I. Introduction

Sensory preconditioning, blocking, overshadowing, second-order reinforcement, these are all terms that were coined by learning psychology more than 20 years ago and are well established using classical conditioning setups. Classical conditioning is often described as the transfer of the response eliciting property of a stimulus to a new stimulus without that property. This association between an unconditioned stimulus (US) and a conditioned stimulus (CS) can also be established when the animal is in control of the stimulus presentation (operant conditioning). We have not found a single report as to whether the above mentioned concepts also apply to operant conditioning. We used operant patterns and color learning in the Drosophila Flight simulator (see control figure).

II. Operant Conditioning at the Drosophila Flight Simulator

(1) Sensory processing: by manipulating the intensity of the heat beam (US). The flies were trained to distinguish two orientations (right and inverted) of four 1-shaped patterns (US see control figure).

(2) For the CS processing experiments, the coloration of the arena (CS2) was changed whenever the fly brought one of the two pattern orientations (CS1) into its frontal visual field (compound training, CS1+CS2-US). In the subsequent test phase, either the color filter was removed (patterns, CS1 alone), or the patterns were replaced by four identical vertical bars (colors, CS2 alone), or the pattern orientation associated with one color during training was reversed (inefficient CS). If similar positive scores in both CS alone tests and no learning in the nonsense CS test are obtained, it is concluded that no overshadowing occurred between the two CSs and both are learned equally well when presented in a compound.

(3) We used a standard blocking scheme. The first CS was pre-trained to the maximum extent, then a compound training of equal duration followed. To assure the predictive value of the pre-trained CS, an intertesting test for the compound CS was introduced before the compound training. Additional controls were balanced for CS and US presentations.

(4) In order to control for second-order conditioning occurring in our blocking experiment, we used several different procedures to find a second-order effect.

(5) For sensory preconditioning, the flies were allowed to fly in closed loop for 16 minutes (pre-conditioning). The coloration of the arena was changed whenever the fly brought one of the two pattern orientations into its frontal visual field (CS1+CS2). In the subsequent test phase, either the color filter was removed (patterns, CS1+US), or the patterns were replaced by four identical vertical bars (colors, CS2+US). In the final phase, the flies were tested for the CS

III. Operant Answers to Classical Questions

(1) Blocking: In contrast to the current learning theory, operant pre-training of one CS did not diminish the associative strength a second CS acquired when trained in compound with the first (A). The controls (B, C) are balanced for CS and US presentations and differ from the test group in the low predictive value the compound CS attained (first test bar in the area shaded gray). No significant difference was found between test and control groups. Specifically, in no instance were the learning scores in the blocking groups lower than in either control groups or the respective CS Preconditioning (2) groups.

(2) Second-order Conditioning: One reason for the failed blocking experiment depicted in (3) might be the effect of second-order conditioning occurring in the compound training phase. This could not be corroborated since several different procedures did not yield a significant second-order effect.

(3) Sensory Preconditioning: Uninformed pre-exposure of the colors (CS2) and patterns (CS1) compound (area shaded gray) yielded significant learning scores in one CS (not patterns or colors alone) when the other CS had been paired with the reinforce stimulus (training colors or patterns alone).

Data have been pooled since the performance indices in both experimental groups did not differ significantly.