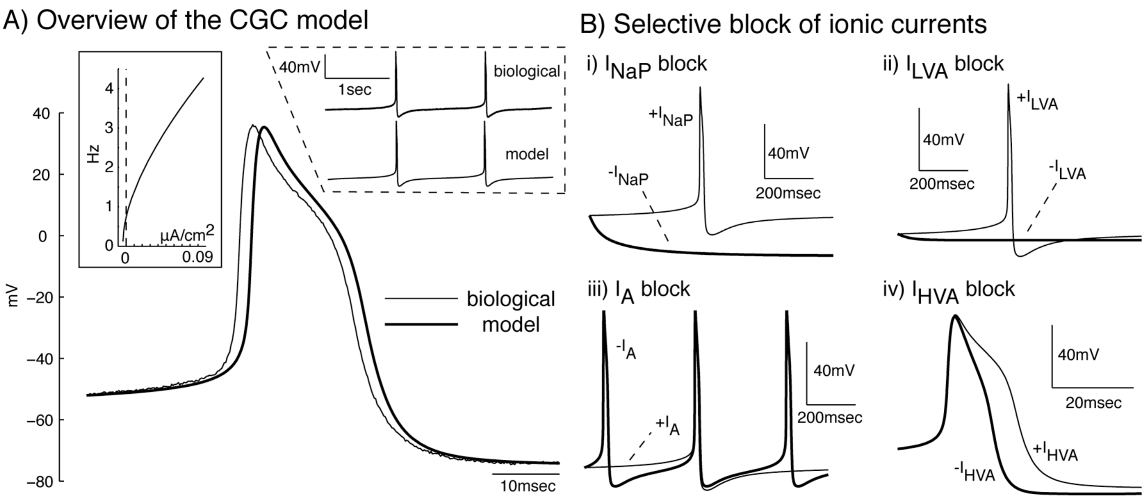

Fig. 1: Overview of the CGCs model and the contribution of specific currents to neuronal excitability. In A, the model has been slightly (2msec) shifted to the right for illustration purposes