**BEHAVIOR IN A NOVEL SITUATION AS INFLUENCED BY
THE IMMEDIATELY PRECEDING ENVIRONMENT¹**

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Behavior in a novel situation, which basically represented an increase in complexity for some Ss and a decrease in complexity for others, was sampled by the use of an exhaustive list of response categories at 5-sec intervals for 24 min. Wide behavioral differences are described. In addition, the feasibility of the time-sampling technique for the study of animal behavior is further demonstrated, and its more general use is advocated.

When animals are placed in novel situations, their behavior changes. However, the novel stimuli do not alter the actual components of the behavioral repertoire; rather, the relative frequency, and perhaps the sequence, of the behavioral components are affected. Thus, an important problem in studying reactions to novelty is finding the determinants of these changes in relative frequency. Arguing in much the same manner, Bindra and Spinner (1958) studied behavioral differences to novelty. They found that for animals coming from similar pretest environments, increasing degrees of stimulus novelty produced large differences in the relative frequencies of the various behavioral components. However, because novelty is determined not only by the current stimulus situation but also by the relationship between the new situation and the previous environment, there is another alternative in studying reactions to novelty: animals can be adapted to different pretest environments and then be exposed to the *same* novel situation.

The effects of long-term rearing environments on various behavioral characteristics have been studied extensively. (See, for example, Zimbardo & Montgomery, 1957; Woods, Ruckelshaus, & Bowling, 1960.) However, little attention has centered on the effects of the immediately preceding environment on behavior in a novel situation. Charlesworth and Thompson (1957) compared normal-living-cage controls with groups that had been confined for 3, 6, and 9 days and found no differences in their behavior when they were

allowed to explore a relatively *more* complex novel environment. But greater variation than this is possible. The purpose of this experiment was to study reactions to novelty when the testing situation represented a *decrease* in complexity as well as an increase. In order to vary this factor, I placed animals in free, restricted, and normal environments for approximately 24 hr before observing them in a 30-in.-square closed field. The animal's behavior was then sampled every 5 sec for 24 min and classified according to exhaustive response categories: freezing or rigidly motionless, sniffing, locomotion, grooming, lying or sitting, and miscellaneous. This technique, which was developed essentially by Bindra and his associates, provides a satisfactory record of the rat's total behavior during an observation period.

METHOD

Subjects

The subjects were 36 Sprague-Dawley rats, half male and half female, which were obtained from a supplier when they were approximately 90 days old. They were weighed, their ears were punched, and they were transferred to standard laboratory cage racks, with two to a cage.

Apparatus

First, a Dashiell maze was used to match the Ss on locomotor exploration. The inside of the maze was painted black, and a 100-watt light bulb was suspended 35 in. from the floor. Next, three types of environmental conditions were used to house Ss before the time sampling. The

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"free environment" consisted of large living cages 24 in. by 44 in. and 12 in. high. Each contained a small maze, a tunnel, and a see-saw; and the floor was covered with peanut hulls. Wire mesh enclosed three sides, so that *S* could observe general laboratory activity. The "restricted environments" were cages 10 in. by 12 in. and 9 in. high. All four walls were solid. The floors and ceilings were of wire mesh, but the cages were so racked that *S* could see only a few inches above and below. The normal laboratory environment was a standard cage 7.5 in. by 9 in. and 7 in. high, with a wire-mesh front. The testing apparatus consisted of a light-grey, 30-in.-square closed field, with a wire-mesh ceiling and a start-box in one corner. A 100-watt light bulb was also 35 in. above the floor of this apparatus. A one-way vision screen separated *E* from the testing apparatus, and a timer behind this screen made a faint noise every 5 sec.

Procedure

I attempted to control for individual differences in locomotor exploration in a novel situation by measuring this variable and using it to match *Ss* in forming the various groups in the experiment. The *Ss* were allowed free entry (Welker, 1957) into a Dashiell maze, and the number of 4-in. floor squares entered by at least the two front feet was then recorded for 4-min periods. The individual differences were large, with scores ranging from 107 to 283. Sex differences were also apparent: the males had a mean of 157.8, and the females had a mean of 200.2.

These locomotion scores for individual *Ss* were then used to form matched groups. Within each sex, the three *Ss* at each matching level were randomly assigned to the three experimental conditions. Thus, *Ss* were classified according to six levels of locomotor exploration in each of the six groups.

Because of the time it took to test each *S*, and because it was necessary to test all *Ss* at approximately the same portion of their diurnal cycle, the six *Ss* at each matching level were run as a subunit of the total experiment in a random order. All testing occurred in the interval between 2 and 7 p. m.

According to the predetermined running order, a group of six *Ss* was placed individually in their respective environments on the afternoon before testing. Although the total time

spent in these environments varied a bit because of variations in the time required for testing, the average time was 24 hr. The *Ss* had been handled sufficiently in the process of weighing, marking, matching, and changing environments so that they were fairly gentle by testing time.

