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Some Effects of Changes in the Feeding Schedule and Weight of Squirrel Monkeys in a Non-Contingent Electric Shock Situation

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SOME EFFECTS OF CHANGES IN THE FEEDING SCHEDULE AND WEIGHT OF SQUIRREL MONKEYS IN A NON-CONTINGENT ELECTRIC SHOCK SITUATION

by

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Organisms placed in a closed environment and given an electric shock have demonstrated increases in rates of behavior. Intra-species fighting (Ulrich and Azrin, 1962; Hutchinson, Ulrich and Azrin, 1965); manipulative behaviors such as lever pressing (Hutchinson, Renfrew and Young, 1971) and chain pulling (Azrin, Hutchinson and McLaughlin, 1965); and biting behaviors against inanimate objects (Azrin, Hutchinson and Sallery, 1964; Hutchinson, Azrin and Hake, 1966), have been produced and maintained through the use of electrical stimulation.

Since the responding was produced and maintained through the use of non-contingent stimulation, it was possible to investigate agents, or environmental conditions, which may affect response rates, without changing the reinforcement density of the experiment. In contrast, rate changes under contingent schedules lead to changes in stimulation. The capability of electric stimulation to produce responding without the existence of a level of deprivation makes it a good stimulus in experiments investigating the effects of food deprivation on behavior. However, experiments that have studied the effects of food deprivation on the responding produced by electrical stimulation, have produced varied and contradicting results. Griffiths (1962) compared food deprived and non-deprived rats, by measuring vigorous movements, vocalizations and excessive urination and defecation and found the deprived group to have higher threshholds to electric shock. Amsel (1950) investigated running time in a maze and did not find a significant result produced by food deprivation when shock was used as the eliciting stimulus, but did find significance when a conditioned stimulus, paried with electric shock, was used as the eliciting agent. However, Blanchard and Blanchard (1966) investigating the same variables that Griffiths (1962) had studied, only separating the different behaviors and looking at the individual rates, found that only the vocalization threshhold was higher for the food deprived group. Misanin and Campbell (1969) investigated escape responding through a door in the chamber, and Dinsmoor (1958) examined lever pressing, which produced escape from electric shock, did not find food deprivation produced a significant change in the responding.

Two recent experiments looked at the effects of food deprivation on the responding produced in a non-contingent electric shock situation (Cahoon, Crosby, Dunn, Herrin, Hill and McGinnis, 1971; Creer, 1973). Cahoon, et al. (1971) found that food deprivation and the intensity of the shock combined to influence the amount of biting of an inanimate object exhibited by their subjects. Creer (1973), however, who investigated the effects of food deprivation on electric shock induced fighting, did not find a significant effect. In the discussion of the results, Creer suggested that one of the critical variables which led to the discrepant findings might be the different response measures of the two experiments (attack of another organism as opposed to biting an inanimate object).

The present study was suggested by data obtained in a non-contingent electric shock experiment with a squirrel monkey in which changes in the feeding pattern of the subject were accompanied by changes in the rate of responding (Bushong, 1973). Since Cahoon, et al. (1971) found a significant change in the rate of biting with a reduction in food (which produced a decrease in weight level) and since one effect of the change in feeding pattern (Bushong, 1973) was a reduction in weight, the present study was designed to further investigate the relationship between different weight levels (produced by the reduction of food) and lever responding and biting behaviors produced by non-contingent shock delivery. Furthermore, the present experiment measured heart rate and body temperature under different levels of food deprivation.

In an attempt to better ascertain the mechanism of action of food deprivation, a drug was administered during the 80% weight level. Several experiments (Mayer and Thomas, 1967; Panksepp and Nance, 1972) have produced evidence that glucose plays a big part in the sensory system that regulates food intake. From this evidence there appears to be a relationship between hypoglycemia in the organism and an increase in the consumption of food by that organism. So while the subject was maintained at the 80% weight level in the present experiment sucrose was administered. Sucrose is converted to glucose by the normal physiological processes of organisms and should have helped to correct any hypoglycemic state that existed.

