

## CURIOSITY IN THE HAMSTER<sup>1</sup>

GERALD E. SCHNEIDER AND CHARLES G. GROSS

*Massachusetts Institute of Technology*

Running time for repeated alley runs by hamsters to end boxes containing (a) nothing, (b) a constant set of objects, or (c) a changing set of objects was in the order  $a > b > c$ : thus, novelty appeared reinforcing. Length of intersession interval (2, 24, 48 hr.) affected only Condition b: thus, "deprivation of novelty" did not increase its incentive strength.

Certain stimuli which evoke exploratory behavior in rodents appear to have reinforcing effects. For example, exposure to a Dashiell maze reinforces spatial and visual discrimination (Montgomery, 1954; Montgomery & Segall, 1955). However, the properties of these stimuli responsible for their reinforcing effects are not clear. Whereas spaciousness, complexity, and novelty each evoke exploratory responses (Berlyne, 1960), Berlyne and Slater (1957) found that both spaciousness and complexity, but not novelty, reinforced the choice of one arm of a T maze. By contrast, Chapman and Levy (1957) showed that a sudden (and thus novel) end-box change would decrease subsequent alley running time.

If novelty is reinforcing for rodents, does it show deprivation effects analogous to those of more conventional reinforcers? In the present experiment we attempted to distinguish between the effects of novelty, complexity, and spaciousness of an end box on alley running and to determine the effects of levels of "deprivation" on incentive strengths of these three types of stimuli.

### METHOD

#### *Subjects*

Twenty-seven male golden hamsters (*Mesocricetus auratus*) were obtained at the age of 5 weeks and housed in pairs in Plexiglas cages ( $13 \times 9\frac{1}{2} \times 7$  in.). Each cage had cedar shavings on the floor and contained a  $7 \times 12$  in. wire screen bent into an inverted U shape. Food was available in these cages at all times.

#### *Apparatus*

The apparatus consisted of an end box ( $24 \times 24$  in.), an alley ( $48 \times 3$  in.), and a start box ( $6 \times 3$  in.), arranged in an L with the alley and start box forming the long side. All sides were 12 in. high and painted gray. The start box and alley were sep-

arated by a guillotine door, and the alley and goal box were separated by a one-way push door so constructed that an *S* could not retreat when it had entered far enough to see the contents of the end box.

End-box stimuli were metal, glass, and plastic objects differing in color, shape, and size, e.g., a model dinosaur, a flour sieve, a coffee cup, etc.

#### *General Design*

After 3 weeks of daily handling, *Ss* were habituated to the apparatus over a 3-day period. They were divided into low, intermediate, and high tameness groups on the basis of the extent an animal would approach *E*'s hand, which held sunflower seeds, and the behavior displayed when picked up. Orthogonally all 27 *Ss* were randomly assigned to one of three end-box conditions. The first group ("Empty Box") always ran to an empty goal box. Each *S* in the second group ("Constant Object") ran to an end box always containing the same four objects. Each *S* in the third group ("Changing Object") ran to an end box, the contents of which changed from trial to trial. In this condition, the end box always contained four objects, but, on every trial, one of the objects was replaced by another one in such a way that no object remained in the end box for more than four trials. Thus, on every trial the end box contained a unique set of objects. The *Ss* were run for four sessions at intervals of 2, 24, and 48 hr., the order of intervals being determined by a  $3 \times 3$  Latin square for each end-box condition group.

#### *Experimental Procedure*

Before an experimental session, each *S* was taken from its cage and placed in the start box. After 3 sec., the guillotine door into the alley was raised, enabling *S* to enter the alley and then the end box. After 60 sec. in the end box, *S* was picked up and returned to the start box. This procedure was repeated until alley times (measured from opening of the guillotine door to passage of *S* into the end box) plus end-box times (always 60 sec.) reached 1,500 sec. When the 1,500-sec. period was up, *S* was allowed to complete the trial and was then returned to its cage until the next session.

