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AGGRESSION DURING THE FIXED-RATIO AND EXTINCTION COMPONENTS OF A MULTIPLE SCHEDULE OF REINFORCEMENT[1]

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Pigeons were trained to key peck for food on multiple reinforcement schedules including components of continuous and fixed-ratio reinforcement and extinction. At the end of the chamber opposite the response key was a restrained target pigeon. The target restraining equipment was designed to record automatically blows struck against the target. When the experimental pigeons were paired with restrained target pigeons they attacked the target. Attack occurred during extinction after both continuous and fixed-ratio reinforcement. Attack also occurred occasionally during fixed-ratio 25 and fixed-ratio 40 and frequently during fixed-ratio 60 and fixed-ratio 120. No attack occurred during fixed-ratio 15 and continuous reinforcement. After a history of stable responding without a target bird present, the introduction of a target bird resulted in severely strained key-peck responding characterized by long periods of neither key pecking nor aggressing.

The presentation of an aversive stimulus has been shown to elicit aggressive behavior from a variety of species (Ulrich, 1966; Ulrich, Hutchinson, and Azrin, 1965). These aversive stimuli may be either exteroceptive, such as electric shock (Ulrich and Azrin, 1962), or interoceptive, such as morphine withdrawal (Boshka, Weisman, and Thor, 1966). Recent data indicated that extinction and trials on which reinforcement does not occur were sufficient to elicit aggressive responding between paired organisms. Rats attacked other rats in a straight alley on such trials (Gallup, 1965). Similarly, rats placed on extinction aggress (Davis and Donenfeld, 1967; Thompson and Bloom, 1966). Azrin, Hutchinson, and Hake (1966) demonstrated that extinction after continuous reinforcement would result in attack behavior in pigeons.

Many intermittent schedules of reinforcement include periods of non-reinforcement for responding. Azrin *et al.* (1966) suggested that intermittent schedules of reinforcement might elicit aggression between pairs of subjects. Recent data demonstrated that fixed-ratio (FR) schedules of reinforcement elicited attack behavior in pigeons (Gentry, 1968). Similarly, biting responses directed toward a pneumatic hose resulted when squirrel monkeys worked on FR schedules of reinforcement (Hutchinson, Azrin, and Hunt, 1968).

The present study sought to determine if a variety of FR requirements would differentially affect the amount of aggression elicited by FR schedules of reinforcement. In addition, the study was designed to ascertain whether the schedule of reinforcement immediately preceding periods of extinction would affect the amount of extinction-elicited aggression.

METHOD

Subjects

Ten experimentally naive male White Carneaux pigeons were used. Five 3-yr-old birds, obtained from the Palmetto Pigeon Plant, Sumter, South Carolina, served as experimental subjects. Five pigeons ranging in age from 3 to 5 yr were targets. All pigeons were housed in individual cages with water and grit continuously available; the experimental animals were maintained at 80% of free-feeding weight, and the target birds were maintained at free-feeding weight.

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Apparatus

The experimental chamber was similar to that described by Azrin *et al.* (1966). At one end was a Model E 1100 PBA Grason Stadler one-key pigeon chamber interior. A key peck in excess of 20 g (0.18 N) was defined as a response and each response resulted in an audible click. During reinforcement a white light illuminated the food magazine and the light behind the response key was extinguished; each reinforcement consisted of the food being available for 3 sec immediately after the reinforced response. A houselight continuously illuminated the interior of the chamber. The chamber was ventilated by an exhaust fan, and a one-way window permitted continuous observation during experimental sessions.

The apparatus for recording aggression was similar to that described by Azrin *et al.* (1966) and was located at the end of the chamber opposite the pigeon key. Willis (1966) demonstrated the relationship of available space to attack behavior in pigeons, with small chambers resulting in greater aggression than larger chambers. To minimize the contribution of chamber size to the elicited aggression, the face of the target-restraining equipment was 20 in. (50.8 cm) from the face of the response key. The target pigeon was restrained in a trapezoid-shaped Plexiglas box open on the top. The target was secured in the box by lacing the opening across the bird's back; the target could move no more than its head and neck. The box was attached to a stabilimeter identical to that described by Azrin *et al.* (1966). The stabilimeter consisted of a hinged panel supported by an adjustable spring and connected to a microswitch. In front of the target bird an inverted U-shaped Plexiglas frame was attached. This frame required the experimental pigeon to attack over or through it, making it impossible to attack the target without displacing the stabilimeter. The frame also gave the target bird more protection and minimized injury to the animal. On each side of the restraining box were stationary, clear Plexiglas panels from the floor of the chamber to the ceiling. These prevented the experimental animal from getting behind the target bird or attacking from the side. A force of 125 g (1.125 N) against the restraining equipment was necessary to close the contacts of the microswitch. This requirement eliminated false displacements due to vigorous defensive movements by the target and rebounds during periods of maximum aggression. Each displacement of the stabilimeter was recorded on a cumulative recorder. Timers arranged to record the duration of aggression recorded cumulatively, stopping when 1 sec elapsed without a stabilimeter displacement. The scheduling and recording were performed automatically by conventional circuitry. Visual observation of the experimental sessions indicated a close correspondence between the automatically recorded attack and the visual evidence of the experimental animal attacking the target.

All five experimental animals were tested with a stuffed pigeon as a target. Only one would attack it. The stuffed target was paired with this bird (S4) throughout the study; a force of 125 g (1.125 N) was required to displace the stuffed target.

