4-1973

Conditioned Suppression in Humans as a Function of Task Complexity

Henry H. James
Western Michigan University

CONDITIONED SUPPRESSION IN HUMANS AS A FUNCTION OF TASK COMPLEXITY

by

Henry H. James

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
April 1973

CONDITIONED SUPPRESSION IN HUMANS AS A FUNCTION OF TASK COMPLEXITY

Henry H. James, M.A.

Western Michigan University, 1973

Due to the nature of the paradigm and subject variability conditioned suppression has been difficult to study in human beings. In the present study performance by humans on a Polar Pursuit Tracker was maintained with money presented according to one of three schedules. Superimposed on this operant were pairings of a 15 sec tone and a 1/2 sec 23-ma @ 1200-vac shock. Each session was divided into four periods. These consisted of a 10 min practice period, a 15 min tone alone period, a 15 min tone shock pairing, and a 15 min tone alone extinction period. There were eight presentations of the tone during each of these periods, and each period was separated from the other by a 5 min break. Task difficulty was varied by altering the speed of the tracker. No change in the accuracy of tracking was obtained during the tone alone control trials, followed by a substantial disruption during the tone-alone shock pairings, and a gradual return to the tone alone baseline after the deletion of shock in the extinction trials. Suppression was sensitive to changes in both task difficulty and reinforcement conditions.

ACKNOWLEDGEMENTS

My thanks to Dr. David O. Lyon, for his equipment, financial resources and good humor. My appreciation to the Psych 160 staff of my thesis era for so generously giving of their time toward my subject recruitment. My gratitude to my committee members, Dr. Neil Kent and Dr. Paul T. Mountjoy; my ex-officio committee member, editor and chief counselor, Syd Dulaney; Kathy for her many hours at the typewriter; and the Midget for her photographic artistry. My greatest debt is to my partner, J. Steven Kiraly, without whose technical expertise this research would not have been possible, and without whose companionship it would not have been fun.

Henry H. James

TABLE OF CONTENTS

Conditioned suppression is a rate decrease during a stimulus which precedes a brief response independent shock, and is considered as the experimental definition of anxiety (Estes and Skinner, 1941). This phenomenon, so easily produced in lower animals, however, has been very difficult to study in humans (Davis, 1968). Sometimes rather than suppression, facilitation occurs during the CS (Kanfer, 1958) or even more confusing, facilitation for some subjects and suppression for others (Toomey and Sidman, 1970).

The present study represents a group research design arranged to demonstrate conditioned suppression in humans. By describing the data with group curves it was hoped the effects of inter- and intra- subject variability could be reduced leaving the more consistent suppression effect for observation.

Inherent in the study of conditioned suppression in humans is a sensitive central problem which may negate all data. If the CS shock pairing is aversive enough to suppress an operant in the experimental setting, it is likely that the human subject will escape the experimental situation rather than suppress his behavior as does his captive infra-human counterpart. In an attempt to widen the range of paramenter values at which human suppression would occur a sensitive response measure was sought. Tracking a target on a Polar Pursuit Tracker was chosen as the task for it requires a fairly high degree of response differentiation, visual

discrimination, and a constant behavioral output on the part of the subject.

Shock values selected for earlier human studies have not been typically "intense". Wherry and Curran (1966) used "pain thresholds" as did Sachs and May (1966). A more recent study by Sachs and Keller (1972) used values up to 5 ma @ 240 vac with some success. In order to decrease any ambiguity regarding the subjective reports of pain, subjects in the present study sustained 23 ma @ 1200 vac. An approximate subjective equivalent is plugging one's car keys into a wall receptacle. To further potentiate any suppression a 15 sec CS was used. As incentive to remain in the experimental situation under such conditions a $10.00 fee was offered for approximately one hour of participation.

Risk of losing subjects through failure to return to the experimental setting was eliminated by exposing the subject to all phases of the study in one session. Risk of early session abortion by subjects was reduced by the contingency that the payment would only occur if the subject completed all phases of the experiment.

METHOD

Subjects

Subjects consisted mostly of students from introductory classes in psychology at Western Michigan University. Signs offering money were posted in building hallways near these classrooms and interested students signed up for appointment slots. The signs read: "Money available to 150 students for participation in experiment. Conditions: 1. You must be a 150 student. 2. You must be on time."

Since these were beginning students and therefore unfamiliar with the suppression paradigm, they were considered naive. Questions asked each subject at the end of their session concerning the experience confirmed this supposition.

A few other subjects were drawn from a population of acquaintances of E who expressed an interest in making money. These subjects were also unfamiliar with the conditioned suppression paradigm.

A total of 97 people showed up for appointments and participated in the experiment. Of these, 59 were included in the research proper. Of the remaining 38, nine were pilot subjects used to determine the lower limit of the tracking speed and to calibrate the shock apparatus. Due to programming or recording failure 15 were discarded and 10 voluntarily terminated the experiment

prior to its completion. The remaining four subjects were run at a high tracking speed of 70 R.P.M.'s and so little data were obtained that they were not included in the study.

Apparatus

Experimental chamber

The chamber room was 80" X 42" X 112" carpeted with indoor-outdoor carpeting and sound attenuated with acoustical tile on the ceiling and walls. Illumination was provided by a 15-w. incandescent bulb and sound masked by a 30-db white noise source.

A model PR-16A Shaw Laboratories Polar Pursuit Tracker was mounted on a 3' X 2' table at approximately a 45° angle from horizontal such that the tracking screen was more accessible to the subject. The pattern on the screen was triangular with squared apexes as shown in Figure 1. A moving light target followed the pattern and was tracked with a curved stylus containing a photo cell. The control panel was mounted on the logic rack outside the chamber. A 110 vac counter mounted to the front lower edge of the tracking screen gave the subject feedback on acquired reinforcers.

Mounted on the wall above the tracker was a Gerbrands universal dispenser enclosed in wood. Quarters could be dropped in a 4" X 4" X 4" clear plexiglas box mounted on the bottom of the dispenser at about eye-level. The subjects could see quarters earned, but because the box was locked could not obtain them

until the end of the session.

Control logic, programming, recording and input equipment

Control and integration of programming and recording were done through BRS solid state logic. This included a pulse former which emitted 5 pulses/sec that were channeled through logic controlled by the on-target or off-target state of the photocell in the tracking stylus. Pulses occurring during the on-target state of the photocell activated "on-target" counters, recorder pens and solid state storage bins. Off-target states activated the appropriate "off-target" recorders. The use of a pulse train converted a temporal measure of time-on and time-off target to more manipulable complimentary counts of "hits" and "misses". This same logic provided the duration and sequencing of the CS-UCS presentations.

Overall session timing, VI reinforcement scheduling and CS-UCS presentations were controlled by a BRS two-channel tape programmer. Thus, the temporal relationships between these stimuli were the same for all subjects.

