Demonstration of a Kamin-like effect after appetitive training*

T. TRIBHOWAN†, W. B. RUCKER, and C. G. McDIARMID
Mankato State College, Mankato, Minn. 56001

Rats were first trained for 18 trials in a three-choice discrimination apparatus with responses to the dark stimulus rewarded by food. After an interval of 5 min, 1 h, 4 h, 8 h, or 24 h, the Ss were given 18 trials of training with the discrimination reversed, the light stimulus becoming the rewarded cue. Memory of the original training, as indicated by errors made on the reversed discrimination (adjusted by analysis of covariance) was a U-shaped function of intersession interval. The reversal learning of rats tested 4 h after original training showed the least interference. These results are consistent with concepts of successive phases of memory but are inconsistent with explanations of the Kamin effect based on incubation of fear.

Kamin (1957) and others (e.g., Brush, Myer, & Palmer, 1963; Denny & Ditchman, 1962) have reported that retention of an incompletely learned avoidance task is a U-shaped function of the interval between training and testing. The Kamin effect is distinguished from the Ebbinghaus forgetting curve by a rise in performance at later testing times and from the reminiscence effect by adequate performance at early testing times.

Systematic studies of the Kamin effect with rats have been conducted only with such aversive tasks as shuttle avoidance. Two alternative explanations of the effect have been confused as a result of the aversive task approach. One hypothesis assumes two successive phases of memory, the first being a short-term phase deteriorating over time and the second a long-term phase consolidating over time. This hypothesis attributes the Kamin effect either to interference with retrieval during the transfer of memory from the first to the second phase (Grossman, 1967, p. 798) or to incomplete overlap between the phases, causing memory to become temporarily unavailable from either phase (Halstead & Rucker, 1968). A second explanation is based on the assumption of a single and continuous phase of memory. The second hypothesis attributes the Kamin effect to the development or incubation of learned fear which may either motivate a stronger conditioned response at later testing times (Pinel &

Cooper, 1966) or produce competing responses, such as freezing, which disrupt retrieval at intermediate testing times (Denny & Ditchman, 1962). Kamin (1957) and later Kumar (1970) have pointed out that explanations of the Kamin effect based on incubation of fear may be challenged effectively if the effect can be produced after training on an appetitive task.

The following experiment was designed to test memory of an appetitive task by performance at various intersession intervals on the reversed problem. Superior performance at intermediate test intervals under these conditions may be attributed more easily to memory factors than to motivational disturbances.

SUBJECTS

Forty young male rats (WF/MAI, 175-200 g on delivery from Microbiological Associates) served as Ss. Before pretraining, all Ss went through a period of deprivation lasting 84 h. During the first 12 h of deprivation, all Ss received no food; after that they received 10 g of regular Purina Rat Chow and 10 45-mg Noyes pellets (Formula A, at 6:00 p.m. on each day). During pretraining, each S was given nine trials per day in the three-choice apparatus shown in Fig. 1 (Rucker & Halstead, 1970). On the first and second days of pretraining, the three stimulus doors were open, and on each trial a S was allowed to descend a ramp from the starting box and to eat two Noyes pellets from a trough in one of the three goalboxes. On the third and fourth days of pretraining, the conditions were similar to those on the first and second days except that the stimulus doors, devoid of discriminative cues, were up and unlatched.

TRAINING AND TESTING

On the day following the end of pretraining, Ss were trained on a

light-dark discrimination task with the dark stimulus as the positive cue. During each of the 18 trials of training, a dark plastic stimulus card was positioned behind one of the three doors, and the light behind the door was switched off, whereas the lights behind the other two translucent doors were switched on. The dark stimulus was switched from door to door on successive trials according to the first 18 trials in a pseudorandom sequence devised by Rucker & Halstead (1970). All Ss were trained using the following sequence of rewarded positions (left, L; middle, M; right, R), given over trials: RMLLLRMRMMRLMRMLM. Correct responses were rewarded with two Noyes pellets. A response was counted when the rat got his ears between the two columns that framed a stimulus door. An incorrect response terminated the trial. At the end of a trial, the rat was returned either to the startbox to wait out a 1-min intertrial interval or to his home cage at the end of training to wait out the intersession interval to which he was assigned.

The testing situation was similar to the training situation, but the lighted door, instead of the dark stimulus, was the positive cue. All Ss were tested using the following sequence of rewarded positions given over trials: MRLRLRLRMLRMMMLRLR.

DESIGN

The Ss were run in eight squads with five rats in each squad. One S in each squad was tested at each of the following intersession intervals: 5 min, 1 h, 4 h, 8 h, and 24 h. Intersession intervals began at the end of the last training trial. In order to control in part for a possible time of day effect, half of the Ss were trained and tested using one schedule and the other half using a different schedule. These two schedules are shown in Table 1.