METHOD

Subjects

Three naive adult male squirrel monkeys weighing between 800 and 1200 grams, when on ad lib. feeding, were used in the experiment. Subjects were housed individually and during the baseline phase of the experiment fed five times per day. Subjects were allowed free access to water throughout the experiment.

Apparatus

Monkeys were individually placed in a sound attenuating chamber and restrained in a Plexiglas chair (Hake and Azrin, 1963). The electric shock was delivered through electrodes placed on the tail of the monkey. The tail was shaved once per week, and prior to each session it was cleaned with alcohol and then electrode paste was rubbed into the tail to maintain constant low resistance.

A 32 cm. long section of latex surgical tubing, with an internal diameter of 95 mm. and a wall thickness of 6 mm., was suspended in front of the monkey parallel to its mouth. The tubing was connected to a pressure sensitive switch which required a momentary pneumatic pressure of 2 mm. of mercury for activation. A lever protruded from the front panel of the chamber which required a downward force of 25 grams for activation (Hutchinson, Azrin and Hake, 1966).

The electrocardiogram (EKG) was recorded by use of a method developed by Ludlow (1973). EKG was recorded with a Sanborn 100 through tin surface electrodes attached to an electrode belt which held the electrodes in place on the monkey's upper torso. The heart rate, in beats per minute, was recorded through leads I and II with the filter set to 1 on the electrocardiograph. The recording was produced on heat sensitive paper moving through the machine at 50 mm. per second. The procedure used was similar to the methods used by Ramsay, Pomerleau and Snapper (1968) and Pare, Isom and Reus (1970. The temperature was recorded in degress Centigrade with a tele-thermometer using rectal probe.

The data were collected daily throughout the session with the use of counters and cumulative recorders. The sessions were programmed on electromechanical circuitry and solid-state logic.

Procedure

Experimental sessions lasting 64 min., were carried out five days per week. During each session 15 non-contingent electric shocks, one every four minutes, were delivered to the tail of the monkey. Shock intensity was 400 v.a.c. and the duration was 200 milli-seconds (Hutchinson, et al., 1966).

On alternate days of the experiment the subjects were taken individually into separate rooms and restrained in a holding chair while EKG and temperature recordings were taken. To prepare the subject for the EKG electrode paste was rubbed into the chest and the electrodes were fastened tightly to the chest; the rectal probe was then inserted into the monkey, and a 15 second reading taken with the cardiograph was followed by the recording of the temperature.

The monkey was then taken to the experimental chamber, its tail swabbed with alcohol and rubbed with electrode paste placed under the electrodes. Following the completion of the session the EKG and temperature were again recorded in the separate room and then the subject returned to its home cage. On days in which heart rate and temperature were not taken, the subject was taken directly to the chamber room and the session started.

The experiment consisted of seven phases in which the subjects' responding was recorded. Conditions in the experimental chamber were maintained the same throughout the experiment; all manipulations with the food given the subject and the sucrose administered were carried in the home cage of the subject.

The experiment consisted of seven phases: a baseline condition during which the monkey was maintained at its free feeding weight, 90% of its free feeding weight, 80% of its free feeding weight, a period at the 80% weight in which sucrose was administered, a continuation of the 80% weight, a return to the 90% weight and a return to free feeding weight. Refer to Table 1 for sequence of phases. Subjects were in the shock situation during all phases and during the time needed to reduce the subject's weight to the 90 and 80% levels, and to return them to the higher weights.

Subjects were sequenced to produce a multiple baseline design involving the phases sequenced so that no two subjects entered or left a phase at the same time. Thus when the second monkey started phase 2, the other two monkeys remained in the phase 1 condition; when the second monkey started phase 2, the third monkey was still in phase 1, and finally the third monkey started phase 2. This spacing was maintained for all monkeys throughout all phases.

The sucrose was administered orally at 0.3 grams/100 grams body weight, at the 80% level, and was administered 30 minutes prior to the time the monkey normally started its experimental session.

TABLE 1

Sequence of the experiment showing the phases involved and the number of days S was in each phase. Number of days were correct for first 6 phases; however, in the 7th phase MC-24 was maintained for only 6 days and it was not possible to return MC-76 to its free feeding weight.

