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PUNISHMENT OF SHOCK-INDUCED AGGRESSION[1]

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Squirrel monkeys were restrained in a chair equipped with a tail-shock apparatus and a pneumatic bite hose located in front of the subject's face. An aggressive response was recorded when the monkey bit the hose. Initial sessions in which no shocks were delivered produced some biting. When biting during these sessions stabilized at a near-zero level, regularly scheduled shocks were delivered to the monkey's tail, causing a consistently higher rate of biting. After several sessions under these conditions, a punishment phase was introduced in which the previous shock conditions were maintained, and every bite was followed immediately by another, more intense shock. Biting under these conditions was suppressed to a near-zero level. When the punishment contingency was removed, biting increased. With one subject, two additional bite-contingent stimuli were examined: (1) a milder shock that, when made contingent upon hose biting, also suppressed that response, and (2) a contingent tone that had no obvious suppressing or facilitating effect. Individual differences among subjects were extreme, but the effect of bite-contingent shock was consistent. Observations of the subjects during the punishment sessions indicated the existence of certain side effects that resulted from the use of punishment to suppress shock-induced aggression.

Rats, cats, hamsters, monkeys, and other animals have been observed to attack a partner after presentation of electric foot-shock (Ulrich, Hutchinson, and Azrin, 1965). Furthermore, such fighting in response to aversive events is not confined to members of like species, but occurs between animals of unlike species as well (Ulrich, Wolff, and Azrin, 1964). Other aversive events that produce a fighting reaction are intensely heated floors, back shock through implanted electrodes (Ulrich and Azrin, 1962), tail shock (Azrin, Hutchinson, and Sallery, 1964), tail pinch (Azrin, Hake, and Hutchinson, 1965), morphine withdrawal (Boshka, Weisman, and Thor, 1966) and food removal (Azrin, Hutchinson, and Hake, 1966; Thompson and Bloom, 1966). The pain-aggression reaction thus appears to be a general phenomenon occurring among a wide variety of animals in response to many different aversive events.

Nonaggressive responses have been conditioned as a function of escape from or reduction of the same aversive events that produce aggression (Sidman, 1966). The fact that aversive stimulation produces aggression as well as escape and avoidance led to several investigations of their interaction in situations where both behaviors were possible (Ulrich and Craine, 1964; Ulrich, Stachnik, Brierton, and Mabry, 1965; Ulrich, 1967*a*; Azrin, Hutchinson, and Hake, 1967; Taylor, Ulrich, and Colasacco, 1969). These studies showed that the interaction between unconditioned fighting and escape-avoidance varied as a function of the history of the subjects, their physical proximity, and the nature of the escape-avoidance response.

Another important aspect of aversive stimulation is its punishing effect (Azrin and Holz, 1966). When an aversive event closely follows a response, the subsequent frequency of that response decreases. This punishment phenomenon poses an interesting question regarding the consequent control of aggression. Since aversive stimulation produces aggression, it has been suggested that the use of punishment

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to suppress aggression may be an inappropriate technique (Ulrich, 1967*b*). The delivery of shock immediately after an aggressive response may, in fact, produce an even greater frequency of aggression than if it were not delivered. On the other hand, it may be found that the aggressive response would be suppressed by response-contingent aversive events.

The purpose of this study was to examine the effects of following each shock-induced aggressive response with additional shock.

METHOD

Subjects

Three mature male squirrel monkeys, weighing between 650 and 800 g, were housed individually with continuous access to food and water, which was supplemented with additional vitamins. All subjects were experimentally naive before the start of the study.

Apparatus

The restraining chair and bite-hose apparatus are described in detail by Hutchinson, Azrin and Hake (1966). Briefly described, it consisted of a Plexiglas chair that securely restrained the subject at the waist and still permitted relatively free movement of the upper portion of the body. The tail was restrained under shock electrodes. A rubber bite hose was mounted on the wall in front of the monkey's face. Biting the hose produced a change in air pressure that, by means of a pressure transducer, caused the contacts of a silent switch to close and thus record a discrete bite. The Plexiglas restraining chair was housed in a larger outer chamber that provided light and sound attenuation, ventilation, and masking noise. The chamber also contained a 60-db, 10,000-Hz tone generator. The presentation and duration of this tone were controlled by the scheduling equipment. The monkeys could be monitored by means of a closed-circuit television located in an adjacent room, along with the scheduling and recording equipment.

