Probability learning to avoid shock¹

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Probability learning to avoid shock in a Y-maze was investigated in 48 male hooded rats, using a non-correction procedure. The independent variables were intensity of shock, and probability of shock. One side of the Y, (A_1) was shock-free with probabilities $\pi = .90, .75$, or $.60$, while the other side was shock-free with probabilities $1 - \pi$. The major findings were: (a) probability matching by high-shock Ss, but as an artifact of shock occurrences, (b) more A_1 's by the low-shock Ss, (c) a positive recency effect, and (d) no tendency to maximize to either side.

Relatively little has been reported about the joint effects of magnitude and probability of shock on choice behavior. Cole, Belenky, Boucher, Fernandez, & Myers (1965) have given a brief review of findings where correction procedures were used. Cole et al found increasing overmatching of $\pi = .667$ with increasing shock intensity, also using a correction procedure.

The present study was designed to study the effects of varying both probability and intensity of shock on choice behavior, using a non-correction procedure. It was expected that increasing both shock level and probability in one side would increase the probability of choosing the more frequently shock-free side. A second purpose was to see if a non-correction procedure would yield learning described by an identity operator model for the effect of nonreinforced trials (Weinstock, North, Brody, & LoGuidice, 1965).

Method

The Ss were 48 male, hooded rats, 90-120 days old. Beginning 10 days before the experiment, Ss were maintained on a 1/2 hr. per day feeding schedule, and handled by E for 5 min. each day. The Ss were about 20 hr. food deprived at the beginning of each session.

The apparatus was a Y-maze made of galvanized steel. The stem was 6 in. long. The arms were 30 in. long and 3-1/2 in. wide, with floors having a downward angle toward the center with a 2/3 in. separation along their lengths, so that when the floor was charged it was impossible for S to avoid the shock. An Applegate generator supplied the shock. Each arm terminated in a goal box. Guillotine doors between the start box and stem, and between the stem and each arm, prevented retracing. Photocells located 8 in. inside each arm turned on the shock throughout the length of the arm. The only escape from shock was in the goal boxes, which were baited with four 97 mg Noyes food pellets on every trial. Since it was possible for S to avoid shock by not running, food deprivation and reward were used to insure running.

Each S received 22 pre-experimental trials without shock: six forced-choice trials on days 1 and 2, with

an equal number to each arm in random order, followed by five free-choice trials on days 3 and 4. Then Ss were assigned to one of six treatment groups, with each group subdivided to counterbalance the A_1 side between right and left. If S chose one side seven or more times during free choice, he was randomly assigned to a sub-group whose A_2 side corresponded to this preferred side. The remaining Ss were randomly assigned to fill the 12 sub-groups.

A total of 50 experimental trials was run for each S, five on day 5, seven on days 6-8, and eight on days 9-11. For each S, π was either $.60, .75$, or $.90$, and the shock level was either $.25$ or $.40$ ma. As soon as S accepted the food pellets he was removed from the goal box and retained in a carrying case between trials. The intertrial interval was never less than 10 nor more than 15 min.

Results and Discussion

As shown in Fig. 1, the proportion of A_1 responses was directly related to π , as expected. This effect was significant over all trials, $F = 200.16, df = 2/42, p < .001$, as well as the last 10 trials, $F = 31.2, df = 2/42, p < .001$.

Low-shock Ss tended to make more A_1 's than did high-shock Ss, but the difference was not significant over all trials, $F = 2.30, df = 1/42, .10 < p < .20$. During the last 10 trials, low-shock Ss made significantly more A_1 's than did the high-shock Ss, $F = 4.61, df = 1/42, p < .05$. An explanation of this unexpected result was obtained by examining each S's trial-by-trial choices. There was an overall tendency for Ss to switch choices away from a previously shocked side. This was

Fig. 1. Learning curves showing the proportion of runs to the low probability of shock side as functions of shock intensity and probability.

Fig. 2. Recency data: The probability of response A_1 following various numbers of consecutive E_1 events as functions of probability and shock level over 50 trials.

done following 95.3% of such trials by high-shock Ss, but only 71.6% by low-shock Ss; the difference in number of switches was significant, $F=56.0$, $df=1/42$, $p<.001$. On the other hand, there was little overall tendency to avoid a previously shock-free side, less than 5% for all groups with no significant difference among groups, $F<1.0$. During the last 10 trials, high-shock Ss switched following 100% of shocks, while low-shock Ss did so following only 67% of such trials. This difference was significant, $F=16.41$, $df=1/42$, $p<.001$. During the last 10 trials none of the Ss switched following a shock-free trial.

The influence of immediately preceding events may also be seen in the effects of homogeneous runs of E_1 events shown in Fig. 2. Over all trials the probability of making an A_1 response increased rapidly with increased runs of E_1 's, with zero probability of an A_2 following runs of four or more E_1 's. This positive recency effect is similar to that reported by Cole et al, except that in the present study the probability of an A_1 following zero E_1 's, i.e., one or more E_2 's, was less than .5, while they found probabilities greater than .5.

The effect of immediately preceding events appears to be stronger in the present study.

In general, Ss tended to switch choices immediately following shock, and to persist in choosing an immediately preceding shock-free side. This tendency was stronger for the high-shock Ss. The low-shock Ss tended to overmatch π , though not so much as reported by Cole et al. The high-shock Ss tended to match π , but apparently as an artifact of the control over choice behavior exerted by the occurrences of shock.

Were the effects of shock simply the opposite of positive reinforcement, the present non-correction procedure might be expected to yield behavior consistent with an identity operator model for the effect of nonreinforced trials (Weinstock et al, 1965), with most Ss maximizing A_1 's and the other Ss maximizing A_2 's. This was not the case; over the last 10 trials, only seven of the 48 Ss made all A_1 's, and six of these were in the $\pi=.90$ groups. No Ss made more than six A_2 's; only three Ss made as many as six, and all were in the $\pi=.60$ groups. It appears then in a non-correction, probability shock situation the effect of avoiding shock is not described by an identity operator model.

In general, the stimulus utilized to determine behavior was more immediate than that assumed in the available theories which predict choice behavior. While both probability and intensity of shock did influence the number of responses to a particular alternative, it was a much less complex and more immediate stimulus that tended to determine each S's next response, namely, whether or not a shock occurred on the previous trial.

References

- Cole, M., Belenky, G. L., Boucher, R. C., Fernandez, R. N., & Myers, D. L. Probability learning to escape from shock. *Psychon. Sci.*, 1965, 3, 127-128.
- Weinstock, S., North, A. J., Brody, A. L., & LoGuidice, J. Probability learning in the T-maze with noncorrection. *J. comp. physiol. Psychol.*, 1965, 60, 76-81.

Note

1. This study is based upon the first author's M. S. Thesis, and was supported by a grant from the University of Wisconsin Graduate School. It was read in part at the Midwestern Psychological Association meeting, Chicago, 1966.