Alley times were transformed into common logarithms on the basis of results of Bartlett's test of homogeneity of variance. Analyses of variance were

<sup>1</sup> This research was partially supported by Grant 3TIGM-1064 from the National Institutes of Health, United States Public Health Service.

then carried out on mean alley times for the first session and for the Latin square, consisting of Sessions 2, 3, and 4.

In addition to alley times, the frequency of bodily contact with an object at the termination of the end-box period was determined for the Constant Object and Changing Object groups. This frequency divided by the total trials is termed the "exploration ratio." To determine the significance of differences between groups in this score, Mann-Whitney U tests were carried out for each session.

RESULTS

*Effects of End-Box Conditions*

End-box conditions were a significant source of variance ( $F = 8.79, p < .01$ ). As indicated by Figure 1, the Changing Object group consistently showed the lowest alley times, significantly lower than the Empty Box group during all four sessions, and significantly lower than the Constant Object group during the last two sessions. The Constant Object group ran significantly faster than the Empty Box group only during the initial session. Furthermore, the mean alley time of the Changing Object

group decreased significantly from Session 1 to Session 4 ( $p < .05$ ).

The two groups with objects in the end box did not differ in their exploration ratio in the first session. The Changing Object group was in contact with a stimulus object at the termination of the end-box period relatively more often than the Constant Object group in Sessions 2, 3, and 4 (Figure 1).

*Effects of Intersession Interval ("Deprivations")*

Independent analyses of mean session alley times were carried out for each end-box group. Variance due to intersession interval was significant only for the Constant Object group ( $F = 3.58, p < .05$ ) and reflected a decrease in alley time with increasing intersession interval.

*Effects of Tameness*

Variance due to tameness was significant only in the first session ( $F = 6.09, p < .01$ ), the tamer Ss running faster. The absence of the effect in later sessions might reflect elimination of tameness differences among Ss with continued handling. Interactions of tameness with end-box conditions, intersession interval, or order of testing, as well as higher-order interactions, all failed to reach significance at the .05 level.

DISCUSSION

Spaciousness (relative to the start box and alley) characterized all end-box conditions. Complexity characterized the Constant Object and Changing Object conditions. In any conventional sense of the term, novelty of the Constant Object condition was never higher and declined much more rapidly than the novelty of the Changing Object condition.

In the first session, the Changing Objects and Constant Objects were explored with the same relative frequency. However, the exploratory behavior in the Constant Object condition rapidly declined in subsequent sessions, presumably as a function of decline in novelty of the objects. Thus, novel and complex stimuli evoked more exploratory behavior than merely complex stimuli.

In the initial session, the Constant and Changing Objects reinforced alley running similarly and more than the Empty Box. However, in subsequent sessions, alley time in the Constant Objects condition increased and was no longer different from alley time in the Empty Box condition. By contrast, the rein-

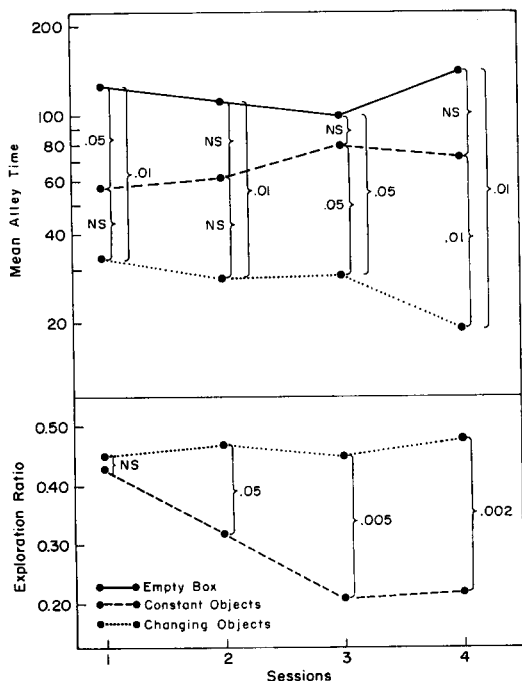


FIG. 1. Upper: Mean alley times are plotted for each group over the four experimental sessions. Lower: Exploration ratios for the two groups running to objects are plotted over the four sessions. (The probabilities that differences between groups were due to chance are less than the values shown. NS indicates  $p > .05$ ).