TABLE 1

Phase 1	Free feeding weight (ff)	10 experimental days
Phase 2	90% (ff) weight	10 experimental days
Phase 3	80% (ff) weight	8 experimental days
Phase 4	S maintained at 80% weight and sucrose administered	10 consecutive days and 8 experimental days
Phase 5	80% (ff) weight	10 experimental days
Phase 6	90% (ff) weight	10 experimental days
Phase 7	Free feeding weight (ff)	10 experimental days

RESULTS

No significant change was found in the heart rate throughout the different phases of the experiment. The mean rates of heart rate per phase: 353 beats per minute for MC-76, 354 beats per minute for MC-73, and 325 beats per minute for MC-24; remained relatively stable with the exception of a slight decrease in MC-73's heart rate which appeared at the end of the experiment and did not appear to be related to any of the conditions of the experiment. The mean temperatures remained relatively stable at 38 degrees Centigrade throughout the experiment.

The mean rates of lever pressing and hose biting showed some change when computed by phases; however, the change was not a consistent on across subjects and the variability within phases was large, confounding the results (see Tables 2 and 3).

The rates of lever pressing for MC-73 and MC-24 did show some degree of consistency until the return to the baseline phase (see Figures 1 and 2). The rates of bite responding for MC-24 and MC-76 appeared to have one change during the weight reduction, then remained relatively stable; again with the exception of the return to the free feeding weight for MC-24 (see Figures 2 and 3).

The administration of sucrose at the 80% weight level, produced no consistent change between monkeys. While intense changes in the mean rates of biting and lever pressing were observed for MC-73, MC-24 and MC-76 did not demonstrate this effect.

TABLE 2

The daily responding for MC-73 and MC-24 throughout all phases. Number of days between changes in phases for MC-73 were 15 days from free feeding to 90% weight, 2 days from 90% to 80% weight, 7 days from 80% to 90% weight and 3 days to return to free feeding weight. Number of days for MC-24 were: 2 days from free feeding to 90% weight, 4 days from 90% to 80% weight, 3 days from 80% to 90% weight and 5 days to return to free feeding weight.

TABLE 2

MC-73

Bite	1	2	3	4	5	6	7	8	9	10
Free feeding	258	335	271	765	649	461	88	241	554	294
90% weight	335	282	273	203	161	84	78	311	419	296
80% weight	214	128	177	18	255	279	228	366		
Sucrose	368	472	385	443	438	237	286	171		
80% weight	157	140	195	108	103	287	286	274	78	206
90% weight	125	130	231	237	63	391	400	331	476	308
Free feeding	415	368	357	326	266	338	372	307	341	328

Lever press	1	2	3	4	5	6	7	8	9	10
Free feeding	201	382	320	538	626	706	1132	792	987	1360
90% weight	698	582	816	867	868	1511	977	1521	1590	2427
80% weight	2158	2967	1951	2319	1485	2559	2678	2789		
Sucrose	3291	3064	4362	1721	488	150	242	353		
80% weight	68	66	109	236	188	137	117	210	162	292
90% weight	1772	2027	1782	961	570	864	1711	991	1507	1343
Free feeding	795	307	688	699	203	556	119	197	212	385

MC-24

Bite	1	2	3	4	5	6	7	8	9	10
Free feeding	180	166	141	183	180	156	50	99	89	137
90% weight	139	69	156	115	91	96	74	103	114	179
80% weight	173	245	202	179	103	137	181	176		
Sucrose	134	131	148	165	125	117	116			
80% weight	111	143	156	129	124	130	95	104	97	127
90% weight	67	118	178	84	151	164	171	168	146	130
Free feeding	100	38	51	57	98	91				

Lever press	1	2	3	4	5	6	7	8	9	10
Free feeding	913	1175	1200	1157	953	1204	1291	1484	1525	737
90% weight	1799	1146	1466	711	1435	1288	946	1349	1021	1927
80% weight	1630	2130	2049	1503	1062	1795	2060	1990		
Sucrose	1898	2873	1949	1646	2038	1725	1082	2312		
80% weight	2359	2541	1284	1295	1675	1503	1543	1154	1648	1360
90% weight	892	1584	1003	1063	1110	1484	919	1737	1822	1525
Free feeding	1646	1940	1297	2140	1714	2398				

TABLE 3

The daily responding for MC-76 throughout all phases. Number of days between free feeding and 90% weight for MC-76 was 5, 3 days from 90% to 80% and 2 days from 80% to 90% weight.

