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Effects of response prevention upon the "Kamin effect" in rats

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After rats had incompletely learned a shuttle escape-avoidance task, response prevention procedures were introduced and animals were retested on the avoidance task after 0, 1, or 24 h. Female control animals, which did not receive response prevention, showed the U-shaped retention function characteristic of the "Kamin effect," while response prevention disrupted avoidance performance under every condition. Male rats exhibited a much smaller effect with minimal recovery after 24 h. Results were discussed in terms of potential methodological and theoretical significance for the problem of residual fear.

The U-shaped retention function for avoidance performance during the relearning phase of an incompletely learned avoidance response was initially reported by Kamin (1957). Subsequently, the effect has been reported often (Brush, 1971) and is commonly referred to as the "Kamin effect." Since interpretations of this effect typically include some reference to the role of classically conditioned fear, this investigation attempted to eliminate the Kamin effect by introducing response prevention techniques between original and relearning training sessions.

EXPERIMENT I

Method

Subjects. The Ss were 96 adult female albino Sasco rats. Maintained 2 rats per cage with food and water always available, animals were assigned at random to eight groups of 12 rats each.

Apparatus. The apparatus, two identical 36 x 4 x 14 in. automated shuttleboxes, were constructed of clear Plexiglas and were housed in sound attenuating enclosures. The grid floors consisted of 1/8-in. stainless steel grids spaced 5/8 in. apart, center to center. Shock of 1.3 mA was delivered to the grids by a Grason-Stadler shocker scrambler, Model E 1064GS. A Sonalert tone source, mounted on the Plexiglas top of each box, produced a 2,800 Hz tone at 85 dB, re .0002 dynes/cm^2. Running responses were monitored by a photocell system while programming and recording were achieved by appropriate relay circuitry.

Procedure. For all Ss in all conditions, the variable intertrial interval averaged 40 sec, consisting of a fixed sequence of 40-, 20-, 20-, and 80-sec intervals which cycled repetitively. The CS-US interval was 5 sec, both CS and US being response terminated. Upon placement in the apparatus prior to the original training, each rat remained undisturbed for a 30-min adaptation period and then immediately received 25 acquisition trials. After an appropriate delay, Ss were reintroduced into the apparatus for a 5-min adaptation period prior to receiving 25 additional relearning trials. All Ss were treated identically during both sets of training trials and were differentiated only by the treatment interpolated between original and relearning sessions. There were three delay conditions in which relearning trials occurred either immediately, after 1 h or after 24 h. Three groups, one at each delay interval, did not receive response prevention and only had the appropriate delay between the two training sessions. In the case of the 0-h delay condition, each rat was removed from the apparatus, spent 5 min in its home cage, and was then returned to the apparatus for an additional 5-min period. Such a procedure controlled for the time component of both response prevention and adaptation to the apparatus. In addition, since the locus of maximal "Kamin effect" is around 1 h (Denny & Ditchman, 1962), response prevention was administered immediately, i.e., the first 10 min of the hour delay, or after 50 min, i.e., the last 10 min of the hour delay. Thus, there were five response prevention groups, three receiving immediate response prevention but relearning either immediately, after 1 h or after 24 h, and two receiving response prevention after 50 min, but relearning 1 h or 24 h following original learning. All rats in the group, given both immediate response prevention and immediate relearning trials, were routinely removed from the apparatus prior to response prevention to control for handling variables present in all other conditions. Response prevention consisted of placing the rat in the apparatus for 10 min, during which time it could not escape or terminate the continuously present buzzer CS.

Two basic experimental analyses are embedded within the eight experimental conditions. Restricting the analysis to the three delay values, the basic experimental design consists of three levels of delay between original and relearning training sessions (immeidate, 1 h or 24 h) orthogonal to two levels of response prevention (none or immediate) with 12 Ss per cell. Restricting the analysis to the three response prevention operations, the basic experimental design consists of two levels of delay between original and relearning training sessions (1 h or 24 h) orthogonal to three levels of response prevention (none, immediate or after 50 min) with 12 Ss per cell.

Results

Analysis of variance performed on the number of avoidances during the original 25 learning trials was not significant, indicating that any differences during relearning could not reasonably be attributed to differential performance during original learning. The main results for frequency of avoidances during the primary relearning stage are summarized in Fig. 1. Inspection of Fig. 1 indicates a large classical "Kamin effect" for the no response prevention conditions, and suggests a minimal or nonexistent effect when response prevention procedures were introduced before the additional relearning trials. Perhaps more importantly, it is clear that response prevention had a marked decremental effect, reducing frequency of avoidances dramatically compared to the no response prevention conditions under the immediate and 24-h delay conditions.

