Aversive stimulation and rats' preference for familiarity*

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Hooded rats were confined in the stem of a T-maze in which glass doors prevented access to black-white choice arms. On a subsequent free choice trial, when both arms were either black or white, rats shocked prior to choice spent a greater amount of time in the unchanged arm, whereas unshocked controls preferred the changed arm. It was suggested: (1) that the results provide firm support for the hypothesis that aversive stimulation elicits a shift in preference toward familiarity; (2) that the behavior of shocked laboratory rats in this type of situation may be akin to the "neophobia" observed in wild rats.

It is commonly claimed that high levels of fearfulness inhibit rats' exploratory behavior (e.g., Montgomery & Monkman, 1955; Halliday, 1966; Lester, 1968). Although most workers would agree with this claim, the empirical evidence rests mainly on two findings: aversive stimulation decreases locomotor activity (e.g., Montgomery & Monkman, 1955), and aversive stimulation eliminates spontaneous alternation (Thompson & Higgins, 1958; Sheldon, 1968). As Sheldon (1968) suggests, the evidence from the former experiments is ambiguous: a lower level of ambulation, of itself, does not necessarily indicate a lower level of exploration. For this reason, he suggested that the evidence from the latter experiments provides more convincing support for the hypothesis. In these experiments, rats were presented with the opportunity of entering a maze arm that they had previously explored (the familiar arm) and an arm that had previously been blocked (the novel arm). Rats shocked in the stem before choice tended to enter the familiar arm, whereas unshocked rats tended to enter the novel arm. However, since the rats were permitted to move between the stem and the "familiar" arm during the preshock habituation period, explanations in terms of *response* repetition, perhaps independent of *stimulus* conditions, can also account for the results obtained from the shocked groups. Although the results of a subsequent study (Aitken & Sheldon, 1970), in which shocked rats entering the novel arm withdrew from this arm more rapidly than shocked rats entering the familiar arm, appear to rule out explanations entirely in these terms, more convincing evidence could perhaps be provided by allowing rats to choose between relatively familiar and novel areas that they have not previously entered. In order to provide such evidence, the experiment described here examined the effect of electric shock on rats' response to stimulus change, using a technique first reported by Dember (1956).

Dember (1956) confined rats in the stem of a T-maze in which glass doors prevented access to black-white choice arms. On a subsequent free choice trial, when both arms were either black or white, the rats tended to enter the arm that had been changed in brightness. Positive replications have been reported by several other workers (e.g., Fowler, 1958; Woods & Jennings, 1959). If it could be shown that aversive stimulation produces a preference for the unchanged arm in this type of situation, then this would indicate a genuine shift in preference toward familiarity unconfounded by previous responses. It is of interest to note in this context that Fowler (1958) has suggested that failures to replicate Dember's findings (e.g., Levine, Staats, & Frommer, 1958) may have occurred because of uncontrolled variations in fearfulness.

SUBJECTS

Ss were 24 hooded rats about 140 days old, obtained from the National Institute for Research in Dairying at about 30 days. The rats had been regularly handled since arrival and had explored a complex maze daily for a period of 4 days, ending 14 days prior to the present experiment.

APPARATUS AND PROCEDURE

The apparatus has been fully described elsewhere (Aitken & Sheldon, 1970). It consisted of a T-maze with a short stem and two relatively long choice arms. Two-thirds of the stem was taken up by a startbox with a grid floor through which a 2-mA shock, lasting 0.5 sec, could be delivered. Glass guillotine doors could be fitted into the openings of the choice arms and an opaque door to the startbox. Black-white cardboard inserts were constructed to fit into the choice arms.

The basic design consisted of a habituation period, followed by a free choice trial. For the habituation period, all three doors were placed in position. One choice arm contained a black insert and the other, a white insert. Each rat was placed in the choice point area between the startbox and the glass doors, at the openings to the choice arms. After 5 min, the rat was placed in a delay cage for 30 sec. During this period, the glass doors were removed and one of the inserts changed so that both were of similar brightness: either black or white. For the free choice trial, the rat was placed in the startbox and the door raised after a further 30 sec. Two shocks were delivered to the shocked group: one 15 sec and one 10 sec before the door was raised. The door was lowered after each rat had entered one of the choice arms.

Data recorded consisted of initial choice, initial choice latency, and position in the maze at 5-sec intervals, for a period of 2 min following choice. For scoring purposes, the maze was divided into three sections: the two choice arms and the area between these arms. A rat was regarded as having moved to a new section when its four legs (body, except for tail) had passed into that section. To facilitate the time sampling of position, a signal was received at 5-sec intervals through headphones worn by the E.

Twelve rats were shocked prior to the choice trial. The shocked and unshocked rats were treated identically except for shock presentation prior to release from the startbox. Thus, there were four ($N = 6$) conditions referring to shock treatment and to whether the rats were presented with two black arms or two white arms during the free choice trial. The appropriate left/right counterbalances were carried out within each of the subgroups.

RESULTS

Eleven of the 12 unshocked rats initially entered the changed arm, whereas only 6/12 shocked rats did so (fourfold exact test, $p = 0.034$). These proportions were unaffected by brightness condition, and there was no apparent position bias.