TABLE 3

MC-76 Bite	1	2	3	4	5	6	7	8	9	10
Free feeding	157	241	196	199	173	266	194	270	302	171
90% weight	349	279	232	208	176	201	137	157	136	162
80% weight	134	136	155	157	123	164	143	169		
Sucrose	162	214	141	141	112	159	160	142		
80% weight	136	145	128	131	138	169	179	157	146	141
90% weight	191	181	171	156	122	142	147	199	176	162

Lever press	1	2	3	4	5	6	7	8	9	10
Free feeding	53	52	33	25	47	19	41	39	48	21
90% weight	43	59	71	37	38	43	27	32	22	18
80% weight	23	17	43	47	16	17	30	33		
Sucrose	37	23	17	24	23	29	21	20		
80% weight	20	19	36	14	21	18	33	25	33	38
90% weight	25	21	21	12	9	23	22	25	16	26

FIGURE 1

Percent change in responding for MC-73 comparing phases 2-7 with phase 1 session rates.

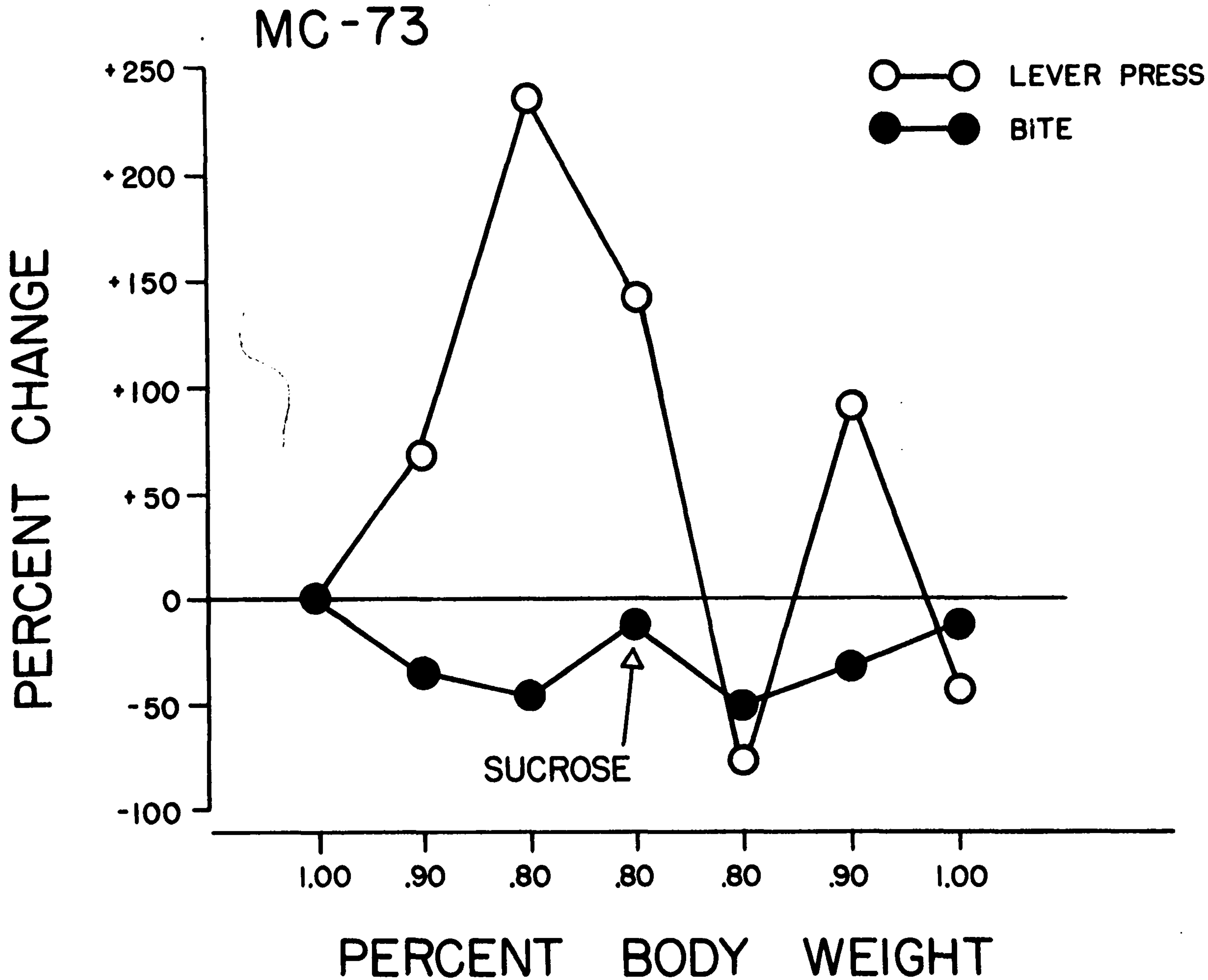

MC-73
LEVER PRESS
BITE
+250
+200
+150
+100
+50
0
-50
-100
PERCENT CHANGE
SUCROSE
1.00
.90
.80
.80
.80
.90
1.00
PERCENT BODY WEIGHT

figure I

FIGURE 2

Percent change in responding for MC-24 comparing phases 2-7 with phase 1 session rates.

