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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NOTE

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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

caffeine had no effect on weight but that it reduced initial activity in the experimental environments. This latter result was interpreted according to a model developed from Glanzer (1953, 1958).

It has been variously reported that the administration of caffeine, due to the drug's stimulant action, brings about an increase in activity (Goodman & Gilman, 1968). Such a statement is possibly an oversimplification. First, most studies have involved the short-term administration of the drug, and it is not always possible to predict a drug's long-term effects from its short-term action. Second, in many studies, the relevant behavioral analyses have not been sufficient. This experiment was designed to investigate the long-term effects of caffeine administration on growth and activity.

METHOD

Twelve rats, six females and six males, were used. All were Wistar albinos bred at the Animal Laboratory, University of Nottingham. At weaning, these rats were assigned to two groups; each group contained an equal number of males and females. The control group was given food and water ad lib, while the experimental group was given food and caffeine citrate solution ad lib.

In a previous pilot experiment, it was noted that, on the average, a rat consumed about 50 ml of water per day. The caffeine dose was therefore adjusted so that each rat received 100 mg/kg of caffeine citrate per 50 ml of solution per day.

For 4 weeks, the rats were tested daily

in activity boxes that resembled their home cages. Their time in these boxes was divided into two periods: (1) an initial (acclimatization) period of 10 min and (2) a second (settled) period of 30 min.

During these weeks, the rats were also weighed daily.

At the end of the 4 weeks, it was decided to obtain a second measure of activity, lest the effects observed were partially due to the physical limitations of the activity boxes. The rats were tested in an open-field apparatus. There was no noise present, and the light was of similar intensity to that experienced in the home cages. The rats were scored for: (1) locomotion, the number of open-field areas entered; (2) rearing, the number of times rearing occurred; (3) grooming, the number of times grooming occurred; and (4) defecation, the number of fecal boluses dropped.

RESULTS

For the average weekly weights of the rats, see Table 1. The individual scores were subjected to an analysis of variance. The effect due to the weeks was significant at $p = 0.001$. The effect due to sex was significant at $p = 0.001$, but there was no significant effect due to the drug. The only significant interaction was between weeks and sex, $p = 0.001$.

Table 2 shows the weekly activity of the rats. The individual scores were subjected to an analysis of variance. The effect due to the drug was significant during the initial 10-min period, and over the total period ($p = 0.01$) but not during the 30-min period. The effect due to sex was

significant during the initial 10-min period ($p = 0.001$), during the total period ($p = 0.01$), but not during the 30-min period. There was no significant interaction.

The average open-field scores of the rats are shown in Table 3. The individual scores were subjected to an analysis of variance. The effect due to the drug was significant for the locomotion and rearing scores ($p = 0.05$). There was no significant effect due to sex or any significant interaction.

DISCUSSION

The above results show that the long-term administration of caffeine does not affect growth. The differences in activity, discussed below, cannot therefore be attributed to an effect on growth. The normal difference in weight due to sex was found ($p = 0.001$).

The results also show that activity, upon introduction into the experimental environments, was reduced when this initial period was viewed as a whole. Activity during the remainder of the time spent in the environment was normal.

This effect may be explained by a model of behavior (Cox, unpublished) developed from Glanzer (1953, 1958) to explain drug-induced changes in spontaneous alternation.

It was suggested that caffeine, by increasing cortical arousal (Lewis, 1962), increased the animal's ability to handle its sensory input. Such an increase in the efficiency or rate of information processing would cause the animal's perception of its environment to become satiated more quickly.

The assumption was then made that an animal's level of activity in any environment is related to the degree to which its perception of that environment is satiated.

Thus, the caffeinated animal's initial activity in any environment would be less than normal if this period were viewed as a whole.

Whether or not this explanation is accepted, these results underline the need to examine several of the established truths concerning drug action. Many may be gross oversimplifications.

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NOTE

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Table 1
The Average Weekly Weights of the Rats

Week	Normal		Caffeine	
	Female	Male	Female	Male
1	56.0g	53.0g	53.6g	54.4g
2	89.9g	89.4g	89.0g	92.6g
3	123.3g	130.4g	122.5g	136.9g
4	144.6g	170.0g	138.7g	174.6g

Table 2
The Average Weekly Activity of the Rats (Arbitrary Units)

Activity	Normal		Caffeine	
	Female	Male	Female	Male
10 Min	204.5	128.6	140.0	72.0
30 Min	135.5	98.8	106.3	77.3
Total	340.0	227.5	246.3	149.3

Table 3
The Average Open-Field Scores of the Rats (See Method)

Group	Locomotion	Rearing	Grooming	Defecation
Normal				
Female	100.6	36.0	0	1
Male	103.3	33.0	0	0
Caffeine				
Female	64.6	14.6	0	0
Male	50.6	11.3	0	0