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Availability of an Aggressive Response During Sidman Avoidance

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AVAILABILITY OF AN AGGRESSIVE RESPONSE DURING SIDMAN AVOIDANCE

by

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Michael Albert Minervini

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INTRODUCTION

During the past fifteen years behavioral scientists have devoted considerable energy to the experimental analysis of aggression and escape/avoidance. Although research efforts were initiated along parallel and mutually exclusive lines, the two response classes have frequently been combined in experiments designed to test their interaction. One basis for such investigations was the discovery that aggression could be reliably produced by the presentation of an aversive stimulus, usually electric shock (Ulrich and Azrin, 1962). Since many of the aversive control schedules used to generate instrumental behavior also employed a good deal of noxious stimulation, researchers began to suspect that the escape/avoidance data might be confounded by the production of (heretofore unmeasured) aggressive behavior; conversely, the tendency to escape or avoid aversive stimuli could cast doubt on the inexorable nature of the pain-aggression reaction in studies which focused solely on aggressive behavior. The difficulty was simply that traditional escape or avoidance experiments afforded no opportunity to engage in attack behavior whereas the elicited aggression designs systematically precluded the option of either avoidance or escape (Ulrich, 1973).

Some research had already produced evidence which indirectly suggested that the potential for an attack response existed in a shock avoidance situation. The aggression reaction has proved to be both strong and reliable in response to shock - Azrin (1965) has shown that animals, when shocked, will actually work to produce a target. In addition other aversive enviornmental changes such as the onset of extinction and high value fixed-ratio schedules will produce aggression (Webbe, DeWeese and Malgodi, 1974). It seems reasonable, therefore, that the conditions engendered by a shock avoidance schedule might be sufficient to produce aggression. And, although escape/avoidance performance has proved relatively immune to deterioration when combined with a concurrent schedule of positive reinforcement (Kelleher and Cook, 1959; Catania, 1966), the opportunity to make an aggressive response might interact with on-going avoidance performance.

The research aimed at examining the aforementioned interaction has been characterized by a few basic design strategies and has yielded several general conclusions (despite some apparently conflicting results). A short review follows:

Ulrich and Craine (1964) reported that when individual rats, previously trained on a discriminated avoidance task, were paired with a second, naive subject, the avoidance performance suffered a large decrement, due, the authors suggest, to a concommitant increase in fighting or pre-fighting behavior (the assumption of a stereotyped fighting or sparring posture). A second study (Ulrich, Stachnik, Brierton and Mabry, 1966) revealed that when subjects were paired from the onset of training both their acquisition and maintenance were clearly inferior when compared to the avoidance efficiency of single subjects. Once again the results were attributed to occurrences of shock-elicited fighting. Furthermore, observation revealed that the avoidance lever presses were usually made by one member of the pair: "In such cases the non-avoider would attack, whereas the avoider struck both at the bar and toward the other animal."[1] In a third experiment Ulrich (1967) employed a cooperative escape procedure which required that a response be emitted (on separate levers) by each of two subjects working side by side in order for shock to be terminated. The results were unambiguous: fighting interferred considerably with escape, but only when a plexiglas partition separating the two subjects was removed. Replacement of the partition resulted in reinstatement of efficient escape behavior. The authors concluded: "Shock presented to animals that can fight raises the probability of fighting and lowers the probability of escape or avoid-

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[1]Ulrich, R. E., Stachnik, T. J., Brierton, G. R. and Mabry, J. H., "Fighting and Avoidance in Response to Aversive Stimulation." Behavior, XXVI 91966), 128.

ance. If the animals are close but cannot reach one another, fighting does not develop and escape is relatively unaffected. It therefore does not seem meaningful to speak of either reflexive fighting or escape avoidance as having dominance over the other without specifying the attending conditions."[1]

Perhaps the most systematic and convincing treatment of attack avoidance, and escape reactions was carried out by Azrin, Hutchinson and Hake (1967) in a series of six experiments which dealt directly with the interaction and relative prepotency of the fight and flight reactions.

The first two experiments were similar to Ulrich, et al's. (1966) study except that an escape (instead of an avoidance) contingency was in effect and restrained rats (isolated from shock) were used as targets. The results were basically the same: Single subjects demonstrated more rapid acquisition and superior maintenance as compared to subjects in the "social" condition. The second experiment showed that as the escape response became more difficult (via a ratio requirement) the probability of escape decreased and fighting frequency rose.

The third experiment by Azrin, et al. formed the basis for the present investigation and will, therefore,

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[1]Ulrich, Roger, "Interaction Between Reflexive Fighting and Cooperative Escape." Journal of the Experimental Analysis of Behavior, X (May 1967), 317.

be described in some detail. This study employed squirrel monkeys as subjects and focused on their performance in a schedule of continuous (Sidman) avoidance as a function of availability of an attack response directed at an inanimate target (bite hose). Since the animal was fixed by a restraining chair and faced both the aggressive and the instrumental manipulanda (which were readily accessible) the "spatial incompatibility" of the two previous experiments was eliminated; i.e., in the first two studies the escape lever and the restrained target rat were positioned in opposite corners of the chamber, precluding simultaneous access. During the first ten sessions no contingencies were in effect and baseline data were collected - five sessions of no-shock baseline (on lever and hose) and five sessions of hose biting baseline in response to regular, unavoidable shocks (hose in, lever removed). Next, the lever was replaced and training began on a schedule of Sidman avoidance (response-shock and shock-shock intervals = 30"). The effect of the attack response was assessed by periodic removal of the hose for (unequal) blocks of sessions (there are several additional details to the procedure outlined above, but these will be examined later). The results were straightforward: Once the animals became efficient avoiders they took very few shocks and bit the hose in short bursts (only) upon receipt of these shocks. Of greater interest here was the fact that the presence of the bite hose had no noticeable effect on avoidance rate or avoidance efficiency. The authors thus concluded that (as in the previous studies) aggression had been displaced, in this case by avoidance.

Azrin, et al's., three remaining experiments represent extensions of the one just described. In an attempt to reduce to a minimum any incompatibility between the two responses the fourth experiment required continuous lever holding as an escape response. As long as lever holding was effective, biting was nearly absent. Only when lever holding was made ineffective did attacks occur at high levels and escape responding diminish. The next study was concerned with attack during discrete-trials (signalled) avoidance. Here again bites were highly correlated with shock; i.e., no biting occurred during the conditioned stimulus; and, manipulation of hose availability had no effect on responding. In the sixth and final experiment an attack response (hose bite) forestalled shock in a discrete-trials avoidance procedure. The monkeys quickly learned to avoid in this situation; bites occurred within 2" of condition stimulus onset. When shocks were made unavoidable, however, most biting occurred in the absence of the conditioned stimulus.

