

Results from the tests with reinforcement, given on the right sides of Figs. 1 and 2, generally support the findings from the extinction test. Minima at the S- value are characteristic of the group gradients for all 3 days of reinforcement in the N group, as well as of the group gradients for the first two tests in the P → N group. However, it is noteworthy that, of the three birds in the latter group, one showed more responding to the S- value than to any of the other line tilts (or blank) over the second and third test days, and another bird displayed this same effect on the third day. Although this outcome might be interpreted as revealing the previously positive function of S- (since none of the three N birds showed the effect on any day of testing), Hearst et al (1970) reported that continued testing with reinforcement at all dimensional values led often to a reversal of the original incremental gradient around an always-negative S-; such gradient reversals generally appeared after 5-10 sessions of testing. Unfortunately, we gave only three reinforcement tests in the present experiment, so the opportunity to observe gradient reversals in our other Ss may have been lost.

In summary, the general shape of gradients around S- during tests in extinction was not greatly affected by prior training on a discrimination in which the final S- served as an S+. On the other hand, residual effects of the prior training were revealed in the sheer amount of test responding and possibly in the greater likelihood or rapidity with which one may observe gradient reversals when reinforcement is supplied at all dimensional values. These results appear to support Konorski's belief that "If a positive food CS is converted into a negative CS by nonreinforcement . . . the result of this conversion is unstable, and the previous positive character of the stimulus may be easily revealed . . . [Konorski, 1967, p. 323]." However, the interpretation and general applicability of our group differences would be greatly clarified by results from additional comparison groups, particularly ones in which (1) original reinforcement of responding at the previously positive S- does not involve an S-, or later extinction of responding at the S- does not involve an S+, or (2) the discrimination in the original learning phase is not the reverse of the final discrimination. Control groups of this kind would help to determine, for example, whether the obtained differences occurred because the P → N group had received more total reinforcements and sessions during training than the N group or

because the P → N group had learned two discriminations before the generalization tests and the N group only one.

In conjunction with the generalization tests, it would be valuable in future work to determine whether the S- in the P → N birds would actually prove to be an "inhibitory stimulus" according to Rescorla's (1969) and Hearst et al's specific definitions and detection procedures, i.e., by combining S- with a well-conditioned S+ or by transforming S- into an S+. Some recent work of Guth (personal communication, Indiana University, 1970) suggests that over a variety of

experimental conditions a previously positive S- does not acquire inhibitory properties in rats; it will not reduce operant behavior when presented together with a strong S+, whereas a consistently negative S- will.

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Effects of age and housing conditions on shock-induced aggression*

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This study demonstrated that the stability of fighting rates over sessions was, in part, a function of how the Ss were housed outside the experimental chamber. Age was not shown to be an important determinant of elicited aggression, primarily because any effects of this variable were confounded by the variability produced by housing conditions.

Two variables shown to effect the rate of shock-elicited aggression are housing conditions and age. Ulrich & Azrin (1962), for example, reported that the same degree of fighting was induced by shock when rats were housed separately as when the same Ss were housed in pairs. However, a later study by Hutchinson, Ulrich, & Azrin (1965) found that fighting in response to footshock occurred less frequently in rats housed separately than in rats housed in a colony. Age has also been shown to be a determinant of the rate of elicited aggression. Hutchinson et al (1965) reported that there was a direct relation between the rate of fighting and the S's age. While this finding was generally supported in a later study by Powell & Creer (1969), they also suggested that the relationship between age and aggression was partially due to the confounding of age and the size of the enclosure in

which the Ss were observed. Considering these few investigations, the tentative conclusion that can be drawn is that, while the frequency of induced aggression is a function of the age of the Ss and housing conditions, it is a complex relationship.

There were two purposes for conducting this experiment. The first purpose was to compare the rate of fighting that occurred over sessions between rats housed separately and rats housed two to a cage. Of particular interest was whether or not housing conditions had an effect on the number of sessions required for fighting to stabilize. The second purpose was to determine if there was a direct relation between the number of sessions needed for fighting to stabilize and age when Ss, housed separately or together, were paired in the test chamber for repeated sessions.

