JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1970, 14, 153-164 NUMBER 2 (SEPTEMBER)

AN EXTINCTION-INDUCED INCREASE IN AN AGGRESSIVE RESPONSE WITH HUMANS[1]

J. F. KELLY AND D. F. HAKE

SOUTHERN ILLINOIS UNIVERSITY AND ANNA STATE HOSPITAL

Nine subjects, 14 to 18 yr old, pulled a knob on a schedule of monetary reinforcement. Concurrently, they escaped or avoided periodic presentations of a tone by pressing a button that required 1.5 lb (6.67 N) of force or by punching a padded cushion that required 20 lb (88.96 N) of force. The punching response was designated as an aggressive response because the force of this response together with its topography was comparable to responses of humans that deface objects and produce escape or counter aggression from other humans. It was found that button pressing was the preferred concurrent avoidance response and there were few punches. However, when the monetary reinforcer was discontinued (extinction) punching increased for seven of the nine subjects, but there was no consistent change in the rate of button pressing. When the punching response was replaced by another non-preferred but non-aggressive response, neither this response nor button pressing increased during extinction. Hence, the increase in punching during extinction cannot be attributed solely to the fact that it was a concurrent response or a non-preferred response.

A recent experiment showed that upon the discontinuation of food reinforcers for key pecking, pigeons would leave the vicinity of the response key and peck a restrained target pigeon (Azrin, Hutchinson, and Hake, 1966). Pecks against the target pigeon were defined as aggressive responses when they displaced the target pigeon enough to activate a microswitch. Hutchinson, Azrin, and Hunt (1968) extended this finding by showing that the withdrawal of positive reinforcers will also produce aggressive behavior in squirrel monkeys. In that study, bites into a rubber tube closed a pneumatic switch, thereby defining the aggressive response. In these experiments the objective measurement of direct aggressive behaviors made it possible to observe that the discontinuation of positive reinforcers can increase aggressive behavior. The present study attempted to provide an objective measure of direct aggressive behavior in humans in order to determine whether discontinuation of a positive reinforcer could also increase aggressive behavior in humans.

The lack of objective measures of direct aggressive responses has limited the study of human aggression. This has probably been due in part to ethical considerations. First, it is not permissible to allow direct physical attack between human subjects. Second, it is not possible to expose humans to the severe conditions that may be necessary to produce frequent occurrences of direct aggressive responses. These considerations, and the hypothesis that aggressive behavior is largely the result of inner causes, have led to the use of devices such as rating scales, questionnaires, interviews, and projective tests to measure the underlying inner causes of aggressive behavior rather than measurement of aggressive behavior *per se*.

The first problem, the inability to allow direct physical attack between humans, does not necessarily prevent the study of aggressive behavior in humans since such behavior can be measured against inanimate target objects. For example, a punch that moved a doll enough to activate a switch has been defined as an aggressive response (Cowan and Walters, 1963). Similarly, an increase in the force of a plunger-pushing response that was

[1]Experiment I is based on a thesis submitted by the first author in partial fulfillment of the M.A. degree at Southern Illinois University. The investigation was supported by grants from the Mental Health Fund of the Illinois Department of Mental Health and Grants MH-14280 and MH-04926 from the National Institute of Mental Health. Dr. R. Campbell and Dr. E. Sulzer provided valuable advice during the planning of the study and in the preparation of the manuscript. The authors also appreciate the valuable suggestions of Drs. N. H. Azrin, R. R. Hutchinson, H. B. Rubin, and Mr. Jay Powell. Reprints may be obtained from D. F. Hake, Behavior Research Laboratory, Anna State Hospital, Anna, Illinois 62906.

a part of a required task has been designated as an aggressive response (Haner and Brown, 1955). In these studies, as in the infra-human studies mentioned above ,the use of an inanimate target object allowed objective measurement of the response defined as aggressive and also eliminated the confounding effects of counter-aggression.

It is possible that the second problem, the difficulty in arranging conditions that will produce aggressive behavior in humans, is due to (1) a history of punishment for displaying emotional behaviors in the presence of other humans, and (2) the wide range of aggressive responses that the human can emit in addition to the one that is being measured. The subject, knowing that his behavior is being monitored, may not make aggressive responses or, if he does, he may not emit the one response that is being measured. It may have been these same considerations that led Haner and Brown (1955) to measure aggressive behavior solely in terms of a change in the force of a response that occurred as a part of a required task. Another approach that does not require the introduction of severe conditions is to provide reinforcement for the aggressive response. Reinforcement might overcome the prohibitions against making the aggressive response as well as increase the probability that if an aggressive response does occur, it will be the response that is being measured rather than some other aggressive response that is not being measured.

In the present experiment, knob-pulling responses were maintained on a schedule of monetary reinforcement. At the same time, periodic occurrences of a tone could be escaped or avoided by either of two responses: a button press that required 1.5 lb (6.67 N) of force, the easier response, or a punch that required 20 lb (88.96 N) of force against a padded object, the aggressive response. The punch was designated as an aggressive response because the force of this response together with its topography appeared comparable to responses of humans that deface objects and produce escape or counter-aggression from other humans. The availability of an easier avoidance response, the button press, indicated that occurrences of the aggressive response could not be attributed to reinforcement of avoidance responding alone. Experiment I attempted to determine if punching would increase when the monetary reinforcer was discontinued.

EXPERIMENT I

Subjects

Nine, 14- to 18-yr-old male students from local public schools were used. Before the experiment, each subject and one of his parents signed a consent form that established the project personnel as protectors of the subject's welfare and rights during the experiment and described the responses and contingencies of the experiment. Two precautions were taken to prevent the subjects from influencing the behavior of one another through social contact. First, social contact at the laboratory was limited by scheduling the subjects at different times. Second, social contact outside the laboratory was also limited for four subjects (S-2, S-3, S-4, and S-9) who were from four different towns and, according to their responses to a questionnaire completed before the experiment, had no prior knowledge of the experiment or contact with any of the other subjects.

