Attention Deficit and Hyperactivity in a Drosophila Memory Mutant

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1. Abstract

Action selection is modulated by external stimuli either directly or via memory retrieval. In a constantly changing environment, animals have evolved attention-like processes to efficiently filter the incoming sensory stream. These attention-like processes, in turn, are modulated by memory. The neurobiological nature of how attention, action selection and memory are interconnected is unknown. We describe here new phenotypes of the memory mutant radish in Drosophila melanogaster. Radish mutants, when allowed to freely explore visual objects, show reduced attention. A more random alternation of brain activity is observed in response to these patterns. These brain recordings were performed in the fly's home arena without distracting visual patterns surrounding the fly. The larger peak below 1 Hz (off scale) represents responses to the visual objects rotating around the fly at 0.33 Hz. The larger peak below 1 Hz represents responses to the visual objects rotating around the fly at 0.33 Hz.

2. Mutant optomotor behavior

A. Arena setup. Visual objects rotate around the fly counter-clockwise with a period of 3 s. B. Average power spectra between 0 and 5 Hz for wild-type (blue line, n=25) and radish (red line, n=24) torque behavior in 6-minute closed-loop flights with two distinct visual objects. C. Random alternations in choice behavior, as well as a well-defined oscillatory hyperactivity in both brain activity and behavior. D. Frequency distribution for 8 wild-type flies exposed to the two competing objects. E. Frequency distribution for 8 sets of flies chronically exposed to drug for 24 hours were transferred back to normal food for 1-2 hours and tested (Recovery).

3. Radish behaves randomly in the maze

Fig. 1: Evaluating the behavior of individual radish mutant flies in the maze. A. Average Local Field Potential (LFP) activity following a novelty transition. B. Time course of an example trial. C. Time course of an example trial. D. LFP activity following a novelty transition. E. Time course of an example trial. F. Time course of an example trial. G. Time course of an example trial. H. Time course of an example trial.

4. Radish is hyperactive


5. An attention deficit in radish


6. Attention-like bias switches randomly in radish mutant flies


7. Ritalin rescues radish