APPARATUS

A Grason-Stadler Model E3125 rat box was used, in which the inner chamber measured 11½ x 9¼ x 7-5/8 in., with two sides constructed of metal and the other two of clear plastic. Shock from a Grason-Stadler No. 1064 GS shock source, equipped with a shock scrambler, was delivered to a grid floor which consisted of stainless steel rods, 3/32 in. in diam and spaced ½ in. apart. The door to the insulated test

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cubicle, which contained the experimental chamber, was removed to permit an unobstructed view of the animals through the Plexiglas door of the inner chamber. A shielded 10-W bulb provided illumination.

The various stimulus conditions used were programmed remotely by standard electromechanical apparatus. Counters and two Lehigh Valley Model 1321 polygraphs provided a record of the O's responses and the shock presentations. The shock parameters used in the study were monitored daily by attaching a meter to the grid floor and measuring the electrical current. The grid was wiped clean between each session to remove feces and other foreign matter.

SUBJECTS AND PROCEDURE

The Ss, 12 female and 12 male experimentally naive Sprague-Dawley rats, were divided into three groups of four pairs of rats each and tested at 30, 60, and 90 days of age, respectively. Four rats in each group, two male and two female Ss, were housed in separate cages and were brought together with a partner of the same sex only during the experimental sessions. The remaining four Ss in each group, two male and two female rats, were paired according to sex and lived two to a cage. These same pairings were used in testing the animals within the experimental chamber. The animals were divided into one of the three groups at 20 days of age and maintained in either of the two

housing conditions until the completion of the experiment.

Fighting responses were defined and recorded in a manner described by Ulrich & Azrin (1962). Two Es independently depressed microswitches to record the striking movements that occurred between rats, standing upright and facing one another, with each shock presentation. To preserve the independence of the two Es further and to prevent either from responding to the auditory click of his partner's microswitch, a second switch was depressed when no fighting occurred to the shock. The responses recorded by the Es were summed and divided by two in order to provide the rate of fighting observed for each pair during any particular session. Greater than 95% agreement was obtained between the two Es in registering shock-elicited fighting in this study.

Azrin, Ulrich, Hutchinson, & Norman (1964) found that shocks of 2-mA intensity and a duration of 0.5 sec were optimal for eliciting fighting in paired animals. These parameters were used in the present study. The shock was presented at a frequency of 20 shocks/minute. The Ss received 100 shocks daily. This procedure was repeated each day until the rate of fighting between each pair stabilized. The criterion for stability was met when, during four consecutive sessions, the mean rate of fighting remained within a range of 10 responses. This standard was selected

because preliminary investigation indicated that once attained, little variation from this criterion occurred over six additional sessions.

Each experimental session was separated by 24 h. During the initial session, the animals were observed for a period before shock was presented to determine if any spontaneous fighting took place between pairs. None of the Ss exhibited this behavior.

RESULTS

Figure 1 shows the rate of fighting that occurred with the 30-day-old Ss across sessions. It may be seen that the fighting rate of the Ss housed in individual cages stabilized in fewer sessions than were required by the Ss who remained with the same partner both in the home cage and in the experimental chamber.

Figure 2 depicts the rate of fighting that occurred with the 60-day-old rats across sessions. As noted, the fighting rate of the Ss housed individually again stabilized in fewer sessions than was the case with the animals paired together both in the experimental chamber and in the home cage. The pair of male animals in the latter condition never reached the criterion for stability because one of the Ss contracted what proved to be a fatal respiratory infection.

Figure 3 shows the rate of fighting that took place with the 90-day-old Ss over sessions. It may again be seen that the fighting rate of the Ss housed in separate cages stabilized in fewer sessions than was required by the Ss of the same sex who remained with the same partner both in the home cage and in the test chamber. The rate of fighting of the female rats in the latter condition, however, stabilized in fewer sessions than were needed by the male Ss housed in separate cages.