The authors derived several important conclusions from their research. These include: 1) escape/avoidance was prepotent over attack behavior; 2) the response requirement was only conditionally important: "The response requirement ... was not important except insofar as it changed the frequency or duration of shock delivery. These results suggest a general rule: the amount of attack during a shock escape or avoidance procedure is determined by the frequency and duration of the shocks actually received under that procedure."[1]; 3) target availability was only conditionally important: "The presence of target appears to interfere with shock avoidance or escape behavior only when (1) the avoidance behavior is not eliminating the shocks, and, (2) the avoidance and attack reactions are physically incompatible."[2]

With respect to the quote in conclusion number two, Ulrich (1963) has reported some contradictory evidence. Using a procedure somewhat similar to the cooperation escape design described previously, these investigators found that aggression increased when the escape responses were rendered ineffective even though the frequency and duration of shocks _did_ _not_ increase. Perhaps Azrin, et al's. statement need only be qualified by an appeal to

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[1]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_, X (March, 1967) 145.

[2]ibid.

conditioning history.

More recent experimentation (Hayes, Daley and Cheney, 1969; Whitman and Doleys, 1973) on the fight/flight interaction seems generally to bear out the conclusion suggested by Azrin, Hutchinson and Hake (1967). A few studies, however, deserve mention. Wolfe, et al. (1971), for example, found that when a more naturalistic behavior (running) was designated as the escape response the preference for escape over attack was even more striking. In reference to Azrin, et al's. third conclusion (concerning target interference) it is significant that in this study the onset of escape availability immediately disrupted fighting despite the obvious "incompatibility" of the two responses (fighting and running). The authors also point out that their procedure guaranteed the occurrence of fighting or pre-fighting behavior at the time of escape availability. Apparently, then, aggressive responding becomes even less probable when juxtaposed with a "natural" alternative.

A final bit of evidence on the topographical requirements imposed in aversive situations comes from an experiment by Davis and Hirschorn (1973). Although similar to other designs in which individual subjects are given escape training and subsequently paired to evaluate the effects of a second animal, this study is notable both for the low shock intensity (.4 mA) employed and for the analysis of escape disruption which occurred in the social situation. Since the shock was not intense enough to produce reliable fighting the authors attempt to account for part of the deterioration of escape behavior by appealing to the species-specific characteristics of the escape bar press (Bolles, 1968). As this point is still in contention a complete explanation is not warranted here. Suffice to say that such an analysis radically alters the supposed source of a paired subject's interference.

One characteristic common to most of the reserach cited thus far is that the escape or avoidance schedule parameters were held constant while the behavioral interaction was studied. That is, once attack was made available the response requirements typically did not vary - except in those instances where responding was occasionally rendered totally ineffective (extinction). Azrin, et al's. second experiment is an exception to this trend - recall that in it the ratio requirement for escape was progressively increased utnil responding ceased. The results indicated that target interaction was greatest at intermediate fixed ratio values. The utility of this strategy becomes apparent if one considers the fact that few aversive contingencies remain invariant in social situations outside of the laboratory. Unfortunately, the escape program employed was plagued by the problem of "incompatibility" (the restrained rat and the escape lever were about 11 inches apart) and so the effect of the target may have been appreciably attenuated. The second block of experiments (the avoidance studies) eliminated the problem of incompatibility but did not incorporate any on-going changes in response schedules.

The present investigation, therefore, employed a procedure like Azrin, et al's. third experiment (already described) in which monkeys with access to both a bite hose and lever responded on a schedule of Sidman avoidance. However, when efficient avoidance had been established the response-shock and shock-shock values were progressively decremented in an effort to increase the probabilities of attack and the attack-avoidance interaction. Other deviations from the original design included: Subjects' histories, shock parameters, method of target evaluation, and session length. Finally, past data obtained in this laboratory indicated some possibility of facilitation (Hutchinson, Renfrew and Young, 1971) or "take-off" effects on the bite hose, which might well have completely displaced the avoidance responding.

METHOD

Subjects

The subjects were three adult male squirrel monkeys which were housed in separate, adjacent cages and maintained at ad libitum weight via several daily feedings (water was continuously available). Each of the subjects had served in at least one of several previous studies in which elicited attacks were punished (Ulrich, 1973; Mueller, 1974), however, no subject had ever been exposed to a reponse lever or to an experimental avoidance contingency. Only Subject 203 had apparently suffered any residual effects from his previous history in that shock-induced hose biting was almost completely suppressed. Subject 306 on the other hand, was such a vigorous biter that it was necessary to clip his canine teeth in order to prevent him from biting completely through the hose. This clipping was accomplished with no apparent detrimental effects. None of the subjects had been used for at least four months.

Apparatus

Hutchinson, Azrin and Hake (1966) have described in detail a restraining apparatus and bite hose assembly which closely approximate the arrangement used in this laboratory. Briefly, this consisted of a plexiglas restraining chair which allowed the subject freedom of movement from the waist up (unlike Hutchinson's apparatus, no neck yoke was employed). The subject thus faced an intelligence panel which contained a retractable bite hose and response lever and an unused food magazine. The semicircular (Mueller, 1974) bite hose (natural latex surgical tubing) was 5/8" in diameter and projected through a slot in the panel at about the subject's eye level (a masonite mask prevented access to the hose when it was retracted). Bites of sufficient intensity displaced a volume of air which, via a pressure transducer closed a microswitch and defined an attack response. Approximately 5" below and 2-1/2" to the right of the hose was a senitive response lever which, when depressed, produced a faint click (as did the hose microswitch). Half second, 300 volt AC shocks (compared to Azrin, et al's. 100 mesc, 150 volt shocks) were delivered through a 50,000 ohm series resistor to two brass electrodes which rested on the shaved portion of a subject's partially restrained tail. The animal colony room separated the test chamber room from an equipment area which contained the electromechanical switching systems and recording equipment used to control the experiment and collect data. A ventilation fan generated masking noise throughout the session and an incandescent lamp provided ample chamber illumination.

Procedure

Sessions were conducted seven days a week with no exceptions. Each subject's tail was shaved every Monday just prior to the session. A 50% alcohol solution was used to clean the tail about three times a week and EKG-Sol was used daily to minimize skin resistance. Hoses were replaced periodically. Sessions were typically 70' long (whereas Azrin, et al's. were 5 and 8 hours in duration). However, during the first and last 5' of every session the animal simply sat in a dark, quiet chamber. Although no shocks were being presented and no contingencies were in effect during this time bites and lever presses were recorded. Operation of the house light and fan signalled the beginning of the session proper.

In order to determine operant levels of biting and lever pressing each subject was exposed to a no shock baseline until responses on both manipulanda approached zero. Subject 105 and Subject 203 were run for thirteen sessions while Subject 306 had only six sessions in this phase.

