The combined effects of frustrative nonreward and shock on aggression between rats*

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Twenty-eight rats were individually placed in an operant chamber where they received food-reinforced barpress training for 15 min each day for 7 days. An additional 28 rats were similarly placed into the chamber, but were given no training. On the next 2 days, two food-reinforced or two nonreinforced Ss were placed in the chamber together. Previously reinforced Ss were given extinction training for 4 min. Then one-half of the pairs in each condition received shock and the other half did not. The group given extinction training plus shock displayed significantly more aggression than the group given only shock, and both shocked groups exhibited more aggression than both nonshocked groups. Thus, the effects of shock and frustrative nonreward combined to enhance aggressive responding.

Numerous studies have demonstrated that, with proper stimulus parameters, shock elicits aggression in pairs of rats (e.g., Hutchinson, Ulrich, & Azrin, 1965; Ulrich & Azrin, 1962; Ulrich, Hutchinson, & Azrin, 1965). Monkeys, mice, and cats also display aggression upon shock presentation (see Ulrich, Hutchinson, & Azrin, 1965). Gallup (1965), Davis & Donenfeld (1967), and Azrin, Hutchinson, & Hake (1966) have observed aggression in animals subjected to extinction and other frustration-arousing conditions, i.e., no reward in a situation where there is an expectancy of reward (Amsel, 1958). These experiments thus provide evidence that both shock-elicited and frustration-elicited aggression exists. The purpose of the present study was to investigate the combined effects of shock and frustrative nonreward on aggression by comparing the magnitude of aggression between pairs of rats which were both shocked and frustrated, neither shocked nor frustrated, only shocked, or only frustrated.

SUBJECTS

Fifty-six individually housed male Holtzman rats obtained from Holtzman Co., Madison, Wisconsin, 108-113 days old and 328-431 g on the first day of deprivation, were food-deprived and maintained at 80% of their ad lib body weights. The mean weights of the Ss among the four

groups did not differ ($F < 1$), and weight differences between Ss of each pair for each group did not differ ($F = 1.34$, $df = 3/24$, $p > .20$). On the last day of the experiment, one pair of Ss was dropped from the experiment due to a procedural error.

APPARATUS

A Lehigh Valley environment test chamber, equipped with two response bars, one foodcup (mounted equidistant between the two bars), a houselight, a one-way mirror, and a fan, was housed inside a Lehigh Valley environment cubicle. A 12 x 9½ in. board was placed upright in the operant chamber opposite the response bars to reduce the chamber size to 8 x 9½ in. Lehigh Valley control panel equipment programmed reinforcement (37-mg pellets, P. J. Noyes Co.) presentations, barpress counts, and shock intervals. A Lafayette shocker (Model A-615c) and a shock scrambler constructed from eight DPDT relays designed after Hoffman & Flesher (1962) delivered shock to the floor grids, and a Hunter interval timer controlled shock duration. Four microswitches (two for each O) connected to a Stoelting Co. polygraph recorder were used to record responses. The chamber was washed and aired after each test session. Both bars remained in the chamber during all phases of the experiment.

EXPERIMENTAL DESIGN

In Phase 1 (7 days), all Ss were individually placed in the operant chamber, but only one-half of the Ss were given food-reinforced barpress training. In Phase 2 (2 days), two food-reinforced or two nonreinforced Ss were run together. One-half of the Ss under each Phase 1 condition received shock, while the other half

did not, and none of the Ss received food reinforcement for barpress responses. Therefore, Ss reinforced in Phase 1 were frustrated in Phase 2. The four groups making up the 2 by 2 factorial were designated: SF, SNF, NSF, NSNF (S = shock, F = frustration, NS = no shock, NF = no frustration).