Data were automatically recorded in five areas:

1. Reinforcers presented were counted on a Sodeco counter.
2. CS-Tone presentations were counted on a Sodeco counter.
3. Total hits and misses were counted on Sodeco counters.
4. Hits, reinforcers and CS presentations were recorded on a Gerbrands cumulative recorder.
5. Hits during a 15-sec time sample immediately preceding

the 15-sec CS presentation were printed along with hits tallied during the CS by a printout recorder for the computation of suppression ratios.

In addition, skin resistance across the surface electrodes was monitored with a VTVM, volt-ohm meter.

A model BRS SG002 electronic shock source provided a stimulating 23 ma at 1200 vac as the UCS. These shocks were presented through a pair of surface electrodes mounted in plastic 2" apart and attached to the unfavored inside forearm about halfway between elbow and wrist with an Ace bandage. The bandage held firmly but still allowed instant electrode removal at the subject's discretion by simply pulling on the exposed cable.

The CS was generated at 4000 hz by a RCA model 154 audio oscillator through an amplifier. It was presented to the subject at about 80 db by a 6" metalic exponential hi-fi speaker horn mounted under the tracker table.

Procedure

Experimental design

Subjects were run in an overall 3 X 4 design to detect sensitivity of conditioned suppression to three different reinforcement conditions and four levels of task difficulty as shown in Table I. Unfortunately, after the equipment was dismantled a subject had to be discarded due to insufficient data so that only four subjects are accounted for in the VI-C 40 R.P.M. cell. The three reinforcement conditions tested were:

1. L.S., or lump sum where $10.00 was paid the subject if he finished the session no matter what his performance.

2. VI-C, or a variable-interval schedule of reinforcement in the form of counts earned on a digital counter. Each count recorded was worth 25¢ upon completion of the session. The VI was programmed to make forty reinforcers available to the subject during the session which also comes to $10.00. The VI will be detailed in a following section.

3. VI-Q, or the same VI as mentioned above. In addition to the counter, however, quarters were dropped visibly into a clear plastic box in front of the subject as they were earned.

The task difficulty was varied by changing the speed at which the light target moved around the tracking pattern. Speeds of 30, 40, 50, and 60 R.P.M. were chosen for the study. Pilot sessions indicated 20 R.P.M. to be too slow (very few misses) and 70 R.P.M. to be too fast (very few hits) for interpretable data to be generated.

Session format

The sessions were run in four phases, each separated by a 5-min rest period or "break" as illustrated in Table II. The first ten minutes was the warm-up phase to help familiarize the subject with the apparatus, the reinforcement schedule and to stabilize the effects of any task learning curve. Phase II was a 15-min run during which eight tones (CS's) were presented as controls. Phase III, also 15-min, presented eight more tones (CS's), this time paired with the UCS (shock). Finally, Phase IV again presented eight CS's alone during the 15-min run for

extinction of the CS.

Subjects were given instructions in a tone of "friendly neutrality" as they were being seated in the chamber. Each was told the following:

1. The whole session would last one hour and fifteen minutes.
2. They would work one 10-min run (phase) and three 15-min runs, each separated by a 5-min break.
3. If they had any qualms about receiving electric shock, they may quit anytime they wished, but that early termination forfeited any earnings.
4. They would earn:

   L.S. Group - $10.00 if they completed the session.

   VI-C Group - Counts on the counter in front of them which were worth 25¢ each at the end of the session.

   VI-Q Group - Quarters which would drop in the plastic box in front of them and could be removed at the end of the session. Counts were tallied as described above.
5. The tracking task was described and briefly demonstrated.
6. It was reemphasized that the only way they could lose their earnings was to terminate early.

During the seating in the chamber, the explanation, and demonstration, the subject was casually asked if he were right or left handed. As the instructions continued, the electrode was placed on the lower inside forearm of the unfavored side. Any questions, except for clarifications, were answered with, "I'm sorry, but I can't tell you any more about the experiment. If you wish to quit at anytime, you should feel free to do so."

Schedules

Subjects compiled a total of 55 min actual tracking time. In order to make $10.00 worth of quarters or 25¢ counts available at this time, forty reinforcers were programmed such that the schedule was a VI-1' 22" with the longest interval between available reinforcers being 2' 36" and the shortest being 04". The other interreinforcement intervals were randomly distributed between these extremes in 4-sec multiples.

Programmed on a second channel of the VI tape were the CS-UCS cycle onset signals that presented these stimuli during the appropriate phases. There were eight 15-sec CS presentations during each of the 15-min phases separated from each other or the start of the phase by a minimum of 1 min and a maximum of 3 min with a mean of 1.66 min. During the pairing phase (III), the CS was immediately followed by a .5-sec, 1200-vac, 23-ma shock. The synchronization between events in the operant components and those in the classical components were the same for all subjects.

RESULTS

Reinforcement Conditions and Task Difficulty As They Affected Overall Rates

Of the three (3) reinforcement conditions, the VI-C (counts on a counter worth 25¢ each earned on a VI 1' 22") appeared to generate the highest overall level of performance. Figure 2a displays the mean percent hits for all subjects as a function of the reinforcement schedule during each of the four phases of the experiment (5% of the data from which the means were computed were lost due to recording errors.) From this figure, the VI-C group performed better overall than the LS ($10.00 Lump Sum pay-off) or the VI-Q (quarters earned on a VI 1' 22") during all phases but the warm-up.

Variance in task difficulty appeared to affect overall performance. As the speed of the tracker in R.P.M.'s increased, the level of performance as measured by mean percent hits decreased (See Figure 2b). The figure shows mean percent hits to be an inverse linear function of the tracker speed in R.P.M.'s The curves for the four phases of the experiment do not appear to differ significantly from one another in this figure, although the extinction phase curve is very slightly although consistently above the rest in overall performance. This figure also includes the data from the four subjects run at 70 R.P.M. It should be noted that these data points represent means of only 15 samples

each, (exception: 40 R.P.M. data points represent means of 14 samples each.)

Suppression

The results were analyzed in terms of the degree to which the tracking performance was disrupted during the pre-shock stimulus as reflected in the suppression ratio. This ratio was computed using the formula:

$$\frac{\text{Pre-CS 15-sec Control} - \text{15-sec CS}}{\text{Pre-CS 15-sec Control} + \text{15-sec CS}}$$

This ratio may yield a value of zero (indicating no suppression), or of plus one (indicating complete suppression), or of negative one (indicating facilitation in which the control rate is zero and some responses occur during the CS facilitation).

In Figure 3a the mean suppression ratio for all subjects is plotted as a function of the tone CS presentation for the three phases of the experiment. While the degree of suppression shown at any given point is small, the overall effect can best be termed "classic." The control phase of eight CS (tone) presentations shows a slight degree of disruption of tracking performance during the initial presentations in the series followed by an apparent habituation to the CS occurring by the fourth trial. From trial four to eight the CS appears to have had no effect on tracking performance during the control phase.