Subjects were usually tested once daily and were usually paid at the end of the session.

Apparatus

The test compartment, which measured 6.5 by 6.5 by 6 ft (2.0 by 2.0 by 1.8 m) high, was inside a well-ventilated and sound-attenuated chamber especially designed for human subjects (Industrial Acoustics Inc., Model No. 1202). Figure 1 is a diagram of the experimental apparatus. The three response mechanisms located on the front of the table-mounted console were a brass knob (Lindsley manipulandum), which required a pull of 3 lb (13.34 N), a button, which required a push of 1.5 lb (6.67 N), and a coin slot for inserting pennies. These forces were measured directly with a gram gauge. The coin slot was located on a 7 by 3.6 in. (17.8 by 9.2 cm) inset panel that also contained three 0.75-in. (1.9-cm) diameter stimulus lights. The fourth response mechanism was a 12-in. (30.5-cm) diameter padded cushion located 6 in. (15.3 cm) to the right of the console. This cushion was mounted on a concealed rod that was attached to a load cell (ATC Series 6004) which in conjunction with a classifier/controller (ATC Series 6401) measured force exerted against the cushion. A

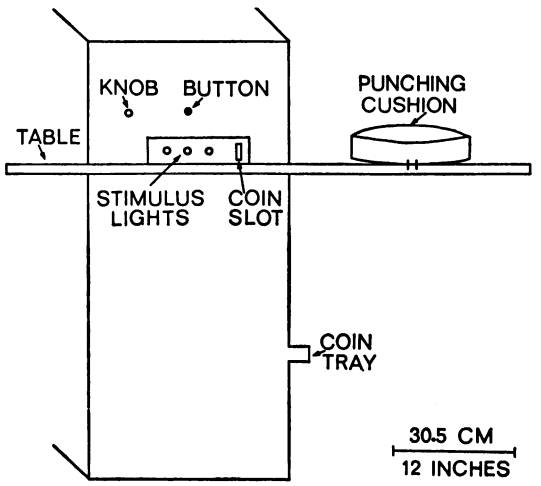

Fig. 1. Diagram of the apparatus. The diagram is drawn to scale except for the inset panel which has been drawn slightly larger to make it clearer.

downward force of 20 lb (88.96 N) or more defined a punching response. This required force was determined by weighing operations. All response mechanisms provided different auditory feedback except for the punch and the button press, which produced the same feedback.

A cabinet beneath the console contained a coin dispenser that delivered coins to a tin tray attached to the side of the cabinet. Concealed within the cabinet, approximately 30 in. (76.2 cm) below the head of a seated subject, was a 6-28 v DC Sonalert Signal (SC628) which sounded at a frequency of 2800 Hz and an intensity of 68 db.

A one-way glass on the wall to the right of the subject was covered to insure privacy.

All stimuli and responses were automatically scheduled and recorded by electro-mechanical relay circuitry located in an adjacent room.

Procedure

Before the first session, the subject was seated in front of the apparatus and read the following instructions:

> "Your task is to pull this knob until these green, white, and green lights go out. When the three lights go out, you are to insert a penny into this slot (experimenter points to slot). When you insert a penny into this slot with the lights out, you will be paid here (experimenter points to coin tray). There will be a tone coming on during the session. To stop it from coming on or to shut it off if it does come on, you may either press this button or hit this cushion (experimenter points to each). Either one will keep the tone off for a brief period of time. If there are no questions, I shall leave and you may start when the three lights come on."

Questions by the subject were answered by re-reading all or part of the instructions. The subject was then told that the session was finished when the three panel lights stopped coming on. Finally, after being given 45 pennies, the subject was left alone in the chamber. For the subsequent sessions, the 45 pennies were left on the table, and the subject began responding when the three stimulus lights were illuminated. After the first session, the subject was told that he would be paid the amount of money dispensed by the machine. No instructions were given regarding whether the subject could keep any pennies that were not used but they were usually left.

While a subject was pulling the knob, there was a green-white-green arrangement of the three stimulus lights. After 200 knob-pulling responses, the three lights extinguished simultaneously. Insertion of a penny at this time produced: (1) a change to red illumination of the stimulus lights for 1 sec; (2) an audible click from the operation of the coin dispenser; and (3) the delivery of a nickel to the coin tray. The 68-db tone was scheduled to occur every 60 sec. It could be terminated or postponed for 60 sec by pressing the button or by punching the cushion. Each session lasted until the subject obtained 40 nickels or until 45 pennies were used, whichever occurred first.

The procedure may be described as concurrent schedules in which knob-pulling on a fixed-ratio schedule was reinforced with nickels while button pressing and/or punching on a non-discriminated avoidance schedule (Sidman, 1953) was reinforced by reducing the number of tones. Two steps were taken to minimize the possibility of close temporal contiguity between the escape-avoidance responses and the nickel deliveries in order to minimize the possibility of adventitious reinforcement of these responses by the monetary reinforcer. First, a fixed-ratio schedule, which typically has a high terminal response rate, was used as the concurrent positive reinforce-

ment schedule in order to reduce the likelihood of escape-avoidance responses near the end of a ratio. Second, button-pressing and punching responses were ineffective in the interval between the completion of a knob-pulling ratio and the delivery of a nickel for the last five subjects (S-2, S-3, S-4, S-6, and S-9). If a subject emitted a button press or a punch at this time, it was recorded, but there was no response feedback; if a tone was sounding it was not terminated.

