Spring 2018

Reconstruction of the tail nociceptive withdrawal response from combinations of movement primitives associated with individual muscles in the rat

Justin Nguyen
James Madison University

Reconstruction of the Tail Nociceptive Withdrawal Response from Combinations of Movement Primitives Associated with Individual Muscles in the Rat

---

An Honors College Project Presented to

the Faculty of the Undergraduate

College of Science and Mathematics

James Madison University

---

by Justin Quang Nguyen

May 2018

Accepted by the faculty of the Department of Biology, James Madison University, in partial fulfillment of the requirements for the Honors College.

FACULTY COMMITTEE:

____

Project Advisor: Corey L. Cleland, Ph. D.
Associate Professor, Biology

____

Reader: Tim Bloss, Ph. D.
Associate Professor, Biology

____

Reader: Kevin Caran, Ph. D.
Associate Professor, Chemistry

HONORS COLLEGE APPROVAL:

____

Bradley R. Newcomer, Ph.D.,
Dean, Honors College

PUBLIC PRESENTATION

This work is accepted for presentation, in part or in full, at UMBC Undergraduate Research Symposium in the Chemical and Biological Sciences on October 14th, 2018, at the Society for Neuroscience meeting on November 12th, 2018, and at Biosymposium on April 13th, 2018.

Abstract

One type of involuntary movement is the nociceptive withdrawal response (NWR), in which mammals move a part of their body away from noxious, or tissue damaging, stimuli. Previous studies have evoked the limb NWR in diverse animals such as cats, frogs, and humans. However, there is minimal information on how complex movement arising from numerous muscles and joints, such as in the tail of the rat, is effectively coordinated.

The specific aim was to identify the contribution of movement from individual extrinsic muscles to the tail NWR utilizing a new technique. From previous studies, extrinsic muscles in the pelvis have been shown to be the primary components in controlling tail movement. In our experiments, the NWR was first evoked in intact-unanesthetized rats by applying heat stimuli (laser, 980nm, 2-6 watts) to the lateral surface of the tail. Tail movement in the NWR was away from the stimulus, in the lateral direction, resulting in a local bend in the tail in the region of stimulation. Subsequently, the rat was deeply anesthetized and the tendons from extrinsic muscles were pulled manually to create movement "primitives". To assess whether movement in the NWR could be explained by movement primitives arising from the movements created by individual tendons, the NWR in the first part of the experiment was computationally reconstructed in terms of the movement primitives from the second part of the experiment in which tendons were pulled. Our results indicated that the NWR could be reconstructed from the movement associated with pulling one or at most two tendons. Thus, although the rat tail has numerous muscles that act on the tail, one or two muscles acting through tendons are sufficient to account for the entire NWR, thereby potentially simplifying the central nervous system control of movement.