During the conditioning phase where each CS terminated with

a brief electric shock, some conditioning is apparent as indicated by an increase in suppression ratio to a value between .15 and .20 for all groups. This change in the suppression ratio continues with some fluctuation until trial eight. It is clear from these data that the CS had a consistent suppressing effect on tracking performance not demonstrated during the earlier control phase. Finally, during extinction when the CS was presented without shock the CS effect on tracking performance is shown by the steady decline of suppression ratio toward the "0" line.

Reinforcement Conditions and Task Difficulty As They Affected Suppression

In Figure 3b the mean suppression ratio for each subject group under the three reinforcement conditions is plotted separately as a function of CS (tone) presentations for the three phases of the experiment proper. While the degree of suppression shown is small, it is consistent. The three curves approached zero suppression during the control phase, moved completely above the 0 line during the pairing phase and returned to the 0 line during extinction. It is not apparent, however, that there were any significant differences among the groups. The only difference of any note is that during pairing and extinction the VI-Q group showed a tendency to be more sensitive to suppression. Of the data points in the pairing phase (see figure) the VI-Q group displayed the highest suppression ratios in five out of the eight cases and the second highest in the remaining three. It is also

notable that the highest mean suppression ratio for any group of any phase was recorded for the VI-Q group (7th presentation, pairing phase).

In the Extinction Phase, the VI-Q group's sensitivity to suppression was, again, very slightly but reliably above the other two groups. The figure shows the VI-Q group to have suppressed more in six cases out of eight and to be second in suppression sensitivity in the remaining two. The consistent relative height of the VI-Q group curves during pairing and extinction contrast with "mixed" appearance of the three groups in the control phase.

In Figure 3c, the mean suppression ratio for each group under each task difficulty level (tracker R.P.M.) is plotted as a function of CS (tone) presentations for the three phases of the experiment. The overall consistent suppression effect is similar to the function in Figure 3b. The 60 R.P.M. group (the greatest task difficulty) showed the highest level of suppression in four cases out of eight with one additional tie. Three trials during the conditioning phase CS presentations 3, 5, & 6 were higher than any other group in any phase. During extinction this group showed the highest degree of suppression on six trials out of eight.

Subject Variability

Skin resistance readings taken across the surface electrodes (used for shock delivery) with a VTVM showed wide variability both within and among subjects. Mean resistances for all subjects

at the end of each phase were as follows:

End Phase I: $\bar{x}$ = 147,000 ohms
End Phase II: $\bar{x}$ = 74,000 ohms
End Phase III: $\bar{x}$ = 49,000 ohms
End Phase IV: $\bar{x}$ = 24,000 ohms
n = 59

Overall, the skin resistances of the subjects decreased markedly. However, in a few cases skin resistance went up from the beginning to the end of the session. At the end of Phase I subject skin resistance spread widely between 20,000 ohms and 1,000,000 ohms (a range of 980,000) but by the end of Phase IV, they varied between 15,000 ohms and 40,000 ohms (a range of 25,000 ohms).

Subjects also varied widely in their subjective reports as to the aversiveness of the UCS. The following is a sample:

313 - "My arm is tired." The shock didn't bother her.

306 - "Not too bad." Rated UCS "5" on a 1 - 10 scale of pain.

302 - Tears, sobbing and shaking.

118 - ". . . shock didn't really hurt." Said waiting for it was worse than the UCS itself.

117 - Subject thought UCS intensity was a function of being on target.

110 - Shock didn't bother her if she concentrated on the tracking task.

307 - Didn't even notice earnings, only the CS.

119 - Said his watch told him when phase was almost over. The closer the end, the less he cared about the shock.

114 - "That shock hurts!"

112 - "The shock's not so bad."

104 - Shock made it hard to concentrate. "It throws you off."

103 - The third shock was "bad" then subject said he "ignored" the CS and "got used to the UCS."

218 - During CS he "concentrated" on his girl and the money.

217 - "Scared the hell out of me. Reported trying to avoid the UCS by varying responses.

213 - "Bolt of lightning . . . " "When that tone comes on I can't follow that thing for shit."

211 - Shock not so bad. Reported "paranoia" during extinction phase, however.

210 - "Worse than the army."

204 - "Bad at first." Didn't like the last phase - "too much worry."

Some subjects laughed about the experience during the five-minute break following the pairing phase, a few cried and shook. When asked what they noticed about the shock, a few subjects reported that it increased in intensity with each presentation. A few others reported they felt a decrease. There was no correlation between these reports and the degree of suppression or skin resistance.

Subjects also varied a great deal in their ability to perform the tracking task. In the warm-up phase for the 30 R.P.M. group, subjects' hit scores ranged from 26% to 81% ($\bar{x}$ = 49%). At 60 R.P.M. they ranged from 12% to 33% ($\bar{x}$ = 21%) on target during warm-up. Some subjects, therefore, performed better at the fastest tracking speed than others at the slowest.

CONCLUSIONS

Reinforcement Conditions and Task Difficulty As They Affected Overall Rate

The fact that the VI-C group displayed a noticeably higher mean percentage of hits than either of the other two groups in all phases but the warm-up (see Figure 2a) was a surprise to the experimenter. It was expected that the LS group would show the lowest mean percent hits since there was no money contingency on accurate target tracking. However, it was hypothesized that the VI-Q group would probably perform best overall since reinforcement for that group was secondary (25¢ tokens with which primary reinforcers could be obtained) while the VI-C group reinforcers were tertiary (counts on a counter for which 25¢ tokens could be obtained). The results show that the VI-Q group performed no better as measured by mean percent hits than the LS group. Why the VI-C group out-performed the other two during the three phases where the CS was presented is unknown.

Task difficulty as measured by tracking R.P.M.'s was a potent variable in overall performance. The curves for all phases slope downward smoothly as R.P.M.'s increase (see Figure 2a); there was no substantial difference among phases except to note that in both Figure 2a and 2b the extinction phase curve is consistently although slightly above the rest. This could be accounted for by task learning, facilitation due to a CS-no-UCS presentations (relief) and or

fixed-interval responding as the end of the session and pay-off drew near.

Suppression

The suppression displayed in Figure 3a is clear enough in topography, but differs from curves typical in animal research in its intensity. Bergstrom (1970) using a similar tracking task to study the effects of stress demonstrated even less suppression than the research described here. This was probably due to the low intensity shock provided which was reported to be seven times "threshold" at the highest setting. Since the present study did not use the same system to scale intensity, shock aversiveness is difficult to compare. However, since pilot subjects reported "feeling" 2-ma from the shock source used, the UCS was at least 11 times threshold.

In a review article, Davis (1968) made the statement that no "typical" conditioned suppression procedure had been successfully employed with human subjects. Sachs and May (1966) reported no suppression using humans on a VI-30 lever press. The present study in no way reflects the single organism reliability of lower animal research; it does provide data indicating that in the experimental setting, human beings are subject to the suppression phenomenon.