Subjects were tested under the above conditions until there were five consecutive sessions in which the number of punches for any one session differed by fewer than five from the number in any of the other four sessions. These five sessions were referred to as the baseline. Preliminary work with other subjects indicated that punching was the non-preferred response occurring at a very low rate and that this stability criterion could be met easily. Extinction was introduced after this baseline criterion was reached. During the extinction sessions, only the first five knob-pulling ratios produced the monetary reinforcer. The extinction results are based on the performance during the extinction portion of the session. Except for the absence of the monetary reinforcers, all conditions during extinction remained the same as under the reinforcement condition. Each subject was scheduled for at least three consecutive extinction sessions. However, if a subject left the chamber during one of the first two extinction sessions before all 45 pennies were used, he was exposed to only two extinction sessions before being returned to the reinforcement condition. This behavior seemed to indicate that a subject might prematurely terminate participation in the project if continued on extinction. Two subjects did discontinue participation during the extinction condition (S-7 and S-9), and one (S-8) returned for only one reinforcement session after the extinction sessions. The other subjects were returned to the reinforcement condition for at least five sessions. Three subjects (S-1, S-2, and S-3) were continued on the reinforcement condition for 10 or more sessions and then exposed to extinction a second time. S-1 discontinued participation during the second extinction series, but S-2 and S-3 completed the second extinction series and were then returned to the reinforcement condition for five sessions.

Results

Figure 2 shows the rate of punching responses for the seven subjects who had an increase in punching during extinction; the other two subjects rarely punched. Subject 8 (not shown) had no increase in punching during extinction; he punched once during baseline and once during extinction. Subject 9 (not shown) never made a punching response during baseline but punched twice during extinction. All seven subjects shown in Fig. 2 made a few punches during the baseline condition, but the rate of punching was below six per hour in all baseline sessions. During extinction, however, the rate of punching increased and was more variable. These seven subjects had at least one extinction session with a rate of 15 punches per hour and five of them had one or more sessions with a rate of at least 30 punches per hour. Three subjects (S-2, S-4, S-7) had punched at rates of 12 responses per hour in one (S-2) or two (S-4, S-7) sessions before the baseline criterion was reached, but these pre-baseline rates were still never as high as those obtained during extinction.

Six of these seven subjects were returned to the reinforcement condition for five sessions, and three of them returned to baseline punching rates within one (S-3) to four (S-1, S-2) reinforcement sessions. The other three (S-4, S-5, S-6) did not return to baseline punching rates within the five reinforcement sessions. Hutchinson *et al* (1968) noted a similar but transient persistence of aggressive responding with monkeys upon the reinstatement of the original reinforcement condition (lower fixed-ratio requirement).

Three subjects (S-1, S-2, S-3) were exposed to extinction a second time. Although only five baseline sessions are shown before the second extinction series, S-2 and S-3 were run until 10 consecutive sessions met the baseline criterion. Upon the introduction of extinction, punching rates increased, although they were usually not as high as they had been in the first extinction series. Subject 1 withdrew from the experiment during the second extinction series, but S-2 and S-3 were returned to the reinforcement condition, at which time they resumed their baseline punching rates.

It will be recalled that punches could either terminate (escape punches) or postpone tones

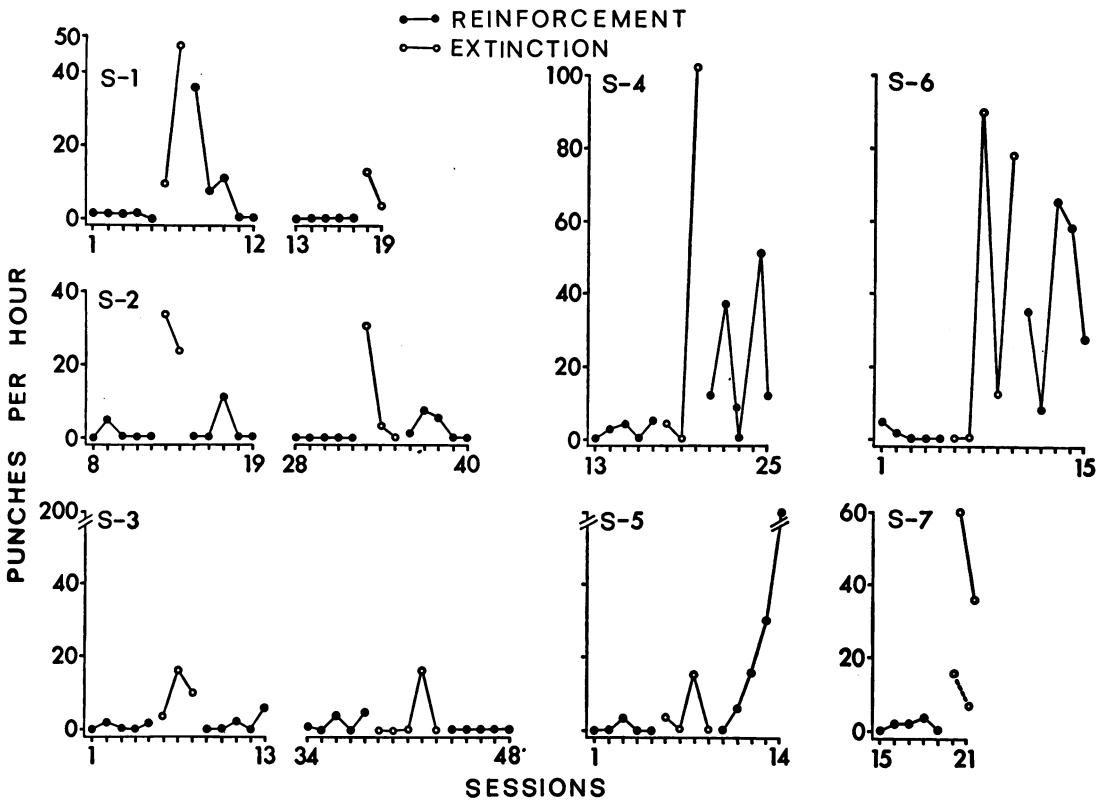

Fig. 2. The rate of punching responses across all conditions for the seven subjects who had an increase in punching during extinction. This figure and subsequent figures present the five reinforcement sessions meeting the stability criterion (baseline), all extinction sessions, and the next five reinforcement sessions. The same procedure was followed for the second introduction of extinction. The sessions are numbered from a given subject's first session in the experiment. The solid circles represent reinforcement sessions, and the open circles represent extinction sessions. Although most sessions lasted around 40 min, the punching rates were plotted on an hourly basis in order to facilitate presentation of the data. The dashed lines during extinction for S-7 represent a corrected rate. (See text for method of calculation.)