Procedure

The experiment consisted of five stages. Table 1 shows the sequence of experimental manipulations and the number of sessions required to complete each procedure with each pigeon. First, each experimental animal was given seven sessions in the experimental chamber; a target was in the restraining box and the response key and reinforcement mechanism were inoperative. Second, the targets were removed and the experimental animals were trained to eat from the food magazine and then shaped to key peck. During the shaping procedure, each key peck resulted in food reinforcement. Seventy to 80 reinforcements were presented during each of three shaping sessions. After key-peck training, all animals were run on a multiple reinforcement schedule consisting of 10 reinforced key pecks followed by 5 min of extinction (*mult* FR 1 EXT). The pattern of 10 reinforcements followed by 5 min of extinction was repeated six times per session. During the reinforcement components, the response key was alternately lighted by red or green lights, and during extinction the response key was darkened. This procedure was continued until each pigeon responded only when the key was lighted. The target pigeon was not present during the shaping or during any sessions before the demonstration of a stable state of responding by the experimental pigeon on the *mult* FR 1 EXT schedule.

Table 1

The sequence of experimental manipulations and the number of sessions required for each procedure.

Procedure	Subjects				
	E-1	E-2	E-3	E-4	E-5
Naive experimental bird with target	7	7	7	7	7
Experimental bird shaped to key peck—no target	3	3	3	3	3
mult FR 1 EXT—no target	4	4	4	4	4
mult FR 1 EXT—target present	9	8	10	8	8
mult FR 15 EXT FR 1 EXT—no target	5	5	5	4	5
mult FR 15 EXT FR 1 EXT—target present	10	12	10	9	11
mult FR 25 EXT FR 1 EXT—no target	3	3	3	3	3
mult FR 25 EXT FR 1 EXT—target present	9	10	7	7	11
mult FR 40 EXT FR 1 EXT—no target	3	4	3	3	4
mult FR 40 EXT FR 1 EXT—target present	10	8	11	11	10
mult FR 60 EXT FR 1 EXT—no target	5	6	3	3	3
mult FR 60 EXT FR 1 EXT—target present	8	9	9	10	9
mult FR 120 EXT FR 1 EXT—no target	6	0	7	6	5
mult FR 120 EXT FR 1 EXT—target present	12	0	10	14	11
mult FR 120 EXT—no target	3	4[a]	3	3	3
mult FR 120 EXT—target present	5	10[a]	7	8	7
mult FR 120 EXT FR 1 EXT—no target	3	3[b]	3	3	3
FR 120 and FR 1 discriminative stimuli contingent upon aggression	1	1[b]	1	1	1
Extinction of key pecking—no target	7	7	7	7	7
No key pecking—target present	7	7	7	7	7

[a]Subject 2 had been continued on FR 60 and at this point *mult* FR 60 EXT was used.
[b]*mult* FR 60 EXT FR 1 EXT.

Next, the target pigeon was placed in the restraining box and the *mult* FR 1 EXT schedule was continued. A changeover delay of 5 sec was used during extinction to prevent accidental reinforcement of aggression by the presentation of the discriminative stimulus for the reinforcement component. After a single test session with a live target, each bird was run for a single session with the stuffed target. A minimum of eight sessions were conducted using *mult* FR 1 EXT. When the frequency of aggression during the extinction periods stabilized, the target animal was removed and the FR N ($N > 1$) schedule was introduced.

Each experimental animal was trained to peck the red light on an FR 1 schedule and to peck the green light on an FR 15 schedule. Each session consisted of a multiple schedule of reinforcement alternating three FR 15 and three FR 1 periods of 10 reinforcements each, and all reinforcement periods were separated by 5 min of extinction (*mult* FR 15 EXT FR 1 EXT). When a stable *mult* FR 15 EXT FR 1 EXT response pattern had been displayed, the target pigeon was again introduced. Sessions started with FR 1 and FR N on a random basis throughout the study. After a stable frequency of aggression was displayed during extinction after both FR 1 and FR 15, the FR N requirement during the presence of the green light was increased. Each time, the criterion for increasing the FR N requirement was the stability of the aggression during the extinction periods following both the FR N and FR 1 reinforcement periods. The target bird was always removed before the FR N requirement was increased and was not returned until the response rate on the *mult* FR N EXT FR 1 EXT schedule had stabilized. The FR N requirement was changed successively from 15 to 25 to 40 to 60 to 120 responses. The red light remained a discriminative stimulus for FR 1 throughout the study. (Bird S-2 was never used at FR 120.) The 5-sec changeover delay was included whenever the experimental pigeon attacked during the FR N component in order to delay the presentation of food reinforcement for key pecking at least 5 sec after an aggressive response. This was to prevent the accidental development of a response chain of aggression and key pecking ultimately reinforced by food.

During a later portion of the experiment, the FR 1 component was omitted and the

birds were run on a *mult* FR N EXT schedule. At the completion of this stage, for a single session, the discriminative stimuli for FR 1 and FR 120 (FR 60 with Bird S-2) were presented contingent upon aggression by the experimental birds.

After these procedures had been completed, the final stage of the experiment was performed. For one week the experimental animals were placed in the apparatus daily with the key and reinforcement equipment inoperative; the targets were not present. The pigeons were then placed in the chamber with the target pigeons while the response key remained inoperative; this too continued for one week.

