World Academy of Science, Engineering and Technology
International Journal of Cognitive and Language Sciences
Vol:10, No:08, 2016

Variations in Spatial Learning and Memory across Natural Populations of Zebrafish, Danio rerio

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Abstract : Cognitive abilities aid fishes in foraging, avoiding predators & locating mates. Factors like predation pressure & habitat complexity govern learning & memory in fishes. This study aims to compare spatial learning & memory across four natural populations of zebrafish. Zebrafish, a small cyprinid inhabits a diverse range of freshwater habitats & this makes it amenable to studies investigating role of native environment in spatial cognitive abilities. Four populations were collected across India from waterbodies with contrasting ecological conditions. Habitat complexity of the water-bodies was evaluated as a combination of channel substrate diversity and diversity of vegetation. Experiments were conducted on populations under controlled laboratory conditions. A square shaped spatial testing arena (maze) was constructed for testing the performance of adult zebrafish. The square tank consisted of an inner square shaped layer with the edges connected to the diagonal ends of the tank-walls by connections thereby forming four separate chambers. Each of the four chambers had a main door in the centre. Each chamber had three sections separated by two windows. A removable coloured window-pane (red, yellow, green or blue) identified each main door. A food reward associated with an artificial plant was always placed inside the left-hand section of the red-door chamber. The position of food-reward and plant within the red-door chamber was fixed. A test fish would have to explore the maze by taking turns and locate the food inside the right-side section of the red-door chamber. Fishes were sorted from each population stock and kept individually in separate containers for identification. At a time, a test fish was released into the arena and allowed 20 minutes to explore in order to find the food-reward. In this way, individual fishes were trained through the maze to locate the food reward for eight consecutive days. The position of red door, with the plant and the reward, was shuffled every day. Following training, an intermission of four days was given during which the fishes were not subjected to trials. Post-intermission, the fishes were re-tested on the 13th day following the same protocol for their ability to remember the learnt task. Exploratory tendencies and latency of individuals to explore on 1st day of training, performance time across trials, and number of mistakes made each day were recorded. Additionally, mechanism used by individuals to solve the maze each day was analyzed across populations. Fishes could be expected to use algorithm (sequence of turns) or associative cues in locating the food reward. Individuals of populations did not differ significantly in latencies and tendencies to explore. No relationship was found between exploration and learning across populations. High habitat-complexity populations had higher rates of learning & stronger memory while low habitat-complexity populations had lower rates of learning and much reduced abilities to remember. High habitat-complexity populations used associative cues more than algorithm for learning and remembering while low habitat-complexity populations used both equally. The study, therefore, helped understand the role of natural ecology in explaining variations in spatial learning abilities across populations.

Keywords : algorithm, associative cue, habitat complexity, population, spatial learning
Conference Title : ICAC 2016 : International Conference on Animal Cognition
Conference Location : Bangkok, Thailand
Conference Dates : August 30-31, 2016