Avoidance learning in fish after fear conditioning under chloretone^{1,2}

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Goldfish were paralyzed with chloretone during fear conditioning in an attempt to eliminate the development of responses which would be incompatible with shuttling during later avoidance training. This group showed no decrement in avoidance responding while a group which was fear conditioned without chloretone showed the expected decrement. The data would seem to support the incompatible response hypothesis.

Two factor theory (Mowrer, 1951) proposes that two processes are involved in avoidance learning: the classical conditioning of fear to the conditioned stimulus (CS) through the pairing of the CS with an unconditioned stimulus (US), and the instrumental conditioning of the avoidance response which is reinforced by the reduction of this conditioned fear. One might predict from this that the conditioning of fear to the CS prior to avoidance training would facilitate the subsequent learning of the avoidance response. Experimental evidence, however, has not been entirely consistent with this prediction. Mullin & Mogenson (1963) reported that when various amounts of fear conditioning were given to rats prior to avoidance learning there was no significant improvement in learning and the variability of the learning scores increased greatly with an increase in the number of fear conditioning trials. Pinckney (1967), employing the same methodology with fish as Ss, found an increase in variability and a decrease in avoidance performance with an increasing number of fear conditioning trials. Mullin and Mogenson attributed the variability in learning scores to the acquisition of either favorable or incompatible motor responses learned during fear conditioning and suggested that the interfering responses might possibly be prevented by fear conditioning the animal while he is immobilized.

The purpose of the present study was to test the hypothesis that responses which interfere with later avoidance behavior are learned during fear conditioning. Fish were immobilized with chloretone during fear conditioning to prevent the development of incompatible responses. With this procedure it would seem likely that fear conditioning would facilitate avoidance learning, as suggested by two factor theory.

Subjects

Ss for this study were 72 goldfish, *Carassius auratus*, 2 to 3 in. in length, obtained from local dealers. Prior to experimentation Ss were housed in 20 gallon community tanks which were heated and continuously aerated.

Apparatus

The apparatus for fear conditioning consisted of a 2-1/2 gallon glass aquarium with a plywood top containing a 7-1/2 W overhead light and electrodes fitted into each end of the tank. The CS was the onset of the light and the US was an electric shock which was pulsed by a shock interrupter. The apparatus for avoidance conditioning was an aquatic shuttlebox consisting of an 18 in. *Betta splendens* display tank which was divided into two compartments of equal size by a gray Plexiglas doorway, and was enclosed in a plywood shell containing two 25 W bulbs, one at the end of each compartment. The CS was the onset of the light at the end of the compartment occupied by S, and the US was an electric shock delivered through a pair of electrodes in the ends of the tank. The shock was developed from a 110 VAC source, passed through a variable resistor and pulsed by a shock interrupter at a rate of 6 pulses per sec. The shock level was 7 V and had an on-time of 60 msec and an off-time of 100 msec. A pair of Hunter interval timers controlled the onset and duration of the CS and US. Six shuttleboxes and fear conditioning chambers were used throughout the study.

Procedure

After a 30 min adaptation period in the shuttleboxes, Ss were given 10 pretraining trials during which the CS was presented for 15 sec. These Ss who avoided during the first 10 sec of this period on more than five out of the 10 trials or more than two out of the last five trials were rejected. Seven Ss were discarded for this reason. Each S was immediately transferred from the shuttlebox to the fear conditioning chamber where half of the Ss remained in a .02% solution of chloretone and half in water for 15 min. Eighteen drugged and 18 non-drugged Ss were then given 20 fear conditioning trials using a delayed conditioning procedure with a 10 sec CS-US interval, a 5 sec US, and a 2 min inter-trial interval. Another 18 drugged and 18 nondrugged Ss were placed in the apparatus for 40 min but were given no fear conditioning trials. The drugged Ss were then transferred to 2-1/2 gallon aquaria containing fresh water where they remained for 15 min to allow the effects of the chloretone to wear off. Ss were then placed in the shuttleboxes and given 50 avoidance trials, using the delayed conditioning procedure employed during fear conditioning. A response to the CS, consisting of swimming through

Fig. 1. Mean avoidances in each block of 10 trials for drug-no fear conditioning (D-NFC), drug-fear conditioning (D-FC), no drug-fear conditioning (ND-NFC), and no drug-fear conditioning (ND-FC) groups.

the doorway into the unlighted compartment, terminated the CS and resulted in the avoidance of shock. A response during the 5 sec shock period terminated both the CS and US. The CS and US were terminated automatically at the end of the 5 sec US if S failed to respond.

Results

The mean number of avoidances in 50 trials for the drug-fear conditioning (D-FC), drug-no fear conditioning (D-NFC), no drug-fear conditioning (ND-FC), and no drug-no fear condition (ND-NFC) groups were 33.4, 26.3, 28.6, and 32.7, respectively. The mean number of avoidances made during each of five blocks of 10 trials are shown in Fig. 1. These data were subjected to an analysis of variance and the main effects of drug and fear conditioning were not found to be significant. The analysis yielded an F of 9.32 ($df=4/272$, $p < .01$) between blocks of trials and an F of 4.39 ($df=1/68$, $p < .05$) for the drug by fear conditioning interaction.

Discussion

The results of this study are not clear cut in terms of the hypothesis due to the complication of a drug effect. Perhaps if more time were allowed for the effect of the chlorotone to wear off this factor

would be eliminated. It is possible that the difference shown between the D-FC and D-NFC groups might be attributable to arousal effects of the shock in the D-FC group. Since there was no drug group which was given shock without light pairing this cannot be entirely ruled out. If, however, the light-shock contingency was learned, or even if the shock alone was perceived by S, which would be necessary for an arousal effect to occur, a decrement should have occurred as in the ND-FC group unless the drug was playing a role such as the elimination of incompatible responses. Conversely, if the shock was not perceived, S should have shown the same drug decrement as in the D-NFC group.

Several hypotheses have been formulated on the nature of the learning involved in the development of responses which are incompatible with the avoidance response of shuttling. The possibility of the development of superstitious behavior due to the termination of shock irrespective of S's responses was suggested by Pinckney (1967). Another possible interpretation is that responses such as freezing are conditioned through the classical conditioning paradigm used in fear conditioning. Responses made during the CS in anticipation of shock would be reinforced by the shock. These responses might be either compatible or incompatible with avoidance. Overmier & Seligman (1967) suggested a learned "helplessness" to account for the decrement in avoidance and escape behavior after inescapable shock. All responses would be punished by the shock resulting in a complete suppression of responding or a learned helplessness. This hypothesis could also be applied to fear conditioning since all responses made during the CS would be punished by the shock. Although the present data suggest that some type of incompatible response is learned during fear conditioning, the way in which these responses are learned remains unknown.

References

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Notes

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