RESULTS

During the first stage of the procedure, when the experimental animals were placed with the targets in the apparatus before any reinforcement history in the chamber, no aggression occurred. One of the pigeons (S-4) displayed some cooing, head bobbing, and ruffling of feathers, but no actual blows were struck.

Pilot work indicated that duration of attack, although positively correlated with the number of stabilimeter displacements, was less sensitive and did not reflect changes in the rate of attack behavior. For this reason, the frequency of blows (displacements of the stabilimeter) was used as the primary index of aggression.

During the extinction components of the multiple reinforcement schedules, the subjects displayed attack behavior directed toward the target. Aggression occurred during extinction after both FR 1 and FR N. Within sessions and between sessions of the same multiple schedule of reinforcement, there was no apparent difference in the number of target displacements that occurred after FR 1 and FR N. That is, the immediately preceding schedule of reinforcement did not differentially affect the rate of attack behavior displayed by the experimental pigeons during the extinction components of the multiple schedules. However, changes in the FR N requirement

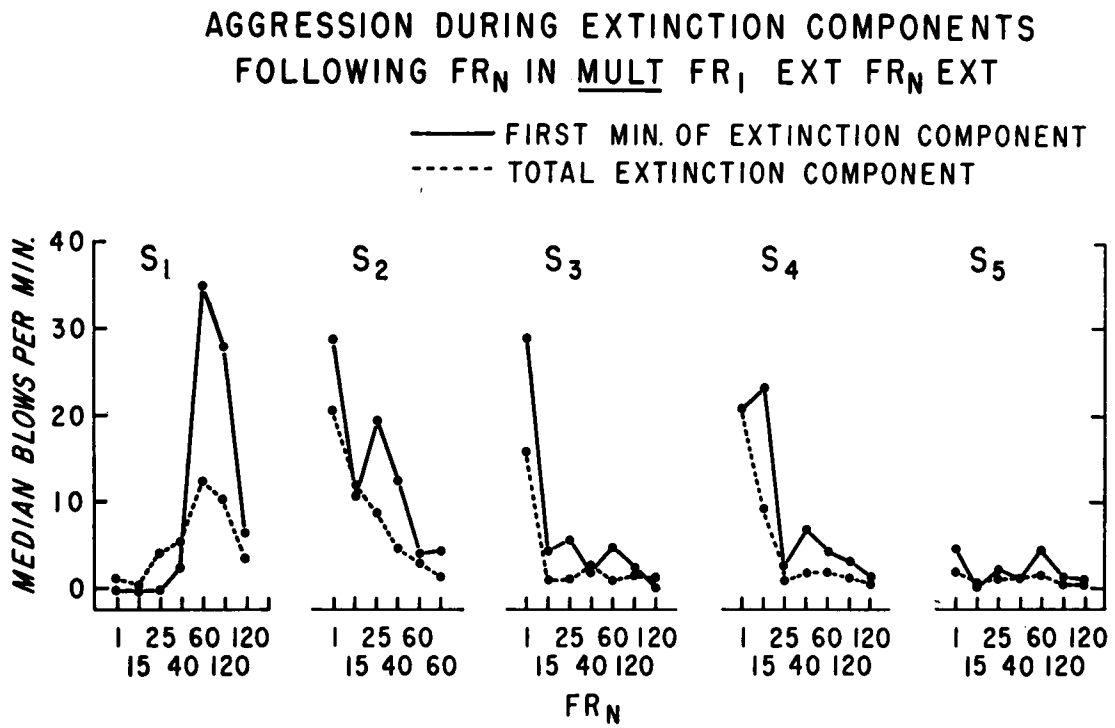

Fig. 1. Each graph reflects the aggression by each subject during extinction following FR N in *mult* FN EXT FR 1 EXT. The aggression indicated at 1 on the abscissa is that which occurred during extinction when the *mult* FR 1 EXT schedule was used. The aggression at the final point on the abscissa was obtained during EXT in *mult* FR N EXT. For all subjects, the broken line is based upon the first min of each post FR N extinction component. The solid line is based upon the aggression during the entire post-FR N extinction component.

did seem to result in changes in the rate of attack behavior during extinction in general.

Figure 1 shows the median number of blows struck during extinction after FR N in each *mult* FR N EXT FR 1 EXT schedule used. The solid line indicates the aggression occurring during the first minute of extinction immediately after each reinforcement component; the broken line indicates the rate of aggression occurring during the entire 5-min extinction component. The units on the abscissa indicate the preceding FR requirement; the repetition of the final unit indicates the stage in the study when the *mult* FR N EXT schedule was included. Because there were no differences in rate of aggression between the post-FR 1 and post-FR N extinction periods, these graphs may be considered to be representative of the aggression that occurred during all extinction components. Figure 1 reflects the changes in the rate of aggression that accompanied changes in the FR N requirements and the inter-subject variability in the amount of aggression displayed. For three of the subjects, the amount of aggression was high during extinction in *mult* FR 1 EXT and decreased with increases in the FR N requirements of *mult* FR N EXT FR 1 EXT. Subject S-1 showed a rather low rate of aggression after the lower FR N requirements, showed a higher rate of aggressive responding with greater FR N requirements, and then displayed a decrease in aggression when the *mult* FR N EXT schedule was introduced. Subject S-5 aggressed very little during extinction throughout the entire study.

