Invertebrate Learning and Memory: Chapter 36. Behavioral and Neural Analyses of Punishment Learning in Honeybees (Handbook of Behavioral Neuroscience)

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Studies on learning and memory in honeybees have been historically framed in an appetitive context because bees learn remarkably well about sensory stimuli if these are associated with food. We review studies in which bees learn about olfactory stimuli associated with the noxious stimulation of an electric shock. In response to such stimulation, bees exhibit a sting extension response (SER). Pairing a neutral odor with shock results in associative learning so that bees exhibit conditioned SER to the originally neutral stimulus and avoid afterwards that stimulus when given the possibility of moving away from it. SER conditioning leads to long-term memory formation, which depends on transcription and translation. Aversive reinforcement properties are mediated by dopamine, and a rich network of dopaminergic neurons exists in the bee brain. Taken together, these studies open new research avenues to understand how bees learn about aversive events in their environment.

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