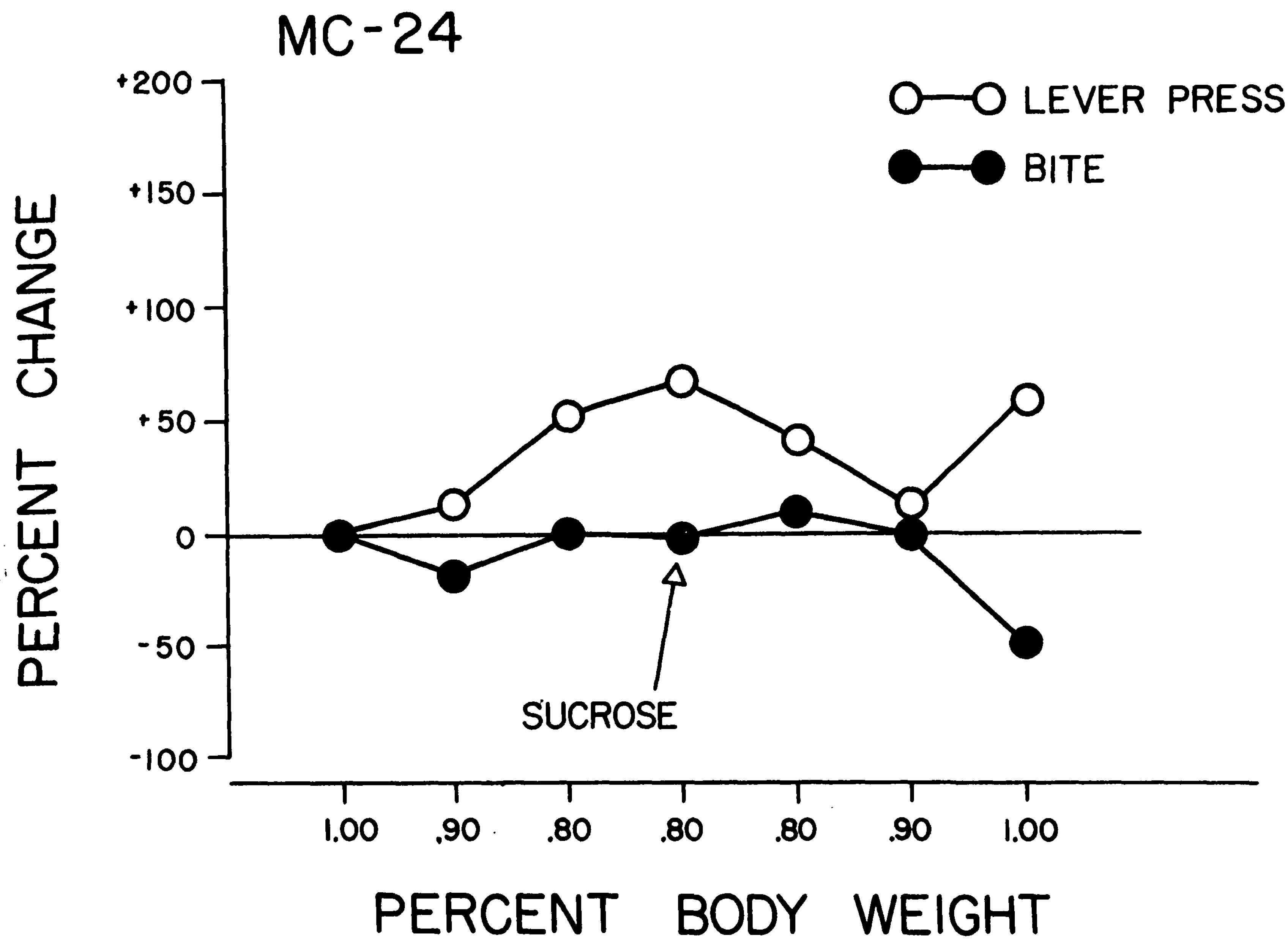

MC-24
LEVER PRESS
BITE
PERCENT CHANGE
+200
+150
+100
+50
0
-50
-100
SUCROSE
1.00
.90
.80
.80
.80
.90
1.00
PERCENT BODY WEIGHT

figure 2

FIGURE 3

Percent change in responding for MC-76 comparing phases 2-6 with phase 1 session rates.