Figure 1 also shows that the aggressive behavior occurred at a higher rate during the first minute of extinction than during the total 5-min extinction component. Thus, the rate of aggressive responding decreased as a function of the amount of time in extinction.

During the FR N components of the multiple schedules of reinforcement, the experimental subjects could emit one of three responses: each subject could peck the response key, attack the target, or do neither. The latter was arbitrarily described as pausing. The incidence

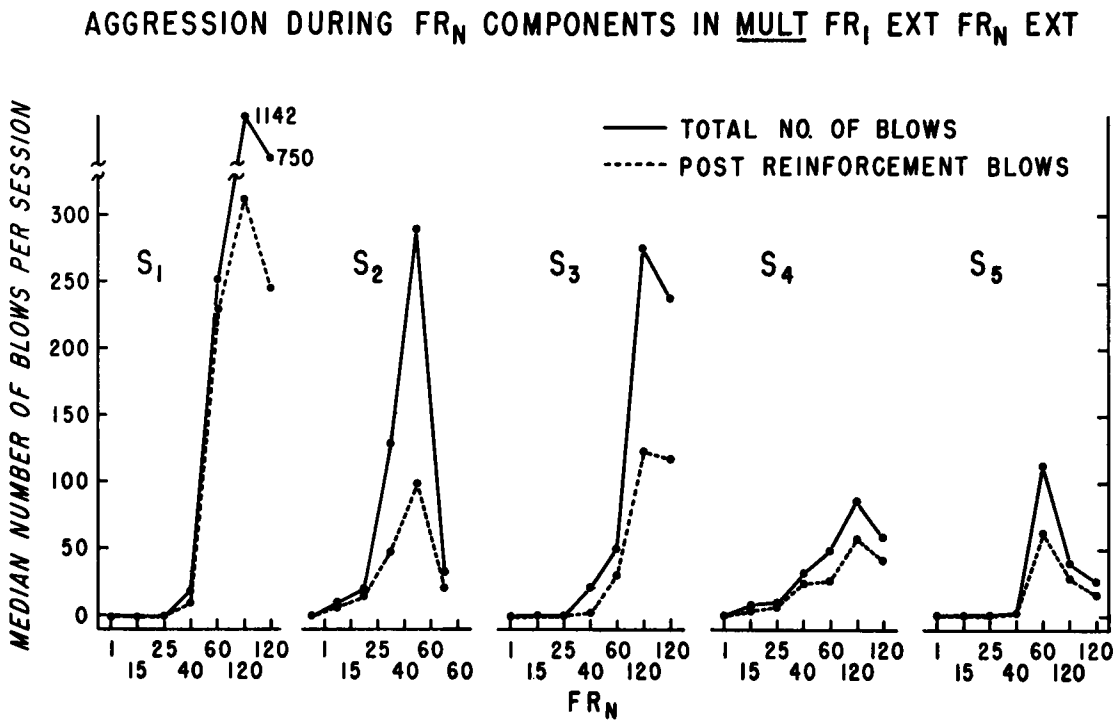

Fig. 2. Each graph shows the median cumulative number of blows per session that occurred during the FR N components in *mult* FR N EXT FR 1 EXT. The aggression at 1 on the abscissa reflects the number of blows that occurred during FR 1 in the *mult* FR 1 EXT schedules. The final unit on the abscissa indicates aggression occurring during FR N when the *mult* FR N EXT schedule was used. Post-reinforcement blows were those target displacements that occurred within 5 sec of the termination of reinforcement, and continued without an interruption exceeding 5 sec.

of all three responses was altered by increases in the FR N requirements.

Figure 2 shows the amount of aggression that occurred during the FR N components within the *mult* FR 1 EXT FR N EXT schedule. The solid line indicates the median number of target displacements per session during the three FR N components; the broken line indicates the number of blows that occurred during FR N immediately after reinforcement terminated. The units on the abscissa indicate the FR used; the repetition of the final unit indicates the aggression occurring during FR N in the *mult* FR N EXT schedule. From these graphs it can be seen that only two birds attacked the target during FR 15 and FR 25, but with the introduction of FR 40 all birds engaged in some aggressive behavior. With the exception of S-5, all subjects displayed increased aggression with increased FR N requirements. S-5 showed an increase in aggression accompanying the increases in the FR requirement as high as FR 60, but the increase to FR 120 resulted in a decrease in aggression. For all subjects, the introduction of the *mult* FR N EXT schedule resulted in a decrease in the amount of aggression during FR N as compared to the aggression during the same FR N in *mult* FR N EXT FR 1 EXT.

Attack that immediately followed reinforcement termination was defined as that aggression that occurred within 5 sec of reinforcement and continued until a pause in excess of 5 sec occurred. This criterion was based upon the stereotyped aggressive-like behavior that often immediately preceded attack and often occurred during attack. This behavior consisted of the experimental animal fluffing its feathers, cooing, bobbing its head, and often striking with its wings in the general direction of the target. Typically, this response pattern did not exceed 5 sec. From Fig. 2 it can be seen that when the lower FR N requirements were used, most of the attack behavior occurred shortly after reinforcement was terminated. With the higher FR N requirements (FR 60

