The effect of the onset of stimuli on reactivity in the rat

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Forty rats, maintained on either ad lib food and water or on 22-h food deprivation, were tested in a photobeam cage under conditions of no specific external stimulation or where tone, light, or the odor of amyl acetate or food were presented. The results indicated that the onset of all stimuli resulted in an increase in activity counts for all groups, but the increment in activity varied for the different stimuli. The greatest increase in activity for the ad lib group was to the light stimulus; for the food-deprived group, it was to the food-odor stimulus.

Campbell & Sheffield (1953) have suggested that activity in the rat represents a reaction to environmental stimuli that is enhanced by the effects of deprivation. The generality of this finding has gained some support (Campbell, 1964), but two recent lines of investigation have questioned the exact conditions under which such behavior changes occur. (1) It has recently been agreed by several investigators (cf. Bolles, 1967; Tapp, Zimmerman, & D'Encarnacao, 1968) that rat "activity" does not represent a unitary dimension of behavior but is a complex of acts that are reflected differentially by the kinds of equipment that are used to assess it. This finding restricts the generality of any statement regarding the effects of deprivation on an organism's reaction to environmental stimuli. (2) It has also been shown that rats respond differently to different stimuli when their presentation is made contingent upon a lever press (Tapp & Long, 1968). If an animal's behavior to different stimuli varies significantly when they are made response-contingent, would not his response to these stimuli in an apparatus sensitive to some component of activity vary in a similar differential manner?

The aims of the present experiment were to examine the findings of Campbell & Sheffield (1953) utilizing a different measure of activity, i.e., photocell cages. The onset of several different stimuli were compared within the same apparatus in order to determine the relative effects of these stimuli on the behavior of both food-deprived and satiated animals.

SUBJECTS

The Ss in this experiment consisted of 40 male albino rats of the Holtzman strain, weighing between 300 and 340 g at the beginning of the experiment. When the animals were received in the laboratory, they were housed individually and allowed to adapt to the laboratory environment for 10 days while being maintained on ad lib feeding. At the end of this period, one-half of the animals were adapted to a diet of 13 g of powdered lab chow per day for 12 days. This diet was given at the same time each day at a period that corresponded to the end of their projected test session. The control animals were maintained on ad lib food and water for this period.

APPARATUS

The apparatus consisted of eight double Wahmann cages, measuring 9 x 17 x 7 in., which were housed, two per shelf, in an enclosed wooden cabinet. The tops of the cages were covered with Plexiglas, and the cages were arranged within the cabinet to prevent visual contact between animals. Each cage had a single photoelectric cell, placed in the center, 8¾ in. from either end and 2¼ in. above the floor. A light source was placed directly opposite the photocell, with a Wratten 87c filter placed over the light to prevent transmission of light at wavelengths less than 850 millimicrons. Any movement that the animal made which broke this beam activated a relay that recorded the count on an electromagnetic counter. A constant air flow was forced through the cabinet by means of a blower mounted at the top. The ventilation system within the cabinet was designed so that air was drawn through the bottom of the cabinet, past the animals, and exhausted into the room through the ceiling of the cabinet. The entire apparatus was maintained in a sound-insulated room that was ventilated and maintained at a temperature of 78 ± 2°F (D'Encarnacao, 1968).

The stimuli consisted of a tone, light, and the odors of amyl acetate and food. The tone consisted of a 680-Hz at 74.5 dB re .0002 stimulus against a background noise of 65 dB. The tone was delivered through 2.4-in. speakers mounted at the front of a cabinet, above and slightly behind each cage. The light was mounted above the cages, and the intensity of the light measured from a position directly facing the bulb was 0.5 ft-L. Two odors were also used as stimuli: amyl acetate and Purina lab chow. These odors were introduced into the apparatus by placing the food at the air-inlet aperture of the cabinet. In this way, the air flow carried the appropriate odor throughout the cabinet.

Five groups of eight rats, half of which were on a 13-g feeding schedule and half of which were on ad lib feeding, were placed in the photocell cages for 2-h test sessions on 5 successive days. After the animals were in the apparatus for 1 h, one of five different conditions was introduced. These conditions consisted of the onset of light, the onset of the tone, the presentation of the odor of amyl acetate, the presentation of rat chow, or a control condition in which no stimulus was introduced. In the control condition, the E entered the test room after 1 h in order to control for the possible effects the E might have produced by entering the room. The test conditions were presented once in a counterbalanced order to all groups. Automated equipment allowed the recording of photocell counts

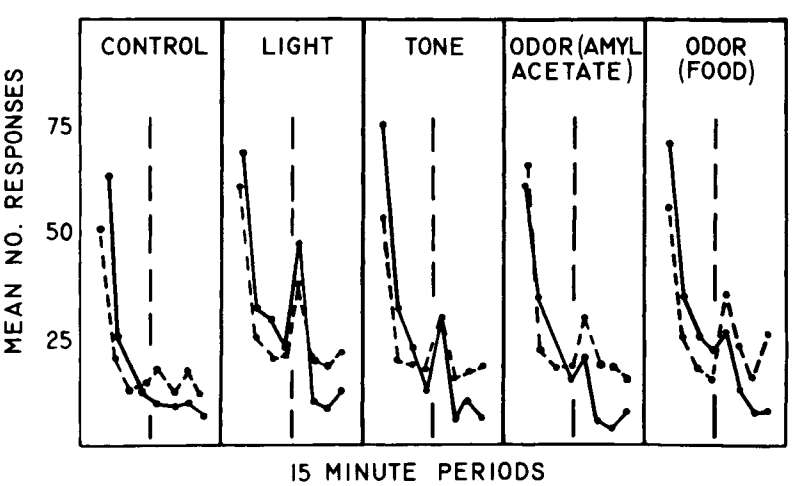

Fig. 1. Mean number of activity counts for all groups. The broken lines represent the 23-h deprived groups, while the straight lines represent the ad lib group. See text for explanation.

for 15-min periods over the 2-h session.

