CONFIRMATION OF A POSITIVE RELATION BETWEEN DEPRIVATION AND NUMBER OF RESPONSES EMITTED FOR LIGHT REINFORCEMENT¹

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That light onset reinforces operants is by now established fact. Many aspects of the phenomenon remain to be investigated, however. Among them is the relation of deprivation to disposition to work for a light reinforcer. On the face of it, there is little reason why deprivation should affect the reinforcing value of light onset, for the occurrence or non-occurrence of flashes of light seems irrelevant to the satisfaction of a physiologic need such as hunger or thirst. In fact, Forgays and Levin (1958) found no relation between deprivation and responding for a light reinforcer. However, Davis (1958) reported a positive relation between these variables, and it will be seen that the present report confirms his finding.

An immediate explanation of such a positive relation is available in the concept of drive as "energizer." It is common knowledge that deprivation raises general activity level; the increase in number of light-reinforced responses emitted by deprived animals may simply reflect the elevation in their activity level. But another type of explanation is possible. Two investigators (Campbell & Sheffield, 1953; Sheffield & Campbell, 1954) have suggested that the action of deprivation is primarily to lower thresholds to external stimulation. On this hypothesis, one would expect no elevation in activity or in bar-pressing on the part of deprived animals in the total absence of changing external stimulation, but considerable elevation where such changes in stimulation were present. The present report offers data that challenge the explanatory power of both types of interpretation.

METHOD

Two replications of the experiment were run. In most respects they were similar. Differences between them will be pointed out as occasion arises.

Apparatus

In the first replication, one Skinner box was used. In the second, two boxes were used and animals were run alternately in each on successive days. The boxes were constructed by modification of J. C. Higgins aluminum ice chests (Sears, Roebuck and Co.), and the experimental chambers of each were made as identical as possible.

The inside dimensions of each experimental chamber were 8 by 11 inches by 8.5 inches high. Each chamber contained a Gerbrands rat lever and an illuminable plastic panel made of a 2- by 4-inch piece of milky plastic mounted in the wall above the lever, its lower edge

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being 2 inches above the top of the lever. Behind the panel, outside the chest, a 25-watt frosted light bulb was mounted in a shielded box. When the bulb was lit the panel provided approximately 1 foot-candle of illumination. No sounds were associated with onset or termination of the light.

The walls, floor, and ceiling of the chamber were of unpainted sheet metal. The lever was made of unpainted sheet metal, and was 2 inches long by 0.5 inch thick, mounted in one wall, with its lower edge 0.75 inch above the floor; and it extended 0.5 inch out from the wall. Its effective depression required a pressure of about 18 grams and a downward excursion of about 3 millimeters. The lever was wired to programming and recording equipment in another room, and sounds of this equipment did not reach the experimental room. The only sound associated with depression of the lever inside the experimental room was a faint click of the lever microswitch whenever the lever was depressed.

Temperature of the experimental room was thermostatically maintained at 70 to 72° F, and temperature inside the experimental chamber rose no more than 2 to 3° F during an animal's experimental session.

Subjects

Eighteen male albino rats of Sherman strain, Scott Farm stock, were used in each replication. In the first, they were about 153 days old at the start of the experiment. In the second, they were about 126 days old. Rats were housed in individual cages of clear plastic.

Procedure

Feeding Regimen. Animals of each replication were divided randomly into three groups of six animals each, and 3 weeks were devoted to accustoming them to the feeding regimen. Group I (the satiated group) was fed dry Purina lab pellets in an amount which seemed to permit growth at a normal rate for their ages (Spector, 1956), but not so much that food from one day was found in their cages on the following morning. Thus, it was assured that all animals were moderately hungry, and would eat to satiation, when fed 2 to 4 hours prior to their daily experimental sessions. Water was always available in their living cages.

Group II (the moderately deprived group) was maintained on a schedule of 23.5 hours' food deprivation and at about 90–93% of free-feeding weights. These rats were fed a mash consisting of 60% water to 40% ground Purina chow by weight, plus a drop of a multivitamin solution (Poly-Vi-Sol, Mead Johnson & Company). Feeding time was adjusted daily to maintain animals at approximately constant weights, so that feeding varied between 5 and 50 minutes per day, and hours of deprivation at time of running varied between 22.5 and 23.5 hours. Water was always available to these rats in their living cages.

Group III (the severely deprived group) was maintained on a schedule of 23.5 hours' food and water deprivation and at about 80–83% of free-feeding weight. Water was never available to these rats except in their mash; consequently, the mash fed to Group III was made more watery than Group II's: 70% water to 30% ground chow plus vitamins. As in Group II, feeding times were adjusted daily for each rat to maintain animals at constant weights, and hours of deprivation varied between 22.5 and 23.5 hours.

Operant-level Measurements. Each rat was run in a Skinner box for 25 minutes daily for 30 days, without explicit reward. Darkness and silence prevailed. Animals were fed in their living cages immediately after running.

Light-reinforcement Session. On the 31st session, one change in procedure was introduced: every bar press now produced illumination of the plastic panel for 3 seconds.

RESULTS

Table 1 gives the median number of bar presses per group during each 5-day block of operant-level sessions and for the single light-reinforcement session. The table reveals the principal results of the study.