Table 1

Number of escape and avoidance punches during extinction, and the distribution of avoidance punches within the ratio requirement during extinction.

Subject	*Escape Punches*	*Avoidance Punches*	*% Avoidance Punches during or Immediately before the First Fourth of the Ratio Requirement*
S-1	11	35	97
S-2	7	46	78
S-3	0	23	59
S-4	21	59	100
S-5	7	2	100
S-6	41	50	85
S-7	33	6	100

(avoidance punches). Table 1 shows the number of escape and avoidance punches during extinction for each subject who had an increase in the rate of punching during extinction. It can be seen that five subjects made more avoidance punches while two made more escape punches. This table also shows that most of the avoidance punches during extinction occurred after the ratio requirement had been completed and the empty coin dispenser had operated, or early in the next ratio. Only avoidance punches were used in this calculation since the distribution of escape punches was determined by the distribution of tones. A similar distribution of aggressive responses has been reported for squirrel monkeys (Hutchinson *et al.*, 1968) and pigeons (Gentry, 1968) that were responding on a fixed-ratio schedule of positive reinforcement.

Figure 3 presents the rate of responding on the other escape-avoidance manipulandum, the button press. For all nine subjects, at least 95% of the escape-avoidance responses during baseline were button presses. Since tones were scheduled every 60 sec, a response rate of 60 responses per hour was theoretically sufficient to avoid all tones. The subjects did not avoid 100% of the tones, but all had button-pressing rates of at least 60 responses per hour for each baseline session. During extinction there was no consistent change in the rate of button pressing, but it was observed to decrease more often than it increased. For example, the button pressing rates of subjects (S-1, S-4, S-5, S-6, S-7, S-8) dropped below 60 per hour for at least one session. Five of these six subjects were returned to the reinforcement condition, and four (S-1, S-4, S-5, S-8) resumed responding at a rate of at least 60 responses per hour.

During extinction the only scheduled stimulus change was the discontinuance of money, but due to the changes in avoidance behavior there were also changes in the number of

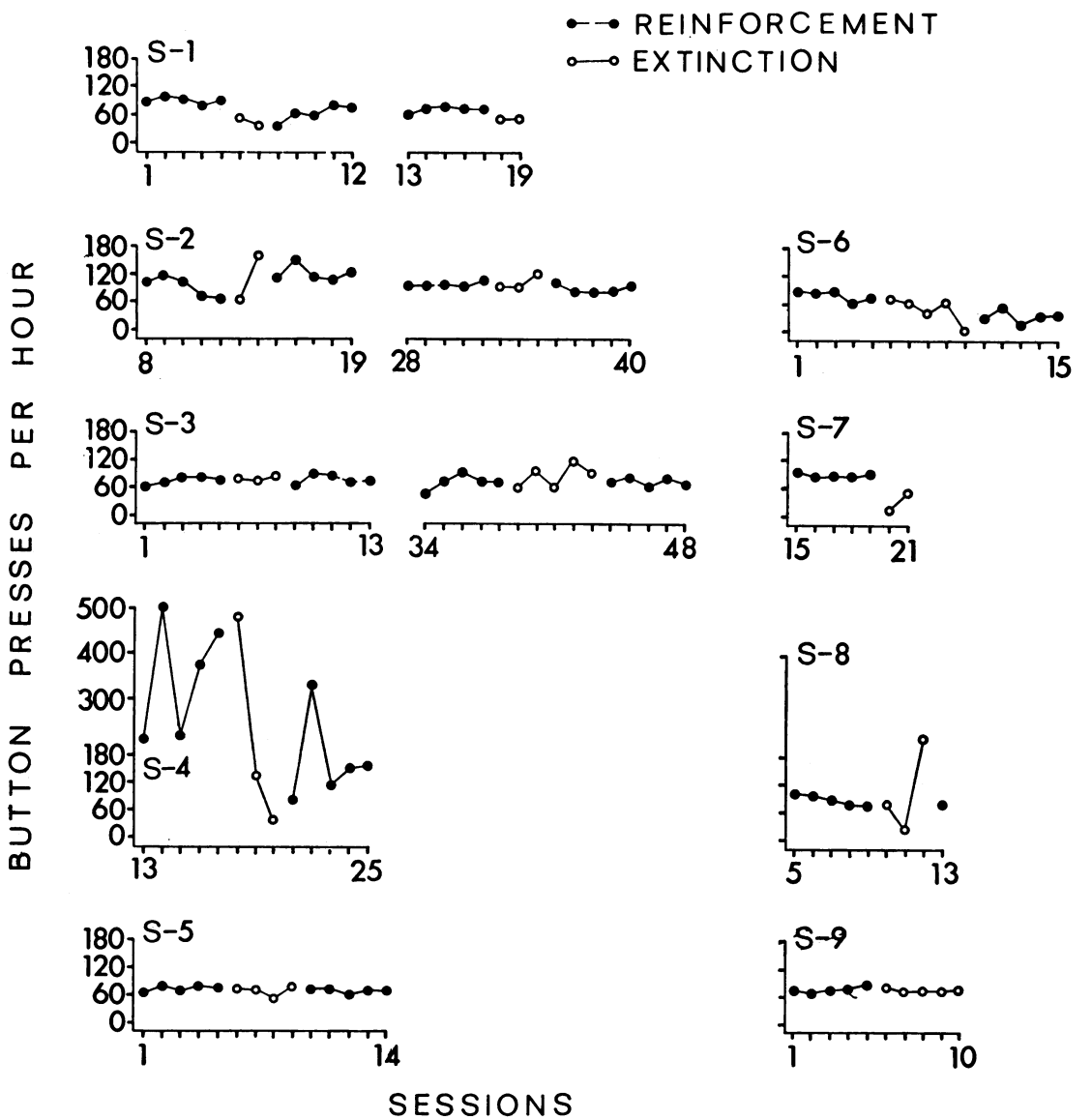

Fig. 3. The rate of button-pressing responses across all conditions.