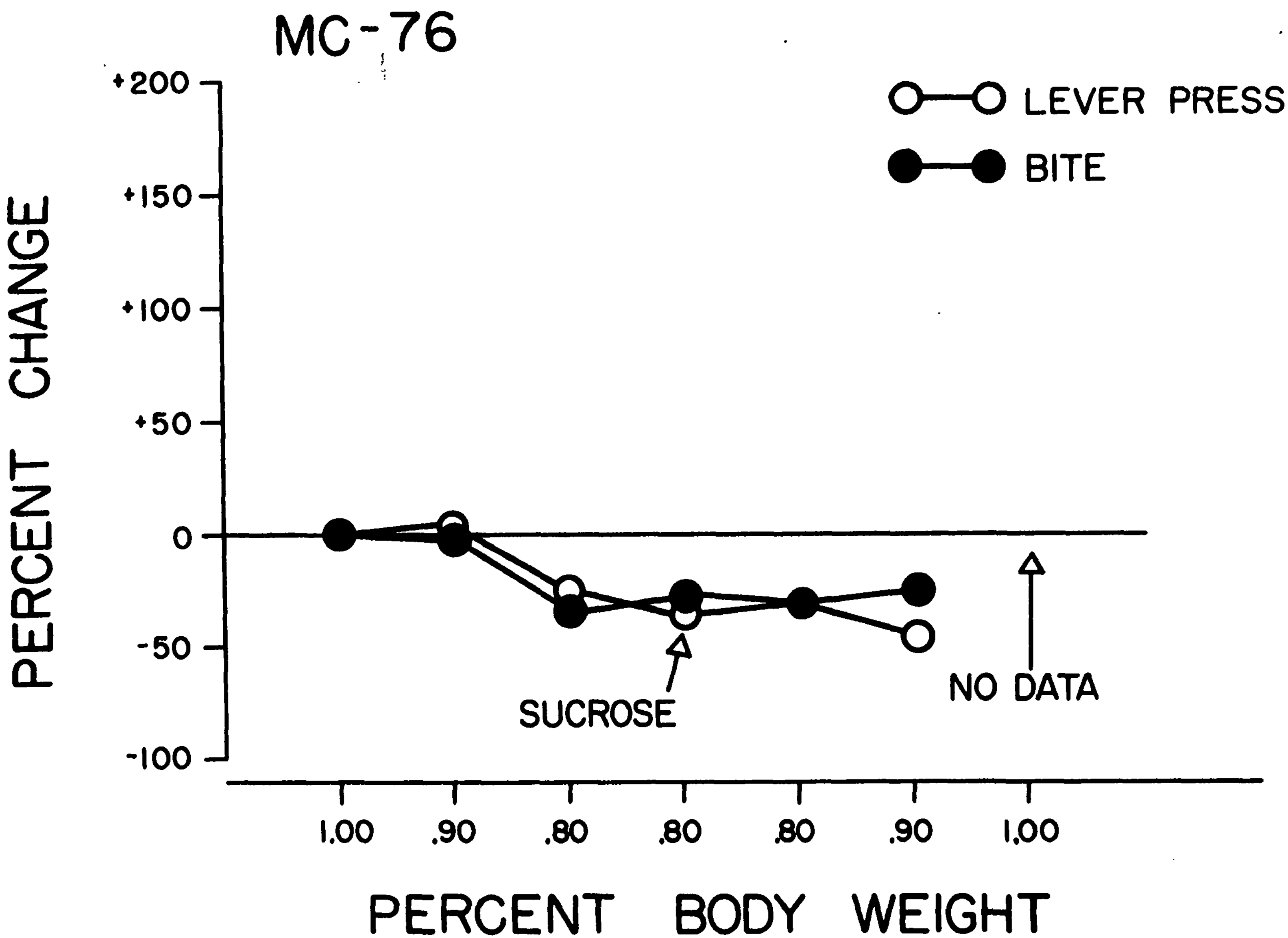

MC-76
LEVER PRESS
BITE
PERCENT CHANGE
+200
+150
+100
+50
0
-50
-100
SUCROSE
NO DATA
1.00
.90
.80
.80
.80
.90
1.00
PERCENT BODY WEIGHT

figure 3

DISCUSSION

The data appeared to lend support to Creer's hypothesis that different behaviors may be affected differently by food deprivation. In the present experiment heart rate, body temperature and the bite responding for MC-24 and MC-76 were not found to be affected by the food deprivation. However, the bite responding for MC-73 and the lever responding for MC-73 and MC-24 appeared to be affected, but this was obscured by the large variability within phase.

One possible explanation was that the pre-shcok behaviors were more sensitive to food deprivation than post-shock responding. Lever press responding is primarily a pre-shock function in non-contingent shock situations, unfortunately in the present experiment it was not possible to ascertain the percent of pre-shock and post-shock lever pressing since the cumulative recorders used