The number of (5-sec) time samples a rat spent in either choice arm was used as an estimate of the amount of time spent in that arm. The shocked rats spent a median time of 45.0 sec in the unchanged arm and 12.5 sec in the changed arm (Wilcoxon test, $T = 12$, $N = 11$, $p < .05$). The medians for the unshocked rats were 27.5 and 37.5 sec, respectively ($T = 12$, $N = 12$, $p < .025$). In order to check for

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possible brightness and Brightness by Shock Treatment effects, changed-arm-preference scores were computed. These scores were obtained by expressing the number of time samples when a rat was observed in the changed arm as a percentage of the number of time samples when it was observed in both arms. Analysis of variance of the arcsine transformed scores gave a significant effect for the shock treatment: the means were 65.3% for the unshocked rats and 26.1% for the shocked rats ($F = 4.82$, $df = 1/20$, $p < .05$). Neither of the other terms approached significance ($F < 1$, in each case).

An analysis of the log latency scores gave a significant effect only for the shock treatment: the means were 19.5 sec for the unshocked rats and 4.2 sec for the shocked rats ($F = 15.50$, $df = 1/20$, $p < .001$). The brightness and Brightness by Shock effects failed to approach significance ($F < 1$, in each case). Finally, the latencies within the shocked group were examined to see if there was a relationship between latency and the novelty value of the arm initially entered. The mean latencies for rats entering the changed and unchanged arms were 6.3 and 2.7 sec, respectively ($t = 1.266$, $df = 10$, n.s.).

DISCUSSION

The initial choice results indicate that more shocked than unshocked rats preferred the unchanged (or relatively more familiar) arm. However, since these rats did not show a clear preference for the more familiar arm, the data from the shocked group can be interpreted by suggesting that the painful stimulation had such a disrupting effect on behavior that *initial* choices were random.

The data obtained from the time sampling of position were more conclusive. Although initial choice appeared to be random, during the period following this choice, the shocked rats reliably preferred the unchanged arm. Thus, the results of this experiment, together with the results from the studies mentioned above, appear to indicate that laboratory rats do show a genuine shift in preference toward familiarity after aversive stimulation. Further, this finding supports Fowler's (1958) suggestion that failures to replicate Dember's (1956) original report of a response-to-change effect (Levine, Staats, & Frommer, 1958) may have occurred because of uncontrolled variations in fearfulness.

It is tempting to look for a parallel between the behavior of tame laboratory rats subjected to aversive stimulation and the adaptive "neophobia" shown by wild Norway rats under certain conditions (see e.g., Barnett, 1958a, b; Galef, 1970). More specifically, it seems worth speculating that this adaptive neophobia, apparently much reduced in laboratory rats by selective breeding (Barnett, 1958b, 1963), may become manifest when these animals are subjected to noxious stimulation. Bolles (1970) has recently emphasized the importance of this type of analysis in interpreting the literature on avoidance learning. His comments are worth quoting because they give an indication of the theoretical pitfalls that await those who regard the laboratory rat merely as a preparation: "In short, I am suggesting that the immediate and inevitable effect of severe aversive stimulation on a domesticated animal is to convert it, at least temporarily, into a wild animal by restricting its response repertoire to a narrow class of species-specific defense reactions (SSDRs). I am suggesting further that this sudden, dramatic restriction of the subject's (S's) behavioral repertoire is of the utmost importance in the proper understanding of avoidance learning [Bolles, 1970, p. 33]."

REFERENCES

AITKEN, P. P., & SHELDON, M. H. Electric shock and rats' preference for the familiar arm of a maze. British Journal of Psychology, 1970, 61, 95-97.

BARNETT, S. A. Experiments on 'neophobia' in wild and laboratory rats. British Journal of Psychology, 1958a, 49, 195-201.

BARNETT, S. A. Exploratory behaviour. British Journal of Psychology, 1958b, 49, 289-310.

BARNETT, S. A. *A study in behaviour.* London: Methuen, 1963.

BOLLES, R. C. Species-specific defense reactions and avoidance learning. Psychological Review, 1970, 77, 32-48.

DEMBER, W. N. Response by the rat to environmental change. Journal of Comparative & Physiological Psychology, 1956, 49, 93-95.

FOWLER, H. Response to environmental change: A positive replication. Psychological Reports, 1958, 4, 506.

GALEF, B. E. Aggression and timidity: Responses to novelty in feral Norway rats. Journal of Comparative & Physiological Psychology, 1970, 70, 370-381.

HALLIDAY, M. S. Exploration and fear in the rat. Symposium of the Zoological Society of London, 1966, 18, 45-59.

LESTER, D. The effect of fear and anxiety on exploration and curiosity: Toward a theory of exploration. Journal of General Psychology, 1968, 79, 105-120.

LEVINE, S., STAATS, S. R., & FROMMER, G. Studies on 'response by the rat to environmental change.' Psychological Reports, 1958, 4, 139-144.

MONTGOMERY, K. C., & MONKMAN, J. A. The relation between fear and exploratory behavior. Journal of Comparative & Physiological Psychology, 1955, 48, 132-136.

SHELDON, M. H. The effect of electric shock on rats' choice between familiar and unfamiliar maze arms: A replication. Quarterly Journal of Experimental Psychology, 1968, 20, 400-404.

THOMPSON, W. R., & HIGGINS, W. H. Emotion and organised behavior: Experimental data bearing on the Leeper-Young controversy. Canadian Journal of Psychology, 1958, 12, 61-68.

WOODS, P. J., & JENNINGS, S. Response to environmental change: A further confirmation. Psychological Reports, 1959, 5, 560.