World Academy of Science, Engineering and Technology
International Journal of Cognitive and Language Sciences
Vol:16, No:10, 2022

Neuronal Mechanisms of Observational Motor Learning in Mice

Authors : Yi Li, Yinan Zheng, Ya Ke, Yungwing Ho

Abstract : Motor learning is a process that frequently happens among humans and rodents, which is defined as the changes in the capability to perform a skill that is conformed to have a relatively permanent improvement through practice or experience. There are many ways to learn a behavior, among which is observational learning. Observational learning is the process of learning by watching the behaviors of others, for example, a child imitating parents, learning a new sport by watching the training videos or solving puzzles by watching the solutions. Many research explores observational learning in humans and primates. However, the neuronal mechanism of which, especially observational motor learning, was uncertain. It's well accepted that mirror neurons are essential in the observational learning process. These neurons fire when the primate performs a goal-directed action and sees someone else demonstrating the same action, which suggests they have high firing activity both completing and watching the behavior. The mirror neurons are assumed to mediate imitation or play a critical and fundamental role in action understanding. They are distributed in many brain areas of primates, i.e., posterior parietal cortex (PPC), premotor cortex (M2), and primary motor cortex (M1) of the macaque brain. However, few researchers report the existence of mirror neurons in rodents. To verify the existence of mirror neurons and the possible role in motor learning in rodents, we performed customised string-pulling behavior combined with multiple behavior analysis methods, photometry, electrophysiology recording, c-fos staining and optogenetics in healthy mice. After five days of training, the demonstrator (demo) mice showed a significantly quicker response and shorter time to reach the string; fast, steady and accurate performance to pull down the string; and more precisely grasping the beads. During three days of observation, the mice showed more facial motions when the demo mice performed behaviors. On the first training day, the observer reduced the number of trials to find and pull the string. However, the time to find beads and pull down string were unchanged in the successful attempts on the first day and other training days, which indicated successful action understanding but failed motor learning through observation in mice. After observation, the post-hoc staining revealed that the c-fos expression was increased in the cognitive-related brain areas (medial prefrontal cortex) and motor cortices (M1, M2). In conclusion, this project indicated that the observation led to a better understanding of behaviors and activated the cognitive and motor-related brain areas, which suggested the possible existence of mirror neurons in these brain areas.

Keywords : observation, motor learning, string-pulling behavior, prefrontal cortex, motor cortex, cognitive
Conference Title : ICABCD 2022 : International Conference on Attention, Brain and Cognitive Science
Conference Location : New York, United States
Conference Dates : October 06-07, 2022