has suggested, the presence of another S provides a kind of "arousal," this property might be transient and influence performance only during a limited period following institution of the social conditions. Perhaps our procedures, which utilize measures obtained during a rather short period of extinction, provide an optimal situation for detection of this arousal effect. Further, an explanation of the present findings in terms of transient arousal also assumes that the effect is specific to the partner's presence in the test situation, because all pairs are maintained as cagemates.

Some further considerations of the present findings are related to their specificity to the task situation. The use of a single manipulandum for concurrent operation by two animals raises the possibility that extinction differences may depend on competition between pair members. Winslow (1944b) has reported that enhanced performance by cats in a problem box is observed when a competitor is provided. However, both Winslow (1944a), using cats, and Scott & McCray (1967), using dogs, have reported a negative effect of competitors on speed in a runway. In opposition to explanations based on competitional dependency, the present test procedures have yielded very little of the kind of "extinction induced social interaction" reported by Davis & Donefeld (1967). In an effort to gather more information about the effect of social interaction during test, one additional group of 10 Ss was trained alone and, subsequently, extinguished in the presence of an untrained animal. Under procedures like those of Experiment 3, these Ss showed a mean of 131 responses to extinction, which appeared reasonably close to the 142 of alone-together Ss. Although the intent was to provide a nonresponding naive animal, the untrained rats tended to center their activity about the manipulandum and, thus, may not have provided an effect different from that of another trained animal undergoing extinction.

One further issue regarding situation specificity suggests a limitation upon the interpretation of the present findings. Although Ss originally trained together do not show the same high resistance to extinction as do animals trained alone, it is not clear that this result is a distinctive product of training conditions. Rather, this difference might depend upon the pairing of some animals before extinction testing and the consequent provision of adaptation to the condition of "togetherness" in the test compartment. In order to evaluate this possibility, two groups of eight rats (four pairs per condition) received three 1-h sessions of adaptation together in the test compartment (with no food delivery) prior to institution of training conditions like those of Experiment 1. Under these conditions animals trained alone and extinguished together did not differ in terms of resistance to extinction from Ss both trained and extinguished together. Two similar groups received adaptation alone before training and subsequent extinction, and these groups also failed to differ significantly on extinction measures. Of course, this latter aspect of the results was disappointing in relation to our prior findings and their interpretations, but it may be noted that differences were in the predicted direction (mean of 171 responses for alone-together and 128 responses for together-together Ss), the N was small (8), and variability was great. Despite the failure to replicate in this extension of the original experiments, it was suggested that exposure to social pairing before administration of training conditions yielded an adaptation effect similar to that assumed to occur when Ss were actually trained together.

Although the evidence is certainly indirect, initial social pairing at the time of testing seems to yield a kind of arousal, which enhances the amount of responding a rat will display in an extinction test, and this influence may be characterized as distinctively "social." However, mere provision of a partner at the time of extinction does not necessarily produce a response facilitation, since this effect appears dependent upon the social experience provided both prior to and during extinction.

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Mediation of rat-mouse interspecific aggression by cage odor*

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Killer rats were placed in each of four cage conditions; these were: home cage, rat-soiled cage, neutral cage, mouse-soiled cage. Latencies to attack and kill were measured, and it was found that the mouse-soiled condition was most effective in increasing latency to kill and reducing the number of killing responses.

Tollman & King (1956) have suggested that there is an olfactory releaser involved in intraspecific aggression in mice. Ropartz (1968) has demonstrated that altering the scent of one of a pair of mice increases the latency to attack threefold and that removal of the olfactory bulb eliminates fighting altogether. Similarly, Archer (1968) has shown that putting mice into a cage recently occupied by other mice decreases the latency to attack. Thus, there appears to be substantial evidence that the odor of one mouse acts to release aggressive behavior in another mouse.

In rat-mouse interspecific aggression, however, there is ample evidence that olfactory cues *inhibit* mousekilling. Karli, Vergnes, & Didiergeorges (1969), in a recent review, have suggested that olfactory cues activate a system which inhibits the release of aggression. They cite evidence that rats that did not previously kill mice would do so after removal of the olfactory bulbs. Thus it appears that olfactory cues have opposite effects on these two forms of aggression.

If the above statement is accurate and if the odor of other mice (or of a neutral cage) releases aggression in the

*In conducting the research described in this report, the investigators adhered to the "Guide for Laboratory Animal Facilities and Care," as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Sciences, National Research Council.

mouse, one would expect that cage odors would inhibit aggression in the rat.

METHOD

The Ss were 10 hooded male rats of the Wistar strain that weighed 180-220 g at the beginning of the experiment. All rats used were killers, as determined in the following manner. Each rat was individually caged for at least 7 days. One mouse was put into each cage and left for 15 min. Each rat was presented with three mice in succession for 5 days. Only rats which killed all mice on every day were used in this study. The mice were male ICB SWISS, weighing 25-30 g.

