REINFORCEMENT SIGNALING IN *DROSOPHILA*

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ABSTRACT

Memory performance levels can reliably match the intensity / amount/ probability of reinforcement. Interestingly, experience with a reinforcer unpaired from any predictors can enhance or impair later associative learning. We identified and characterized the reinforcement matching and the pre-exposure induced behavior in *Drosophila* spatial operant learning using high temperature as negative reinforcement.

Further we investigated the neural systems influencing matching and pre-exposure effect. Analysis of the *white* mutant implicates a role for serotonin and dopamine in memory matching. Using genetic and pharmacological manipulations, we found that serotonin but not dopamine plays a critical role in reinforcement matching. The serotonergic system is required for reinforcement processing in the heat box. Our results also show that the serotonergic reinforcement circuit is required for uncertainty bias in the heat box. Furthermore, altering the excitability of serotonergic neurons is sufficient in memory matching and inducing the pre-exposure effect. Another important finding is that the absence of a behavioral predictor is important for the pre-exposure effect and this effect can bias learning in a positive way.

Moreover, we also looked at the role of serotonergic signaling in aversive olfactory learning. Unlike the spatial learning where serotonin mediates the aversive reinforcing signal, serotonin enhances the olfactory memory 3 and 6 hrs post training.

Finally, serotonin and dopamine seem to have specific functions in two different aversive learning paradigms arguing against common negative reinforcing signals. Octopamine, known to mediate some positive reinforcing signals, seems dispensable for place learning. This either supports the conclusion of the absence of an appetitive component in place learning or the presence of one that is not dependent on octopamine.