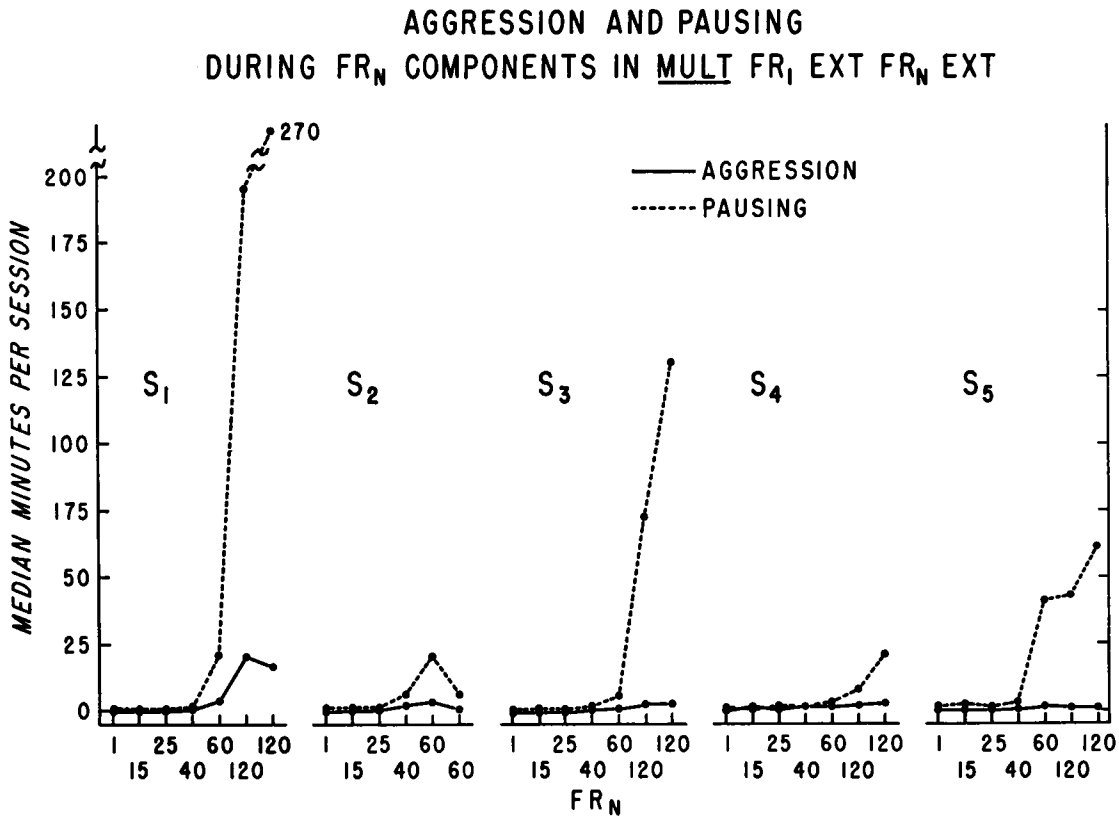

Fig. 3. The time engaged in aggression is the amount of time the experimental pigeon actually attacked the target bird. Pausing time is that time during which the experimental bird neither key-pecked nor aggressed.

and FR 120), proportionately less aggression occurred immediately after reinforcement was terminated.

Figure 3 shows the amount of time each subject engaged in attack and pausing during the FR N components. As previously shown in Fig. 2, a rather marked increase in the number of target displacements accompanied increases in the FR N requirements, yet Fig. 3 shows that the amount of time actually engaged in attack did not increase markedly. Although there was a slight increase in the amount of time engaged in aggression, this increase did not approach the magnitude of the increase in target displacements nor the pausing during FR N. As shown by the broken line in Fig. 3, as the FR requirement was increased each bird spent a larger amount of time neither key pecking for food nor attacking the target. Although there was considerable intersubject variability in the amount of pausing, all birds displayed a large amount of time engaged in pausing during FR N. These data indicate the small relative amount of time the experimental animals actually engaged in attack during the high FR N components.

Figures 4, 5, and 6 show cumulative records of key-pecking responses during a session without a target present (key-NT) and the cumulative records of the concurrent responses of key pecking (key-WT) and attack (target) during a single session with a target bird present. The records in all three figures were produced by Bird S-3 and are representative of this subject's response patterns during each *mult* FR N EXT FR 1 EXT schedule shown. From each of these figures it can be seen how previously stable key-peck responding became severely disrupted when the target pigeon was introduced. With increased FR N requirements, as

