Effects of delay conditioning and pseudoconditioning on heart rate and suppression of drinking¹

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In each of two experiments, the tachycardic response to a CS was equivalent for classical delay conditioning and pseudoconditioning groups. Subsequent to conditioning sessions, the first experiment showed that the CS had effects on the initiation of drinking that were dependent on prior conditioning procedures, while the second experiment showed differential CS effects on the suppression of an already established drinking response.

In a previous paper (Caul, Miller, & Banks, 1970), it was reported that the tachycardic response to a stimulus was the same under procedures of classical delay conditioning and pseudoconditioning. In addition to the questions regarding sensitization, pseudoconditioning, and conditioning posed by these data, another question exists regarding the relationships between heart rate and behavioral indicants of emotionality. Does the equivalent heart-rate responding under the two conditioning procedures indicate that the CS would have equivalent effects on ongoing behavior? Rescorla's analysis of CS-US contingencies suggests that the CS should have behavioral effects dependent on the prior conditioning procedure (Rescorla, 1967; Rescorla & LoLordo, 1965). The present experiments were designed to replicate the finding of equivalent heart rate under delay and pseudoconditioning procedures as well as to assess subsequent behavioral effects.

EXPERIMENT 1

Method

Twenty-four male Carworth CFN rats, ranging in weight from 217 to 249 g at the beginning of the experiment, served as Ss. Two electrodes were implanted under the skin on the midline of the back of each rat and a schedule of water deprivation was introduced 3 days after electrode placement. For the remainder of the experiment, animals were given access to water for 30 min each day after the conditioning or test session. The 3 adaptation days and 7 conditioning days were exactly as in the previous experiments (Caul et al, 1970). The conditioning procedures for the 12 classical Ss replicated

Group CH of the previous study, i.e., 10 trials per day of a 6.5 CS (buzzer), which terminated at the end of a 0.5-sec, 2.0-mA scrambled shock. The procedure for the 12 animals of the pseudo group corresponded to that of Group PH in the previous study, i.e., the US followed termination of the CS by 22 to 34 sec on each trial.

Drinkometer testing was begun after 7 conditioning days and continued for a minimum of 34 daily sessions. Animals that were drinking on the 34th day but had not provided 16 days of drinking data were continued until 16 drinking days were obtained. A drinking day was defined as a drinkometer session that included 25 or more total licks. At the outset of drinkometer testing, one wall of the conditioning box was removed and replaced with a similar wall fitted with a drinking tube. The initial drinkometer day was the first session during which water was available in the conditioning box and was the animal's first exposure to the watering device.

Fifteen seconds after an animal was placed in the apparatus, the CS was presented for 15 sec. Fifteen-second periods of CS-off and CS-on alternated until 10 periods of each condition had been presented. Shock was never presented during drinkometer testing. Licks were recorded during the 5-min drinkometer session.

Heart-rate results. During the third adaptation day, which consisted of 10 CS trials, pre-CS heart rates decreased over trials ($p < .01$) for the 24 animals and there was an increase in rate to the CS ($p < .01$). There were no group differences.

During conditioning, both groups showed reliable tachycardias to the CS (57.0 bpm for the classical group, $p < .01$, and 60.2 bpm for the pseudo group, $p < .01$). There were no differences between the two groups in magnitude of response or in intertrial heart-rate level.

Drinkometer results. Table 1 shows the number of animals in each group that made 25 or more licks during the 34 drinkometer testing days. By the 26th day of drinkometer exposure, all rats of the pseudo group drank, while only three classical rats were drinkers. This difference of 100% pseudo drinkers vs 25% classical drinkers remained through the 34th drinkometer test day, with the exception of Day 29 when one pseudo animal failed to drink.

In order to assess the pattern of drinking for the pseudo group, the first 16 sessions of 25 or more licks were considered for each rat. On the pseudo animals' first day of licking, 93% of the total licks were recorded in the CS periods. This percentage decreased over sessions to 64% as the total number of licks increased from a mean of 188 licks on an animal's first drinking day to 674 licks on Drinking Day 16. It should be added, however, that all three drinkers of the classical group also drank predominantly in the CS periods. In fact, the daily percentage of licks during the CS for these three animals is not unlike the data for the 12 animals of the pseudo group.

Although the group behavior of the pseudo and classical groups was clearly different, the fact that 9 of the 12 classical animals never started to drink during the 34 test sessions made it impossible to compare behavior during CS-on and CS-off periods. The second study investigated the suppression of drinking by a CS following these conditioning procedures after first establishing the drinking behavior.

