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Modeling Central Pattern Generator Controlling Walking and Paw Shaking in Cats

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TITLE: Modeling Central Pattern Generator Controlling Walking and Paw Shaking in Cats

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INTRODUCTION: Central pattern generators (CPGs) are neural circuits controlling many motor functions such as walking, breathing, and flying.

PURPOSE: Our model explains paw-shaking and walking locomotion in cats.

METHOD: We developed a computational model of a CPG controlling a cat walking or paw shaking. This model is assembled of two populations with three neurons each. The neurons excite each other within each population and inhibit each other between populations. These neurons are controlled by a half-center oscillator motif. We have investigated the bursting dynamics within this model and discovered two distinct regimes which correspond with walking and paw shaking. Walking regimes typically have many spikes per burst and periods of around one second. Paw-shaking regimes typically have few spikes per burst and has a period of around a tenth of a second.

RESULTS: By modifying the sum of excitatory conductances, (gSynE), we controlled transition of the model between the bursting activities resembling walking and paw shaking. Paw shaking regimes were observed at a relatively low gSynE values, while walking were recorded at higher gSynE values. By investigating the bursting dynamics, we found that the transition from paw shaking to walking is at a higher gSynE value than the transition from walking to paw shaking.

CONCLUSION: The CPG exhibits bistability; and either walking or paw shaking regime can be obtained with the same gSynE. We demonstrate bistability of walking and paw-shaking regimes when the gSynE value is around 5.75 nS.