4-1979

Effects of Cue Presence, Duration and Association with Reinforcement on a Punishment Procedure

Elias Robles Sotelo
Western Michigan University

EFFECTS OF CUE PRESENCE, DURATION AND ASSOCIATION WITH REINFORCEMENT ON A PUNISHMENT PROCEDURE

by

Elias Robles Sotelo

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 1979

Acknowledgements

During the preparation of this thesis, I benefited from the advice and helpful suggestions of the members of my committee, Dr. Arthur G. Snapper, Dr. David O. Lyon and Dr. Jack Michael. Specially, I would like to thank Dr. Arthur G. Snapper, chairman of my committee, whose ideas and enthusiasm were essential to the production of this study. Also I would like to thank the Congreso Nacional de Ciencia y Tecnologia for providing the financial support that made possible my stay and education at Western Michigan University. Finally, I would like to express my gratitude to those persons whose aid and support contributed to the completion of my thesis.

Elias Robles Sotelo

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ROBLES SOTELO, ELIAS

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WESTERN MICHIGAN UNIVERSITY, M.A., 1979

University Microfilms International 300 N. ZEEB ROAD, ANN ARBOR, MI 48106

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Introduction

Punishment is an operant conditioning procedure that typically produces a decrease in the rate of the punished response. Punishment has been functionally defined as a "reduction in the future probability of a specific response as a result of the immediate delivery of a stimulus for that response" (Azrin & Holz, 1966). The stimulus is called a "punishing stimulus" or a "punisher". In a typical punishment experiment, a subject's response is maintained at a medium rate through positive or negative reinforcement. A punishing stimulus (e.g., a shock) is then delivered as a consequence of the same response according to a given schedule, and its effects are observed.

Usually, operant research studies the effects of punishment by maintaining the baseline reinforcement schedule and continuing the punishment procedure until the subject achieves some sort of "steady state" responding. This design implies that the reinforcement schedule maintaining the baseline will be one of the important variables affecting the results.

The actual suppressive effect of the procedure depends on several other kinds of variables such as those related to the characteristics of the punishing stimulus, the presence of discriminative stimuli, the schedule according to which the punishment is delivered, etc. For instance, it has been demonstrated (Church, 1969) that the intensity of the punishing stimulus has a direct relationship with the amount of suppression produced. Within certain limits, then, the higher the intensity of the punishin[illegible] ulus, the greater the suppression.

This kind of relationship, seems to be true also for the duration of the punishing stimulus (Church, 1969). Church (1969) has analyzed the effects of the combination of intensity and duration and has called it the "severity" of the punishing stimulus. Again, severity was found to hold the same relationship with suppression as intensity and duration alone.

Another important variable in the punishment procedure is the frequency with which the punishing stimulus is presented. It has been found (Azrin & Holz, 1966) that continuous punishment (one punishing stimulus presentation for every response) is more powerful in producing suppression than intermittent schedules in which only some of the responses are punished. It has also been demonstrated that punishment delivered immediately after the response is more effective in suppressing behavior than when it is given with some delay (Church, 1969).

A very important variable at least in terms of procedure, is the requirement of a contingency relationship between the response and the punishing stimulus. The response by definition must be a necessary condition for the punisher to occur. This relationship is important because it establishes the basic difference between punishment and another procedure called conditioned suppression or conditioned emotional response (CER). This procedure has been described by Lyon (1968) as a situation in which "...a short duration stimulus is superimposed on an operant performance and terminated independently of the animal's behavior coincidentally with a brief unavoidable shock." In this sense, then, the main difference between a conditioned suppression procedure and signalled punishment is the fact that punishment depends on the occurrence of the response whereas on conditioned suppression the pairings between the originally neutral stimulus and the shock are presented regardless of the animal's behavior. It seems reasonable to believe, then, that from the animal's point of view, unless he suppresses completely there is no difference between a punishing procedure in which a response produces a signal at the end of which the shock is delivered and typical CER procedure.