Reinforcement Conditions and Task Difficulty As They Affected Suppression

It was predicted that the VI-Q group would show the least sensitivity to suppression since suppression is inversely related to reinforcement intensity (Geller, 1960; Brady and Conrad, 1960; Vogel and Spear, 1966). Since visible quarters define secondary reinforcement (tokens) on a VI while counts which earned quarters defined a tertiary reinforcer, it was hypothesized that responding under the VI-Q condition would be least affected by the CS. The exact opposite occurred. Figure 3b shows, if anything, the VI-Q group suppressed more during the tone than either of the other two. A possibility exists that the quarters increased suppression sensitivity by helping divert subjects' attention from the tracking screen during the CS. This explanation is supported by Brimmer's (1971) attending hypothesis where the stimuli attended to are the stimuli in control. When S^D's command attention, responses generated are strong and CS's do not have much effect on behavior. However, when CS's command attention, S^D's generate weaker responses and rate decreases.

Some subjects reported that the tone didn't "bother them as much" if they "concentrated" on the tracking task. Anything that could decrease this "concentration" by diluting attention such as clear plastic box filling with quarters could also increase the "overshadowing" potency of a tone paired with a strong electric

shock. Further research is required to test the validity of this explanation.

Lyon (1964) and Lyon and Felton (1966) found ratio schedules relatively insensitive to suppression indicating suppression sensitivity may be a function of response rate. This suggestion fits well with Brimmer's (1971) as well as Sachs and May's (1966) hypothesis. However, the present study found the highest tracking speed (and therefore, the highest rate of responding) to be the most sensitive to suppression. An explanation that resolves this incongruity without destroying either hypothesis is simply that increased rate decreases suppression sensitivity only as long as it is a function of increased attention. Increased rate on an FR schedule is a function of increased control of internal and external S^D's. When increased rate is demanded while the S^D's remain the same no change in suppression sensitivity occurs until the point is reached where the task difficulty exceeds ability to make reliable discriminations. At this point, attention is weakened and the CS becomes more "overshadowing". Since the groups at slower speeds did not differ significantly from each other while the 60 R.P.M. group showed a greater degree of suppression, it is suggested that members of this high R.P.M. group approximated the degree of task discrimination difficulty at which attention to the target was more difficult to maintain.

Subject Variability

Difficulty in obtaining stable results using humans in conditioned suppression research is typical (Toomey and Sidman, 1970; Kanfer, 1958). In fact, demonstrating any suppression at all is difficult (Davis, 1968). The problems appear to be lack of experimental control over previous conditioning histories and certain moral restrictions.

Reinforcers

In this study, money was used as a reinforcer to maintain responding and participation. Both the type (Geller, 1960) and the degree of deprivation (Glick, 1969) are partial determiners of the degree of suppression elicited by a given CS. Subjects' verbal reports as to the potency of the reinforcer offered in this study ranged from "I don't care about the money, I was just curious about the experiment" to "I wanted to quit after the first shock, (sob, sob) but I heard I could get $10.00 in this experiment and so I already spent the money (more tears)." Clearly, some subjects were under higher deprivation than others, and perhaps, were even working for different reinforcers. Rosenthal (1965) suggests subject performance is often affected by hopes of a favorable evaluation by the experimenter. Subjects in the present study frequently asked, "How did I do?" Other researchers (Sachs and May, 1966; Milgram, 1963) point out that some subjects respond in

experimental settings simply because they are told to by the experimenter. The "audience effect" as described by Hake and Laws (1967) attenuated suppression in pigeons when a second bird was visible to the experimental animal. In human research this social facilitation is not unlikely since subjects in the chamber probably perceive being "observed" directly or indirectly by the experimenter and therefore have an audience. All of the above mentioned variables could serve to strengthen baseline responding and therefore decrease suppression, perhaps partially explaining the difficulty in obtaining suppression in the experimental settings with humans.

Schedules

While the "actual" schedule of reinforcement presented here was a VI-1' 22", this may not have been the subjects' perception (the rat is always right). Verbal reports at the end of sessions showed very few of the subjects were aware of the "actual" conditions for reinforcement or shock delivery. Superstitions were frequent (typical of VI's and non-contingent tone-shock presentations) (Wherry and Curran, 1966). The schedule of reinforcement is a potent variable in determining the degree of suppression (Lyon, 1963; Lyon, 1964) and also the extinction of suppression (Brady, 1960). This would indicate that not only the subjects' perception of the present conditions effect suppression sensitivity, but also his history of reinforcement under anxiety-

arousing conditions in his years of living before entering the experimental setting (Hendry and VanToller, 1965).

Given the highly complex and varied histories of the average college student, it does not seem unreasonable to assume that a subject may not be working solely for the reinforcers available, but perhaps places himself on an avoidance schedule. Kanfer (1958) points out that past learning in humans demands that "One should do something to avoid dangers" (This may include teeth grinding, concentrating, etc.). Such histories interfere with the suppression phenonmenon in that they often drive behavior up in rate rather than down (Toomey and Sidman, 1970). It is possible that such avoidance attempts are partially successful if the increased rate effect increases attention to the task and decreases it to the CS. This attempt need be successful only part of the time to show a decrease in suppression (Willis, 1968; Sachs and May, 1966). Campbell (1956) showed that as shock intensity increased, the proportional reduction in intensity necessary for learning to occur decreased. Since the shock intensity in this study was relatively high (23-ma at 1200-vac) a relatively small perceived reduction in intensity through any avoidance means mentioned above may have reduced suppression or even promoted facilitation for those subjects.

UCS and CS Intensity

In general, previous research indicates a direct relationship

between the intensity of the UCS (Wenton and Jordan, 1970; Chruch, Raymond and Beauchamp, 1967) and the intensity of the CS upon the severity of suppression (Kamin and Schaub, 1963). However, animal researchers take great pains to insure naivete in research subjects due to the effects of history with intense aversive stimulation on suppression. It appears the relative or perceived intensity is the real potent variable, not the absolute shock value in milliamperes (Wherry and Curran, 1966). Human subjects with no history of aversive stimulation via shock or otherwise are difficult to find. Subject verbal reports of the shock aversiveness based on a 1 to 10 scale (1 = least painful ever experienced, 10 = most painful) ranged from 3 to 10 (for those asked). In other words, for some, the UCS was relatively impotent, while for others, it was reportedly the worst thing they had ever felt. The subject who rated the shock the lowest was a Viet Nam War veteran with a subsequent history of extreme aversive stimulation (he had been wounded).

All of the suggested explanations above need, of course, experimental confirmation. However, they do indicate reasons why past efforts have yielded so little fruit in the area of human conditioned suppression, and, therefore, what variables will have to be accounted for in future research. Some may never be controlled due to moral and legal restrictions such as the problem of increasing UCS intensity to overshadow reinforcement motivated behavior without producing an escape from the entire experimental

setting. Civil rights doctrines presently in vogue will not allow subjects to be locked in chambers against their will. This does not mean that conditioned suppression as a phenomenon cannot be "validated" in humans. Ample field observations in war-zones describe behavior that no other explanation fits as wll as conditioned suppression and the complimentary C.E.R. (conditioned emotional response). Adult human beings, "shivering, crouching and deficating," unable to make any "more appropriate" responses such as firing their weapons or even running away are not discernably different from Estes and Skinner's rats in 1941.

