The Effects of Brain Control: A 3-D Agent-based Model for Studying Pain

Kayla Kraeuter[1,2,4,*], Carley Reith[1], Benedict Kolber[3], Rachael Miller Neilan[1]

[1]*Department of Mathematics & Computer Science, Duquesne University, Pittsburgh, PA 15282*

[2]*Department of Engineering, Duquesne University, Pittsburgh, PA 15282*

[3]*Department of Neuroscience & Center for Advanced Pain Studies, University of Texas at Dallas, Richardson, TX, 75080*

[4]*Neurodegenerative Undergraduate Research Experience, Duquesne University, Pittsburgh, PA, 15282*

`kraeuterk@duq.edu`

Neuropathic pain is caused by injury to the nervous system and involves brain areas such as the central nucleus of the amygdala (CeA). Recently, we developed the first 3-D agent-based model (ABM) of pain-related neurons in the CeA, yet simulation of the ABM using realistic parameters (13,000 neurons and 22,000+ neural connections) was time consuming. In this poster, we describe our efforts to improve the computational efficiency of our 3-D ABM, which resulted in a ∼96% reduction in execution time. With this upgraded model, we were able to perform a sensitivity analysis to explore the impact of several key parameters on model output. Our results show that model predictions of pain are most sensitive to the quantity and connectivity of select neuron-types in the middle region of the CeA. These results highlight the importance of computational modeling in exploring spatial and cell-type specific properties of brain regions to inform future wet-lab experiments.

keywords: agent-based model, amygdala, pain, sensitivity analysis, NetLogo