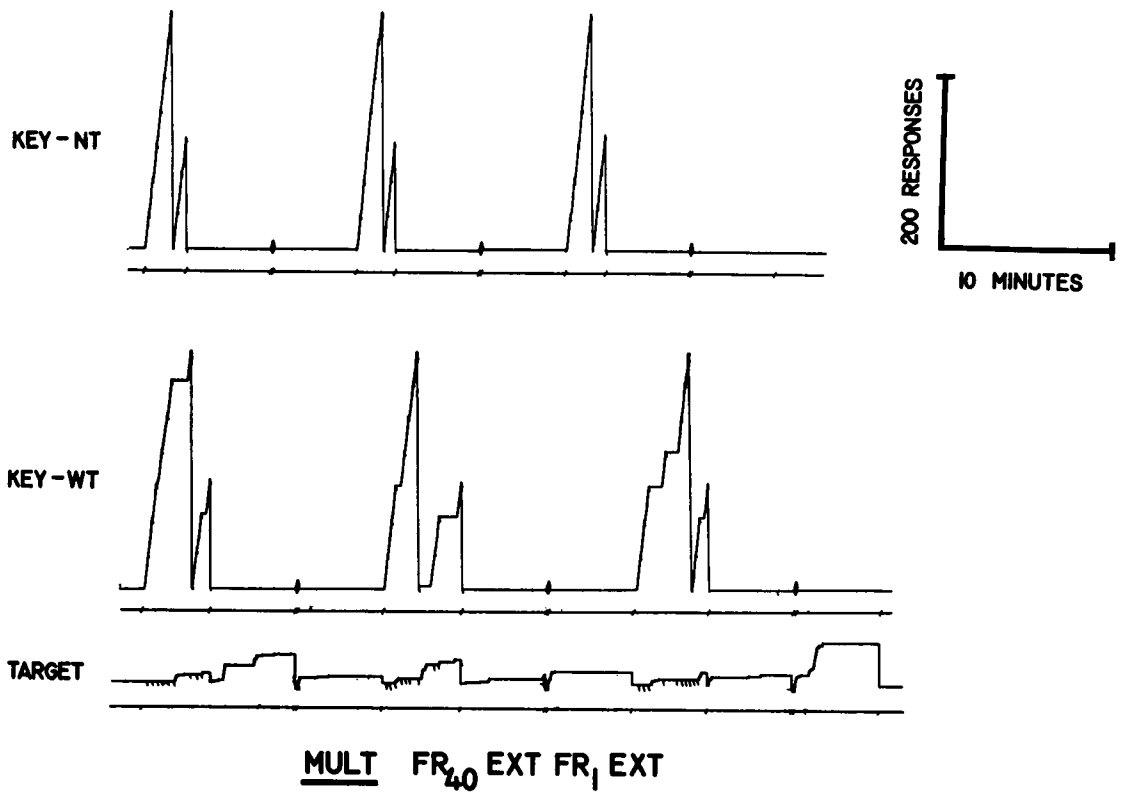

Fig. 4. These cumulative records are representative of the response pattern of Subject S-3 under two conditions. For all the records the upper line indicates the responding and the brief downward deflections indicate the occurrence of reinforcements. The deflections on the lower line indicate changes in the components of the multiple schedules of reinforcement from FR 40 to extinction to FR 1 to extinction. Record KEY-NT shows key pecking without a target bird present. Record KEY-WT shows key pecking when a target was present. Record TARGET shows target displacements during the same session as record KEY-WT. The brief downward deflections of the pen on record TARGET indicate the occurrence of reinforcement for the key pecking shown in record KEY-WT.

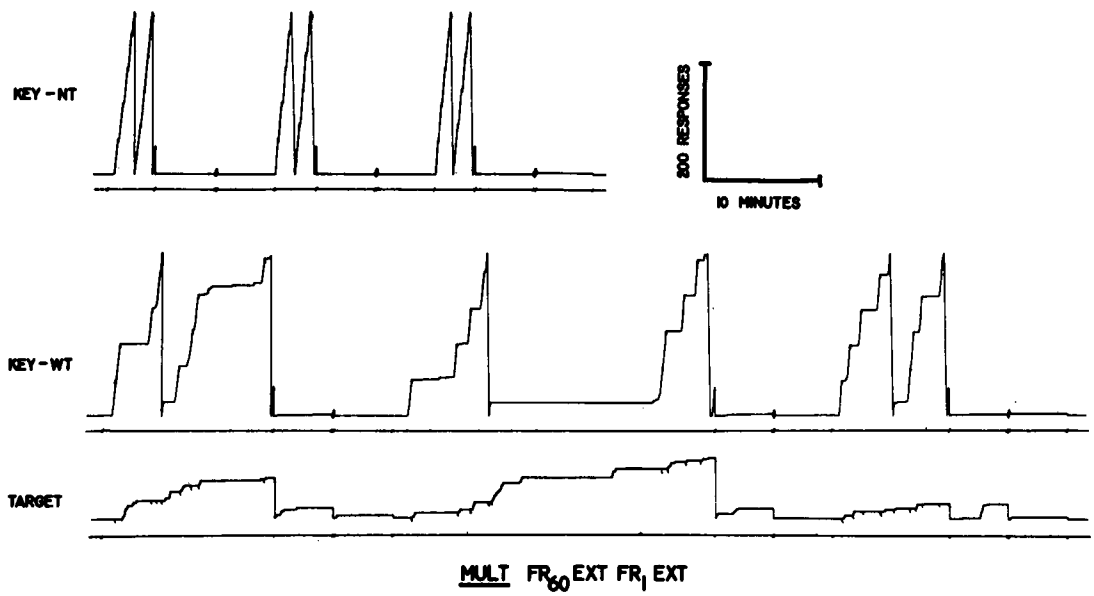

Fig. 5. These cumulative records are representative of the response pattern of Subject S-3 under two conditions. For all the records the upper line indicates the responding and the brief downward deflections indicate the occurrence of reinforcements. The deflections on the lower line indicate changes in the components of the multiple schedules of reinforcement from FR 60 to extinction to FR 1 to extinction. Record KEY-NT shows key pecking without a target bird present. Record KEY-WT shows key pecking when a target was present. Record TARGET shows target displacements during the same session as record KEY-WT. The brief downward deflections of the pen on record TARGET indicate the occurrence of reinforcement for the key pecking shown in record KEY-WT.

the aggression had become much more pronounced during FR N, the key-peck response strain also became much more pronounced. Removal of the target bird resulted in a return to a response rate comparable to those records in Fig. 4, 5, and 6 labeled key-NT.