PROCEDURE

Each S was assigned randomly to one of the four groups and paired with another S from the same group. The testing order was also randomized. All Ss were placed on deprivation for 10 days. Groups NSF and SF were then magazine trained and shaped to press the bar, and Groups SNF and NSNF were placed in the experimental chamber for 15 min. Each S in a pair from either Group NSF or Group SF was assigned randomly to one of the two bars and was reinforced only for pressing that bar. The other S of that pair was reinforced only for pressing the other bar. For the next 7 days, reinforced Ss were given one pellet for each barpress response on the appropriate bar. Nonreinforced Ss were not given pellets for any response. Sessions were 15 min for all Ss in Phase 1, and all Ss were run individually. For the 2 days in Phase 2, the pairs of Ss were brought into the experimental room individually and then placed together in the operant chamber. For the first 4-min, barpress counts were recorded, and no shock was presented to any S. None of the Ss were reinforced for pressing the bar. The shock control apparatus was then turned on for all pairs, but the shocker was turned on only for Groups SNF and SF. The stimulus parameters used were 1-mA shock, of .5-sec duration, every 20 sec for 11 min. Fighting, striking, posturing, and pawing responses were recorded. Posturing was recorded when both Ss were facing each other with both forepaws held out, jaw opened, and head thrust forward (Vernon, 1967). Pawing was defined as any contact with a forepaw or hindpaw of one S with the other while both were *not* in the posture position. Striking responses were defined as any contact with a forepaw of one S or both Ss with the other while both were in the posture position. A fighting response was defined as a strike during a discrete posturing duration. Therefore, for any one posturing duration, there could be only one fight but any number of strikes recorded. Both Os recorded striking (fighting) responses, one O recorded posturing time, and the other O recorded pawing responses. Inter-O reliability was .98 for fighting responses and .98 for striking responses. Inter-O reliability for the pawing and posturing measures, which

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Fig. 1. Mean number of fighting (top) and striking (bottom) responses for Groups SF, SNF, NSF, and NSNF on Days 1 and 2 of Phase 2.

was obtained from pilot data, was .96 and .95, respectively. The fighting and striking responses that are reported represent means for the two Os.

RESULTS

Figure 1 depicts the mean number of fighting and striking responses on Days 1 and 2 of Phase 2. Group SF clearly fought and struck more than the other groups on Day 1. A series of 2 by 2 analyses of variance was conducted for all groups on Days 1 and 2. The analysis on fighting responses for Day 1 indicated that shocked groups fought more than nonshocked groups ($F = 51.44$, $df = 1/24$, $p < .001$), frustrated groups fought more than nonfrustrated groups ($F = 9.45$, $df = 1/24$, $p < .01$), and the interaction between the shock and frustration conditions was also significant ($F = 5.84$, $df = 1/24$, $p < .025$). The analysis on striking responses for Day 1 indicated that shocked groups struck more than nonshocked groups ($F = 54.21$, $df = 1/24$, $p < .001$), frustrated groups struck more than nonfrustrated groups ($F = 7.53$, $df = 1/24$, $p < .025$), and the interaction between the shock and frustration conditions was also significant ($F = 5.16$, $df = 1/24$, $p < .05$). Individual comparisons indicated that Group SF displayed

significantly more fighting and striking responses than did Groups SNF and NSF ($ps < .001$). Group SNF exhibited significantly more fighting and striking responses than did Group NSNF ($p < .001$), but Group NSF did not display significantly more fighting and striking responses than Group NSNF ($Fs < 1$). Thus, the group frustrated and shocked fought and struck more than the other groups on Day 1. The data which appear in Table 1 represent the number of fights and strikes per pair in Groups SNF and SF. It is clear that the overlap in the number of fights and strikes between Ss in Groups SF and NSF is very small. The analysis on Day 2 data (unequal n) indicated that shocked groups fought and struck more than nonshocked groups ($F = 27.26$ and 18.51 , $df = 1/23$, $ps < .001$, respectively). No other differences were significant ($Fs < 1$).

On Day 1, the mean number of shocks until the first fight was 2.1 for Group SF and 11.0 for Group SNF, and this difference was significant ($F = 6.60$, $df = 1/12$, $p < .025$). The difference in total number of fights and strikes between Groups SF and SNF was not entirely due to the fact that Group SF started fighting sooner. Inspection of the data within Day 1

indicated that the magnitude of the differences between the two groups was the same throughout the session.