tones. There was a considerable number of tones across all conditions, and the number was variable; but it was frequently higher during extinction. The seven subjects that showed an increase in punching during extinction averaged 22 tones per hour during baseline and 34 per hour during extinction. Since infrahuman research has shown that aversive stimuli can produce aggressive responding, *e.g.*, Azrin, Hutchinson, and Hake (1967), and since the escape-avoidance behavior in the present experiment suggested that the tones had aversive properties, the possibility arose that the increase in punching during extinction was due to the increase in tones and a resultant increase in punches in response to the tone, *i.e.*, escape punches. However, for five of the seven subjects (Table 1) most of the punches during extinction were in the absence of the tone, *i.e.*, avoidance punches, and these alone represented an increase in punching during extinction. Also, the tone *per se* did not appear to be entirely responsible for escape punches during extinction: given a tone, the probability of a punch was higher during extinction (0.2) than during baseline (0.02). This was true for all subjects except S-3 (Table 1) who made no escape punches. As a result, the increase in punching during extinction could not be due solely to the increase in tones. In order to estimate the rate of punches during extinction not attributable to an increase in tones, the average rate of tones during baseline was substituted for the rate of tones during extinction. When this baseline rate of tones was multiplied by the probability of a punch during a tone for the extinction sessions and this "corrected" rate of escape punches added to the rate of avoidance punches, it was found that only in the case of S-7 (see Fig. 2, dashed lines are overall corrected rates) was the increase in punches during extinction due in part to an increase in tones.

Figure 4 shows that discontinuing money had little effect upon the rate of knob-pulling for seven of the nine subjects. During extinction the response rates of these seven subjects approximated the average baseline response rate, 180 to 300 responses per minute for a

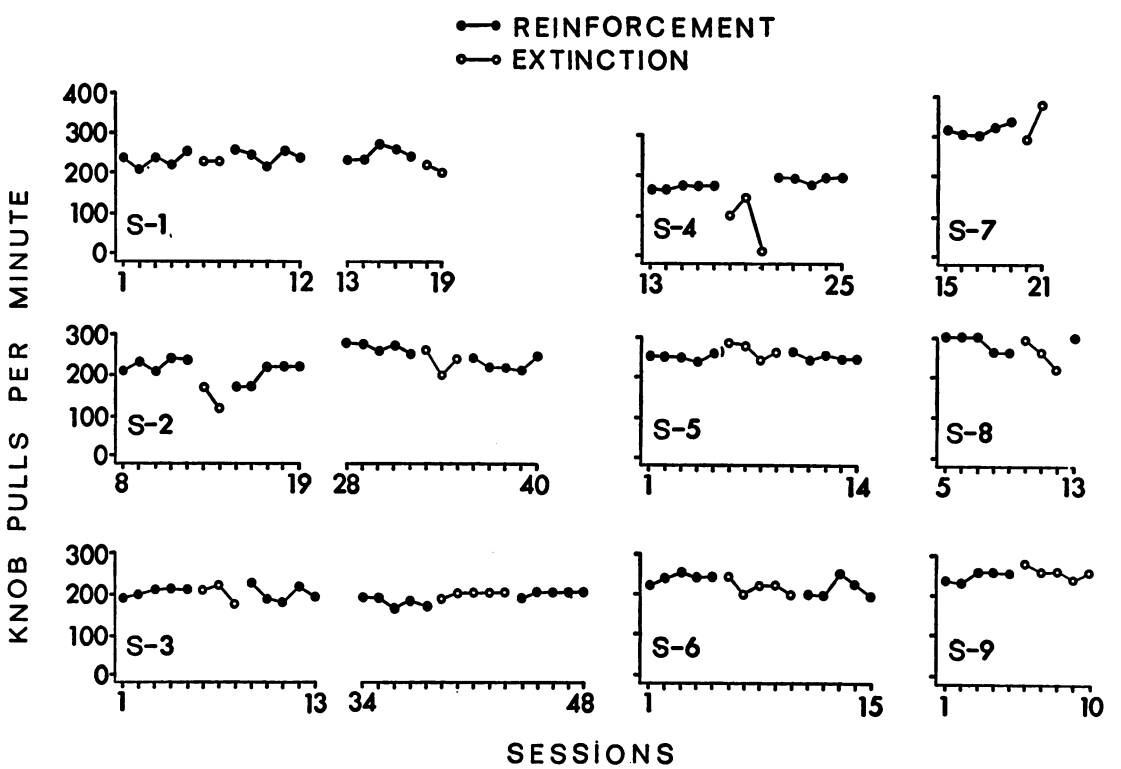

Fig. 4. The rate of knob-pulling responses across all conditions.

Table 2
The number of extra pennies inserted per extinction session.

