Responses of female rats to the individual body odors of male rats*

LESTER KRAMES

University of Toronto, Erindale College, Toronto, Ontario, Canada

Sixteen receptive females were first observed during a 10-min habituation period that consisted of presenting them with two empty cardboard tubes housing the odors from the same male. After the habituation period one tube was removed and replaced with a tube housing the odors from a novel male. During the second 10-min testing period, the females spent a significantly greater amount of time with the novel males' odor, after both 5 min ($p < .02$) and 10 min ($p < .01$) of testing. The females' response to the novel males' odor indicated that female rats can use olfactory cues to discriminate between individual male rats.

Carr, Krames, & Costanzo (1970) have shown that polygamous male rats after copulating with one female are more attracted to the odor of a novel female than to that of their original partner. Since the odors used were collected prior to copulation, the data further suggest that male rats can discriminate between females on the basis of bodily odors peculiar to the individual female. Zucker & Wade (1968) have suggested that the attraction of the male to the novel females' odor could be the stimulus basis of the resumption of copulatory behavior, seen when a novel female is paired with a male that has ceased to copulate with its original partner (i.e., the Coolidge effect).

On the other hand, polygamous female rats failed to respond differentially to the odors from novel vs original sex partners (Carr et al, 1970). This finding suggested that female rats might not be susceptible to the same resumption of copulatory behaviors seen in males. However, when females were paired with a novel male after copulating to cessation, they did resume copulating (Krames, 1969). An alternative hypothesis that would explain the females' failure to respond differentially between novel- and original-partner odors suggests the possibility that females cannot discriminate between males on the basis of individual odor cues. The present experiment was designed to test that hypothesis.

METHOD

Receptive females that had been habituated to the odor of a particular male were then observed in the presence of that odor and the odor of a novel male. The Ss responded differentially toward the two odors only if they could discriminate

*This article is based upon a dissertation submitted in partial fulfillment of the requirements for the PhD degree at Temple University. The research was supported by a grant from the Department of Psychology, Temple University.

between them. This procedure of measuring an S's response to a novel stimulus has been used successfully in the past to measure discriminative ability in other sensory modalities (i.e., Berlyne, 1950; Montgomery, 1953; Berlyne & Slater, 1957; Courtney, Reid, & Wasden, 1968).

SUBJECTS

The Ss were 16 ovariectomized female rats of the Long-Evans strain, housed in groups of four per home cage. The cages, measuring 10 x 15 x 28 in., were made of hardware cloth; the floors were covered with sawdust. The males used as odorant animals were gonadally normal and also of the Long-Evans strain. The males were housed individually in order to avoid the mixing of bodily odors. All animals lived in an air-conditioned room in which the day-night cycle was reversed. They had constant access to Purina Lab Chow and water.

PROCEDURE AND APPARATUS

Each S when 3 months old was rendered receptive by exogenous injections of oestradiol and progesterone according to a procedure described by Carr, Loeb, & Dissenger (1965) and observed individually during two successive 10-min exploratory periods in her own home cage.

During the exploratory periods, two cardboard containers that had earlier housed a male were placed in the rear

corners of the home cage. The testing technique was similar to that described in detail by Carr et al (1965). The containers were cylindrical and made of heavy hardboard; they measured 4 x 7 in. Perforations at either end allowed air to pass through the container and into the S's home cage, but Ss could neither see nor touch the inner surfaces of the containers previously occupied by the males. Attached to each container was a cardboard atrium, measuring 4 x 3 in., which was separated from the container by excelsior. The 4 x 7 in. container was covered by a removable cardboard sleeve. During the exploratory periods, E recorded the number of seconds S spend investigating the odors in the containers. An S was said to be investigating a given odor if S's head extended into the atrium containing that odor.

The male odors used during testing were collected as follows. Two 4 x 7 in. containers were joined together and the double container was sealed at either end by perforated caps. One male was then placed for 2 h into each double container with a small amount of sawdust added to absorb urine and feces. At the end of the 2-h period, the males were removed, the cardboard containers were separated, and each was attached to a cardboard atrium and covered by a cardboard sleeve. The assembled apparatus was referred to as an odorant tube. All animals were habituated to the cardboard containers prior to the experiment by placing an empty container in their home cages 4 days before the experiment began.

The experiment consisted of observing the female's behavior during two 10-min exploratory periods: a habituation period and a novelty period. During the habituation period two empty odorant tubes, each housing the odors of the same male, were placed in the rear corners of the female's home cage. The amount of time S spent investigating each odorant tube was recorded by E.

After the habituation period, the female was removed from her home cage for 5 min, during which time one of the

Table 1
Mean Time Spent in a Response to Novelty Test by Female Ss Investigating the Odors from a Novel Male vs the Odors from a Male to Which They Had Been Habituated

Test Period	Mean Investigation Time (in Seconds)					
	Habituation Test			Novelty Test		
	Original Odor Left	Original Odor Right	Mean Difference	Novel Male Odor	Original Male Odor	Mean Difference
First 5 Min	†	†	†	8.70	3.58	+5.12*
Second 5 Min	†	†	†	7.26	3.36	+3.90
First & Second 5 Min	15.82	15.94	-0.12	15.96	6.94	+9.02**

†Data not collected at this point, * $p < .02$. ** $p < .01$

4 x 7 in. containers was exchanged with a similar container housing the odor of a novel male. The container housing the novel odor was placed in the female's cage according to a counterbalancing procedure that ensured that the test odors were presented an equal number of times on both sides of the cage. Since two females in different cages were observed at a time, only two odorant males were needed per pair of Ss. Thus, each male could serve as original odorant in one cage and novel odorant in another.

