

Good vs Bad: How Do Flies Distinguish Smells?

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Abstract

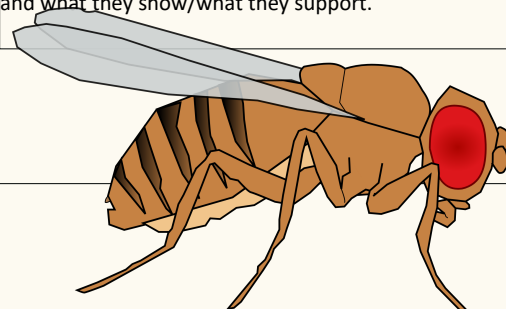
The ability to learn which stimuli in the environment predict rewards and punishments accordingly isn't yet explored in larger brain. Insects, such as *Drosophila Melanogaster*, provide traceable model systems in which detailed circuit mechanisms can be understood. Review of the recent papers describing the circuit basis of appetitive and aversive learning and decision-making in *Drosophila* and we discuss the open questions in the field. A summary of the articles described the state-of-the art understanding of the role of the different neuron types in the *Drosophila* learning circuit, called the mushroom body (MB) : the Kenyon Cells (KC) that encode conditioned stimuli (such as odors), the mushroom body output neurons that encode the learnt information, and the dopamine neurons (DANs) that provide the teaching signals that drive learning and pair an odour with a learnt value. This shows that the mushroom body is the prime circuit for differentiating scents and learning whether they predict positive or negative experiences. However, despite recent progress in the field, many open questions remain, including how the learnt information encoded by the population of mushroom body output neurons is processed downstream of the mushroom body and used to select actions.

Introduction

Learning which stimuli causes punishment versus reward is difficult to understand in larger brains. Rather, the *Drosophila Melanogaster*, or better referred to as the fruit fly, is used as a reference for how learning is consolidated. Associative learning is a vital component in the *Drosophila*. So, how do flies distinguish smell? Using the Mushroom Body, implement associative learning to distinguish between reward and punishment stimuli. The Narrative Review establishes the basics of learning, and the Mushroom body with it's key components and cells (such as Kenyon Cells and Dopamine Neurons). It also shows the different experimental techniques used to detect activity in the circuits.

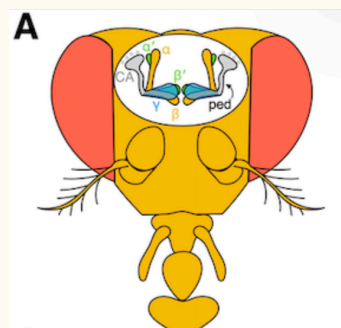
Methods

For this review, I selected twenty papers on the role of *Drosophila* mushroom body in learning and action-selection, using the following key words for searches in PubMed: *Drosophila*, mushroom body, associative learning, action selection. I focused on recent papers, as well as some seminal papers that revealed key principles of structural and functional organization of the learning circuit. Using primary sources for data to provide evidence for the findings stated, and to show the use of experimental techniques, how they operate and what they show/what they support.

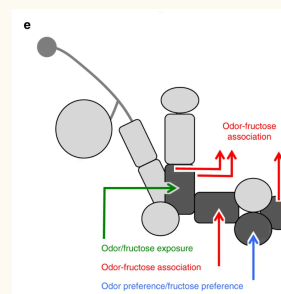


Results

The Mushroom Body is the prime center for differentiating scents, and pairing a stimuli with a reactions. With Kenyon Cells (KCs) that are used for olfactory discrimination. A combination of specific KCs make up the scent. Dopamine Neurons (DANs) are used to pair the odor with a specific response. Then Mushroom Body Output Neurons (MBONs) are what drive the response. So, this process links attractive odors with corresponding responses, and same with avoidance offers. These cells and processes are what make up the stimuli and response pair up.



The Adult *Drosophila* Mushroom Body (and the lobes)



DAN in a larvae *Drosophila*

Discussion

The findings and studies support the idea that the Mushroom Body (MB) helps flies detect punishment or reward. This supports the idea that flies don't just recognize odors, but they also recognize if its good or bad. Kenyon Cells where shown to identify the specific odors, while Dopamine Neurons pair them with a response. This supports how the neurons work together in processes to drive associative learning.

Conclusion

The Mushroom Body (MB) is the primary center for associative learning with a stimulus (scent) to a response, either punishment or reward. To tie this into larger, more complex brains, relating the functions of the MB to similar functioning structures in different brains help make sense of these findings in correlation to larger brains. When more advanced technology is built, such as non-invasive imaging, then comparison with the *Drosophila* and the more complex brain can be put into use.

References

file:///Users/adhyakoickel/Downloads/References.pdf