When ready for testing, *S* was placed in the start-box leading to the 30-in.-square field. As soon as *S* oriented itself toward the start-box door, the door opened. Latency was recorded from this time until *S* had fully entered the field and the door was closed. Behavior was then recorded every 5 sec for 24 min. The exhaustive response categories listed and defined by Bindra and Spinner (1958) were used: freezing or rigidly motionless (F), sniffing (S), locomotion (W), grooming (G), lying or sitting (L), and miscellaneous (M). These authors reported 85% interjudge agreement with this classification of responses; and I found comparable results in my laboratory.² Sniffing and locomotion were the only two responses which occurred simultaneously. Following the procedure of Bindra and Spinner, this event was recorded as sniffing. The timer, which was behind the one-way vision screen, ran continuously even when *S* was in the start-box, so that the faint click it produced formed a part of the general background noise. But just in case *Ss* might respond to it, they were observed continuously, and the behavior just preceding the click was recorded. As it turned out, an *S* occasionally froze momentarily to the click at the beginning of its test period; but this orienting reaction (Berlyne, 1960) quickly dropped out. Other laboratory activity was virtually eliminated during the testing sessions, so that only normal background noises were present. I did all handling and observation work, so that *Ss* were not run "blind."

RESULTS

Sniffing

Figure 1 shows mean number of sniffing responses per min during successive 3-min blocks. The total number of responses was analyzed by a matched-groups analysis of variance.

²Indeed, in checking interobserver reliability, I found that any discrepancies are more likely caused by the *Es'* sampling different behaviors in a rapidly changing sequence rather than disagreeing in the identification of any particular behavior.

Fig. 1. The frequency of occurrence per minute of sniffing for males and females from the free (F), restricted (R), and lab cage (L) environments.

According to this analysis, the sex differences are significant, with the males making fewer sniffing responses than the females ($F = 10.17$, $P < .005$). By inspection, the significant environmental differences ($F = 9.17$, $P < .005$) must be due to the greater drop-off in the frequency of this response for the free-environment Ss during the second half of the 24-min period. But most Ss do show some decline in sniffing over time. If t tests are used to compare the number of responses in the first 6 min with those in the last 6 min, the decline at or beyond the .05 level is significant for all groups except the restricted males and the lab cage females. Yet, even in these groups, only three of the twelve Ss showed an increase. In general, then, sniffing decreases in frequency as the animal becomes adapted to this novel situation; furthermore, this decline is more rapid in those Ss coming from the more complicated free environment.

Grooming

Figure 2 shows the frequency of grooming responses. As before, a matched-groups analysis of variance was performed on the total scores. Again, sex differences occur, with the males showing a greater number of grooming responses during the observation period

($F = 6.32$, $P < .025$). Environmental differences are also significant ($F = 5.16$, $P < .025$), which are obviously due to the greater frequency of occurrence in the free animals. The dip in the curve for both of the free groups during the sixth period was not produced by a few markedly deviant scores, but it is characteristic of the individual records as well. Indeed, seven of the twelve Ss in these two groups show a lower frequency for the sixth period than for both the fifth and seventh periods, and four more Ss show either a decline from the fifth to the sixth or a rise from the sixth to the seventh. This is an indication of the cyclic nature of their responding which will be referred to again later. However, the interesting thing is that here the Ss are declining and rising again about the same time after their exposure to the novel situation.

According to the t tests comparing the frequency of grooming during the final 6 min with that during the first 6 min, a significant increase occurred at or beyond the .05 level for all groups except the restricted males. Yet, even though it is not large enough to be significant, the Ss in this group also showed an increase. In general, the conclusions are that grooming behavior increases as a function of time when animals are introduced into a novel environ-

Fig. 2. The frequency of occurrence per minute of grooming for males and females from the free (F), restricted (R), and lab cage (L) environments.

ment; that the animals coming from the more complex free environment show greater amounts of grooming; and that when it occurs at these higher frequencies, it tends to occur in cycles, *i.e.*, waxing and waning over successive time blocks.

Freezing

There were no consistent differences in the frequency of this response for either the experimental conditions or the sex of the Ss. This seems to be an individual characteristic; some animals in all groups froze relatively often, and some seldom froze.

Lying

This response occurred so infrequently in the responses to novelty studied by Bindra and Spinner (1958) (only 3 out of 4500) that it would not be expected to be very important for short-term observational work. Yet, in the current study, it turned out to yield one of the most striking differences between our experimental groups. This response occurred 177 times out of 10,368 responses that were recorded, and *all* of these were produced by three free-environment males and one free-

environment female during the final 9 min of the 24-min period. These Ss just curled up in a corner and, in some cases, went to sleep. In contrast, all the Ss in the other groups remained active the entire time.

Other Behavior

Walking seldom occurred alone. It was most often accompanied by sniffing; following Bindra and Spinner (1958), it was recorded as a sniffing response. There were no differences between sexes or experimental groups for the walking responses that were recorded.