REFERENCES

Bergstrom, Bengt. Tracking performance under threat-induced stress. Scandanavian Journal of Psychology, 1970, 11, 109-114.

Brady, Joseph V. Extinction of a conditioned "fear" response as a function of reinforcement schedules for competing behavior. The Journal of Psychology, 1955, 40, 25-34.

Brady, J. and Conrad, D. Some effects of limbic system self-stimulation upon conditioned emotional behavior. Journal of Comparative and Physiological Psychology, 1960, 53, 128-137.

Brimmer, C. J. Attention and conditioned suppression. Psychonomic Science, 1971, 22, (3), 131-132.

Campbell, Byron A. The reinforcement difference limen (RDL) function for shock reduction. Journal of Experimental Psychology, 1956, 52, (4), 258-262.

Church, Russell M., Raymond, George A., and Beauchamp, Ross, D. Response suppression as a function of intensity and duration of a punishment. Journal of Comparative and Physiological Psychology, 1967, 63 (1), 39-44.

Davis, Hank. Conditioned suppression: A survey of the literature. Psychonomic Monograph Supplements, 1968, 2, (14), 283-291.

Estes, W.K. and Skinner, B.F. Some quantitative properties of anxiety. Journal of Experimental Psychology, 1941, 29, 390-400.

Geller, I. The acquisition and extinction of conditioned suppression as a function of the baseline reinforcer. Journal of the Experimental Analysis of Behavior, 1960, 3, 235-240.

Glick, Stanley D. Effects of food deprivation on response suppression. Journal of Comparative and Physiological Psychology, 1969, 67, (4), 522-525.

Hake, D. F. and Laws, D. R. Social facilitation of responses during a stimulus paired with electric shock. Journal of the Experimental Analysis of Behavior, 1967, 10, 387-393.

Hendry, Derek P. and VanToller, C. Alleviation of conditioned suppression. Journal of Comparative and Physiological Psychology, 1965, 59, (3), 458-460.

Henton, Wendon W. and Jordon, John J. Differential conditioned suppression during pre-shock stimuli as a function of shock intensity. The Psychological Record, 1970, 20, 9-16.

Janfer, Frederick H. Effect of a warning signal preceding a noxious stimulus on verbal rate and heart rate. Journal of Experimental Psychology, 1958, 55, (1), 73-80.

Kamin, Leon J. and Schaub, Ronald E. Effects of conditioned stimulus intensity on the conditioned emotional response. Journal of Comparative and Physiological Psychology, 1963, 56, (3), 502-507.

Lyon, David O. Frequency of reinforcement as a parameter of conditioned suppression. Journal of the Experimental Analysis of Behavior, 1963, 6, (1), 95-98.

Lyon, David O. Some notes on conditioned suppression and reinforcement schedules. Journal of the Experimental Analysis of Behavior, 1964, 7, 289-291.

Lyon, D.O. and Felton, M. Conditioned suppression and variable ratio reinforcement. Journal of the Experimental Analysis of Behavior, 1966, 9, 245-248.

Lyon, D.O. and Felton M. Conditioned suppression and fixed ratio schedules of reinforcement. Psychological Record, 1966, 16, 433-440.

Milgram, Stanley, Behavioral study of obedience. Journal of Abnormal and Social Psychology, 1963, 67, (4), 371-378.

Rosenthal, Robert. The volunteer subject. Human Relations, 1965, 18, 389-406.

Sachs, David A. and Keller, Thomas. Intensity and temporal characteristics of the CER paradigm with humans. Journal of General Psychology, 1972, 86, 181-188.

Sachs, David A. and May, Jack G. Conditioned emotional response with humans: The effect of a variable interstimulus interval using a trace conditioning paradigm. Psychonomic Science, 1967, 9, (6), 343-344.

Toomey, George L. and Sidman, Murray. An experimental analogue of the anxiety-stuttering relationship. Journal of Speech and Hearing Research, 1970, 13, (1), 122-129.

Vogel, J. and Spear, N. Interaction of reward magnitude and conditioned fear on the consummatory response. Psychonomic Science, 1966, 5, 263-264.

Wherry, Robert J., Jr. and Curran, Patrick M. A model for the study of some determiners of psychological stress: Initial experimental research. Organizational Behavior and Human Performance, 1966, 1, 226-251.

Willis, Richard D. The partial reinforcement of conditioned suppression. Journal of Comparative and Physiological Psychology, 1968, 68, (2), 289-295.

FIGURE LEGENDS

Figure 1 — Target path of Polar Pursuit Tracker.

Figure 2a — Overall performance of all subjects as a function of task difficulty (Pursuit Tracker R.P.M.'s). Each experimental phase is graphed separately.

Figure 2b — Overall performance of all subjects as a function of reinforcement conditions. Each experimental phase is graphed separately.

Figure 3a — Suppression ratio as a function of CS trials for each reinforcement group. Trials are divided into the control, pairing and extinction phases of the experiment and the suppression ratios for each reinforcement condition group are graphed separately.

Figure 3b — Suppression ratio as a function of CS trials for each task difficulty group. Trials are divided into the control, pairing and extinction phases of the experiment and the suppression ratios for each task difficulty group are graphed separately.

Figure 3c — Suppression ratio as a function of CS trials for all subjects. Trials are divided into control, pairing and extinction phases of the experiment.

Table I — Subjects grouped according to reinforcement condition and task difficulty variables. The cell with four (4) subjects is due to a last minute discard for insufficient data.

Table II — Session time schedule.