Procedure

Before shock presentation, each subject was placed in the experimental situation in order to provide a no-shock baseline of biting. In this phase, as in all other phases of the experiment, the sessions were 1-hr long. When biting during the no-shock baseline reached a near-zero level, scheduled non-response-contingent shock sessions were begun.

Shock was delivered through a 50,000-ohm resistor in series with the monkey's tail. The tail was shaved, and impedance reduced to approximately 15,000 ohms with electrode paste. In each session, 10 shocks were delivered, one every 5 min. Each scheduled shock was 300 v ac and was 0.1 sec in duration.

After several shock sessions, a punishment procedure was introduced. During this phase, the ten, 300-v scheduled shocks continued to be delivered; however, each bite was immediately followed by an additional shock. For all subjects, the second shock was 600 v ac for 0.1 sec. When the number of bites during these sessions stabilized, the punishment contingency was removed.

For Subject 1, two additional bite-contingent stimuli were examined. Instead of the previous 600-v shock, a less-intense shock of 150 v was used. After a second return to the scheduled shock-alone conditions, a tone of 0.1-sec duration was presented as a consequence of each bite. This phase was then followed by a final return to scheduled shock-alone conditions.

RESULTS

Figure 1 shows hose biting during all phases for all subjects. The left side of the figure shows the total number of bites per session for each subject. Directly to the right are cumulative records for the same subject that illustrate the rate of biting within representative sessions.

During the first session of the no-shock phase, Subject 1 (top graph, left side) bit the hose 103 times. The cumulative record of that session (top, right side of Fig. 1) shows some biting at the beginning and near the end of the session, with periods of time exceeding 15 min in which no biting occurred. This initial rate of biting was not typical of the no-shock phase, since with the exception of one other session, no more biting occurred.

The initial presentation of scheduled shocks (Session 17) produced a sudden increase in biting to 316 for the first session of the phase. Throughout this phase (Sessions 17 to 33), biting varied between a low of 105 and a high of 497. The cumulative record of Session 17