Next, biting levels were established with a shock baseline schedule during which the lever was retracted (to prevent confouncing effects) and unavoidable shocks were presented every 2' for a total of 30 shocks per session. Subject 105 was run for eleven sessions and

Subject 306 for six; Subject 203 (the non-biter) was also run for eleven sessions but one of these was an extra long session in which the frequency and duration of shocks were manipulated to see if any biting could be induced. The next phase was acquisition and maintenance of Sidman avoidance. During acquisition it was necessary to individually manipulate each subject's response-shock and shock-shock (RS/SS) intervals in order to work up to the target parameters gradually. The final RS/SS intervals were both 30" for all subjects. During this condition the presence of the hose on any given session was determined by a table of random numbers (see Table I). It was felt that Azrin, et al's. original procedure of presenting the hose for a block of sessions might have led to target adaptation. At one point after the response had been acquired the experimenter noticed that Subject 306 (due to a programming flaw) was able to occasionally terminate the shock prematurely by making a low latency bar press. This was an atypical pattern and was quickly corrected with a program modification. The Sidman-avoidance training continued until all subjects developed stable and efficient responding. Up to this point the procedure followed was nearly identical to that of Azrin, et al's. third experiment.

The final and critical manipulation made the avoidance contingencies more difficult by decreasing the RS/SS

TABLE I

TARGET AVAILABILITY AND AVOIDANCE PARAMETERS

SUBJECT 105			SUBJECT 203			SUBJECT 306		
SESSION	HOSE	RS/SS	SESSION	HOSE	RS/SS	SESSION	HOSE	RS/SS
34	OUT	30"				20	OUT	30"
35	IN	30"	35	OUT	30"	21	IN	30"
36	OUT	30"	36	IN	30"	22	IN	30"
37	OUT	30"	37	IN	30"	23	OUT	30"
38	IN	30"	38	OUT	30"	24	OUT	30"
39	OUT	30"	39	IN	30"	25	IN	30"
40	OUT	30"	40	IN	30"	26	IN	30"
41	IN	30"	41	OUT	30"	27	OUT	30"
42	OUT	30"	42	IN	30"	28	IN	30"
43	IN	30"	43	OUT	30"	29	OUT	30"
44	OUT	30"	44	IN	30"	30	IN	30"
45	OUT	30"	45	IN	30"	31	IN	30"
46	IN	30"	46	OUT	30"	32	IN	30"
47	IN	30"	47	OUT	30"	33	OUT	30"
48	OUT	30"	48	IN	30"	34	OUT	30"
49	OUT	30"	49	IN	30"	35	OUT	30"
50	IN	30"	50	OUT	30"	36	IN	30"
51	IN	30"	51	OUT	30"	37	OUT	30"
52	OUT	30"	52	IN	30"	38	IN	30"
53	IN	30"	53	OUT	30"	39	IN	30"
54	OUT	30"	54	IN	30"	40	OUT	30"
55	IN	30"	55	OUT	30"	41	OUT	30"
56	IN	30"	56	OUT	30"	42	IN*	20"
57	IN	30"	57	OUT	30"	43	IN	30"

*Should have been OUT

TABLE I (continued)

TARGET AVAILABILITY AND AVOIDANCE PARAMETERS

SUBJECT 105			SUBJECT 203			SUBJECT 306		
SESSION	HOSE	RS/SS	SESSION	HOSE	RS/SS	SESSION	HOSE	RS/SS
58	OUT	30"	58	IN	30"	44	IN	30"
59	OUT	30"	59	IN	30"	45	IN	30"
60	OUT	30"	60	IN	30"	46	OUT	20"
61	IN	30"	61	OUT	30"	47	OUT	10"
62	OUT	30"	62	IN	30"	48	OUT	5"
63	IN	30"	63	OUT	30"	49	IN	5"
64	IN	30"	64	OUT	30"	50	OUT	5"
65	OUT	30"	65	IN	30"	51	IN	5"
66	OUT	30"	66	IN	30"			
67	IN	20"	67	OUT	30"			
68	IN	10"	68	OUT	30"			
69	IN	5"	69	OUT	30"			
70	OUT	5"	70	OUT	30"			
			71	OUT	20"			
			72	OUT	10"			
			73	OUT	5"			
			74	IN	5"			
			75	OUT	5"			
			76	IN	5"			

intervals from 30" to 5" over the course of three sessions. Subject 105 was run for thirty-three sessions on RS/SS = 30". Then, on session 67 - 70 the RS/SS values were 20", 10", 5" and 5" respectively. The hose was present on sessions 67, 68 and 69 but absent on session 70 (the second day at 5"). Subject 203 after being run on RS/SS = 30" for thirty-six sessions was given a similar treatment starting with session 71, except that the hose was absent until session 74 (the second day at 5") at which point it was replaced. This subject also received two extra sessions at 5"; Session 75 - hose out, and session 76 - hose in. The final subject, Subject 306, was run for twenty-two sessions at RS/SS = 30". Then, due to an experimental error this subject was accidently run for one session at RS/SS = 20" with the hose in when it should have been out. This was corrected by running three additional sessions at 30" with the hose out in order to re-establish the pre-manipulation conditions. The Subject 306 was also "taken down" (final phase) between sessions 46 to 49 with the hose absent on sessions 46 - 48 and present on session 49 (the second day at 5"). This subject also received two extra sessions (50 and 51) at 5" with alternating hose availability. The rationale for the hose manipulation during this final stage was simply that it might have been possible for an animal to learn not to bite as the avoidance parameters were decreasing, since an attack duration which exceeded the shock-shock interval would end in shock. Therefore, two subjects (a biter and a non-biter) were brought down to 5" with the hose out in order to prevent the possibility of punished attack (which would certainly have reduced the probability of target interference). Once at 5" (the most difficult condition) the hose could be evaluated by its re-introduction.

RESULTS

During the no shock baseline rates of lever pressing quickly tapered to negligible values (Subject 105 had the highest average at less than two responses per minute). Hose biting displayed the same pattern. Subject 105 was the only subject who bit the hose with any regularity, at an average of fourteen bites per session (but even this animal was down to only four bites for the last session of this phase). The shock baseline condition produced an immediate effect on two animals: Subject 105 attained an average of about 330 bites per session, and Subject 306 bit roughly 200 times per session. Subject 203, however, presumably due to his long punishment history, registered only three biting attacks during the entire phase. In fact, biting was not induced in an extra session in which both frequency and duration of shock were manipulated.

Table II indicates that the presence of the hose had no systematic effect on either the number of lever presses emitted or the amount of shocks received (although the latter is clearly a more valid index of avoidance efficiency). Target and no target performances are nearly identical. Although there are considerable individual differences with respect to lever pressing rates, the frequency of shocks received is consistently low across subjects.