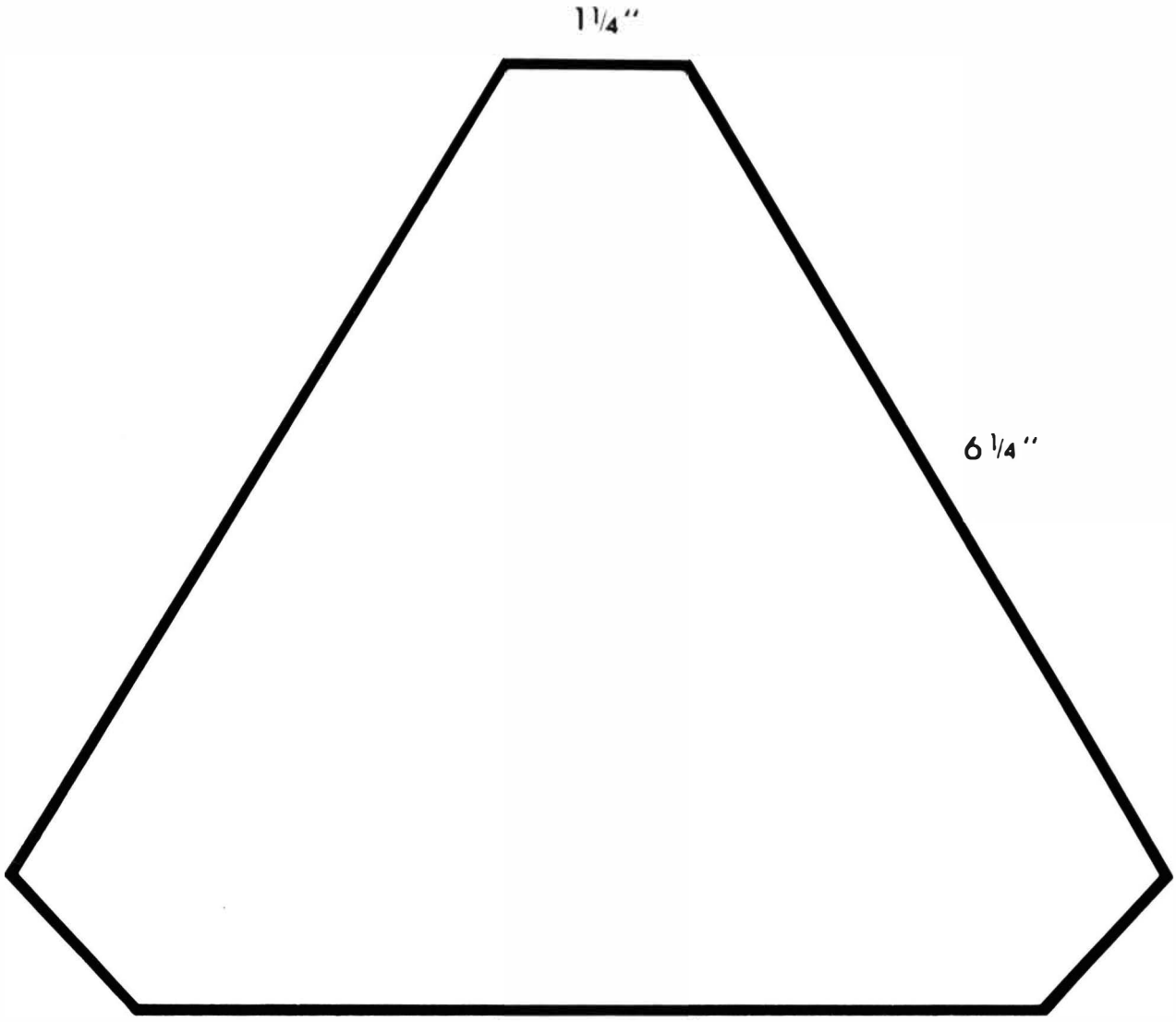

FIG. 1

OVERALL TRACKING PERFORMANCE

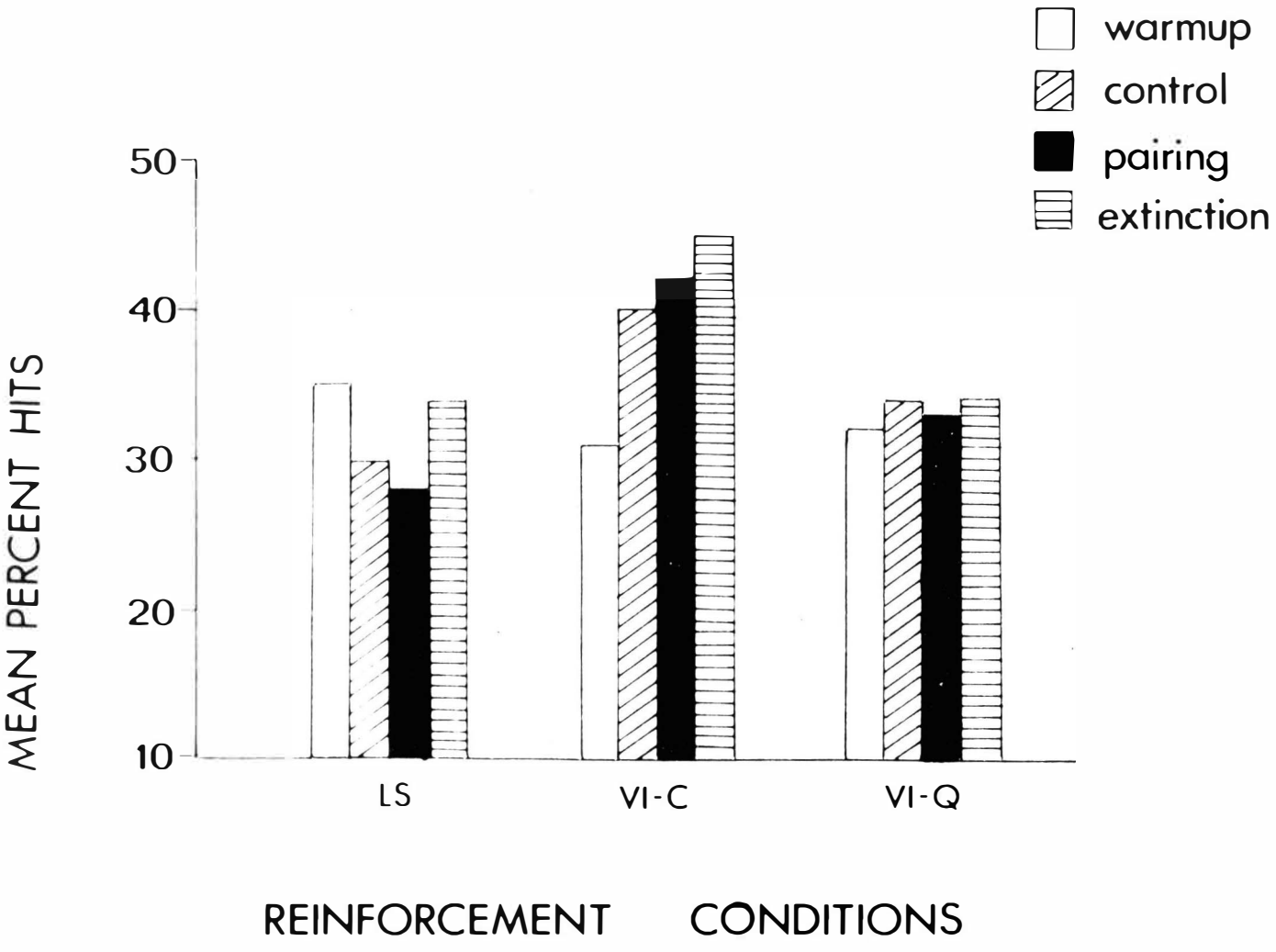

FIG. 2a

