Characterization of Rhythmic Motor Patterns in the Mammalian Thoracic Spinal Cord Neural Network
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The motor system of vertebrates allows for everyday movements such as walking, running, flying, etc. This motion results from the coordinated contraction of various muscles in the body. These contractions ultimately produce what can be described as rhythmic movement, something that can be traced back to the neural networks, or interconnected groups of neurons, present throughout the spinal cord. When these neural networks are able to produce rhythmic activity, they are referred to as "central pattern generators" (CPGs).

The lumbar region of the spinal cord has been identified as a CPG and is the location of most spinal cord rehabilitation efforts due to its control over hindlimb locomotion. The thoracic region, located directly above the lumbar, is presently believed to be controlled by the lumbar CPG (Beliez et al. 2014). Last summer, we found that the isolated thoracic region was able to produce rhythmic activity on its own. This summer, we worked to further identify if the isolated thoracic spinal cord contains an autonomous CPG network capable of producing rhythmic patterns and how the naturally occurring neurotransmitter dopamine influenced this ability.

The isolated thoracic cord of euthanized neonatal mice (P1 to P7) were dissected out and placed in an aerated bath that was continuously perfused with artificial cerebrospinal fluid. Various concentrations of the glutamate analog NMDA and serotonin (5HT), known to induce rhythmic motor bursting (motor neuron activity) in lumbar prparations, were added to the bath to achieve activation. Once a control recording was taken, dopamine was added to the bath. Recordings of bursting activity during control and dopamine conditions were taken through the software Spike2. The smooth and rectified versions of these traces were used to identify the average amplitude (strength and motoneuron recruitment of each burst), burst duration (how long each burst lasts), and cycle period (time between the start of one burst to the start of the following).


In control recordings, different bursting "styles" were present within and across preparations. "Short" bursts had short burst durations, but long cycle periods. "Standard" bursts had longer burst durations, but shorter cycle periods. "Long" bursts had long burst durations and long cycle periods. It's possible that, because the thoracic region is responsible for multiple different motor activities, these bursting styles are different networks being activated (e.g. one bursting style reflects the body breathing while another reflects twisting).

In lumbar preparations, dopamine has been found to slow and stabilize rhythms by increasing the burst duration and cycle period (Sharples et al. 2015). Our results showed an increase in burst duration as well, though, as the dopamine concentration increased, the burst duration remained at the same elevated level, rather than increasing further. Alternatively, the cycle period showed no clear trend. This could potentially be due to the fact that the cycle period of isolated thoracic preparations is longer than that of lumbar preparations, thus it may be impossible for dopamine to further increase it beyond this.

Future experiments should work to identify a more replicable concentration for drug application in order to allow for an increased sample size. Similarly, further work should be committed to better understanding the various busting styles exhibited in control preparations.
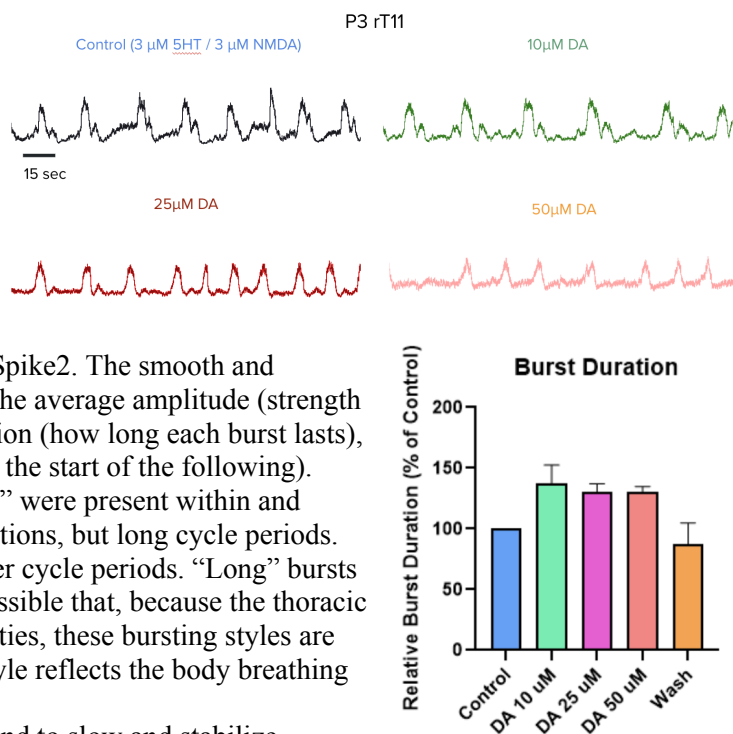
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