Azrin (1956) studied the difference in the amount of suppression produced by what he called "response-correlated" shock compared to "response-uncorrelated" shock. In this procedure five pigeons were trained on a multiple VI 3' - VI 3' schedule of reinforcement with an orange stimulus light associated with one component and a blue stimulus light associated to the other component. The second component (blue light) remained the same for the rest of the experiment while for the first one (orange light) four different conditions of shock were presented separated from each other by sessions of baseline training: (a) fixed interval schedule without response-shock correlation, in which a shock was presented 1 minute after the onset of the orange light independent of the animal's behavior; (b) fixed interval schedule of shock with response-shock correlation, in which the first response emitted after 1 minute from the onset of the orange light received a shock; (c) variable-interval (VI2') schedule of shock without responses-shock correlation, in which the shock was presented once on the average in each shock component independently of the animal's behavior; (d) variable interval schedule of shock with response-correlation, in which the first response after a mean of 2 minutes received a shock. The results of this experiment showed that response-correlated shock produced a greater amount of suppression with both variable and fixed presentation of shock, than response-uncorrelated shock.

In analyzing these results it might be useful to point out that in this procedure the light signaling punishment in the response-correlated phase is not contingent on the response but on the start of that component so the animal can avoid the shock by not responding until the blue light is in effect. At the same time, the phase of response uncorrelated shock does not fit Lyon's definition of CER since the signal is not only present during a short period preceding the shock, but for the entire 2 minute component.

The effect of the duration of the signal in CER has been widely investigated and may help to explain Azrin's results. Stein, Sidman, and Brady (1958) describe the results of their experiment as follows "...animals will suppress in the stimulus period to an extent that does not markedly reduce opportunities for positive reinforcement." These results have been supported by experiments conducted by Carlton and Didamo (1969), Lyon (1963), and Shimoff, Schoenfeld and Snapper (1969). In their study Shimoff et al. (1969) demonstrated in a CER procedure that complete suppression is found through a wide range of stimulus durations (from 3.5 to 60 sec.) when the maximum CS time was 5% of the session length while the amount of suppression between stimulus presentations did not change significantly among CS durations. It was also found that a much greater amount of suppression between stimulus presentations was obtained when the CS was removed completely.

The difference in the amount of suppression caused by the presence or absence of the CS was reported to hold for the punishment procedure also. Raymond and Church (1969) using rats as subjects and the level press response on a variable-interval 1 minute (VI 1') for food compared the amount of suppression produced by four punishment conditions. For one group, punishment was present according to a variable-interval schedule (VI 2') of shock presentation immediately after the response (0 seconds delay); for the second group punishment was present on the same VI schedule but with a delay of 5 seconds between the response and the shock. The third group worked under a schedule similar to that for group two, but with a tone filling the 5-seconds delay between the response and the shock. The fourth group was a control group and did not receive shock. The results showed that the control group did not suppress, the zero delay group suppressed the most and the group with the cue, suppressed significantly less than the group without the cue.

The results obtained by Shimoff, Schoenfeld and Snapper (1969) and those described by Raymond and Church (1969) seem to be supported by the fact that subjects have been found to prefer signaled to unsignaled unavoidable shock (as measured by percent of session length spent in each compartment) when it is delivered on a periodic basis in a shuttle box (Lockhart, 1963; Himowitz, 1973). The theoretical argument most commonly proposed to explain this phenomenon is derived from a safety signal hypothesis. This theoretical position has been described by Seligman (1968) in the following way: "When a stimulus reliably predicts the occurrence of electric shock for an organism, safety, the absence of shock, is reliably predicted by the absence of the signal for shock. In Pavlovian language, the existence of a reliable CS^+ for shock (an excitor of fear) logically implies the existence of reliable CS^- (a differential inhibitor of fear): the absence of the CS^+ is a reliable CS^- because it is never followed by shock."

This argument suggests that the presence of a cue provides a safety signal in the absence of the cue. In behavioral terms, the subject discriminates that shock is associated with the cue. Subjects exposed to uncued shock, then, are unable to form this discrimination so that the entire experimental session and its associated stimuli become "conditioned emotional stimuli" and tend to suppress the baseline behavior.