Figures 4, 5, and 6 also indicate the temporal relationship between the aggressive responding and the termination of reinforcement during FR N. A comparison of the records of the aggressive responding during these three *mult* FR N EXT FR 1 EXT schedules shows the increasing amount of aggression that did not closely follow termination of reinforcement. Although most of the aggression had occurred during post-reinforcement pauses in the extended periods of pausing, during FR 60 and FR 120 the subjects occasionally interrupted FR responding to attack the target. Some of these interruptions of key pecking, with subsequent bursts of aggression, are evidenced in both Fig. 5 and 6. The interruptions are most obvious during the FR 120 record of Fig. 6. Such interruptions were occasionally noted during FR 40, increased somewhat during FR 60, and increased further during FR 120. The decrease in the rate of aggression over time in extinction is also apparent in these cumulative records.

When the FR 60 and FR 120 components were used, Birds S-2, S-3, and S-4 occasionally initiated new attack responses immediately after the onset of the FR discriminative stimulus. Later in the study, when the discriminative stimuli for FR 1 and FR 120 were presented during the time the animals were aggressive, the subjects responded differentially to the stimuli. The onset of the FR 1 discriminative stimulus immediately terminated the attack. The onset of the FR 120 discriminative stimulus was not associated with such an immediate cessation of aggression.

At the end of the study the birds were submitted to a week-long history of daily sessions with an inoperative response key and no available target. The return of the target resulted in only one of the five pigeons aggressing (S-4) briefly during two sessions. All birds displayed the stereotyped aggressive-like responses at the start of these sessions, but except for S-4, these responses did not continue for more than three sessions. Subject S-4 did not continue to display this aggressive behavior after the fifth such session.

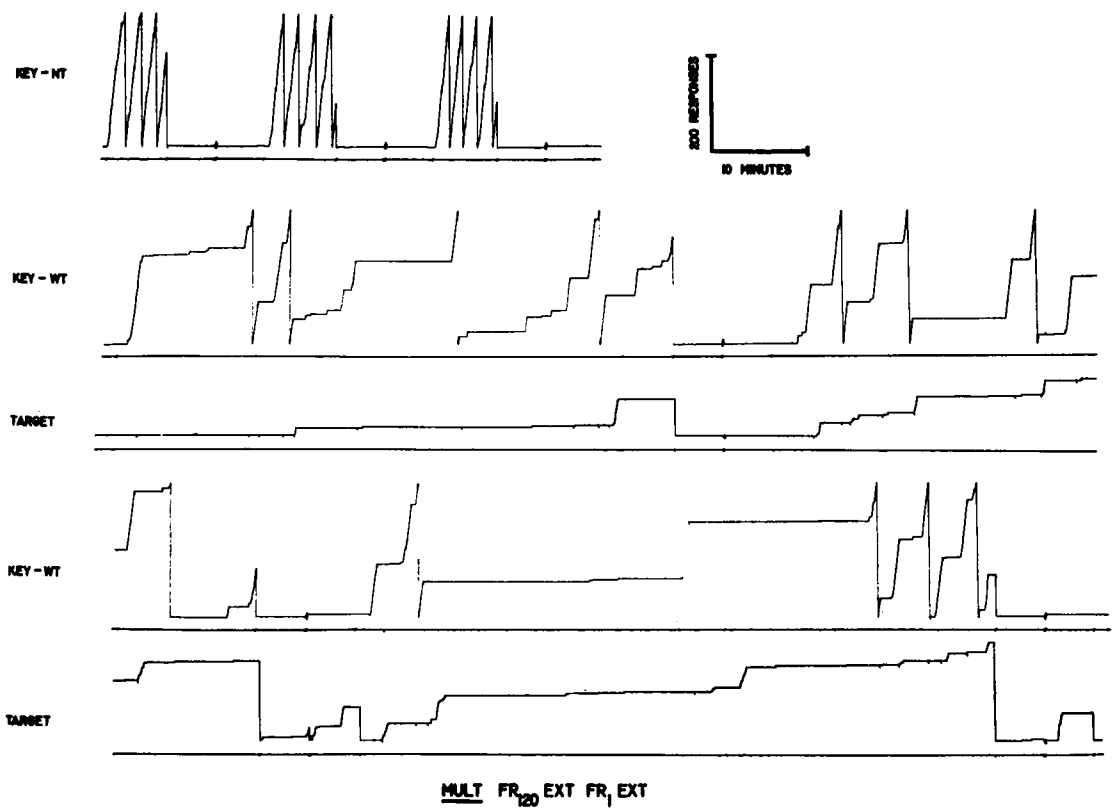

Fig. 6. These cumulative records are representative of the response pattern of Subject S-3 under two conditions. For all the records the upper line indicates the responding and the brief downward deflections indicate the occurrence of reinforcements. The deflections on the lower line indicate changes in the components of the multiple schedules of reinforcement from FR 120 to extinction to FR 1 to extinction. Record KEY-NT shows key pecking without a target bird present. Record KEY-WT shows key pecking when a target was present. Record TARGET shows target displacements during the same session as record KEY-WT. The brief downward deflections of the pen on record TARGET indicate the occurrence of reinforcement for the key pecking shown in record KEY-WT.

