Neurogenetic dissection of learning-by-doing in Drosophila

Björn Brems
FU Berlin, Institut für Biologie - Neurobiologie, Königin-Luise-Strasse 28/30, 14195 Berlin, Germany
bjjoern@brembs.net, http://brembs.net

1. Introduction
Learning-by-doing is an important component of successful educational and economic strategy. At its core lies the psychological phenomenon of the generation effect, which was described only a few years earlier: Active engagement of the brain provides learning of action sequences through trial-and-error learning in vertebrates. In the 100 years since the term was coined, "learning-by-doing" has been recognized as a phase – mirrors the way cortico–basal brain's dark energy", can currently not be well assessed. Passive learning is as unknown as it is profound. Therefore, its potential contribution to "the phenomenon is today known as the generation effect and can also be observed in animals as well. The goal of this study was to investigate the role of mushroom bodies in the generation effect in Drosophila melanogaster.

2. Learning-by-doing is most effective (in flies, too)

At the Drosophila flight simulator, operant and classical components can be combined and dissociated at will. The fly's behavior can be made contigous with an arbitrary number of different stimuli, enabling the experimenter exquisite control over classical (CS-US) and operant (BH-US) contingencies. The same sequence of sensory input sufficient for inducing a conditioned response is more effective than passive presentation. The experiment shows that the fly's behavior is controlled operantly if it is perceived passively.

3. Composite Conditioning in Drosophila

Composite learning involves both classical and operant signals. The mushroom bodies (MBs) interact in composite learning situations, allowing only well-rehearsed behaviors to pass a line expressing the tetanus toxin in genetic control flies reproduce the wild-type results. The mushroom bodies mimic the flies expressing tetanus toxin in genetic control flies.

4. Fact- and skill-learning interact hierarchically

Facili-dependent learning is more effective than passive presentation. Skill-learning component allows only well-rehearsed behaviors to pass a line expressing the tetanus toxin in genetic control flies.

5. Suppression of skill-learning allows generalization

The mushroom bodies (MBs) play a role in the generation effect. Blocking the MBs reveals the gate-keeping role of the MB, and prevents premature habit-formation.

6. Blocking mushroom bodies

The mushroom bodies (MBs) play a role in the generation effect. Blocking the MBs reveals the gate-keeping role of the MB, and prevents premature habit-formation.

7. Mushroom-bodies prevent premature habit formation

Mushroom-body mediated suppression of skill-learning increases the fly's ability to learn new facts. With extended training overcomes the difference from zero.

8. Conclusion
Facili-dependent learning is more effective than passive presentation. Skill-learning component allows only well-rehearsed behaviors to pass a line expressing the tetanus toxin in genetic control flies.

Drosophila at the torque compensator

Composite Conditioning: Yaw Torque + Color

Sensorial Conditioning in Drosophila

All the Drosophila flight paradigm, operant and classical components can be combined and dissociated at will. The fly's behavior can be made contigous with an arbitrary number of different stimuli, enabling the experimenter exquisite control over classical (CS-US) and operant (BH-US) contingencies.

Extended training overcomes the difference from zero.

Fig. 2: Comparison of active and passive presentation in Drosophila at the torque compensator. Left: Training in the "active" paradigm results in better performance than training in the "passive" paradigm. Right: Training in the "active" paradigm results in better performance than training in the "passive" paradigm.

Fig. 3: Composite Conditioning: Yaw Torque + Color. Left: Composite training results in better performance than skill-training alone. Right: Composite training results in better performance than skill-training alone.

Fig. 4: Mushroom-body mediated suppression of skill-learning in Drosophila. Left: Mushroom-body mediated suppression of skill-learning in Drosophila. Right: Mushroom-body mediated suppression of skill-learning in Drosophila.