TABLE II*

EFFECT OF TARGET AVAILABILITY
ON SIDMAN AVOIDANCE PERFORMANCE

SUBJECT 105	HOSE IN	HOSE OUT
Lever Presses/Min.	14	16
Shocks/Hr.	9.8	16.4
No. of Sessions	15	18

SUBJECT 203	HOSE IN	HOSE OUT
Lever Presses/Min.	45	47
Shocks/Hr.	10.5	9.9
No. of Sessions	17	16

SUBJECT 306	HOSE IN	HOSE OUT
Lever Presses/Min.	9	9
Shocks/Hr.	5.6**	6
No. of Sessions	10	11

*NOTE: The data recorded in these averages were taken from only those sessions which employed an RS/SS interval of 30" i.e., acqusition and final manipulation data have been purposefully excluded.

**One session omitted from computation due to power failure.

The uppermost cumulative records in Figures I, II, and III show terminal performance on the 30" avoidance schedule. Subject 105 and Subject 306 could probably be described as more efficient avoiders than Subject 203 in that their response rates are fairly low and steady whereas Subject 203 had a tendency to respond in extremely rapid, spaced bursts. All three subjects, however, were clearly avoiding most of the scheduled shocks. As it happened, Subject 306 had the hose available on this last day (session 45) before the final phase change and a close inspection of the record will show that the hose bites (event line) were almost coincident with shock onset (indicated by deflections of the response pen). This pattern was typical throughout training. Also notice the pauses in responding after shock delivery. This indicates that a short attack burst usually intervened between shock delivery and resumption of lever pressing; i.e., the two types of responding were sequential rather than simultaneous in nature. These pauses cannot, however, be wholly attributed to competition from hose biting since they are also evident on Subject 105's record (no hose session). Visual observation revealed that on those days on which the hose was not available subjects sometimes directed their "attacks" at the mask which prevented access to the target. It is also interesting that these records show no evidence of the "warm-up" effect which sometimes