Subject	Extinction Sessions: First Extinction 1	2	Second Extinction 3	4	5	6	7	8
S-1	0	0[b]	0	23[a]				
S-2	0	0[b]	0	0	0[b]			
S-3	0	0	13	7	13	15	19	20
S-4	0	0	0					
S-5	0	0	0[b]	15				
S-6	3	0	0	14	17			
S-7	0	3[a]						
S-8	0	13	21					
S-9	0	0	0	0	0[a]			

[a]Terminated participation in experiment.
[b]Left chamber before completing session.

given subject, and never dropped below 75% of the average baseline response rate. However, there were other behaviors during extinction that allowed the subject to terminate sessions early and which may be indicative of extinction effects. Table 2 shows the course of a behavior that occurred only during extinction. This behavior was the insertion of more than one of the 45 pennies following a completed knob-pulling ratio or the insertion of a penny before the ratio was completed. These extra penny insertions had the effect of decreasing the number of knob-pulling ratios that could be emitted, since the session ended with the insertion of 45 pennies. For example, if a subject had 20 extra penny insertions he could complete only 25 of the ratios. The number of such extra penny insertions per extinction session is shown in Table 2. It can be seen that these extra penny insertions increased with the number of successive extinction sessions for the six subjects that engaged in this behavior. Table 2 also shows those extinction sessions for which the subject left the chamber before inserting all 45 pennies, and those extinction sessions when the subject terminated participation in the experiment. These behaviors were also restricted to extinction, with the exception of S-8 who terminated participation in the experiment after the first session after extinction.

EXPERIMENT II

The question may be raised concerning whether any concurrent, escape-avoidance response would have increased when the monetary reinforcer was discontinued. For example, it has been shown that when concurrent operants are maintained on variable-interval schedules by the same positive reinforcer, the discontinuation of reinforcement for one results in an increase in the rate of responding for the other (see review by Catania, 1966). In the present experiment, however, the concurrent operants were maintained by dissimilar reinforcers, and there is evidence that the relationship described above may not hold for dissimilar reinforcers (Catania, 1966, p. 239). For example, in concurrent procedures in which squirrel monkeys were used as subjects, there was no increase in avoidance responding when a concurrent food-reinforced response was eliminated (Catania, Deegan, and Cook, 1966) or undergoing extinction (Catania, 1966, pp. 259-265). The fact that the rate of button pressing did not increase in Exp. I also suggests that discontinuation of positive reinforcement for one concurrent response does not produce an increase in the rate of a concurrent negatively reinforced response. These results suggest that the increase in punching was not due solely to the fact that it was a concurrent response. However, it is still possible that the punch increased because it was a non-preferred, concurrent response. A second experiment was conducted to determine if another non-preferred, concurrent but non-aggressive escape-avoidance response would increase during extinction of the positively reinforced knob-pulling response.

Subjects

Five, 15- to 17-yr-old male students from the local high school served. As in Exp. I, each subject and a parent signed a consent form. Subjects were usually tested once daily, and they were usually paid after each session.

Apparatus and Procedure

The experimental apparatus was the same as in Exp. I (Fig. 1) except that the padded cushion was removed and a 2 in. (5.1 cm) diameter door knob protruded 2.25 in. (5.7 cm) from the right side of the console. The response of twisting this door knob 10° in a counterclockwise direction was intended to be the non-preferred and non-aggressive escape-avoidance response. A force of 2.2 in/lb (9.8 N) was required for the response. The force was measured by a gram gauge at the 1 in. (2.54 cm) radius of the door knob. The knob twist-

ing response was designated as a non-aggressive response since its force and topography did not appear comparable to responses of humans that deface objects and produce escape or counter-aggression from other humans. The door knob was attached to the right side of the console 10 in. (25.4 cm) from the front of the console as contrasted with the escape-avoidance button which was on the front of the console. However, the door knob was still easily within reach of the seated subject.

The procedure of Exp. II was identical to Exp. I except that the instructions were changed to read that the subject could either press the button or twist the door knob in order to keep the tone off. Four of the five subjects were tested in two series of extinction sessions. The tone was increased to 80 db before the baseline control of this second series of extinction sessions because of the poor avoidance performance in Exp. II.

Results

Figure 5 shows the rates of both of the escape-avoidance responses. Although all of the subjects occasionally twisted the knob, only one of the five (S-12) showed an increase in knob-twisting during extinction. This increase lasted only one session, and all of the knob-twists in this session came in two bursts of 3 and 19 responses respectively. Similarly, there was no consistent increase in the rate of the preferred button-pressing response. The button-pressing rates were variable, but they were always at least or very near 60 responses per hour, the scheduled rate of tones. However, only about one-sixth of the scheduled