Figure 2 depicts the mean posturing time and number of pawing responses on each day of Phase 2. Analyses of variance (2 by 2) revealed that shocked groups postured more than nonshocked groups on Days 1 and 2 ($F = 45.35$ and 50.02 , $df = 1/24$ and $1/23$, $ps < .001$, respectively), but the main effect of frustration ($F = 2.73$ and < 1 , $df = 1/24$ and $1/23$, $ps > .10$) and the interaction effect ($F = 2.74$ and < 1 , $df = 1/24$ and $1/23$, $ps > .10$) were not significant for Days 1 and 2, respectively. Analyses of variance (2 by 2) indicated that shocked groups pawed less than nonshocked groups on Days 1 and 2 ($F = 5.01$ and 38.23 , $df = 1/24$, and $1/23$, $ps < .05$ -.001, respectively), but the main effect of frustration ($F = 1.35$, and < 1 , $df = 1/24$ and $1/23$, $p > .25$) and the interaction ($Fs < 1$) were not significant.

The shock condition on Day 1 affected the number of barpress responses on Day 2. The mean number of barpress responses for Group SF during the first 4 min was 112.7 on Day 1 and 6.9 on Day 2; this difference was significant ($F = 48.17$, $df = 1/12$, $p < .001$). The mean number of barpress responses for Group NSF during the first 4 min on Day 1 was 117.1 and 46.1 on Day 2; this difference was also significant ($F = 9.85$, $df = 1/12$, $p < .01$). The difference between Groups SF and NSF (6.9 and 46.1) on Day 2 was significant ($F = 26.81$, $df = 1/12$, $p < .001$). During this time, four Ss of different pairs in Group SF never pressed the bar.

DISCUSSION

The data clearly indicate that the magnitude of aggression resulting between Ss which were both shocked and frustrated was greater than between Ss only shocked or only frustrated. In addition, fewer shocks were required to elicit the first fighting response between Ss which were both shocked and frustrated than between Ss only shocked. Thus, the effects of shock and frustrative nonreward, both

Table 1
Number of Fights and Strikes Per Pair on Day 1 for Groups SF and SNF

Pair Number	Fights		Strikes	
	SF	SNF	SF	SNF
1	26.5	16.0	39.5	31.5
2	21.5	12.0	38.5	17.5
3	28.0	9.0	33.0	9.0
4	20.5	9.0	30.5	9.0
5	17.0	20.5	26.5	30.5
6	21.0	5.0	35.5	12.5
7	7.0	3.0	10.5	3.0

shown by previous investigations to elicit aggression, combined to enhance aggressive responding that was greater than that resulting from either treatment alone.

Group SF showed more aggression than Group SNF on Day 1; however, on Day 2, these groups did not differ. This lack of difference was expected. It had been anticipated that fear would become conditioned to the apparatus cues on Day 1 (McAllister & McAllister, 1962), which would result in the observed decrease in Group SF's barpress responding prior to shock onset on Day 2. Since frustration is aroused only when nonreward occurs in the presence of an expectancy for reward, i.e., following a barpress response, little, if any, frustration could have been aroused on Day 2 in Group SF. Thus, only the effects of the shock could have elicited fighting in Group SF. Therefore, as expected, Groups SF and SNF did not display different amounts of aggression on Day 2.

Three additional aspects of the data need to be explained: (1) Why did only the striking and fighting measures show differences between Groups SF and SNF? (2) Why did the shocked groups fight, strike, and posture more but paw less than the nonshocked groups? (3) Why did Groups NSF and NSNF not differ on any response measure? Prior to further research, it is unclear what the best explanation is. However, the type of response measures used may be critical. Fighting, striking, posturing, and pawing measures may be differentially sensitive to different levels of aggression. Fighting and striking responses occurred only under the shock condition. Perhaps only these response measures were sensitive enough to detect the increase in aggression due to the effects of frustration. Pawing responses occurred more frequently under the nonshock condition and may not have been sensitive enough to detect the effects of frustration. This may have been especially true in the present study, since grooming contacts were not eliminated from the pawing measure. The failure to obtain differences between Groups NSF and NSNF, however, is not consistent with the studies of Gallup (1965) and Davis & Donenfeld (1967). In the study by Gallup, rats given continuous reinforcement training in a runway were then switched to a partial reinforcement schedule. In the goalbox, they were allowed access to another rat that had been given identical training in an adjacent runway. Davis and Donenfeld observed fighting, attacking, and biting responses in pairs of rats during

