Spring 2018

Brain Shape Changes Are Associated with the Enlargement of the Cerebellum andthe Evolution of a Novel Sensorimotor System in Mormyrids

Jerry Shen
Washington University in St. Louis

Brain Shape Changes Are Associated with the Enlargement of the Cerebellum and the Evolution of a Novel Sensorimotor System in Mormyrids

Jerry Shen

Mentors: Bruce Carlson and Kimberley Sukhum

Brain shape varies among vertebrates. Mormyrids, a family of weakly electric African fishes, have evolved extreme encephalization and have an enlarged cerebellum, leading to brain shape changes in which the cerebellum expands to dorsally cover all other brain regions. This is comparable to the extreme encephalization and subsequent brain shape changes of the neocortex in primates. By observing these structural brain changes throughout evolutionary lineages and looking for patterns of divergence, we can determine relationships between particular social and ecological variables and morphological brain changes. Mormyrids have evolved a novel electric sensory system in the form of electric organs and electroreceptors. Here, I ask if brain changes associated with sensory system evolution correlate with shape changes in other brain regions. If these changes are correlated, then the evolution of sensory systems may contribute to brain morphological diversification. If not, then the evolution of sensory systems may not affect brain shape. Instead, brain shape may be constrained by factors such as skull morphology. I created 3D reconstructions of mormyrid and outgroup species' brains and placed coordinate points on anatomical landmarks. To assess brain shape variation across species while eliminating the influence of brain size, I then performed geometric morphometric analysis to quantify how coordinates changed across species. I show that extreme enlargement of the cerebellum is correlated with changes in brain shape in mormyrids compared to non-mormyrids. My data provide further support for previous studies that demonstrate morphological relationships between individual brain regions. This study is the first to demonstrate a shift in brain shape corresponding to the evolution of a novel sensorimotor system.