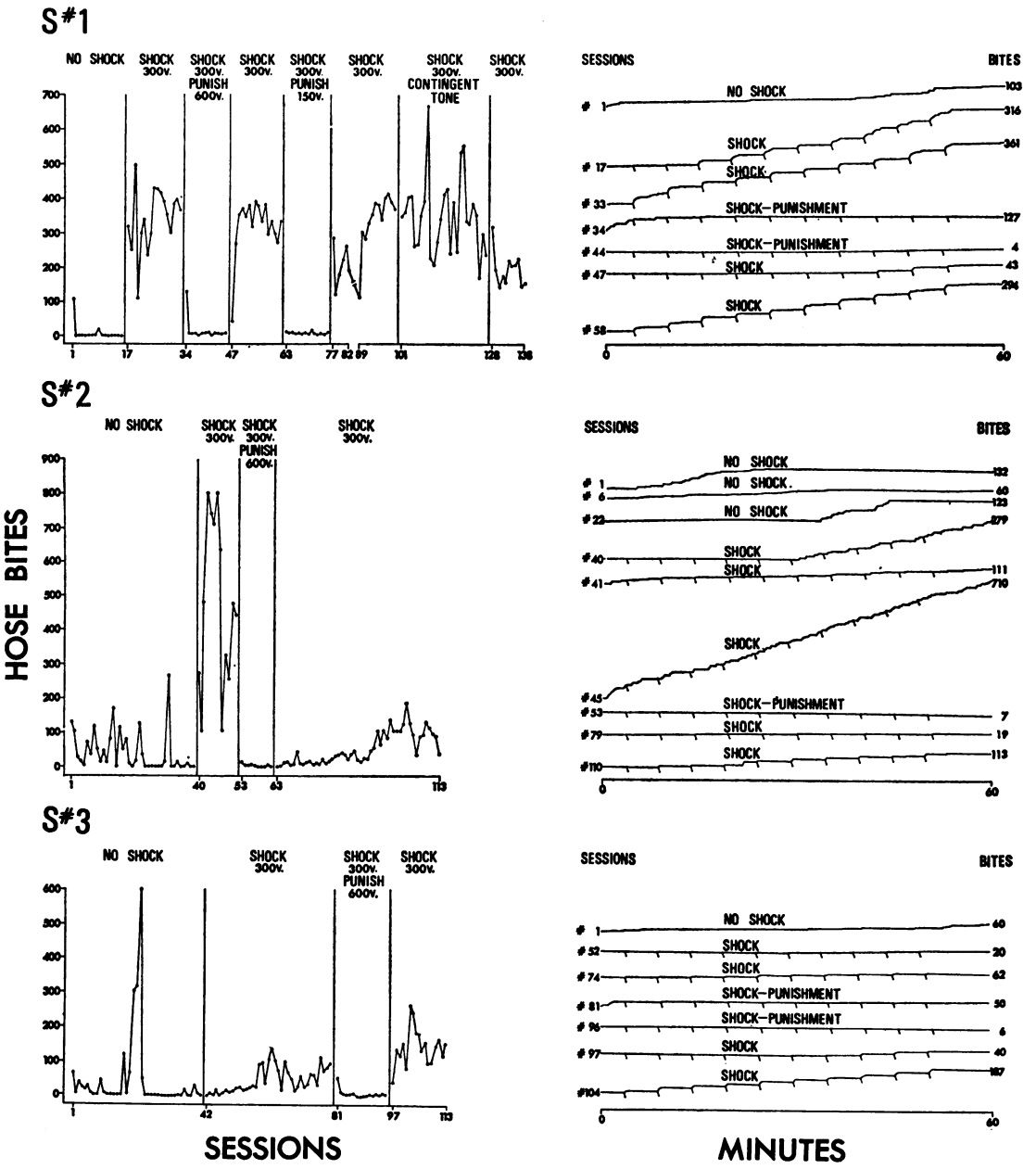

Fig. 1. The rate of hose biting between and within sessions for all subjects. The left side of the figure shows the total number of hose bites recorded during each session. The experimental conditions are labeled at the top of each of the individual graphs and the first session of every phase is numbered. The corresponding cumulative records on the right show the rate of hose biting within selected sessions for the same subject. The number of each session from which the cumulative record was taken is listed at the beginning of each record, and the total number of hose bites per session is given at the end. The experimental phase is identified above each cumulative record. Diagonal marks indicate delivery of a scheduled shock.

and another record (Session 33), which is more typical of this phase, are shown in the cumulative graphs for Subject 1. In Sessions 17 and 33, it can be seen that although biting always occurred directly after shock presentation, it occasionally continued well into the intershock interval.

The punishment phase for Subject 1 was initiated in Session 34. During this phase, each bite produced a 0.1-sec 600-v shock. The sub-

ject bit 127 times during this session. The cumulative record shows that the major portion of the biting occurred before the first scheduled shock was presented. It should again be emphasized that these bites also produced a punishing shock. Throughout the remainder of the punishment phase, biting ranged from zero to eight bites per session. During these sessions, all biting closely followed the delivery of one of the scheduled shocks. A typical cumulative record taken from another session of this phase (Session 44) appears as a straight line.

In Session 47, the punishment contingency was removed and the subject bit 43 times. In subsequent sessions, biting returned to levels equivalent to those observed in the initial scheduled-shock phase. The cumulative record of Session 47 shows an increase in biting within the session, with no bites occurring before presentation of the seventh shock. Cumulative records typical of the post-punishment sessions were similar to the records taken from previous sessions under the same conditions. A cumulative record of Session 58 illustrates this similarity.

The second punishment phase, using a less-intense punishing shock, immediately suppressed biting. The total number of bites during the first session of this phase (Session 63) was eight. Bites throughout the entire phase never exceeded 17 per session. Cumulative records taken from sessions in this phase were similar to the first punishment phase.

Hose biting recovered immediately after the punishment contingency was removed (Sessions 77 to 100). The data collected during Sessions 83 to 88 were invalidated due to an apparatus malfunction.

The presentation of a tone contingent upon each bite was found to be ineffective in suppressing hose biting. In fact, biting during this phase ranged from a low of 204 to a high of 666, the highest ever recorded for Subject 1. The removal of contingent tone showed no apparent change in hose biting from that observed in other nonpunishment sessions.

All experimental phases for Subject 2 are shown in the middle portion, left side of Fig. 1. Representative records for this subject are shown on the right.

Bites during the no-shock phase ranged from 0 to 265 per session. Cumulative records of Sessions 1, 6, and 22 illustrate differences both in the total number of bites between sessions, and differences in the rate of biting within sessions. The even slope of Session 6 reflects a stable rate of biting throughout the session, while Sessions 1 and 22 show sudden bursts of biting at different times within the session. With the exception of one session, biting in the second half of the no-shock phase occurred at a lower and more stable rate.