The novel odor was introduced by switching only the 4 x 7 in. container. In the first 10-min period, as a result of her coming in contact with the odorant tubes while investigating the odors within, the female left her own odor on the atrium and removable sleeve. In order to ensure that the only novel stimulus introduced in the second exploratory period was the novel male's odor, the original atrium and sleeve were attached to the new 4 x 7 in. container that had earlier housed the novel male. Thus, when the female was placed into her home cage for the second exploratory period, E recorded the amount of time each S spent investigating the novel and original male odors.

RESULTS

Table 1 shows the performance of the female Ss during the 10-min habituation and novelty exploratory periods. The mean difference score (mean time spent investigating the container on the left of the cage minus the mean time spent investigating the container on the right of the cage) of -0.12 sec after 10 min of habituation, indicates that the females exhibited no significant tendency to spend more investigation time with either of the odorant tubes when they housed the odors from the same male.

Since the novelty period was the more crucial, the data from this test were recorded in such a manner as to allow an examination of the females' responses after the first and second 10 min of testing. The mean difference score (mean time spent investigating the novel male odor minus the mean time spent investigating the original male odor) of +5.12 sec for the first 5 min of testing reflects the fact that the females spent a significantly greater amount of their investigation time with the novel male odor. (Wilcoxon matched-pairs, signed-ranks test, $T = 20$, $N = 15$, $p < .02$.) The mean difference score (+3.90) for the second 5 min of testing was not significantly different from zero. However, when the mean difference scores were computed for the entire 10 min of testing, the resultant score of +9.02 sec revealed that the females spent a significantly greater amount of the total investigation

time with the novel males' odor ($T = 17$, $N = 16$, $p < .01$).

The females' preference for the novel males' odor during the novelty period can also be seen by use of the preference ratio index, which shows the number of females that spent the greater portion of their investigation time with the novel male odor divided by the number of females that spent the greater portion with the original male odor (Ss that divided their investigation time equally between the two odors were not included in this index). The preference ratio index for the first 5 min of testing was 12/3; for the second 5 min of testing it was 11/3; and after the total 10 min of testing it was 14/2.

The females' response to the novel males' odor in the present study indicates that they are capable of discriminating between males on the basis of bodily odors peculiar to the individual male. The females' prefer the odor of a novel male to an original male prior to copulation but, once copulation ensues, i.e., after one ejaculation or after cessation, she no longer responds preferentially (Carr et al, 1970). This would indicate, as Beach (1965, p. 554) has suggested, that there is a difference in the liability of the male and female to the effects of stimulus satiation

and to the effects of novelty upon their sexual behavior.

REFERENCES

- BEACH, F. A. Retrospect and prospect. In F. A. Beach (Ed.), *Sex and behavior*. New York: Wiley, 1965. Pp. 535-569.
- BERLYNE, D. E. Novelty and curiosity as determinants of exploratory behavior. *British Journal of Psychology*, 1950, 41, 68-80.
- BERLYNE, D. E., & SLATER, J. Perceptual curiosity, exploratory behavior, and maze learning. *Journal of Comparative & Physiological Psychology*, 1957, 50, 228-232.
- CARR, W. J., KRAMES, L., & COSTANZO, D. J. Previous sexual experience and olfactory preference for novel versus original sex partners in rats. *Journal of Comparative & Physiological Psychology*, 1970, 71, 216-222.
- CARR, W. J., LOEB, L. S., & DISSENGER, M. L. Responses of rats to sex odors. *Journal of Comparative & Physiological Psychology*, 1965, 59, 370-377.
- COURTNEY, C. C., REID, L. D., & WARDEN, R. Suppression of running times by olfactory stimuli. *Psychonomic Science*, 1968, 12, 315-316.
- KRAMES, L. The Coolidge effect in male and female rats. Unpublished doctoral dissertation, Temple University, 1969.
- MONTGOMERY, K. C. Exploratory behavior as a function of "similarity" of stimulus situations. *Journal of Comparative & Physiological Psychology*, 1953, 46, 129-133.
- ZUCKER, I., & WADE, C. Sexual preferences of male rats. *Journal of Comparative & Physiological Psychology*, 1968, 66, 816-819.

The effect of changes in ambient temperature on water intake and evaporative water loss*

PHILIP BUDGELL

Institute of Experimental Psychology, Oxford, England

Rats deprived of water at the same temperature and tested at different temperatures drink different amounts. The conclusion that ambient temperature has a direct effect on drinking is supported by the finding that evaporative water loss at the different temperatures could not account for the differential water intake.

In many species there is a positive correlation between water intake and ambient temperature. Three hypotheses have been proposed to explain this relationship: (1) Drinking may be stimulated by local dryness of the oral pharyngeal membranes caused by water evaporation at high environmental temperatures (Gregerson & Cannon, 1932). (2) Drinking may be stimulated by

systemic dehydration consequent upon thermoregulatory water loss (Hainsworth, Striker, & Epstein, 1968). (3) Drinking may be altered by deviations from the normal brain temperature (Andersson, 1963).

The second hypothesis has received considerable attention from Hainsworth and his co-workers. Rats neither sweat nor pant during heat stress, but increase heat loss through the evaporation of saliva spread onto their body surfaces. Hainsworth (1968) indicates that the salivary loss of normal rats at high ambient

*This research was supported by a grant from the Science Research Council. The author wishes to thank J. Fenton for his assistance in carrying out the experiments.