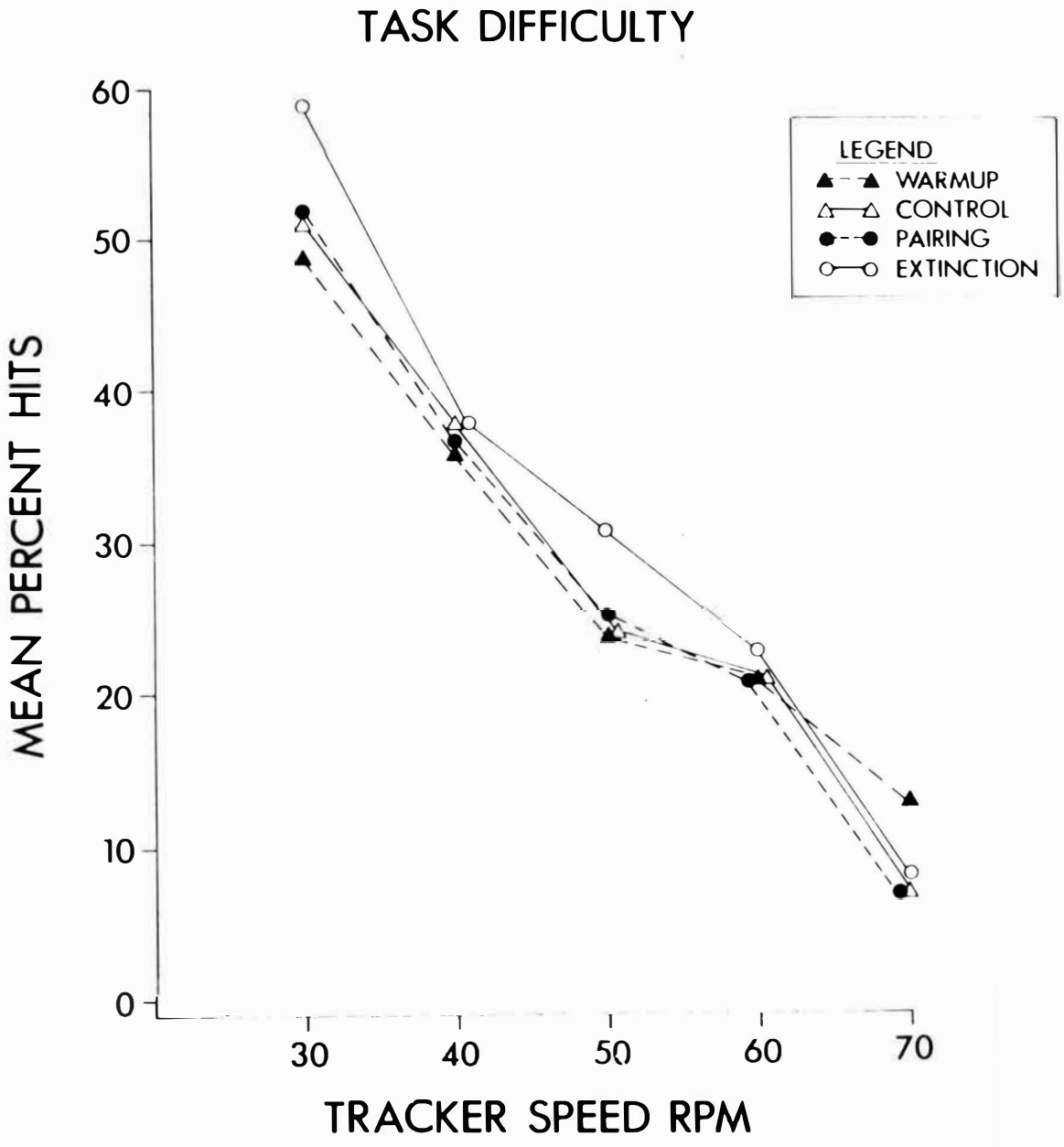
TASK DIFFICULTY
LEGEND
WARMUP
CONTROL
PAIRING
EXTINCTION
MEAN PERCENT HITS
60
50
40
30
20
10
0
30
40
50
60
70
TRACKER SPEED RPM