EXPERIMENT 2

Method

Table 1
Number of Animals Giving 25 Licks or More During Drinkometer Sessions

Day	Pseudo Drinkers	Classical Drinkers	Day	Pseudo Drinkers	Classical Drinkers
1	0	0	18	8	2
2	0	0	19	9	1
3	0	0	20	10	1
4	0	0	21	10	1
5	1	0	22	9	1
6	3	0	23	10	2
7	2	0	24	11	2
8	3	0	25	11	3
9	4	0	26	12	3
10	4	1	27	12	3
11	5	0	28	12	3
12	6	1	29	11	3
13	6	1	30	12	3
14	8	1	31	12	3
15	6	1	32	12	3
16	6	1	33	12	3
17	6	1	34	12	3

Fig. 1. Mean suppression ratios over days.

Twenty-four male Carworth CFN rats, within the range of 125-156 g, were used and treated identically for 12 days. For the first 5 days, their water was restricted to 15 min per day. Heart-rate leads were implanted on Day 3. Days 6-12 consisted of drinkometer training. Each S was given 10 min or 1,000 licks of a saccharin (1.9 g/liter) solution on an FR 2 schedule in the apparatus plus 10-min access to water in the home cage. Days 13-17 were conditioning days during which the drinkometer device was removed from the apparatus. The eight Ss of the classical and pseudo groups were treated exactly as in Experiment 1. Eight additional Ss (random group) were given 10 CS and 10 US presentations per day according to Rescorla's (1967) random control procedure. Thus, there was no CS-US contingency. The CS was presented according to the same time schedule as for the other two groups, but the US was scheduled randomly within the session each day. Water was available after conditioning sessions in the home cage for 20 min. Days 18 and 19 were additional drinkometer training days. Days 20-27 were identical for all rats and consisted of one CER trial each day. After S licked 300 times, one trial was given consisting of a 6-sec pre-CS period and a 6-sec CS. The animal then remained in the apparatus for 10 min, or until 1,000 licks were recorded, and then given water for 10 min in the home cage. No shock was presented during suppression days.

Heart-rate results. As in Experiment 1, the pseudo and classical groups showed equivalent heart rate during conditioning. The tachycardia to the CS was reliable for each group (classical, 28.8 bpm, $p < .01$; pseudo, 27.0 bpm, $p < .01$). The scheduling of the US in the random group precluded heart-rate evaluation.

Suppression results. Lick suppression ratios [(CS licks)/(CS licks + pre-CS licks)] are shown in Fig. 1. The data from two Ss in the pseudo group and two in the random group were excluded because of failure to lick the required 300 times during initial suppression days. Analysis of variance reveals that the groups differed in suppression ($p < .01$) and that the ratio increased over days ($p < .001$). The Groups by Days interaction was not reliable. Groups Random and Pseudo did not differ.

DISCUSSION

Although no differences in heart rate were found during conditioning in either experiment between the classical and pseudo groups, it is clear from Table 1 and Fig. 1 that subsequent behavioral effects of the CS were dependent upon prior CS-US

contingencies. The heart-rate data from the present studies and those of a previous report indicate that the variable trace procedure of the pseudo group was as effective in establishing a tachycardic response to the CS as the procedure of pairing the CS and US. In fact, under both conditions, the increase in rate to the CS was a function of US intensity (Caul et al, 1970). While the classical and pseudo groups did not differ in terms of heart rate, these conditioning procedures did have differential effects on both the acquisition and suppression of drinking in the presence of the CS. The suppression data of Fig. 1 show that the separation of the CS from US in both the pseudo and random groups was effective in attenuating the behavioral effects of the CS as compared with that of the classical group.

These data, as well as those of several other reports (e.g., Werboff, Duane, & Cohen, 1964; Overmier, 1966), support the view that response systems can function independently, given the same environmental or conditioning situation (de Toledo & Black, 1966). In addition, the present results emphasize the need for more data regarding the parameters affecting both the physiological and behavioral responses presumed to reflect emotionality. Perhaps it is not surprising at present that physiological and behavioral

indices of emotionality rarely show a great degree of correspondence. It is, however, instructive to examine those areas of disagreement as well as the areas of agreement among measures in an attempt to understand both autonomic and behavioral responses to a noxious environment.

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The effects of long-term administration of caffeine on growth and activity in rats¹

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A group of Wistar albino rats were reared on caffeine citrate solution. Each

day, during this period, they were weighed, and their activity was measured in an activity box. At the end of the experimental period, their activity in an open field was measured. It was found that