

latencies (when they occur) reflect investigation of the food-hopper by the S. Observation in the present experiment did not confirm this suggestion, but we note some similarities between this configuration and the interresponse times reported on FR schedules with continuous added counters (Ferster & Skinner, 1957). Technically, such schedules are chain FR x (FR 1); however, it is not easy to interpret such schedules in this way because the discriminability of the stimulus changes involved is difficult to specify. An additional point is that these stimulus changes usually occur along a given dimension (e.g., width of slit), which may introduce a further unevaluated effect.

To summarize, four of the Ss in the present experiment provide data similar to those produced from other chained and tandem schedules. In particular, the occasional prolonged pauses after reinforcement, illustrated in Fig. 3, are similar to the breakdown in behavior often observed on other extended chains. This supports the view that the sequences of behavior reinforced by second-order schedules may be regarded as unitary responses essentially similar to the more conventionally defined units of behavior used in the present experiment. Two Ss in

this experiment do not support this generalization, for they responded more slowly on the tandem schedule; however, they also appeared to differ in at least one other respect, i.e., configuration of latencies through the sequence. Similar configurations have occasionally been reported before, both with simple FR schedules (Davison, 1969) and with FR schedules with added counters (Ferster & Skinner, 1957).

#### REFERENCES

- DAVISON, M. C. *Successive interresponse times in fixed-ratio and second-order fixed-ratio performance*. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 385-389.
- FERSTER, C. B., & SKINNER, B. F. *Schedules of reinforcement*. New York: Appleton-Century-Crofts, 1957.
- FINDLEY, J. D. An experimental outline for building and exploring multi-operant behavior repertoires. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 113-166.
- KELLEHER, R. T. Chaining and conditioned reinforcement. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application*. New York: Appleton-Century-Crofts, 1966. Pp. 160-212.
- NEURINGER, A. J., & SCHNEIDER, B. A. Separating the effects of interreinforcement time and number of interreinforcement responses. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 661-667.

attack. The opportunity to attack is evidently reinforcing, since a response was acquired when the opportunity to aggress was made contingent on the response and extinguished when this contingency was removed. Aggression was considered to be a distinct motivational state in the same sense that hunger has been considered a motivational state. It was concluded that it is rewarding to aggress in the motivational state created by the shock "for the duration of stimulation and for a brief period after the cessation of stimulation [Azrin et al, 1965, pp. 179-180]."

Azrin, Hutchinson, & Sallery (1964) report that the probability of attack in monkeys gradually diminished after the shock until it reached zero several moments later. The probability of attack in the first 1.5 sec after the shock was .95, while after 12 sec the probability approached zero. In their study the object of aggression was always available. Similarly, Azrin, Rubin, & Hutchinson (1968) found an inverse relation between biting of an inanimate object by rats and time since shock, but again the object of aggression was always present. The question that prompted the present study was: Will the drive state induced in an animal by an aversive stimulus (foot-shock) persist over time in the absence of an object of aggression?

#### SUBJECTS

The Ss were eight albino rats derived from the Sprague-Dawley strain and obtained from Dublin Animal Laboratories in Virginia. The average weight of the animals was 260 g, with a range of 219-302 g. They were all approximately 90 days old at the start of the experiment. The animals were paired together randomly and given 20 preliminary shocks to accustom them to the experimental arrangement and to ascertain if all animals were fighters. Two animals appeared to be nonfighters and were replaced. The failure to find fighting behavior in monkeys has been previously noted (Azrin, Hutchinson, & Hake, 1963; Azrin et al, 1965), but no one has reported failing to find fighting in rats. The present failure may be due to the use of generally docile Sprague-Dawley rats.

## The effects of delayed presentation of the object of aggression on pain-induced fighting\*

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It has been suggested that an aversive stimulus produces a drive to aggress in shocked organisms. Presumably this drive state will last a short time after the pain stimulus in absence of an object of aggression. This notion was studied in the present experiment by presenting the object of aggression (another rat) 0, 2, 4, or 6 sec after the cessation of the shock. Some fighting behavior was observed, regardless of when the object of aggression was presented. However, the intensity of the fighting behavior decreased markedly as delay of presentation increased from 0-6 sec.

Pain-elicited fighting behavior in rats is a well-known, highly reliable phenomenon (Ulrich, 1967). Ulrich & Azrin (1962) at first suggested that, "The consistent elicitation of the fighting response by aversive stimulation without prior conditioning appears to be best defined as an unconditional reflex [p. 519]." This "fighting reflex" was suggested to be similar, in a general way, to the unconditioned salivary reflex to food.