were set to measure rate of biting. But, it was observed that the majority of MC-73's biting was pre-shock, as opposed to the typical pattern of post-shock (see Figure 4). No conclusions can be drawn from the present data; however, their possible implications in connection with the findings of Amsel (1950) and Ley (1965) that food deprivation appeared to effect avoidance responding, provides reasons for further investigation.

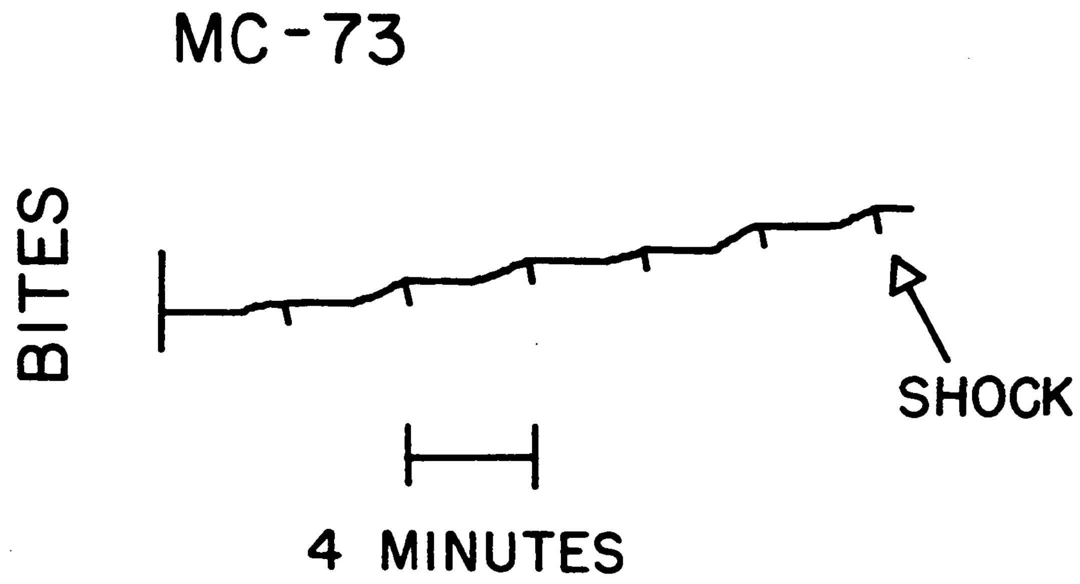
Another area of possible interest produced by the data involves the uncontrolled weight loss of MC-76. Similar uncontrolled loss of weight has been observed in the past (Pare, 1965), however, the suppression of responding that was observed with MC-76 when his weight was systematically reduced (see Figure 3) has not been previously reported. Unfortunately the uncontrolled weight loss was observed in MC-76 only, so no replication was possible, and because of the large variability of the responding within phases, statements about the results were restricted.