Fig. 1. Three-choice discrimination apparatus (Rucker & Halstead, 1970).

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†Present address: Department of Psychology, University of Nebraska, Lincoln, Nebr. 68505.

Table 1
The Training and Testing Schedules

Interval	Times	
	Training	Testing
Schedule 1 (Squads 1-4)		
4 h	10:00-10:40	2:40- 3:20
5 min	10:40-11:20	11:25-12:05
8 h	12:05-12:45	8:45- 9:25
1 h	12:45- 1:25	2:05- 2:45
24 h	3:25- 4:05	4:05- 4:45
Schedule 2 (Squads 5-8)		
8 h	8:00- 8:40	4:40- 5:20
24 h	8:40- 9:20	9:20-10:00
5 min	10:00-10:40	10:45-11:25
4 h	11:15-11:55	3:55- 4:35
1 h	12:05-12:45	1:45- 2:05

RESULTS

The number of correct responses made by Ss during the testing sessions were submitted to an analysis of covariance. This analysis took performance during training into account. The effect of intersession interval was significant ($F = 3.48$, $df = 4/29$, $p < .025$), but the effects of the schedule and of the interaction between interval and schedule were not significant. In both raw and adjusted form, Table 2 presents the mean number of correct responses made during relearning, as a function of intersession interval. In order to illustrate the observed effect in a manner comparable to other studies of the Kamin effect, the function relating adjusted error means to intersession interval is shown in Fig. 2. The error means were computed by subtracting the adjusted mean correct responses from 18, the number of testing trials.

Table 2 also gives the mean correct responses made during training on the first discrimination. The apparent differences between these groups is significant ($F = 2.91$, $df = 4/24$, $p < .05$). Since the analysis of covariance was used to eliminate these training differences from the relearning evaluation, it was especially important to check the assumption of the homogeneity of regression underlying this analysis. The within-groups correlation between training and testing scores was computed to be 0.88. Homogeneity of regression was tested over the 10 groups (2 schedules $\times$ 5 intervals), and no significant differences were found ($F = 2.26$, $df = 3/30$, $p > .10$). Finally, homogeneity of regression was tested between the groups evaluated after 4 h and the remaining eight groups ($F = 2.50$, $df = 1/30$, $p > .10$). Thus, in both cases, the assumption of common slope could not be rejected. Therefore, the effect of intersession interval on reversal learning, which was found to be significant by the analysis of covariance, is valid and does not

reflect differences between groups that might have existed prior to treatment. This conclusion is supported by the positive within-groups correlation between the training and testing scores.

DISCUSSION

In the present experiment, Ss were reinforced positively during both original learning and reversal learning; presumably, no fear was produced by this procedure. The incubation of fear hypothesis is, therefore, inadequate to explain the appearance of the Kamin-like effect in the present study. Since the reversed discrimination was used during testing sessions, failure of memory for the discrimination that was learned first was demonstrated by superior performance on the reversed discrimination of Ss tested 4 h after training, as compared to performance of Ss tested earlier and later. Thus, neither competing responses nor diminished hunger at the critical interval can explain the observed effect. The present study is, therefore, consistent with explanations of the Kamin effect which assume two successive phases of memory.

Klein & Spear (1970) have provided additional support for these explanations. These investigators first trained rats on an active avoidance task which had been shown (Klein & Spear, 1969) to result in a lapse of performance at intermediate intersession intervals. The Ss were then trained at intervals of 5 min, 1, 4, or 24 h to avoid passively the previously safe compartment. The experimental Ss were compared with controls that had received no active avoidance training. In a second experiment, the same design was used, except that passive avoidance experience preceded active avoidance acquisition. In both experiments, the rats tested 1 or 4 h after training on the conflicting task performed as well as did controls that had received no conflicting training. Klein and Spear concluded that incubation of fear and freezing behavior were not responsible for the inability of Ss tested at intermediate retention intervals to retrieve memory of the conflicting training. Apparently adequate memory was not available at intermediate testing times.

Fig. 2. Mean adjusted error scores as a function of intersession interval.

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Table 2
Mean Number of Correct Responses as a Function of Intersession Interval

Measure	Retention Interval				
	5 Min	1 H	4 H	8 H	24 H
Mean number of correct responses (original learning)	7.38	7.62	6.12	7.62	8.88
Raw mean number of correct responses (relearning)	5.75	5.25	7.75	5.62	7.12
Adjusted mean number of correct responses (relearning)	5.84	5.19	8.56	5.57	6.34