An analysis of variance revealed no significant difference in the number of sessions required for the fighting rate to stabilize in each age group as a function of housing conditions ($F = 7.84$; $df = 1,6$; $p > .05$). The difference between age groups ($F = .08$; $df = 2,6$) and the Age by Housing interaction ($F = .04$; $df = 2,6$) were also nonsignificant ($p > .05$). However, since the female Ss appeared to reach the criterion of stability in fewer sessions than was required by the male Ss, the data from the three age groups were divided according to sex to test for differences as a function of housing conditions and sex. An analysis of variance of the data revealed that the difference between housing conditions was significant ($F = 64.30$; $df = 1,8$; $p < .005$), as was the difference between sex ($F = 34.26$; $df = 1,8$; $p < .005$) and the Housing by Sex interaction ($F = 9.19$; $df = 1,8$; $p < .025$).

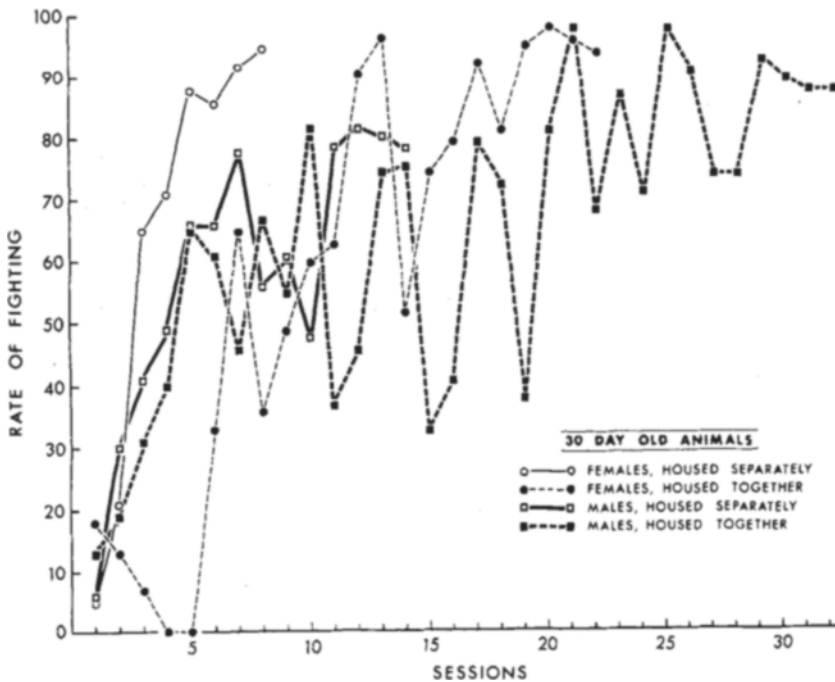


Fig. 1. The rates of fighting that were observed over sessions with the 30-day-old Ss.

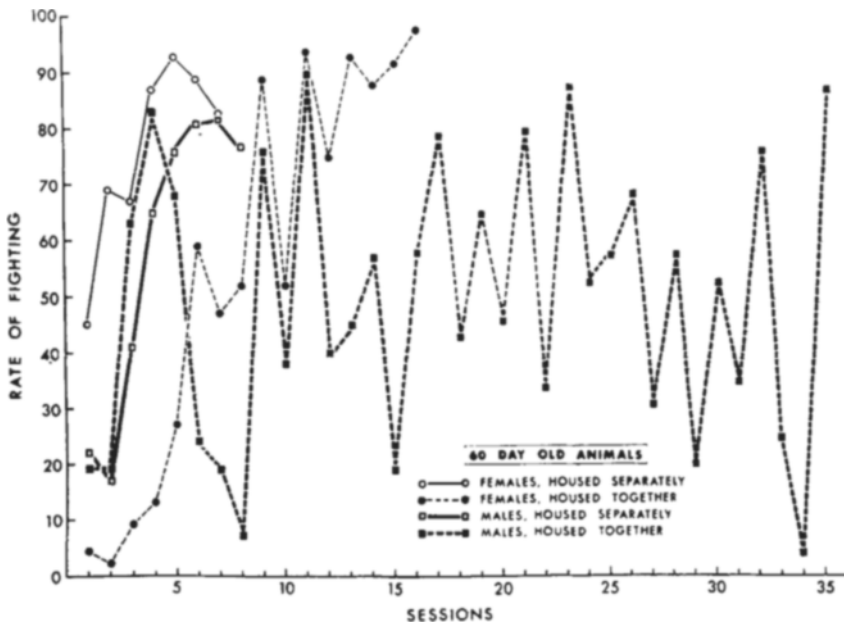


Fig. 2. The rates of fighting that were observed over sessions with the 60-day-old Ss.