FIG. 2b

MEAN SUPPRESSION RATIOS UNDER ALL CONDITIONS

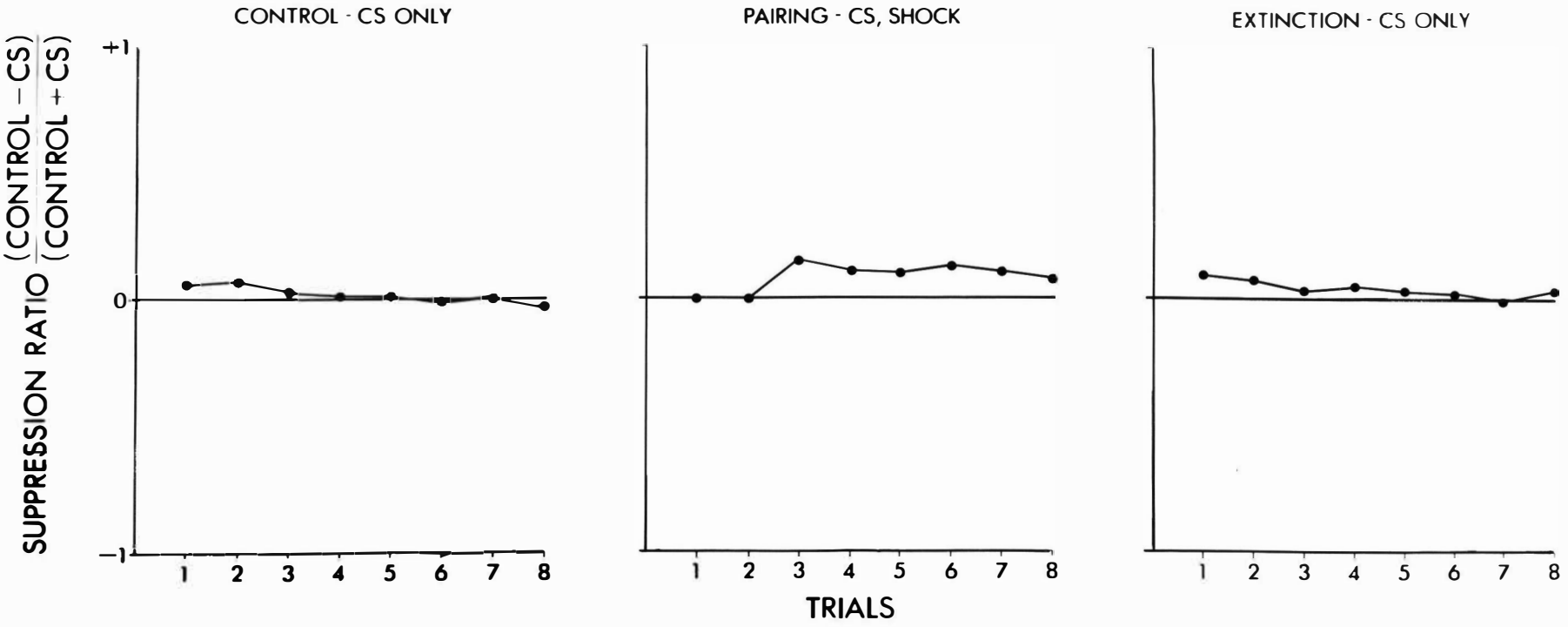

FIG. 3a

MEAN SUPPRESSION RATIOS AS A FUNCTION OF REINFORCEMENT CONDITIONS

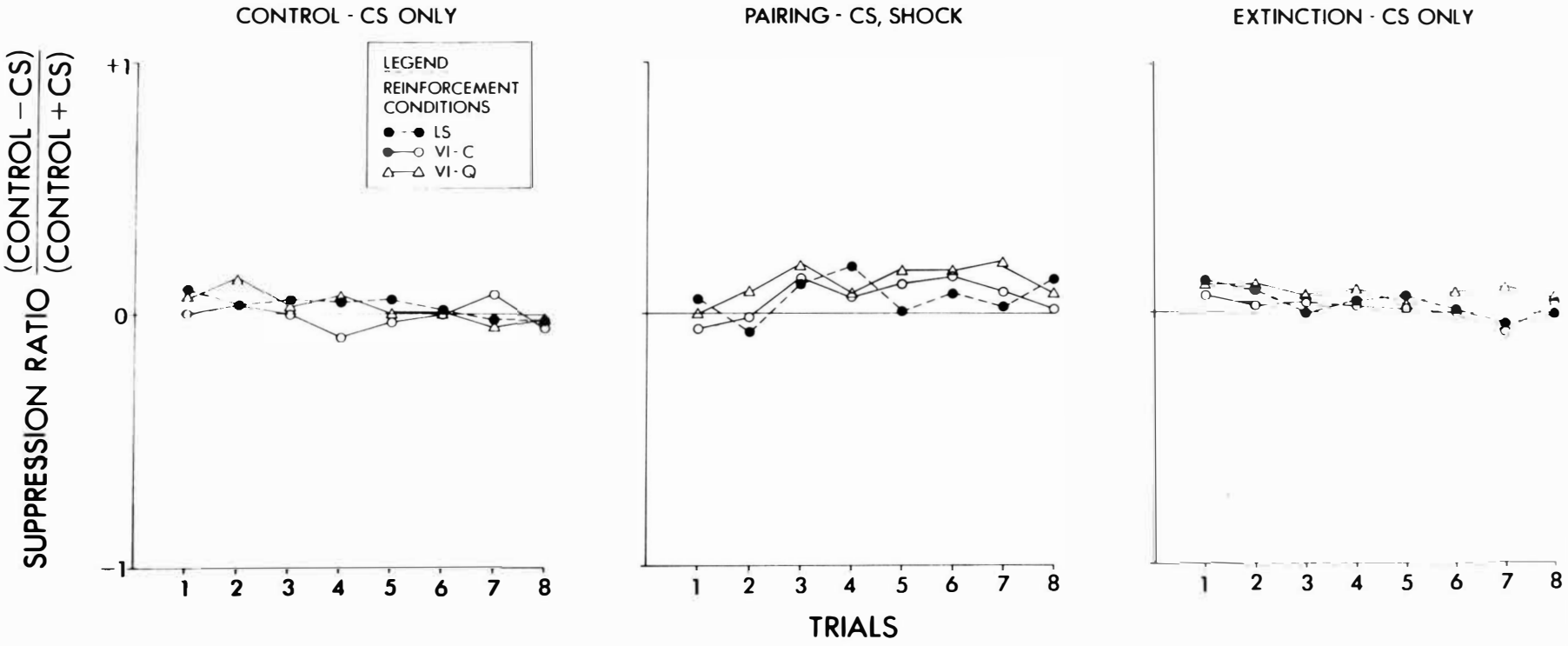

FIG. 3b

MEAN SUPPRESSION RATIOS AS A FUNCTION OF TASK DIFFICULTY

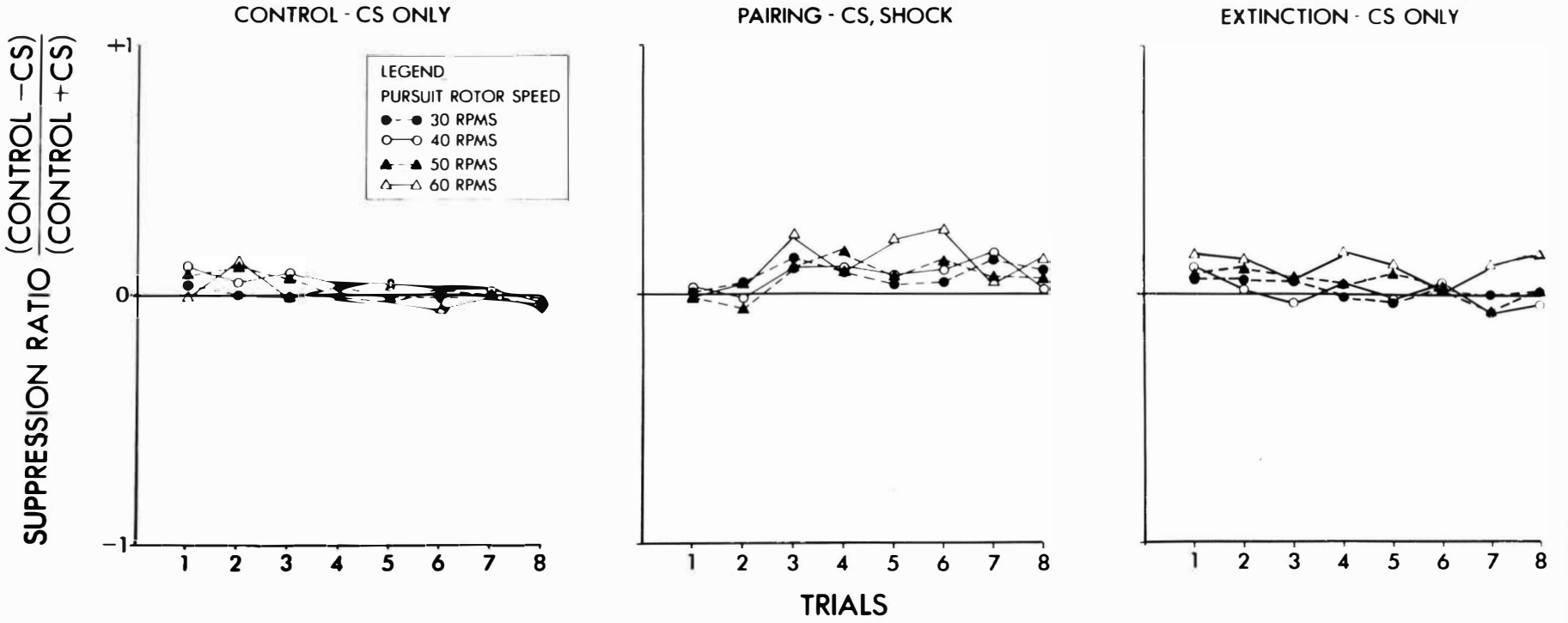

FIG. 3c

TABLE 1
TASK DIFFICULTY
(PURSUIT ROTOR RPM)

REINFORCEMENT CONDITIONS	30	40	50	60
LS	5	5	5	5
VI-C	5	4	5	5
VI-Q	5	5	5	5

TABLE 2
SESSIONS