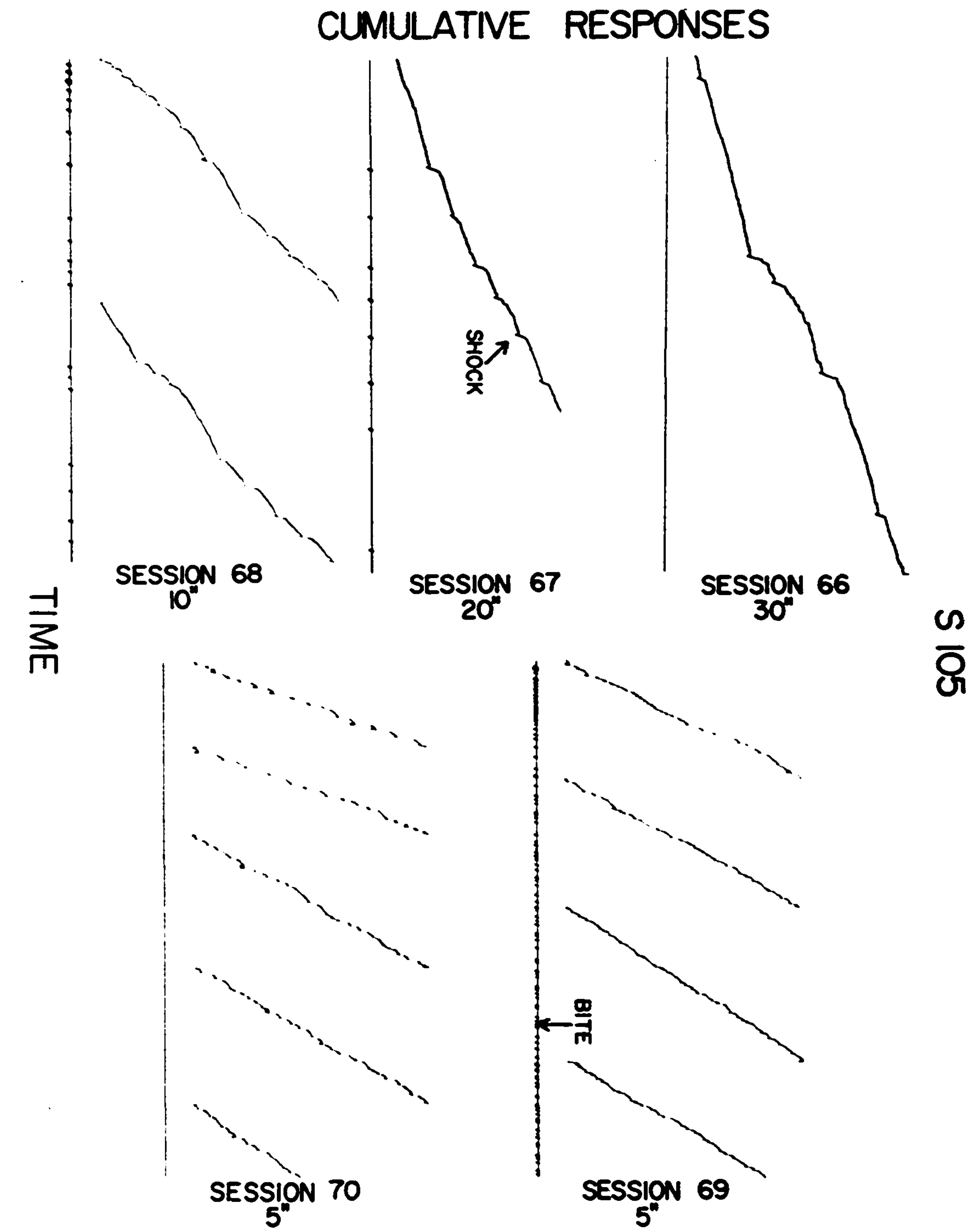

FIGURE I CUMULATIVE RECORDS REPRESENTING FINAL PHASE PERFORMANCE FOR SUBJECT 105

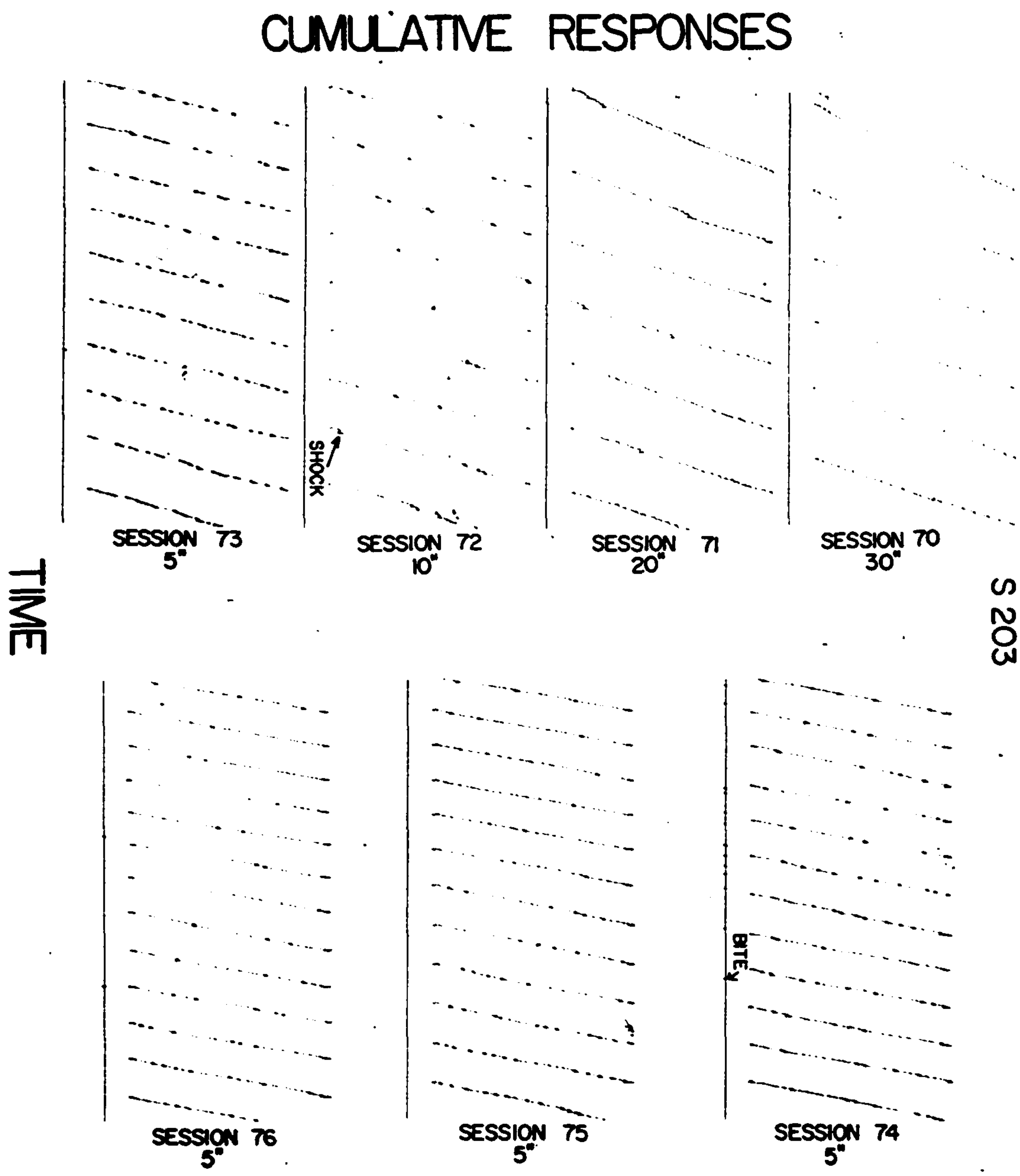

FIGURE II CUMULATIVE RECORDS REPRESENTING FINAL PHASE PERFORMANCE FOR SUBJECT 203

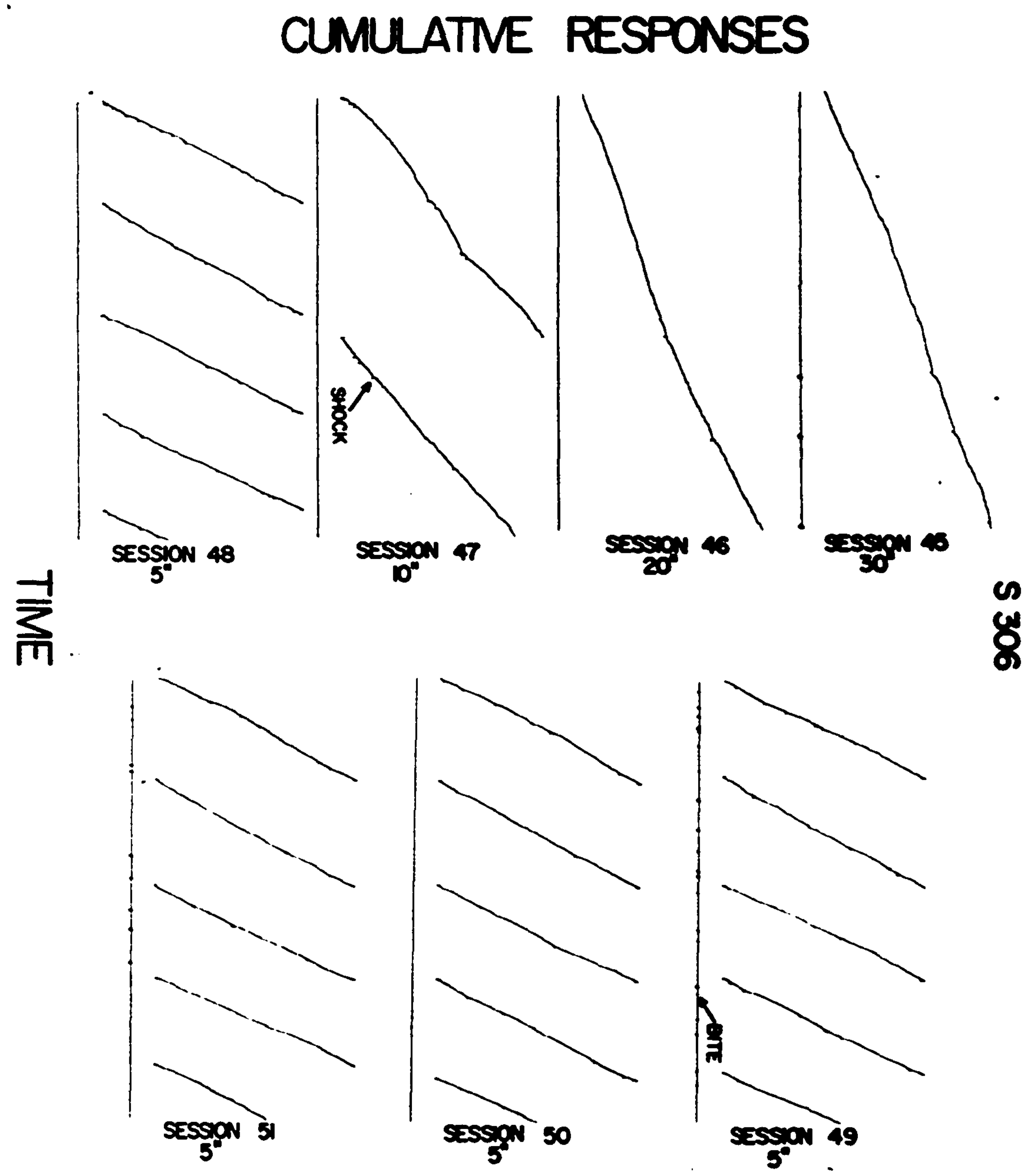

FIGURE III CUMULATIVE RECORDS REPRESENTING FINAL PHASE PERFORMANCE FOR SUBJECT 306 characterizes Sidman-avoidance performance.