DISCUSSION

Azrin *et al.* (1966) demonstrated that extinction following continuous reinforcement would result in aggression between paired pigeons. The present results showed that aggression could be elicited by extinction following an FR schedule as high as FR 120. Thus, although FR has been shown to elicit aggression, so will the termination of an FR schedule elicit aggression.

Typically, the amount of aggression during extinction after both FR N and FR 1 decreased as a function of time since the last reinforcement, *i.e.*, more aggression occurred during the first minute of extinction than during the succeeding minutes of extinction. This result is in agreement with prior results (Azrin *et al.*, 1966). Ulrich and Azrin (1962) demonstrated that aggression can be very resistant to fatigue; thus, the resulting decrease in aggression over time in extinction does not appear to be due to fatigue. Other research has shown that the activity level of an organism and the probability of responding also decreases as a function of time in extinction (Bernstein, 1957). Just as the duration of extinction was a parameter in the research on other behaviors, it had an effect upon elicited aggression in this study. These data suggest that the aggression eliciting potential of extinction decreases as a function of time since the last reinforcement.

Within the multiple schedules of reinforcement, there were no apparent differences in the amount of aggression occurring during extinction following FR 1 and FR N. Thus, the hypothesis that the amount of aggression dur-

ing extinction would be differentially affected by the immediately preceding schedule of reinforcement was not supported. Hutchinson, Azrin, and Hunt (1968) made the tentative conclusion that a history of intermittent reinforcement would result in greater attack behavior during extinction than would a history of continuous reinforcement. Considering the extinction components in general, only one of five subjects showed an increase in aggression during extinction with increased FR N response requirements. One subject showed little change in extinction-elicited aggression throughout the study, and three of the five subjects displayed less extinction-elicited aggression with increased FR N requirements. Thus, the earlier conclusion by Hutchinson *et al.* (1968) was not supported. The discrepancy between the present study and the earlier research could be a function of the present use of multiple schedules of reinforcement. Also, the difference might be a function of species-specific differences; Hutchinson *et al.* (1968) used primates. Obviously, the effect of various schedules of reinforcement upon the aggression eliciting potential of extinction merits considerably more research.

The FR N schedules of reinforcement resulted in elicited aggression in pigeons. With increased FR requirements, aggression increased. Basically, these results are in concordance with both Gentry (1968) and Hutchinson *et al.* (1968). There were, however, slight differences in the temporal relationship between the aggression and the termination of reinforcement observed in this study and in the earlier research. With the lower FR requirements, almost all aggression coincided with post-reinforcement pauses; this result agrees with the results of Gentry (1968) and Hutchinson *et al.* (1968). With the higher FR requirements, proportionally larger amounts of aggression occurred during periods that did not coincide with the termination of reinforcement. The large amount of aggression that did not closely follow reinforcement termination and the occasional interruptions of ratio responding to aggress suggest that the aggression eliciting aspects of FR reinforcement are not confined to the post-reinforcement pause.

The fact that the experimental animals occasionally initiated attack immediately after the onset of the FR N discriminative stimulus, and never aggressed at the onset of the FR 1 discriminative stimulus, suggests that stimuli associated with FR reinforcement could acquire an aggression eliciting potential. This tends to be supported by the pigeons continuing to aggress when the discriminative stimulus for FR 120 was presented contingent upon aggression during extinction, and halting the attack when presented with the FR 1 discrimination stimulus.

The length and frequency of pausing during FR reinforcement schedules and the temporal relationship between pausing and reinforcement have been described in detail (Ferster and Skinner, 1957; Felton and Lyon, 1966). Both of these studies dealt with isolated individual organisms. Organisms submitted to FR schedules display a pause in responding after reinforcement terminates; the frequency and length of pause increases with increases in the FR requirement. All subjects in the present study displayed stable FR responding and typical pausing behavior when the target birds were not present. With the introduction of the target bird, even excluding the time engaged in attack behavior, the pigeons displayed extremely strained performance. These data strongly suggest that response data compiled on individual organisms might not be compared to multiple organism situations. Neither Gentry (1968) nor Hutchinson *et al.* (1968) reported such strained manipulandum responding. This difference in data might be a function of several procedural differences. Gentry (1968) incorporated an FR of only 50; in the present study the response strain was not as apparent during the lower FR requirements as it was during the FR 60 and FR 120 components. Hutchinson *et al.* (1968) used a pneumatic hose to record biting responses as the index of aggression; such an inanimate target might not disrupt responding as the like species targets did in this study.

An interesting aspect of the study involved the last few sessions when a short history of no reinforcement and no key pecking was being established. When first placed in the chamber, the birds displayed the stereotyped aggressive-like response. This suggested that there was a conditioning of the elicited aggressive response to the chamber itself. Ulrich *et al.* (1965) noted a similar response in rats with a history of shock-elicited aggression. Such responding lends support to conceptualizing schedule-induced aggression as an elicited response.

The removal of the key-peck response requirement eliminated aggression in the same manner as reported by Gentry (1968).

The present data suggest that further research on the aggression-eliciting aspects of intermittent reinforcement be undertaken. An assessment of higher FR schedules, both individually and in multiple schedules, is indicated. In order to determine whether the response requirement or the decrease in reinforcement frequency is most closely related to elicited aggression, temporal schedules of reinforcement should be assessed. Much of the research on schedules of reinforcement with single subjects should be duplicated with paired subjects to determine the amount of aggression elicited by each and the response disruption caused by the presence of another animal.

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