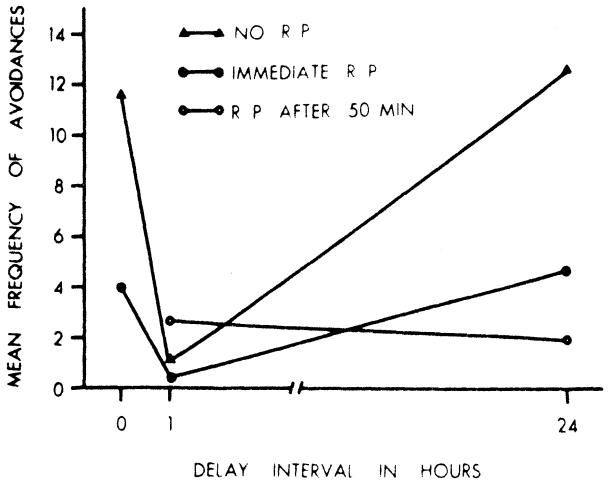

Fig. 1. Mean frequency of avoidance responses as a function of delay between original learning and relearning of a shuttle task and several response prevention (RP) conditions.

Statistical analyses confirmed the qualitative effects summarized in Fig. 1. Both experimental designs yielded identical effects in which the effect of interpolated delay between original and relearning sessions was highly significant ($F = 16.45$, $df = 2/66$, $p < .001$ and $F = 22.91$, $df = 1/66$, $p < .001$), as was the effect for response prevention procedures ($F = 18.51$, $df = 1/66$, $p < .001$ and $F = 7.28$, $df = 2/66$, $p < .005$). The decrement in responding with a 1-h delay, particularly under no response prevention conditions, is revealed in the significant interaction ($F = 3.33$, $df = 2/66$, $p < .05$ and $F = 10.59$, $df = 2/66$, $p < .001$).

In order to evaluate further the effectiveness of the various response prevention and delay procedures, CS and US duration were examined statistically, each of these measures having been routinely recorded on elapsed time meters during the course of the investigation. Analysis of variance performed on CS and US durations during the original 25 learning trials were, with one exception, nonsignificant. For CS duration, the effect for groups which later received response prevention was significant ($F = 5.52$, $df = 1/66$, $p < .05$) reflecting slightly longer overall CS durations for the three no response prevention groups ($\bar{X} = 174.9$) compared to the three groups receiving response prevention immediately ($\bar{X} = 161.88$). This effect can be ignored since it is small and is, if anything, a conservative source of bias. Thus, it seems unreasonable to attribute superior performance, i.e., shorter CS durations, during relearning because these no response prevention groups had inferior, i.e., longer CS durations, during original learning.

In general, the effects for CS duration were very similar to those obtained for frequency of avoidances. A Kamin effect was obtained for CS duration but with shorter CS durations for the 0- and 24-h delay conditions, while response prevention conditions had overall longer CS durations than the no response prevention groups. Thus, the main effect for interpolated delay was significant ($F = 13.85$, $df = 2/66$, $p < .01$ and $F = 8.58$, $df = 1/66$, $p < .01$) as was that for response prevention procedures ($F = 14.22$, $df = 1/66$, $p < .01$ and $F = 4.55$, $df = 2/66$, $p < .05$). For one analysis, the interaction was also significant ($F = 4.82$, $df = 2/66$, $p < .05$).

Mean CS and US duration are summarized in Table 1. It is clear that US duration was a less sensitive measure than either frequency of avoidances or CS duration. In general, and consistent with other measures, response prevention groups had longer US durations ($F = 4.03$, $df = 1/66$, $p < .05$) than the no response prevention groups. However, while US duration did yield a significant effect for delay ($F = 5.72$, $df = 2/66$, $p < .01$), this did not indicate the presence of a Kamin effect. Rather, it only reflects that 0-h delay groups had shorter overall US durations than other conditions.

EXPERIMENT II

Baum and his colleagues have repeatedly demonstrated that introducing extraneous stimulation during response prevention facilitates the effectiveness of response prevention. For example, Baum (1969) placed nonfearful rats in the avoidance apparatus with each experimental animal during response prevention and this social facilitation procedure hastened extinction. The present investigation extends Experiment I by including a social facilitation condition during response prevention.

Method

Subjects. The Ss were 90 adult male albino rats. Maintained as in Experiment I, animals were assigned at random to nine groups of 10 rats each. In addition, four males were maintained individually and were used repeatedly during social facilitation conditions.

Apparatus. The apparatus was identical to that of Experiment I.

Table 1
Mean CS and US Durations and Standard Deviations for Eight Response Prevention Conditions

Response Prevention Condition	0 Delay Interval				1-H Delay Interval				24-H Delay Interval			
	CS		US		CS		US		CS		US	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
None	106.31	32.47	13.62	6.93	171.37	34.83	39.42	36.42	110.12	32.51	22.67	28.52
Immediate	142.62	27.94	26.41	8.54	176.70	23.22	47.52	23.24	160.01	42.98	36.09	20.33
Delayed	–	–	–	–	166.87	45.51	37.11	25.18	169.26	23.92	44.02	21.89