Bites during the initial shock phase also varied greatly, ranging from 106 to 815. Two hundred and seventy-nine bites were recorded during the initial session (Session 40) of this phase. The cumulative record of this session shows that all biting occurred after the sixth shock. Cumulative records taken from later sessions of this same shock phase (Sessions 41 and 45) were more typical. Although the number of bites during Sessions 41 and 45 differed greatly, the occurrence of biting in both cases was not obviously related to shock delivery. In this respect, Subject 2 differed from both Subjects 1 and 3. This tendency to bite throughout the inter-shock interval with little regard to shock presentation is demonstrated in the later half of the cumulative record of Session 40 and in all of Session 45. As can be seen in Session 41, this same tendency to bite throughout the inter-shock interval was also present in sessions where little biting occurred.

In Session 53, the presentation of a 600-v shock contingent upon hose biting immediately suppressed that response. During the punishment sessions, bites ranged from zero to seven per session. In this case, the initial session of the punishment phase (Session 53) was typical of that phase and is shown in the cumulative graph for Subject 2. Contrary to the previous condition, all biting during the punishment sessions occurred immediately after presentation of one of the regularly scheduled shocks.

In Session 63, the punishment contingency was removed. During that session, however, the subject did not bite the hose, and thus was not affected by the change in contingencies. During subsequent sessions, biting did occur, but the number of bites did not return to a level anywhere near that observed during the previous pre-punishment shock phase, and only after many sessions was a gradual increase noted. Cumulative records taken from both early and later post-punishment sessions are shown. It can be seen that most hose biting

tended to occur immediately after presentations of a scheduled shock. Thus, biting differed from that observed during the first shock phase not only in amount, but also in respect to its occurrence in relation to shock presentation.

The bottom graph shows all phases for Subject 3. Cumulative records of representative sessions are shown on the right. During the first session of the no-shock phase, Subject 3 bit the hose 60 times. The cumulative record shows that this biting did not occur in well-defined bursts, but was evenly distributed throughout the session. Major fluctuations in the rate of biting during the no-shock phase were infrequent but extreme, ranging from 0 to 602 bites per session. When this rate of biting appeared more stable, shock was introduced.

Presentation of scheduled shocks in Session 42 did not dramatically increase the amount of biting, although a gradual increase occurred over subsequent sessions. Biting during this phase ranged between 0 and 135 bites per session. The cumulative records of Sessions 52 and 74 are typical of the first shock phase, and show that most biting occurred directly after shock presentation. Although the biting of Subject 3 during the initial shock phase was never as great as Subjects 1 and 2, the punishing effect of bite-contingent shock was still very evident. With the exception of the first punishment session (Session 81), in which 50 bites were recorded, biting during the punishment phase ranged between 0 and 11 bites. During Session 81, most biting occurred before presentation of the first scheduled shock. Session 81, and a cumulative record more typical of the punishment sessions are shown.

As with Subject 1, biting during the first session after the punishment contingency was removed increased as the session progressed. In this session (Session 97) no biting occurred before the seventh shock. Again, all biting tended to follow the presentation of one of the scheduled shocks. For Subject 3, biting during the post-punishment phase returned to a level somewhat higher than the initial shock condition.

Other observations made during this study also merit reporting. Closed-circuit television monitoring, and movies taken during each of the various phases, provided additional information about the subjects' behavior. During the major portion of the no-shock phase, the monkeys generally appeared at ease, although they frequently bit the hose. The scheduled shocks during pre-punishment sessions caused obvious violent skeletal muscle activity and an increase in biting. However, when not engaged in hose biting, the behavior did not appear to differ greatly from the behavior observed during the no-shock phase. In both of these phases, the monkeys generally sat in an upright posture with one or both hands resting on the bite hose. In the punishment phase, however, particularly in the later sessions, the subjects' behavior was dramatically different. When scheduled shock was delivered, all subjects exhibited a general "apprehension" in relation to the bite hose. Upon delivery of a scheduled shock, the subject would jerk, move rapidly toward the bite hose, and then move away again in a whirling motion. Although much activity was observed, upon shock delivery this activity seldom included hose biting. During the inter-shock interval, behavior was typified by either self-abuse (finger biting, face clawing, side biting, *etc.*) or by a general freezing of posture. This freezing of posture was characterized by a crouched or slumped position that was quite dissimilar from the upright posture observed in the non-punishment phases. When the punishment contingency was removed, the additional behaviors observed during the punishment phase ceased.

