
# Bimodal patterning discrimination in harnessed honey bees

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In natural environments, stimuli and events learned by animals usually occur in a combination of more than one sensory modality.  An important problem in experimental psychology has been thus to understand how organisms learn about multimodal compounds and how they discriminate this compounds from their unimodal constituents. Here we tested the ability of honey bees to learn bimodal patterning discriminations in which a visual-olfactory compound (AB) should be differentiated from its visual (A) and olfactory (B) elements. We found that harnessed bees trained in classical conditioning of the proboscis extension reflex (PER) are able to solve bimodal positive and negative patterning tasks. In positive patterning (PP), bees learned to respond significantly more to a bimodal reinforced compound (AB+) than to non-reinforced presentations of single visual (A-) or olfactory (B-) elements. In negative patterning (NP), bees learned to suppress their responses to a non-reinforced compound (AB-) and increase their responses to reinforced presentations of visual (A+) or olfactory (B+) elements alone. We compared the effect of two different inter-trial intervals (ITI) in our conditioning approaches. Whereas an ITI of 8min allowed solving both PP and NP, only PP could be solved with a shorter ITI of 3min. In all successful cases of bimodal PP and NP, bees were still able to discriminate between reinforced and non-reinforced stimuli in memory tests performed one hour after conditioning. The analysis of individual performances in PP and NP revealed that different learning strategies emerged in distinct individuals. As previously found in different animal models, NP solving appeared to be more difficult for bees than PP solving in this new bimodal paradigm. We discuss our results in light of elemental and configural learning theories that may support the strategies adopted by honey bees to solve bimodal positive or negative patterning discriminations.