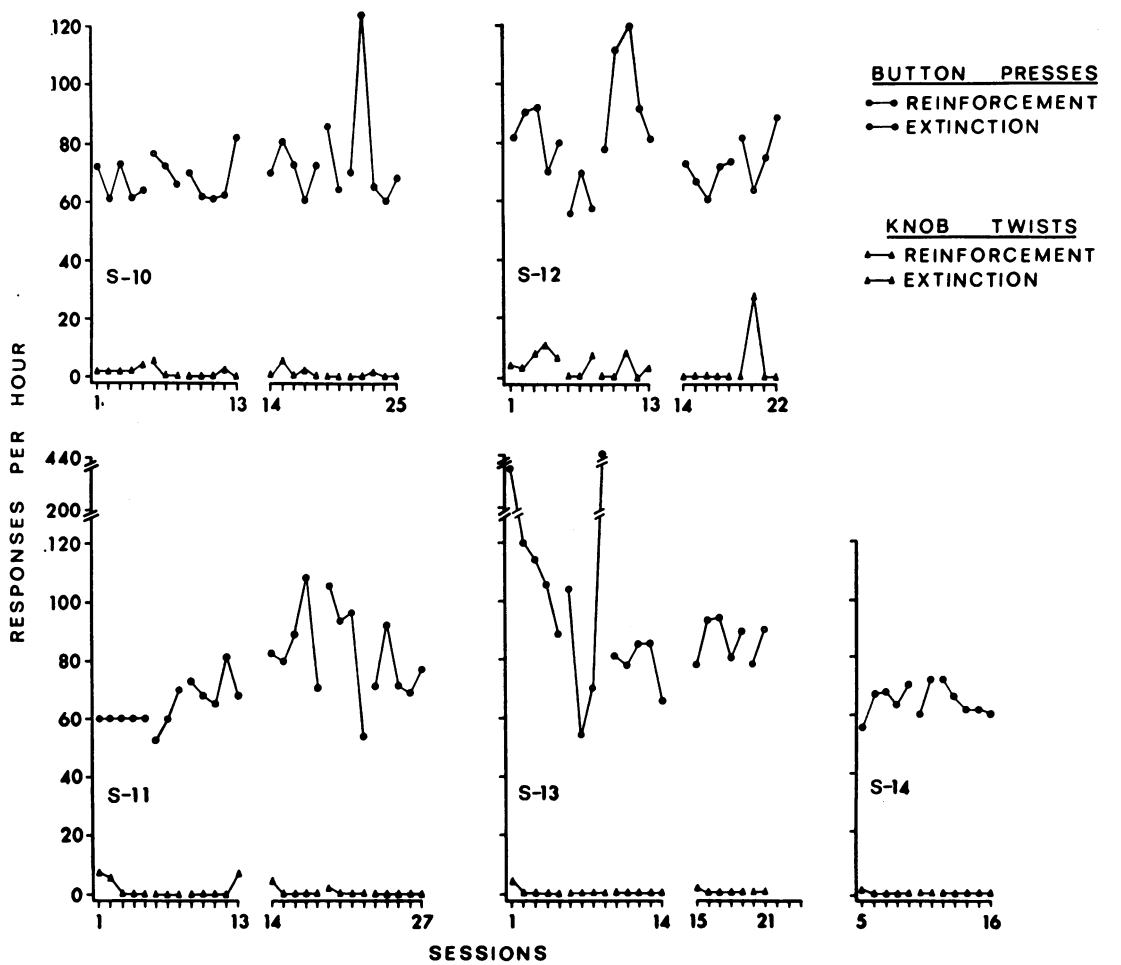

Fig. 5. The rate of knob-twisting responses and button presses across all conditions.

tones were avoided in Exp. II; S-13 avoided consistently, but the other subjects typically waited for the tone to sound and then pressed the button. Increasing the intensity of the tone from 68 to 80 db improved the performance of the subject who was already avoiding, but the increase had little effect upon avoidance performance of the other subjects.

As in Exp. I, the discontinuation of money had little or no effect upon the rate of the knob-pulling response. The average knob-pulling rates during extinction were at least 80% of the average baseline rates of 190 to 290 responses per minute for a given subject and, for a single session, the extinction rate was never below 75% of the average baseline rate. However, as was also the case in Exp. I, there were other behaviors that were restricted to extinction, such as inserting extra coins, leaving the chamber before the session was finished, and discontinuing participation in the experiment, which may be indicative of extinction effects since these behaviors necessarily resulted in a reduction or discontinuation of the knob-pulling responses. The frequency of occurrence of these behaviors is indicated in Table 3 for each extinction session. It can be seen that four of the five subjects frequently inserted more than one penny following a completed knob-pulling ratio and that this behavior tended to increase as a function of the number of extinction sessions. It can also be seen that four subjects left the experimental chamber before inserting all of their pennies and that two subjects terminated participation in the experiment during the extinction phase. None of these behaviors occurred during the reinforcement sessions.

Table 3

The Number of Extra Pennies Inserted per Extinction Session.

	Extinction Sessions							
Subject	*First Extinction*			*Second Extinction*				
	1	2	3	4	5	6	7	8
S-10	0	0	13[b]	27[b]	31			
S-11	0	0[b]	0	0	5	20	36[b]	
S-12	0	0	0	4	10	0	0[a]	
S-13	0	0	20	32[b]	34[b]	39[a]		
S-14	0[b]	0						

[a]Terminated participation in experiment.
[b]Left chamber before completing session.

During extinction there was also evidence of aggressive behaviors that were not automatically recorded. These behaviors, which occurred in both experiments but only during the extinction sessions, consisted of defacing the apparatus and swearing. The defacing responses included tearing the padded cushion, carving on the console, punching holes in the console with a ball-point pen, breaking stimulus lights, bending the coin tray, and kicking the door to the experimental chamber. Some of the subjects swore when they left the experimental chamber and when they were paid at the end of an extinction session.

DISCUSSION

Experiment I showed that upon discontinuing monetary reinforcement for one response, knob-pulling, the rate of an effortful concurrent response, punching, increased. There are several possible interpretations of these results in addition to an extinction-induced increase in an aggressive response. It is possible that something other than extinction was responsible for the increase in punching. The increase in punching during extinction could have been due to the increase in tones. Previous studies have shown that aversive stimuli produce aggressive responses (*e.g.*, Azrin *et al.*, 1967). Since the maintenance of escape-avoidance behavior in the present experiment suggested that the tones had aversive properties, the increase in punches during extinction could have been due to the increase in tones and a resultant increase in punches in response to the tone, *i.e.*, escape punches. This does not seem to be the case since (1) most of the punches during extinction were in the absence of the tone (avoidance punches), (2) given a tone, the probability of a punch was higher during extinction than during baseline, and (3) the correction procedure in which the average rate of tones during baseline was substituted for the rate of tones during extinction showed that only in the case of one subject was the increase in punches during extinction due in part to an increase in tones. Nor does it seem that the increase in punches can be attributed to an increase in the overall aversiveness of the situation resulting from the increase in tones. An increase in the aversiveness of the situation might be expected to increase punches by producing: (1) an increase in

escape-avoidance behavior, or (2) an increase in aggressive responses. First, there was no overall increase in avoidance responding during extinction; the rate of the preferred avoidance response, button pressing, was observed to decrease more often than it increased. Second, if the tones were responsible for making the situation aversive and producing aggression, the punching rates during baseline should not have been at a near-zero level, since there were many tones during baseline.