Miscellaneous responses were also rare, comprising only 0.58 per cent of the total number of recorded responses; hence, no group differences were obtained.

The only significant difference in the analysis of start-box latencies was the sex difference. The males took much longer in making a free entry into the test area than the females. The mean reciprocal latencies in seconds were 0.042 and 0.130, respectively ($F = 11.17$, $P < .005$).

Covariation of Response Categories

Figure 3 shows the manner in which these responses typically covaried in the restricted

and lab cage animals. These groups showed very few differences, and this is a fairly characteristic individual record. It illustrates quite nicely the tendency for the most common (*i.e.*, the most frequently occurring) behavioral components to occur in cycles. In this case, sniffing builds up, declines, and then starts up again. In *Ss* which did a lot of grooming, the same kind of cycling was observed. In general, the conclusion is that successive blocks of time do not contain the same relative proportions of these behavioral components; rather, the most frequently occurring behaviors, at least, tended to wax and wane.

Fig. 3. The typical way in which responses covaried in the restricted and lab cage animals.

Figure 4 shows the covariation of responses in one of the free-environment *Ss* that went to sleep. Notice that the behavioral changes which really differentiate this *S* from the typical restricted and lab cage *Ss* do not begin to occur until 15 or 18 min have elapsed. This record also shows the cycling in the grooming curve.

Behavioral Shifts

In order to obtain an approximate picture of the relative frequency of shifts in behavior from one category to another, sampling runs

(successive entries in the same category) of non-sniffing responses were tabulated. In the restricted and lab cage groups, only 13% of all nonsniffing responses were contained in sampling run lengths greater than 5. In the free groups, 43% of all nonsniffing responses were

Fig. 4. The typical way in which responses covaried in free-environment animals that went to sleep.

in these longer sampling runs. The general conclusion from this tabulation is that the restricted and lab cage groups jump quickly from one behavior to another or quickly return to sniffing whenever this behavior is interrupted. On the other hand, the free animals give a less sporadic picture and are much more likely to engage in relatively long sequences of other behaviors. These long runs of nonsniffing responses occur almost entirely during the second half of the observation period.

Sensitivity to Extraneous Stimuli

An incidental observation was that the animals seemed to become increasingly sensitive to slight *unfamiliar* noises as time went on during the observation period. Familiar noises in the lab, and even relatively loud noises in the heating system, would go apparently un-

noticed. But a slight creak from the observer's stool behind the screen, or even something so faint as the observer's hand brushing a speck from the data sheet, might cause the animals to freeze for several seconds. This sort of responding seemed much more likely to occur in the second half of the observation period. Although this was merely an observation, it is related to a prediction made by Bindra (1959). One implication Bindra draws about reactions to novelty is that we should expect "little or no response decrement if some stimulus change were made after only a small amount of training, and a marked decrement if the same stimulus change were made after somewhat more (medium) training." The observations in this study indicate that Bindra's prediction is worthy of more systematic pursuit.

DISCUSSION

The results of this experiment indicate quite clearly that animals which have been adapted to a free environment behave quite differently when introduced to a novel but less complex environment than do Ss which have been adapted to either a restricted or normal lab cage environment. Hence, in studying reactions to novelty, research should be directed towards finding the *stimulus conditions* which differentiate the novel environment from the one previously adapted to. The term *novel* itself is too general to be of much use in finding the determinants of behavior. Investigation of the *particular stimulus changes between* the adapted environment and the test situation would be more fruitful. In this experiment, stimulus complexity (*i.e.*, the number of stimulus elements and their arrangement) appears to be the important variable; and a more systematic investigation of this continuum should be undertaken. It may be possible to scale environments along this continuum by using such measures as the length of time it takes for sniffing to decline and other responses to increase, or the length of time it takes before the animal engages in a particular interval of grooming, or the time it takes for the animal to lie down.

In addition to the particular results of this study, there are methodological points as well. The study has further demonstrated the feasibility and value of the time-sampling proced-

ure developed mainly by Bindra and Blond (1958) and Bindra and Spinner (1958) for studying animal behavior. Certainly, other categories of responses may prove more valuable in different situations; indeed, in this one, perhaps sniffing while walking should have been differentiated from sniffing while standing still. But, with modifications to suit particular experimental conditions, much more relevant information could be obtained than merely number of defecations, number of floor squares entered, number of errors, and the like.

Finally, the possibility of obtaining stable levels for individual Ss from which the effects of induced changes could be evaluated should not be overlooked. An S's normal behavioral profile could be found from time samplings of behavior. And even though this profile may very well be cyclic, effects could be evaluated not only by changes in relative frequencies of responses, but by interruptions in cycles, or even changes in the frequency of the cycling. Such time samplings do not have to be taken during one continuous interval. Depending upon the study, they could be found through successive short-term samplings spread at fixed or random intervals over longer periods of time.

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