Little support for any of the current theories of consumatory regulation could be generated by the data produced in the present experiment. Changes were noted in the rates of lever pressing and hose biting for MC-73, but with the large variability during the sucrose administration and no replication of the change in responding observed from the other monkeys, no conclusions could be drawn.

Though the present experiment did not demonstrate solutions to the effects of food deprivation on the responding produced in an electrical shock situation, it did raise questions, answers to which may lead to understanding of such effects. The questions raised were: (1) Are pre-shock responses more sensitive to food deprivation? (2) What effect, if any, does uncontrolled weight loss have on the responding produced at a later time under controlled weight loss? (3) What, if any, is the relationship between the variability of responding that was observed in this experiment and also mentioned by Cahoon, et al. (1971) and food deprivation?

FIGURE 4

Shows typical hose bite response patterns for MC-73 and MC-24. (The pattern of responding for MC-76 was similar to that of MC-24.) The post-shock biting pattern (MC-24) has been the most commonly reported one in non-contingent electric shock situations. The pre-shock biting observed with MC-73 resembles very closely the pre-shock lever pressing commonly found in non-contingent electric shock situations.



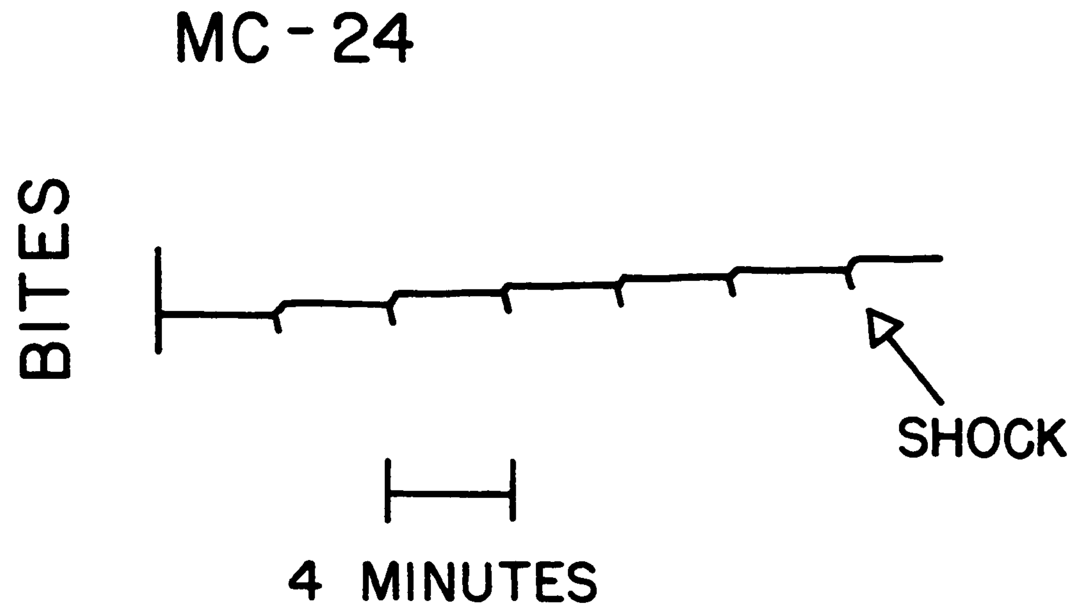


figure 4

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