DISCUSSION

This study demonstrated that the stability of fighting rates over sessions were, in part, a function of how the Ss were housed *outside* the experimental chamber. Two explanations can be given for these results: (1) The Ss housed in separate cages were, except during testing, isolated from their partners. Since isolation is, in and of itself, widely used to induce aggression (Valzelli, 1969; Krsiak & Janku, 1969), the rats in this condition were exposed to two procedures known to produce aggression—footshock and isolation. (2) An explanation for the more variable rate of fighting for the Ss housed together was suggested by incidental observations of Pair 4 (males housed together) of the 60-day-old animals. The Es frequently viewed displays of fighting between the members of this pair while Ss were in the home cage. When this occurred, it was noted that the same rats fought at a lower rate when placed in the test chamber. Since male rats reportedly fight more in social settings (Calhoun, 1962; Barnett, 1963), the above observations could also account for the greater variability in the rates of fighting exhibited by the male Ss housed together in comparison to the rates displayed by the female Ss housed in an identical manner. However, since such observations were decidedly unsystematic, further research is needed to clarify this point.

Age was not shown to be an important determinant of elicited aggression in this study, primarily because any effects of this variable

were confounded by the variability produced by housing conditions. Nevertheless, it does appear as if the initial rates exhibited by the 30-day-old Ss were similar to those obtained by Hutchinson et al (1965) and Powell & Creer (1969), using rats of the same age. The increase in fighting frequencies that occurred with experience in the three age groups coincides with the findings of Powell & Creer (1969).

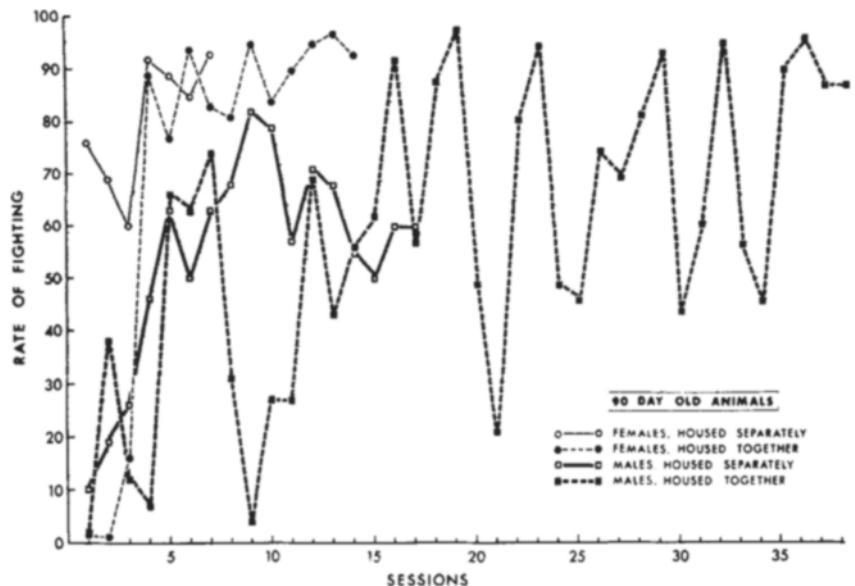


Fig. 3. The rates of fighting that were observed over sessions with the 90-day-old Ss.

No significant differences in the rate of fighting were anticipated between male and female Ss. The opposite results were, however, obtained in this study. The female Ss were significantly more consistent, not only when housed separately but, as the Sex by Housing interaction indicated, when housed with a partner. These findings suggest that female rats may be more appropriate Ss for long-term studies of shock-elicited aggression.

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