forcing properties of the Changing Objects increased. Thus, novelty, complexity, and spaciousness (Changing Objects) were much more reinforcing than either spaciousness (Empty Box) or complexity plus spaciousness (Constant Objects). Furthermore, complexity plus spaciousness was not more reinforcing than spaciousness alone. These results suggest that novelty, per se, has reinforcing properties. Furthermore, under our conditions, the exploration-evoking and reinforcing properties of stimuli were positively related.

The significant effect of deprivation of exploration of the Constant Objects on their incentive value appears analogous to the effect of food deprivation on the incentive value of food. However, this effect may simply reflect a positive relationship between novelty of a stimulus and time-since-its-last-exposure. By

contrast, the reinforcing effect of the Changing Objects was not similar to the reinforcing effect of food, since deprivation had no effect on incentive value.

#### REFERENCES

- BERLYNE, D. E. *Conflict, arousal, and curiosity*. New York: McGraw-Hill, 1960.
- BERLYNE, D. E., & SLATER, J. Perceptual curiosity, exploratory behavior and maze learning. *J. comp. physiol. Psychol.*, 1957, **50**, 228-232.
- CHAPMAN, R. M., & LEVY, N. Hunger drive and reinforcing effect of novel stimuli. *J. comp. physiol. Psychol.*, 1957, **50**, 233-238.
- MONTGOMERY, K. C. The role of the exploratory drive in learning. *J. comp. physiol. Psychol.*, 1954, **47**, 60-64.
- MONTGOMERY, K. C., & SEGALL, M. Discrimination learning based upon the exploratory drive. *J. comp. physiol. Psychol.*, 1955, **48**, 225-228.

(Received April 8, 1964)

*Journal of Comparative and Physiological Psychology*  
1965, Vol. 59, No. 1, 152-154

## COMPARISON OF FIXED AND VARIABLE-RATIO SCHEDULES OF REINFORCEMENT<sup>1</sup>

MILTON D. SUBOSKI

*Indiana University*

For 21 days 8 rats on an FR schedule of 16:1 and 8 rats on VR of 16:1 received 60 reinforcements daily for bar pressing. No significant differences were found in overall response rates, number of large interresponse pauses, postreinforcement pausing, or rate while responding; there was some indication that FR produced "scalloping" while VR did not. Switching FR trained Ss to VR produced immediate and persistent increases in overall response rates and a decrease in postreinforcement pausing. Under VR, the length of the postreinforcement pause was found to be negatively correlated with the number of bar presses required in the preceding ratio.

The purpose of the present study was to provide a quantitative comparison of the bar-pressing performance generated in rats by fixed-ratio (FR) and variable-ratio (VR) schedules of food reinforcement. Although performance on ratio schedules is widely used as a base line for investigation of other variables, Ferster and Skinner (1957), Sidman and Steb-

bins (1954), and Skinner (1938) provide the only reasonably thorough description of the performance produced by FR schedules, and Ferster and Skinner (1957) the only extended discussion of VR schedules. There are no data available which directly compare the characteristics of FR and VR performance under the same conditions using naive animals.

Summary statements of performance generated by the two schedules appear in a variety of secondary sources (e.g., Kimble, 1961, p. 163). These, as well as careful examination of the Ferster and Skinner (1957) data, indicate that FR produces high constant rates broken only by pauses after reinforcement; while VR produces interpolated pausing after responding has begun, with little or no pausing after reinforcement.

<sup>1</sup>This report is based on a thesis submitted to the Graduate School of Indiana University in partial fulfillment of the requirements for the MA degree. The author wishes to express his appreciation to James Dinsmoor, who provided the initial suggestion on which this research is based and assistance when needed, and to Garry Flint, who prepared the trend analyses for computer analysis.