Recent studies on fighting behavior in primates have resulted in a different interpretation of pain-induced fighting. Azrin, Hutchinson, & McLaughlin (1965) found that monkeys in the presence of aversive stimulation will learn to perform an instrumental response (pulling a chain) in order to obtain an object of aggression (a tennis ball). Thus, pain seems to create a changed motivational state in the animal in which it is reinforcing for the animal to

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## APPARATUS

A Grason-Stadler operant-conditioning apparatus was adapted so that its inside measurements were 7 x 9 x 7.5 in. The necessary modification was made by placing inside the box a Plexiglas wall the height and width of the box so that the depth was reduced by 4.5 in. The door of the apparatus was replaced by two doors hinged on either side of the apparatus. When closed there was a small opening between the two doors. Thus, the rats could be placed in each side of the experimental chamber which was separated by an easily removable fiberboard partition. The shock generator was a Grason-Stadler Model E1064 GS with an automatic shock scrambler.

## PROCEDURE

Two rats were placed on opposite sides of the experimental chamber and given five 2.5-mA shocks of .5 sec duration with a 2-sec interval between shocks. After a specified period of time had elapsed from the last shock, the fiberboard partition was quickly removed, thus allowing each rat an object of aggression, the other rat. The partition was removed manually in a consistent way by one O, who measured the time elapsed from the last shock with a stop watch.

Preliminary experimentation with other rats indicated that fighting would occur up to about 6 sec delay. Thus, four delay conditions (0, 2, 4, and 6 sec) were used. The zero condition consisted of the removal of the partition immediately prior to the fifth shock. In the other conditions the partition was removed with the appropriate delay after the fifth shock.

Each of the four pairs of rats were given 10 trials in succession at each delay condition. The order of conditions for a

pair of Ss was determined by randomized blocks. The experiment was conducted on 4 consecutive nights, with pairs of Ss serving in different conditions on each night.

A four-point rating scale was used to measure the intensity of observed fighting behavior. The four levels of fighting were defined as follows: (1) no indication of fighting; (2) stereotyped fighting position, but no interaction; (3) stereotyped fighting position with weak interaction; and (4) stereotyped fighting position with mutual aggression and strong interaction. Two Os separately scored the fighting behavior, and their agreement was high. On 95% of the trials the ratings were identical, with the few discrepancies generally occurring when intense fighting was observed (Ratings 3 and 4).

## RESULTS AND DISCUSSION

The results are straightforward. The intensity of fighting is inversely related to the delay of the presentation of the object of aggression. Each pair of rats reflected the monotonic relationship of decreased fighting intensity to delay. Although the averaging of ordinal data is not strictly permissible, the mean fighting intensity at each delay interval gives an adequate representation of the findings: 0-sec delay, 3.13; 2-sec delay, 2.81; 4-sec delay, 2.35; and 6-sec delay, 1.24. Preliminary experimentation had led to the expectation of complete absence of fighting at the 6-sec delay, but even then under controlled conditions some fighting was observed.

Previous studies (Azrin et al, 1965, 1968) have shown that monkeys and rats will attack an inanimate object after cessation of a pain stimulus. The present results indicate that aggression induced by

the presence of an aversive stimulus will persist after cessation of the stimulus, even in the absence of an object of aggression. The intensity of the fighting behavior is an inverse function of the delay of the object of aggression after cessation of the pain stimulus.

If aversive stimulation does, in fact, induce motivation to aggress, it is apparent that this motive is very different from other motives such as hunger and thirst. As Azrin et al (1965) have noted, the relative brevity of aggression motivation, as compared to hunger, may be attributable to the inability to maintain a continual state of aversive stimulation comparable to continuing food deprivation.

## REFERENCES

- AZRIN, N. H., HUTCHINSON, R. R., & HAKE, D. Pain-induced fighting in the squirrel monkey. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 620-621.
- AZRIN, N. H., HUTCHINSON, R. R., & McLAUGHLIN, R. The opportunity for aggression as an operant reinforced during aversive stimulation. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 171-180.
- AZRIN, N. H., HUTCHINSON, R. R., & SALLERY, R. D. Pain-aggression toward inanimate objects. *Journal of the Experimental Analysis of Behavior*, 1964, 7, 223-228.
- AZRIN, N. H., RUBIN, H. B., & HUTCHINSON, R. R. Biting attack by rats in response to aversive shock. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 633-639.
- ULRICH, R. E. Pain-aggression. In G. A. Kimble (Ed.), *Foundations of conditioning and learning*. New York: Appleton-Century-Crofts, 1967. Pp. 600-622.
- ULRICH, R. E., & AZRIN, N. H. Reflexive fighting in response to aversive stimulation. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 511-520.