RESULTS

The results of the mean number of activity counts for both groups for all experimental conditions are summarized in Fig. 1. There are several findings that are apparent in the figure that are confirmed by the analysis of variance of these data. First, all animals exhibited a greater amount of responding during the first 1-h orientation period in the apparatus when compared to the second hour ($F = 124.57$, $df = 1/30$, $p < .01$). The ad lib animals exhibited a higher level of responding overall during the prestimulus condition but a lower level of responding during the stimulus condition ($F = 25.44$, $df = 1/30$, $p < .01$) than did the food-deprived group.

The onset of the stimuli produces a significant increase in activity for all stimulus conditions. To analyze the nature of this behavioral change in more detail, comparisons were made between the ad lib and food-deprived groups for all stimulus conditions on scores calculated by subtracting the 15 min preceding the onset of the stimulus from the 15 min following the onset of the stimulus. These data are presented in Fig. 2. The analysis of these difference scores revealed that the onset of the stimuli produced an overall effect ($F = 5.31$, $df = 4/200$, $p < .0001$). In general, the control conditions did not produce a significant change in behavior for either group. The onset of all stimuli resulted in an increase in activity counts for all groups, but the increment in activity was differentially high for different stimuli, depending upon the deprivation conditions. For the ad lib group, the onset of the lights and tone reliably enhanced activity counts above control levels (Newman-Keuls, $p < .01$), and the onset of the lights enhanced responding for this group to a greater extent than it did with the food-deprived group (Newman-Keuls, $p < .05$). For the food-deprived Ss, on the other hand, only the odor of food enhanced response levels above those exhibited by the animals in the control condition (Newman-Keuls, $p < .05$).

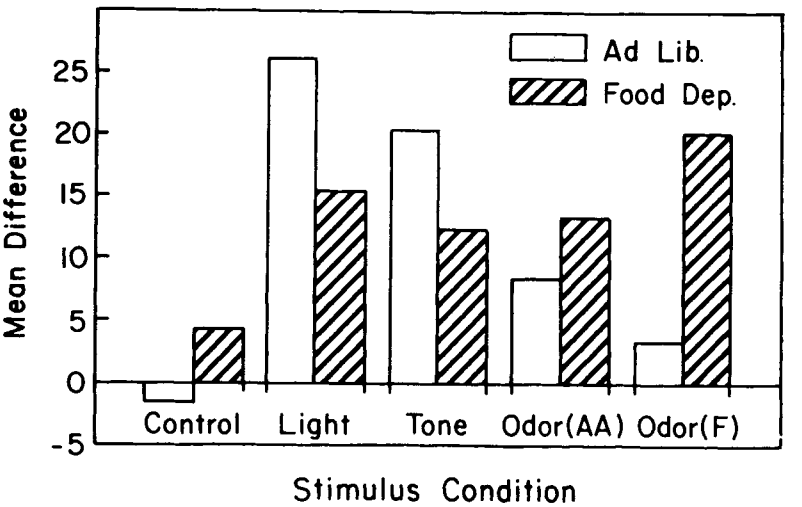

Fig. 2. Mean difference scores between each deprived and ad lib group for all stimulus conditions. See text for explanation.

DISCUSSION

The conclusions that can be drawn from this experiment are, in part, a function of the nature of the comparisons that one makes. All stimuli increase response output within the test situation reflecting the animal's reaction to the onset of the stimuli. However, there was a difference in the relative effectiveness of the stimuli on the behavior of the ad lib and deprived animals. The ad lib animals were more responsive to the onset of the light and the sound within the test situation, whereas the food-deprived animals reacted to a much greater extent than did the ad lib animals to the odor of the food. The increases in the photocell counts, following stimulus onset, provide support for part of the findings of Campbell & Sheffield (1953), which suggest that behavior occurs as a reaction to the stimuli within the environment. On the other hand, the differential effects of the animal's reaction to these stimuli that are increased by deprivation indicate that the deprivation state does not uniformly increase the animal's reactivity to all stimuli. Rather, it appears that the deprived animals are more reactive to those stimuli that serve as cues for the material that potentially satisfies their need state. This is consistent with subsequent studies by Sheffield & Campbell (1964) which suggest that stimuli associated with food intake become conditioned stimuli that elicit reactions.

The results of this experiment are in conflict with results that have been reported by Tapp & Long (1968), which note that deprivation enhances the animal's reaction to all stimuli. However, differences in testing procedure, specifically the mode of delivery of the stimulus, suggest that there may be an essential difference between an animal's tendencies to react to stimulus onset in a device that is sensitive to some component of activity as compared to a device where the animal has some control over the stimuli in his environment. In the Tapp and Long experiment, the animals could respond on a lever to produce the onset of the stimuli. In the present experiments, the onset of the stimuli was passively delivered to the animal, and there was nothing he could do to control its onset. The potential differences indicated by the differences of the outcomes of these studies suggest that a modification of the Campbell hypothesis might be in order. The Tapp & Long (1968) results note that the deprived animal is particularly responsive to the consequences of his behavior. In other words, deprivation lowers the animal's tendencies to react to those effects on the environment that are produced as a result of a particular instrumental act when associated with food-related stimuli.

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