extinction of a barpress response which had been reinforced on a partial reinforcement schedule. The differences in amount and schedule of reward, isolation variables, deprivation level, and type of control group (deprived or not), which may influence the degree of frustration-elicited aggression aroused, would thus make the type of response measures used critical.

In summary, the results of the present experiment showed that the effects of shock and frustrative nonreward combined to elicit aggressive responding that was greater than aggressive responding resulting from either treatment alone. This result adds to the growing body of data which shows that the effects of shock and frustrative nonreward are similar (Wagner, 1969) and combine in their influence on behaviors. Previous research has shown that the effects of shock and frustrative nonreward combine to enhance acquisition of a discrimination (Fowler & Wischner, 1965), to increase resistance to extinction and shock (Brown & Wagner, 1964), and to facilitate acquisition of a hurdle-jump response (Daly, 1970). The present results indicate that the effects of shock and

frustrative nonreward also combine to increase aggression between pairs of rats.

REFERENCES

- AMSEL, A. The role of frustrative nonreward in noncontinuous reward situations. *Psychological Bulletin*, 1958, 55, 102-119.
- AZRIN, N. H., HUTCHINSON, R. R., & HAKE, D. R. Extinction-induced aggression. *Journal of the Experimental Analysis of Behavior*, 1966, 9, 191-204.
- BROWN, R. T., & WAGNER, A. R. Resistance to punishment and extinction following training with shock or nonreinforcement. *Journal of Experimental Psychology*, 1964, 68, 503-507.
- DALY, H. B. Combined effects of fear and frustration on acquisition of a hurdle-jump response. *Journal of Experimental Psychology*, 1970, 83, 89-93.
- DAVIS, H., & DONENFELD, I. Extinction induced social interaction in rats. *Psychonomic Science*, 1967, 7, 85-86.
- FOWLER, H., & WISCHNER, G. J. Discrimination performance as affected by problem difficulty and shock for either the correct or incorrect response. *Journal of Experimental Psychology*, 1965, 69, 413-418.
- GALLUP, G. G. Aggression in rats as a function of frustrative nonreward in a straight alley. *Psychonomic Science*, 1965, 3, 99-100.
- HOFFMAN, H. S., & FLESHLER, M. A relay sequencing device for scrambling grid shock. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 329-330.

Fig. 2. Mean posturing time in seconds (top) and mean number of pawing responses (bottom) for Groups SF, SNF, NSF, and NSNF on Days 1 and 2 of Phase 2.

- HUTCHINSON, R. R., ULRICH, R. E., & AZRIN, N. H. Effects of age and related factors on the pain-aggression reaction. *Journal of Comparative & Physiological Psychology*, 1965, 59, 365-369.
- McALLISTER, W. R., & McALLISTER, D. E. Role of the CS and of apparatus cues in the measurement of acquired fear. *Psychological Reports*, 1962, 11, 749-756.
- ULRICH, R. E., & AZRIN, N. H. Reflexive fighting in response to aversive stimulation. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 511-520.
- ULRICH, R. E., HUTCHINSON, R. R., & AZRIN, N. H. Pain-elicited aggression. *Psychological Record*, 1965, 15, 111-126.
- VERNON, W. M. Classical conditioning of pain-elicited fighting. Unpublished doctoral dissertation, Washington University, St. Louis, Mo., 1967.
- WAGNER, A. R. Frustrative nonreward: A variety of punishment. In B. A. Campbell and R. M. Church (Eds.), *Punishment and aversive behavior*. New York: Appleton-Century-Crofts, 1969. Pp. 157-181.