The results of the final phase are represented in Figures IV, V and VI as non-cumulative data. Recall that Subjects 203 and 306 were exposed to avoidance parameter decrements without a target whereas Subject 105 underwent identical manipulations, but with the hose in. Adjustment to the increasing demand characteristics of the avoidance schedule is reflected by drastic increments in all three dependent measures: Response rate, bites and shocks. However, the two crucial points are the ones which represent the number of shocks received on the last two days (RS/SS = 5"). For all three subjects there is a drop in the number of shocks taken on the second day at 5" relative to the previous session. The fact that this occurred for subjects 203 and 306, who had the hose present on this final day, indicates that a single day's exposure to the 5" avoidance schedule overrode any debilitating effects which might be ascribed to an aggression-avoidance interaction. Notice also that for Subject 105, removal of the target on the second session at 5" did not greatly facilitate performance. Moreover, this subject apparently never learned "not to bite" (see Procedure), since 455 attacks were registered on the first 5" avoidance session.

Finally, Figures I, II and III show how the individual response rates changed over the course of the manipulation. Far from any deterioration or breakdown in performance all

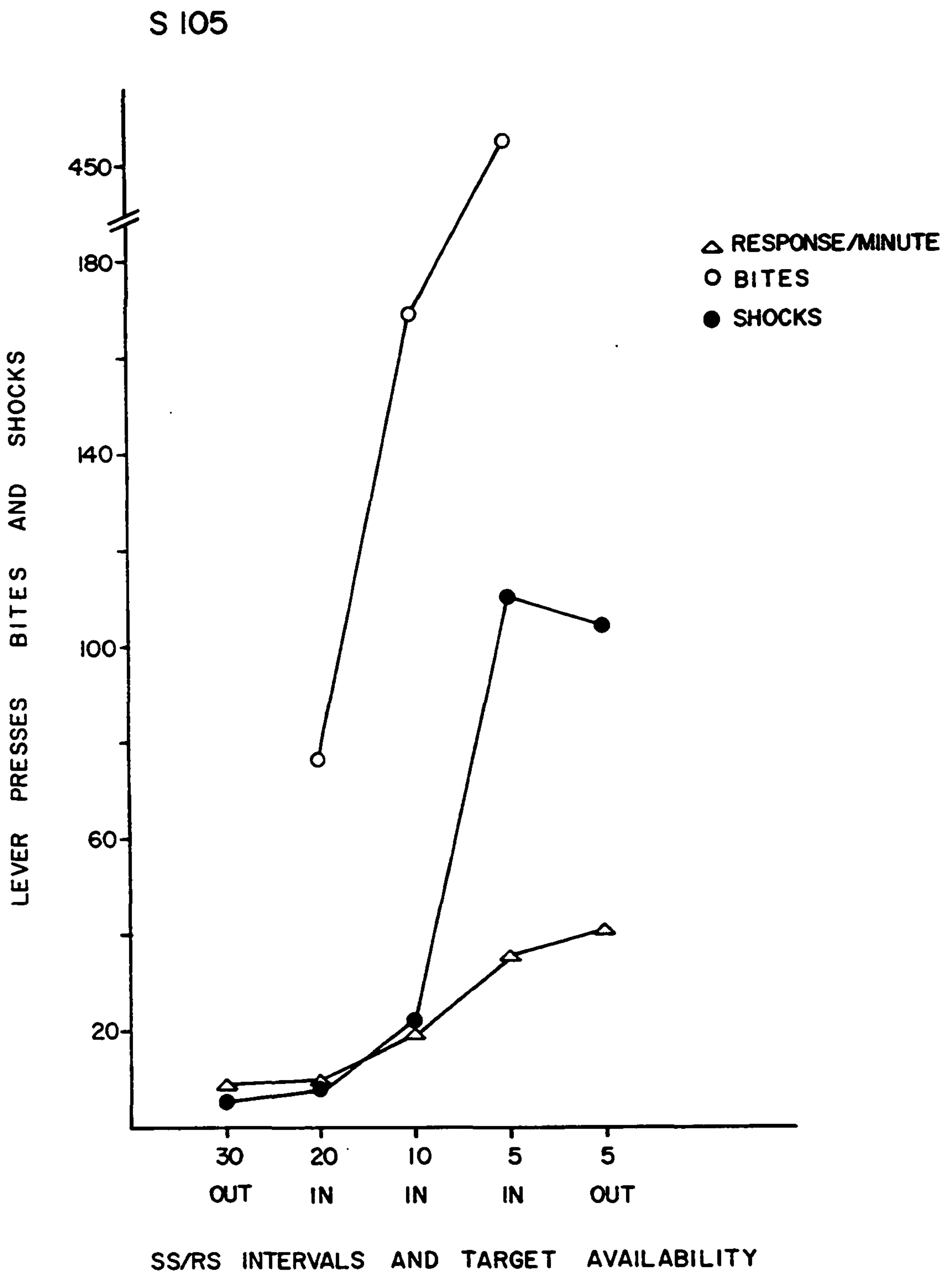

FIGURE IV PERFORMANCE AS A FUNCTION OF RS/SS INTERVALS AND HOSE AVAILABILITY FOR SUBJECT 105

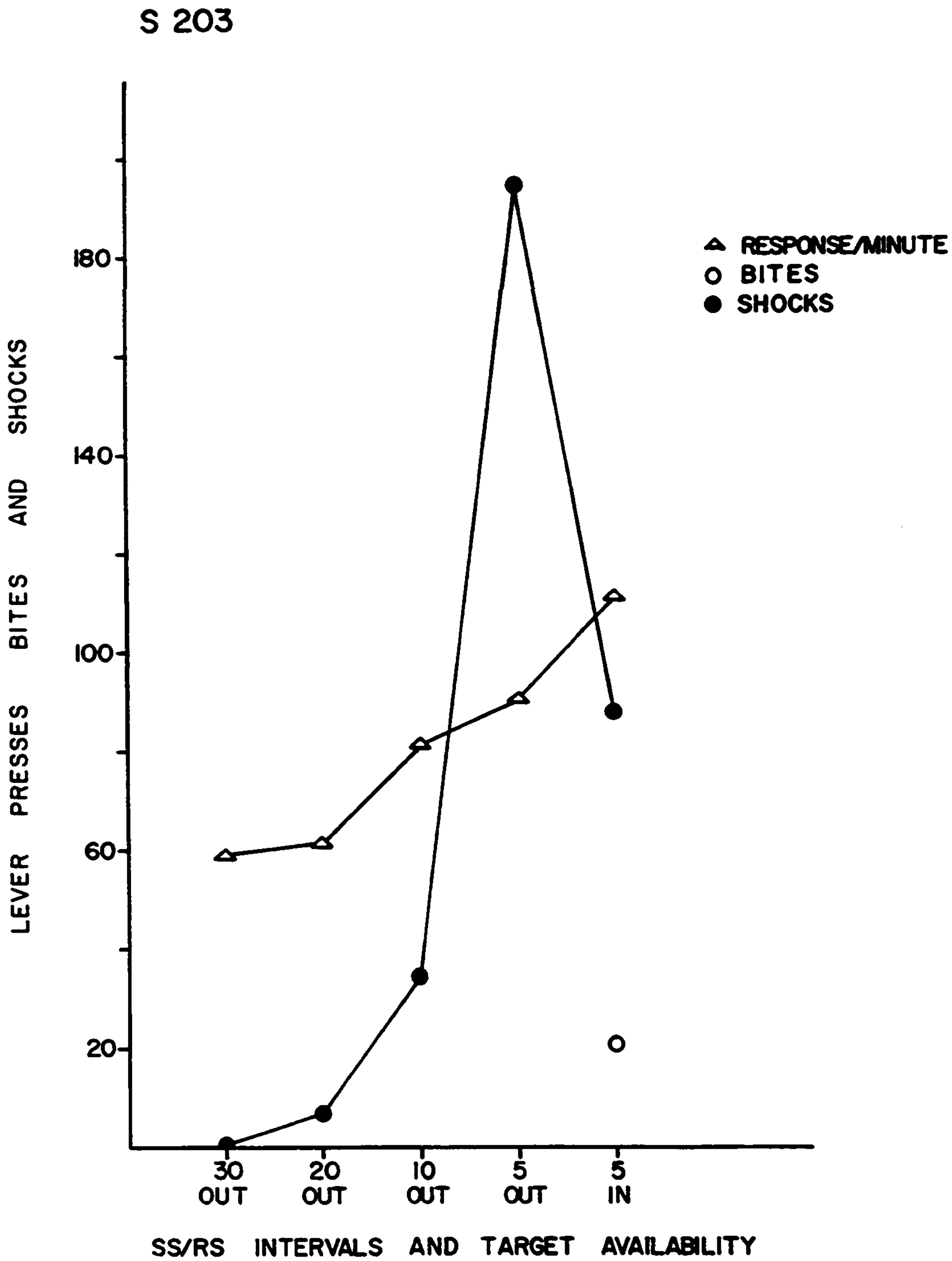

FIGURE V PERFORMANCE AS A FUNCTION OF RS/SS INTERVALS AND HOSE AVAILABILITY FOR SUBJECT 203

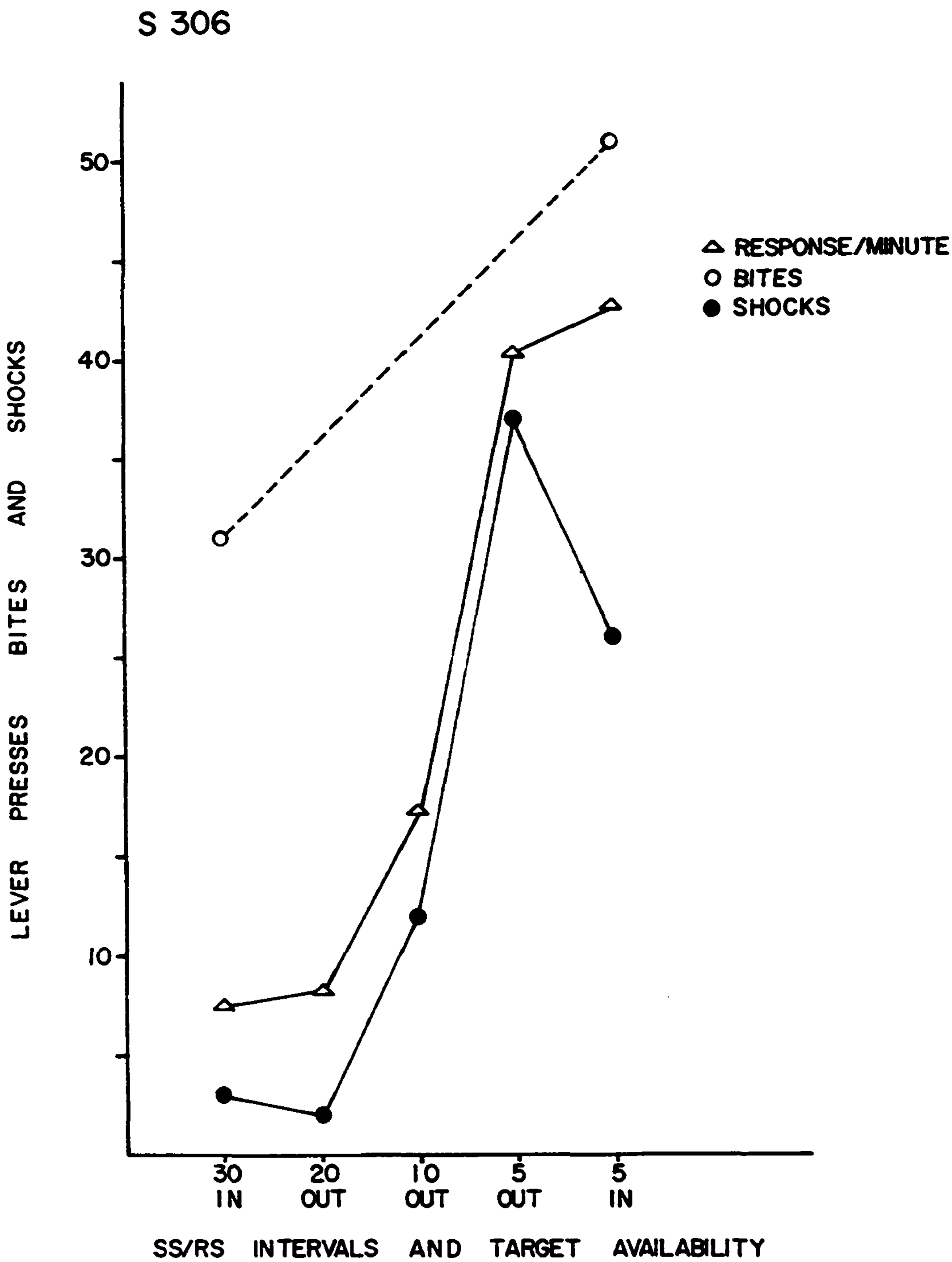

FIGURE VI PERFORMANCE AS A FUNCTION OF RS/SS INTERVALS AND HOSE AVAILABILITY FOR SUBJECT 306 subjects matched the changing response requirements with appropriate between session increases in rate. The records are all fairly stable, there were no unusually long pauses or gross within session fluctuations in lever pressing. In addition, the bite-shock correlation stayed high and the target manipulation was apparently once again ineffective. The last two records for Subject 203 and Subject 306 (not shown in the non-cumulative graphs) represent extra sessions run in order to provide additional evidence that efficiency improved over time, irrespective of hose availability.