DISCUSSION

These results show that shock-induced hose biting was suppressed when aversive stimulation was made contingent upon each biting response. Although individual differences in the rate of responding occurred among subjects and among and within individual sessions, the suppressing effect of response-contingent shock was consistent.

The reasons for the differences in rate of responding during the non-punishment phases are not clear. Some of the variability may have been related to events that occurred in the prelaboratory environment. The variability may also have been related to conditions within the laboratory, such as differences in the manner in which the subjects were taken from their home cages and placed in the chair, the fit of the chair, and other properties associated with the general experimental conditions. Although

this variability and the reasons for it merit further investigation, the fact remains that biting during punishment was in all cases suppressed to a near-zero level.

The effectiveness of punishment in reducing the frequency of some arbitrarily chosen operant response is well documented (Azrin and Holz, 1966; Boe and Church, 1968). Critical variables involving the presentation of the punishing stimulus are the intensity, frequency, scheduling, and immediacy of the punishing stimulus. The effectiveness of the punishment procedure is related also to the deprivation level of the organism and the schedule of reinforcement involved in maintaining the operant response. The present investigation differed from other punishment studies in two aspects: (1) the punished response appears to have many respondent characteristics, and (2) whereas other studies were concerned with the suppression of behaviors conditioned and maintained by positive reinforcement, this study investigated the suppression of behavior produced and maintained by the same stimulus used to punish it.

Other studies have attempted to punish aggression, or a response leading to the opportunity for aggression. In these studies, however, the occurrence of the response was not directly related to the presentation of an eliciting stimulus. Myer and Baenninger (1966) found that some rats immediately killed mice, while in a similar situation, other rats did not engage in this behavior. When a foot-shock was delivered contingent upon an attack response, mouse-killing behavior in the "killer rats" was suppressed. When non-contingent shocks were presented to a "killer rat" after the killing behavior had been successfully suppressed, the killing behavior returned.

Studies investigating the effects of punishing an operant response that led to an opportunity for aggression have met with varying success. Using Siamese fighting fish, Melvin and Anson (1968) and Grabowski and Thompson (1968) reinforced a response that provided an opportunity for aggressive display with the presentation of a mirror image. Melvin and Anson found that when shock was delivered after this response, the response increased in frequency and thus allowed a more frequent display of aggression. Grabowski and Thompson found that a similar procedure suppressed the response, and that delayed punishment or non-contingent shocks delivered on a variable-interval schedule, increased the frequency of the response.

In another study involving aversive stimulation and aggression, Ulrich and Craine (1964) attempted to reinforce non-aggressive responses with shock termination. In this study, shock was presented and continued as long as aggressive responding occurred. Although non-aggressive responding was reinforced with shock termination, and continued aggression punished with continued shock, the time spent fighting increased. A possible explanation for this failure to suppress fighting is that neither the aggressive response that resulted in the continuation of shock, nor the non-aggressive response that resulted in shock termination, was sufficiently specific.

Although many factors remain to be studied, it appears that in cases where aggressive responses, or responses that provide an opportunity for aggression, were successfully punished, the procedure included the immediate delivery of a response-contingent stimulus.

The eventual effectiveness of the punishment procedure in reducing the frequency of hose biting in the present investigation was evident. In certain instances, however, some facilitation of the aggressive response was noted. The data for Subjects 1 and 3 during the first session of the punishment phase (Sessions 34 and 81 respectively) show this effect. On these days, the subjects bit the hose directly after the start of the session. The resulting delivery of bite-contingent shock produced more hose biting. In most sessions, biting did not occur before delivery of the first scheduled shock. When biting did occur at this time, it never involved more than three or four bites. Although a facilitation in the amount of biting as a function of the bite-contingent shock occurred initially, the preponderant effect was a suppression of that response.

In addition to a temporary increase in responding during punishment, the use of shock to suppress shock-induced aggression produced other behaviors as well. As previously mentioned, when subjects were punished for each hose-biting response they ceased biting the hose, and instead frequently bit their fingers or sides, clawed at their face, or in other cases assumed a slumped, atypical posture. These behaviors all occurred only when shock was administered contingent upon a response. In

short, although shock was effective in suppressing hose biting, the punishment of this particular response produced some side effects that suggest that still more research is needed into questions concerning the advisability of using punishment procedures in the control of behavior.

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