First, there was a consistent difference between the medians of the two replications, with animals of the second replication yielding higher response scores than animals of the first replication. The explanation of this finding is not known, but the difference did not, in any case, affect the generality of the other findings.

TABLE 1

Median Number of Bar Presses Emitted by Each Group During Each Five-Day Block of Operant-Level Sessions and During One Light-Reinforcement Session

Session or Session Block	Group I		Group II		Group III (Food and Water Deprived)	
	(Satiated)		(Food Deprived)		(Food and Water Deprived)	
	Replication:		Replication:		Replication:	
N:	One	Two	One	Two	One	Two
	6	6	6	6	6	6
Operant-Level Sessions						
1-5	6.0	8.1	2.0	6.0	1.8	1.5
6-10	2.0	7.1	1.7	5.0	2.7	2.0
11-15	3.5	4.0	2.5	6.5	2.5	5.1
16-20	3.5	6.1	1.6	5.0	1.5	5.0
21-25	2.1	6.5	0.7	4.9	3.5	3.0
26-30	4.0	7.0	1.0	8.0	2.5	7.5
Light- Reinforcement Session	10.0	19.0	21.5	70.0	28.5	120.0

Second, at almost every point, the satiated animals yielded higher operant levels than the deprived animals. Differences between the two deprived groups were not large, nor were they consistently in one direction. Tests of the significance of the differences between groups in operant levels were made by extension of the median test to the 2 by 3 case (Siegel, 1956). Median operant level in the first replication for all 30 sessions was 3.1 in Group I, 1.7 in Group II, and 2.4 in Group III. These values yielded a χ^2 of 20.6. Medians for the second replication were 6.9 in Group I, 4.9 in Group II, and 3.2 in Group III, yielding a χ^2 of 21.0. Both values of χ^2 were significant at the 0.001 level of confidence. In short, in the relatively monotonous stimulating conditions of repeated operant-level measurements, deprivation produced not an elevation, but a slight depression in bar-pressing relative to operant levels of satiated animals.

Third, scores for the light-reinforcement session were everywhere higher than operant levels, whether light-reinforcement scores were compared with medians of five-session

blocks of operant-level measurements, as in Table 1, or with medians of individual operant-level sessions. A light-reinforcement effect was clearly obtained.

Fourth, there was a reversal of the order of the groups on the light-reinforcement session relative to their order during operant-level sessions. Whereas the satiated groups gave higher operant levels than deprived groups, they gave much lower light-reinforcement scores than the deprived groups. The positive relation between deprivation and responding for a light reinforcer reported by Davis (1958) was confirmed.

DISCUSSION

The intriguing aspect of the present findings is the observed reversal in the ordering of the groups on the light-reinforcement session relative to the operant-level sessions. In one case, responding was positively related to deprivation; in the other, inversely related.

One way of accounting for these findings is in terms of general activity. It is commonly held that deprivation is positively related to general activity. Then, the present results demand the conclusion that general activity is directly reflected in light-rewarded bar-pressing, but inversely reflected in unrewarded bar-pressing. Such an argument rests on the assumption that a rise in activity level is a rise in the probability of occurrence of *likely* members of an animal's response repertoire at the expense of (that is, accompanied by a fall in the probability of emission of) less likely members of the repertoire. In the operant-level case, bar-pressing is a response with low probability of occurrence. Any changes in activity consequent upon deprivation, then, would be seen elsewhere than in bar-pressing, and in fact would occur at the expense of the relative frequency of bar presses. Introduction of a light-reinforcement contingency would raise the probability of emission of bar presses sufficiently so that changes in activity would be reflected directly in that and other likely response classes.

Alternatively, a modified form of the Campbell-Sheffield hypothesis would account about equally well for the present findings. That hypothesis, which states that the effect of deprivation is not directly upon activity but rather upon thresholds to external stimulation, adequately accounts for the observed positive relation between light-reinforcement scores and deprivation. However, in this form the hypothesis does not account for the operant-level findings. A refinement of the hypothesis of the following form accounts for all the data. Deprivation lowers thresholds to external stimulation; but in the absence of changing external stimulation, it produces a general quiescence. Such a proposition may be implicit in Sheffield and Campbell's remarks (1954) that left alone, hungry rats do not move about restlessly but spend most of their time sleeping.

SUMMARY

This study examined the relations between deprivation, unconditioned bar-pressing, and responding for a light reinforcer.

Thirty-six male albino rats were run in groups of six. Three deprivation levels were used, and two groups were run in each condition. Two groups were run satiated, two moderately deprived, and two severely deprived. Thirty daily operant-level sessions of 25 minutes each were run in a Skinner box in darkness and silence. In the 31st session, every bar press produced illumination of a plastic panel above the lever lasting 3 seconds.

The findings were:

1. Median number of bar presses was greater on the light-reinforcement session than at any time during operant-level observations.
 2. A positive relation between deprivation and responding for a light reinforcer was found. The severely deprived groups emitted more bar presses for the light than did the moderately deprived groups, and these in turn emitted more bar presses than did the satiated groups.
 3. An inverse relation between deprivation and operant level was found. Generally, satiated groups yielded slightly higher operant levels than did deprived groups.
- Two alternative methods of accounting for the findings were discussed.

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