The rats were maintained in individual cages throughout the experiment, with food and water freely available. The cages for all rats were identical, 16 x 10 x 7 in., and had solid floors covered with shavings. All rats were run in each of the four following conditions: home cage, rat cage, neutral cage, and mouse cage. The home cage was the animal's individual cage, the rat cage was one that had been lived in and not cleaned for 14 days, the neutral cage was a freshly cleaned cage, and the mouse cage was one in which 10 mice had lived for 12 days.

Each rat was removed from its home cage and either returned to it or placed in one of the other cages. A mouse was put in with the rat and latency to attack and kill were recorded. Trials were terminated after 5 min if no attack occurred or 5 min after the first attack if no kill occurred. After each trial the rat was returned to its home cage. Each rat received three trials a day under one condition. Three- to 4-day intervals were allowed before testing in a different condition.

A different cage was used for each condition, but all three trials were conducted in the same cage for each rat. All rats were run in the same condition at the same time. In order to control for practice effects, the order of testing for each rat was home cage, neutral cage, home cage, rat cage, home cage, and mouse cage.

All trials were conducted at the same time of day.

RESULTS

Latencies to attack and kill did not differ for the three home cage conditions. The last home cage session was arbitrarily chosen for statistical comparisons. Median latencies to attack and kill for all three trials of each session are plotted in Fig. 1. Home cage latencies to attack and kill were significantly shorter than mouse cage latencies for the first trial ($p < .01$, Walsch test), shorter than rat cage and mouse cage for the second trial, and shorter than all conditions for the third trial ($p < .02$, Walsch test). Rat cage latencies to attack and kill were shorter than neutral cage latencies for the third trial, shorter than mouse cage latencies to attack but not kill on the second trial, and shorter than both on the third trial ($p < .02$, Walsch test). Finally, neutral cage latencies to kill were shorter than mouse cage latencies ($p < .05$, Walsch test). No other differences were significant.

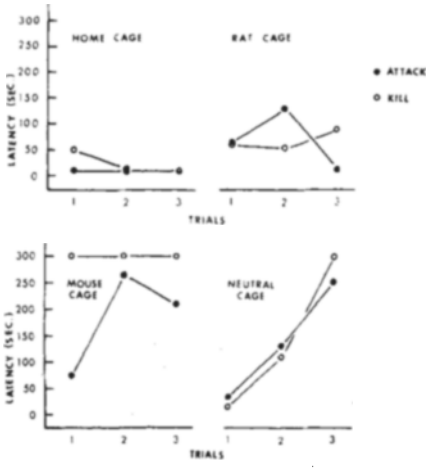

Fig. 1. Median latency to attack and kill in four conditions.

Further information can be gained from examining the percentage of killers in each condition (Fig. 2). From this figure it can be seen that the least killing occurred in the mouse cage condition, followed by neutral cage, rat cage, and home cage. These differences are significant for all three trials at the .001 level (Cochran Q-test).

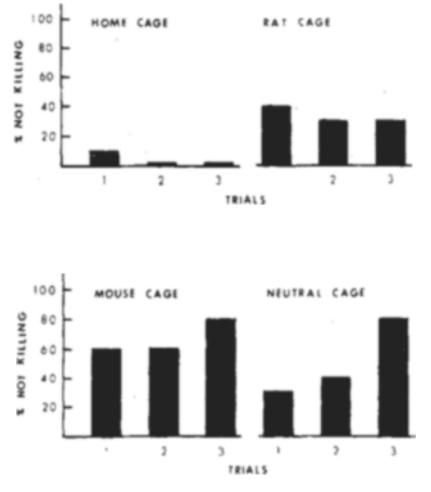

Fig. 2. Percentage of animals in each condition that did not kill.

DISCUSSION

It is apparent that changes in cage odor increase latency to attack and kill for killer rats. It is interesting to note that this increase is least noticeable on the first trial, when disruption effects due to handling and novelty would be expected to be the greatest.

The greatest disruption of mouse killing occurs when the rat is put into a cage previously occupied by mice. This finding lends support to the hypothesis that olfactory cues play a role in inhibiting rat-mouse aggression. It might be hypothesized that nonkiller rats are more sensitive to the inhibiting effects of mouse odors but that even killer rats can be affected if the odor is strong enough.

An alternative explanation for the long latencies in the mouse cage could be that the smell of the individual mouse blended with the general mouse odor, resulting in a sort of odor camouflage and making it difficult for the rat to locate the mouse. Although this possibility cannot be ruled out, it must be emphasized that there are other stimulus cues available, namely sight and sound. Furthermore, if such an explanation were correct, one would expect short latencies in the neutral cage where the odor contrast would be greatest.

Order effects do not seem to be important in this study since the longest latency condition came last, with the next longest second. Practice effects are demonstrably not operating.

The role of odor in inhibiting or releasing aggression must be considered when drug effects on aggression are being studied. Little is known of the interaction of drugs and olfactory sensitivity, and such interactions may help account for some of the discrepancies in the literature.

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