It might also be argued that the punching was the result of an adventitious correlation of punching and the monetary reinforcer rather than the result of extinction. Such adventitious conditioning would have had to develop during the baseline when the monetary reinforcer was available. However, the independence of punching and the monetary reinforcer during baseline is indicated by the near-zero level of punching. Also, the punching during extinction persisted both within and over sessions longer than would seem necessary to learn that it did not produce nickels.

The question may be raised whether any non-preferred, concurrent, escape-avoidance response would have increased during extinction of the positively reinforced response. In Exp. II, a non-preferred and non-aggressive knob-twist response was substituted for the punching response. During extinction of the positively reinforced response, there was no increase in the rate of the preferred escape-avoidance response and only a slight, if any, increase in the rate of knob-twisting. Hence, the increase in punching observed during extinction cannot be attributed solely to the fact it was a concurrent response or a non-preferred response; some other aspect of the aggressive response was essential.

It appears that the increase in punching was due to the discontinuation of money and some aspect of the punching response. The punching response was designated as an aggressive response because the force of this response together with its topography appeared comparable to responses of humans that deface objects and produce escape or counter-aggression from other humans. This example of an extinction-induced increase in an aggressive response extends the phenomenon to humans and may also have implications for those multiple and concurrent schedule procedures in which the discontinuation of reinforcement for one response or during one stimulus results in an increase in the rate of a concurrent response or a response during another stimulus. The present results suggest that some aspect of the responses *per se* in such procedures may partly determine the effects of extinction. It was shown that extinction had relatively little effect upon a non-preferred and non-aggressive response as contrasted to the effect upon the non-preferred but aggressive punching response. Further research will be necessary to determine which aspects of an aggressive response, *e.g.*, force, topography, proprioceptive feedback, account for its higher probability during extinction.

Previous studies of human aggression involving extinction and objective measurement of direct aggressive responses used a procedure in which subjects were prevented from completing a reinforced task (Haner and Brown, 1955; Ulrich and Favell, in press). These studies necessarily involved extinction since completion of the task was required for reinforcement. Hence, the increase in aggressive responses could have resulted from the interruption of the task, from extinction, or from both variables. The present study isolated extinction as a variable that can increase aggressive responses in humans by discontinuing reinforcement for a task that the subjects were allowed to complete.

The present results also indicate that a reduction in response rate, the usual result of extinction, was not essential to produce an increase in aggressive responses since the increase occurred when there was no reduction in the rate of knob-pulling. The discontinuation of reinforcement was a critical factor.

There appear to be several reasons why the discontinuation of the monetary reinforcer did not produce a reduction in response rate. Unlike most extinction procedures the subject determined the amount of time spent in the experimental chamber. Assuming that the environment outside the experimental chamber contained reinforcers, the most uneconomical response would be to remain in the chamber without responding, the usual indicator of extinction. Aside from simply leaving the chamber, which some subjects did, there were only two ways of ending the session. The subject could complete the session as instructed, or he could insert extra pennies.

These two behaviors remained at least partially within the instructions and may have maintained the possibility of reinforcement for the subject, which factors probably account for these behaviors being the most common.

The present results suggest a possible difference in the aggressive responding of humans and infra-humans. For example, in the studies that found an extinction-induced increase in aggressive responses with infra-human subjects (Azrin *et al.*, 1966; Hutchinson *et al.*, 1968; Thompson and Bloom, 1966), there were more aggressive responses, and these occurred sooner after the introduction of extinction than in the present study. These differences may have been because the punching response was more effortful than biting (Hutchinson *et al.*, 1968) and/or pecking (Azrin *et al.*, 1966) or because discontinuation of nickels is less effective than withholding food from a food-deprived animal. Casual observation of the behavior of humans reveals frequent instances in which aggressive responses are held back or emitted only after a long series of instances capable of producing aggressive reactions. If this is the typical pattern of aggressive behavior in humans, and if it is due to the prohibitions against displaying emotional behavior as suggested above, then the effect of extinction in the present study was sizeable, and a major contribution of the present study was to produce a sizeable rate of aggressive responses without introducing severe conditions.

REFERENCES

Azrin, N. H., Hutchinson, R. R., and Hake, D. F. Extinction-induced aggression. *Journal of the Experimental Analysis of Behavior,* 1966, **9,** 191-204.

Azrin, N. H., Hutchinson, R. R., and Hake, D. F. Attack, avoidance, and escape reactions to aversive shock. *Journal of the Experimental Analysis of Behavior,* 1967, **10,** 131-148.

Catania, A. C. Concurrent operants. In W. K. Honig (Ed.), *Operant behavior: areas of research and application.* New York: Appleton-Century-Crofts, 1966. Pp. 213-270.

Catania, A. C., Deegan, J. F., and Cook, L. Concurrent fixed-ratio and avoidance responding in the squirrel monkey. *Journal of the Experimental Analysis of Behavior,* 1966, **9,** 227-231.

Cowan, P. A. and Walters, R. H. Studies of reinforcement of aggression: I. Effects of scheduling. *Child Development,* 1963, **34,** 543-551.

Gentry, W. D. Fixed ratio schedule-induced aggression. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 813-817.

Haner, C. F. and Brown, Patricia Ann. Clarification of the instigation to action in the frustration-aggression hypothesis. *Journal of Abnormal and Social Psychology,* 1955, **51,** 204-206.

Hutchinson, R. R., Azrin, N. H., and Hunt, G. M. Attack produced by intermittent reinforcement of a concurrent operant response. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 489-495.

Sidman, M. Avoidance conditioning with brief shock and no exteroceptive warning signal. *Science,* 1953, **118,** 157-158.

Thompson, T. and Bloom, W. Aggressive behavior and extinction-induced response rate increase. *Psychonomic Science,* 1966, **5,** 335-336.

Ulrich, R. E. and Favell, J. E. Human aggression. In C. Neuringer and J. Michael (Eds.), *Behavior modification in clinical psychology.* New York: Appleton-Century-Crofts, in press.

Received: 16 May 1969.