Zebrafish could shed light into the mysteries of the human spinal cord and its influence on our body

October 12 2021

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University of Ottawa researchers believe zebrafish may provide clues to understanding how the human nervous system develops since this fish experiences new movements similarly to how babies do after birth.

To understand how our nervous system enables us to move and learn new movements such as walking or swimming as we grow, researchers looked closely at the nervous system of zebrafish and built models of developing zebrafish spinal circuits to test and further understand the operation of spinal circuits for moving. Their computational study "Modeling spinal locomotor circuits for movements in developing zebrafish" was recently published in the journal *eLife*.

To learn more, we talked to senior author Tuan Bui, Associate Professor in the Department of Biology, head of the Neural Motor Circuits Lab and member of the uOttawa Brain and Mind Research Institute.

Please tell us more about this research.

"Understanding how the spinal cord controls our body is essential for improving treatments for movement disorders due to injury or disease to the nervous system. We examined the function of the spinal cord in zebrafish since zebrafish and mammals have many spinal neurons in common. These freshwater fish are a widely used model organism in biomedical research.

"Recent studies have described the swimming maneuvers of growing zebrafish and the spinal neurons present at these developmental stages. These studies motivated us to ask what changes in the spinal cord help young zebrafish acquire new swimming movements as they mature."

What role does the spinal cord play?

"The spinal cord is a long, thin, tubular structure extending from the brainstem to the lower part of the vertebral column. It contains several populations of nerve cells (neurons) that help control and coordinate all the body muscles and aid in making movements. We do not yet fully understand the role of each spinal neuron and how they communicate with other neurons and muscles to facilitate movement in animals.

"Early in development, new neurons in the spinal cord are formed, and new connections between spinal neurons are made. For young animals, including human babies, the formation of these new neurons and the establishment of these neural connections coincides with the ability to make new, more skillful maneuvers as the body grows and matures. One approach to understanding how the spinal cord controls our body is examining how new neurons and connections are responsible for gaining new movements."

What did your team discover?

"We built computational models of the spinal cord at different developmental stages. Simulations showed that new swimming maneuvers in zebrafish could arise from adding specific new neurons to the spinal cord and new connections between spinal neurons. These additions enabled the spinal cord to control the pace and duration of new movements.

"We also identified patterns of neural activity that are repeated in different movements. For example, to make tail beats that alternate between the left and right sides, neurons on one side of the spinal cord excite neurons on the other side to switch the direction of the tail beat. However, this activation across the body is exquisitely timed to ensure that each side has sufficient time to generate a tail beat. These patterns may be present in how humans perform locomotor activities like walking and swimming."

Why is this important?

"Our models will identify new functions of different neurons in the spinal cord involved in facilitating movements. A better understanding of how the spinal cord works will help identify the neurons to target to restore movements. However, to benefit individuals with impaired movements due to injury or disease, our findings will need to be combined with improved methods to repair or reactivate the nervous system."

More information: Yann Roussel et al, Modeling spinal locomotor circuits for movements in developing zebrafish, *eLife* (2021). DOI: 10.7554/eLife.67453

Provided by University of Ottawa