DISCUSSION

Results obtained from the first portion of the present study constitute a replication of Azrin, et al's. (1967) finding that availability of a (compatible) attack response had only a negligible effect on on-going avoidance performance. Predominance of the flight reaction was continually in evidence despite the fact that the aggressive and avoidance responses were not physically incompatible, as in the "social" interaction studies (see Introduction). This incompatibility and the topographical characteristics of the response requirement (Wolfe, Ulrich and Dulaney, 1971) probably account for most of the discrepancies between the present data and those generated in some of the paired subject investigations (Ulrich, 1973; Logan and Boice, 1969). There is, however, another fact which might explain the conflicting results sometimes obtained with animate versus inanimate targets; i.e., the variety of stimuli which might be produced by the presence of another animal in the chamber. In most of the literature cited thus far the interference arising from a second subject has usually been interpreted in terms of the shock-induced fighting or threat behavior which directly infringes on time otherwise spent avoiding or escaping. These experiments also typically employed shock intensities which reliably elicited attack (Ulrich, 1973; Azrin, Hutchinson

Hake, 1967). Some recent studies, using considerably lower intensities (Davis and Hirschorn, 1973; Davis, 1969), have also reported avoidance and escape decrements but the incidence of shock induced attacks has been relatively low. These researchers attribute the avoidance disruption to other social phenomena such as sexual behavior, grooming, etc., which have all been observed in response to shock; and, in some cases, to non-shock induced fighting or fighting threats, indicative of "competition" for the lever (Davis, 1969).

There are, then, other sources of interference in a paired subject situation which are apparently unrelated to shock-induced aggression. Thus, the methodology of Azrin, et al. (1967) deviated from traditional designs along at least two notable dimensions: The use of an inanimate target, which simplified quantification of aggression (Hutchinson, Azrin and Hake, 1966); and, the employment of restrained subjects (isolated from shock) in those situations which called for a live target. Although the presence of two freely moving organisms in a chamber more closely parallels extra-laboratory social situations, the arrangement sacrifices a good deal of rigor since the stimuli present (during a fight, for example) are not under experimental control. A number of important variables, including counter-aggression, are thuse free to vary.

The second part of the present investigation was designed to test whether Azrin, et al's. (1967) failure to detect a significant interaction was due to the fact that the 30" avoidance schedule had simply become too easy for the subjects. In other words, performance had become so efficient that the variables responsible for aggression might no longer be present. Apparently this was not the case since the tendency to avoid remained strong in spite of greatly exaggerated response requirements. As "take off" biting or "facilitation" (Hutchinson, Renfrew and Young, 1971) was never observed in any subject, its potential effects cannot be assessed here. It may be possible that the avoidance schedule itself precluded this phenomenon.

These results support indications from early research that avoidance behavior would persist in competition with other sources of interference such as schedules of positive reinforcement (Kelleher and Cook, 1959; Catania, Deegan and Cook, 1966) and, more recently, elevated ambient temperatures (Barofsky, 1971). Neither portion of the present investigation, however, lends credence to the well known two process theory of avoidance[1] (Campbell and Church, 1969) - given the assumption that the presence of a conditioned emotional response could be sufficient to produce

[1]Two-process avoidance theory contends that the animal responds to terminate a conditioned aversive state brought on by the extroceptive or introceptive stimuli that signal the imminence of shock.

attack. Such an account would suggest that biting might be distributed throughout the inter-shock interval, especially during the period which immediately preceeds shock, since this is when the conditioned emotional responses are presumably at maximum strength. The cumulative records indicate that such biting rarely occurred.

Also of relevance to this study is an impressive body of literature on shock produced instrumental responding (Hutchinson, Renfrew and Young, 1971; Hake and Campbell, 1972). These experiments describe a characteristic pattern of lever pressing and biting produced by non-contingent shock which is very similar to the terminal performance obtained here (with a contingency); lever presses predominate before shock, dropping off immediately prior to shock delivery; after shock delivery lever pressing occurs at a relatively low rate as a short burst of biting is emitted. Although this sequence roughly describes what happened here, the avoidance contingency seems to have had some effect in this experiment since bites did not completely supplant lever pressing after shock delivery - the transfer from the hose to the lever was sometimes extremely rapid, resulting in virtually no post-shock pause in lever pressing. This pattern became even more striking as the avoidance parameters were reduced. The research on shock-induced responding, therefore, only partially accounts for the distributions obtained here.

The present findings also confirm ancedotal evidence that attack may play an unsuspected role in studies which have measured only "instrumental" behavior. For example, Pear, et al. (1972) have reported that the post-shock "bursts" and the unusual resistance to extinction often associated with non-discriminated avoidance may be traced to bar biting. Such an interaction would actually facilitate acquisition of the "operant" response. This post shock bursting is analogous to the attacks frequently observed during the post-reinforcement pause of a fixed ratio schedule of positive reinforcement (Gentry, 1968).

Future research on the aggression-avoidance interaction might do well to focus on the effects of lower shock intensities on paired subject escape or avoidance since interference from elicited attack is well documented (Davis and Hirschorn, 1973). At higher intensities shock frequency appears to be a sufficient, although probably not the sole determinant of attack, and it would be useful to study other (social) sources of the agonistic interaction. Another line of investigiation with more direct implications for human behavior would be the area of modification of the aggressive tendency in aversive situations. The emphasis on control is warranted by the fact that aversive enviornments are probably here to stay. The initial research has been encouraging; both the fight and flight reactions seem labile (Ulrich, 1973; Wolfe, Ulrich and Dulaney, 1971; Baenninger, 1970), and the behavioral bias is already in our favor: "Although various escape, avoidance, and attack parameters have been manipulated, with each variation changing the likelihood that attack or escape would be predominant, research to date seems to indicate that if organisms are allowed some effective (and not too difficult) means of escape from aversive stimulation this behavior will predominate over attack reactions. Qualifying this statement are, of course, complex interactions between events that usually determine the escape or avoidance performances and those that determine attack behaviors."[1]

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[1]Ulrich, R., Dulaney, S., Arnett, M., Mueller, K., "An Experimental Analysis of Non-Human and Human Aggression." The Control of Aggression, Chicago: Aldine Publishing Co., Chapter 4, (1973), p. 86.

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