Procedure. In general, the procedures were those of Experiment I. After an adaptation period of 30 min, each rat received 25 acquisition trials. Following an appropriate delay, Ss were reintroduced into the apparatus for a 5-min adaptation period and then received 25 additional relearning trials. All animals were treated identically during both sets of training trials and were differentiated only by the treatment interpolated between original and relearning sessions. Exactly as in Experiment I, there were three delay conditions in which relearning trials occurred either immediately, after 1 h or after 24 h. Three groups, one at each delay interval, did not receive response prevention and only had the appropriate delay between the two training sessions. Three groups received immediate response prevention in which the rat remained in the apparatus for 10 min, during which time it could not escape or terminate the continuously present buzzer CS, and were then retested either immediately, after 1 h or after 24 h. Three groups received immediate response prevention with a naive rat continuously present (social facilitation) in the apparatus and were then retested either immediately, after 1 h, or after 24 h. Thus, the experimental design consists of three levels of delay (0, 1, or 24 h) orthogonal to three response prevention conditions (no response prevention, response prevention or social facilitation) with 10 animals per cell.

Results

Analysis of variance performed on the number of avoidances during the original 25 learning trials was again not significant, indicating that any difference during relearning could not be attributed to differential performance during original learning. The main results for frequency of avoidances during the primary relearning stage are summarized in Table 2. Inspection of Table 2 for frequency of avoidances indicates a small overall tendency for the Kamin effect which was confirmed by analysis of variance ($F = 3.76$, $df = 2/81$, $p < .05$). Because of a large number of zero scores during both original and relearning stages, a more sensitive analysis was made based on the postavoidance score minus the preavoidance score plus 10. These data indicate a somewhat stronger Kamin effect which, while considerably smaller than that obtained during Experiment I with female Ss and while clearly showing incomplete recovery after 24 h, was highly significant ($F = 9.27$, $df = 2/81$, $p < .01$). No other main effects or interactions were significant.

Table 2
Mean Avoidances, Corrected Avoidances, and Standard Deviations for Three Response Prevention Conditions Over Three Delays

Response Prevention Condition	Delay Interval (Hours) 0 Mean	0 SD	1 Mean	1 SD	24 Mean	24 SD
	Post Avoidances					
None	10.1	8.31	2.9	3.3	4.0	3.22
Response Prevention	7.1	8.2	2.3	1.49	7.1	8.15
Social Facilitation	9.7	7.11	7.4	7.67	6.3	6.68
	Corrected Avoidances (Post-Pre + 10)					
None	17.1	6.39	10.6	1.8	11.6	2.37
Response Prevention	15.1	6.92	10.0	1.94	13.0	5.88
Social Facilitation	16.3	7.01	11.5	3.29	12.1	3.5

DISCUSSION

The main results of the present investigation were: (a) in Experiment I, under control conditions where no response prevention procedures were included, our procedures produced a large "Kamin effect"; (b) when response prevention procedures were introduced, avoidance responding was uniformly low across all delay conditions; (c) in Experiment II, where males rather than females were used, a weak "Kamin effect" was obtained.

The absence of a U-shaped retention function under response prevention conditions should not be interpreted as elimination of the "Kamin effect." Rather, response prevention produced an overall decrement in avoidance responding such that all animals, regardless of delay between original and relearning training sessions, made very few avoidance responses. Relative to the high level of avoidance performance in the 0- and 24-h delay groups that did not receive response prevention, response prevention procedures had such a profound effect in Experiment I that avoidance performance per se was eliminated. Apparently, response prevention can nullify whatever advantageous effects prior practice has upon later avoidance performance.

Methodologically, the Kamin effect is potentially important for assessing the effectiveness of response prevention procedures since it represents a preparation in which conditioned fear effects are relatively independent of the effective instrumental response. That is, while the fear response is presumably complete and strong, the instrumental running response has only incompletely expressed itself and is relatively weak. In this regard, the crucial question of residual fear following successful elimination of the instrumental escape-avoidance response (Coulter, Riccio, & Page, 1969; Linton, Riccio, Rohrbaugh, & Page, 1970; Page, 1955; Baum, 1971), while perhaps not eliminated, clearly becomes less important since the effects of response prevention are presumably upon the fear component, rather than on the unexpressed avoidance response.

Since both two-process theory (Mowrer, 1951; Solomon & Wynne, 1953) and relaxation theory (Baum, 1970; Denny, 1971) approaches to the effectiveness of response prevention have considerable difficulty explaining residual fear, that our results suggest that response prevention markedly affects the classically conditioned fear component has considerable potential theoretical significance. However, there are at least two factors which limit the present analysis. First, while avoidance responses occurred relatively rarely during the original 25 learning trials ($\bar{X} = 1.3$ avoidances), the escape response always occurred. Thus, an instrumental, running response was present on every trial. Secondly, response prevention may have produced antagonistic, competing responses which subsequently interfered with the instrumental running response during the relearning session. In any event, further research examining the impact of response prevention on incompletely learned instrumental responses is a promising alternative to conventional procedures.

The reduced "Kamin effect" with male rats relative to that obtained with females is not new (Brush, 1971). Nevertheless, the low baseline undoubtedly prevented the "social facilitation" conditions from being statistically effective although as Table 2 suggests, there is a tendency for more uniform responding, independent of delay conditions when "social facilitation" conditions were in effect during response prevention.

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