An alternative explanation of this effect is possible and is the major question of the current experiment. Assuming the subjects exposed to the CER or cued punishment procedures develop conditioned suppression during the cue, it is clear that shock will never be closely associated with reinforcement or the behaviors that produce reinforcement. However, subjects exposed to uncued delayed punishment are likely to be responding or consuming reinforcement when punishment is delivered. Although research has shown that punishing the consumatory response produces less suppression than punishment of earlier responses in the chain (Church, 1969), the effects of intermittent punishment of all portions of the behavior chain may be more severe than merely punishing the initial response (lever-press).

The purposes of the present study were to replicate Church's finding; to explore the same kind of parametric function found by Shimoff et al., on a punishment procedure, and finally, to investigate whether the close temporal relationship between delivery of reinforcement and shock was a factor contributing to the differences in suppression between cued and non-cued punishment.

Method

Subjects

Twenty male Sprage-Dawley rats from The Upjohn Company Colony in Kalamazoo, Michigan, served as subjects for the experiment. They were housed in individual cages where food (Purina Laboratory Chow) was always available and maintained at 85%, $\pm$ 10 grams, of ad libitum weight by restricting their water intake. The subjects were naive and between 50 and 70 days old at the start of the experiment.

Apparatus

Each experimental chamber was isolated in a light and soundproof enclosure containing a white house light. Masking noise was produced by a Grason-Stadler noise generator Model 901B and by a fan. The chambers were 5 inches deep, 8 inches wide and 6 inches high with a floor composed of 4 1 inch diameter tubular grids through which shocks were delivered. The operandum was a lever projecting 3/4 of an inch into the chamber, 1 inch from the left-hand wall and 1/2 inch above the shock gride. A liquid dipper was located 3 inches to the right of the lever and approximately 1/2 inch above the shock grid. A red stimulus light and a source of auditory stimulation (Sonalert, Model SC628) were located on the left-hand wall. The Sonalert had four levels of sound intensity controlled by resistors of values 0, 10000, 20000, and 40000 ohms. The shock generator produced 325 VAC with current values from .01 to 4.0 milliamperes. Stimulus presentation and data recording were done by a means of a PDP8/e 12K computer using a modified version of the system described by Snapper and Kadden (1969).

Procedure

The subjects were randomly assigned to four groups of five rats and shaped to press a lever. A positive reinforcer throughout the experiment consisted of a 3 second presentation of the dipper filled with .01 cubic centimeters of a milk mixture consisting by volume of 14.3% Carnation dry milk and 85.7% water. For the next 10 days all subjects were run on a schedule of regular reinforcement to insure stability of the lever press response. During this and later phases of the experiment, all subjects in Groups I and II worked simultaneously and subjects in Groups III and IV worked simultaneously as well. Following this phase, all subjects had 5 months of training in a variable interval (VI 30") schedule with a mean value of 30 seconds; the intervals were presented randomly in daily sessions which were 30 minutes long. At the end of this period, four subjects were eliminated from the experiment because they did not meet the stability criterion, thus leaving a total of four subjects per group.

Baseline

During this period, the session length was increased to 39 minutes plus cumulative reinforcement time (3 seconds for each reinforcement earned). The reinforcement schedule was the same VI described above; but for Groups I and III, a random presentation of up to five 8 second long tones was included. This tone was the same used later as conditioned stimulus (CS); this procedure was included to rule out the possibility of any behavioral change due to the presence of the tone. Ten daily sessions of baseline were run.

The procedure of the following phases is described according to their state diagram.

Phase I

Figure 1 shows the state diagram for Group I.

State set one illustrates the basic variable interval schedule where the experimenter starts the session by turning on the house light. A probability of 0.167 is gated every 5 seconds to set up a reinforcer, the first response thereafter produces reinforcement.

State set two contains two timers that produce pulses every .10 seconds (Z5), and every 3 minutes (Z6) respectively. This state set also controls session length and maximum number of shocks.

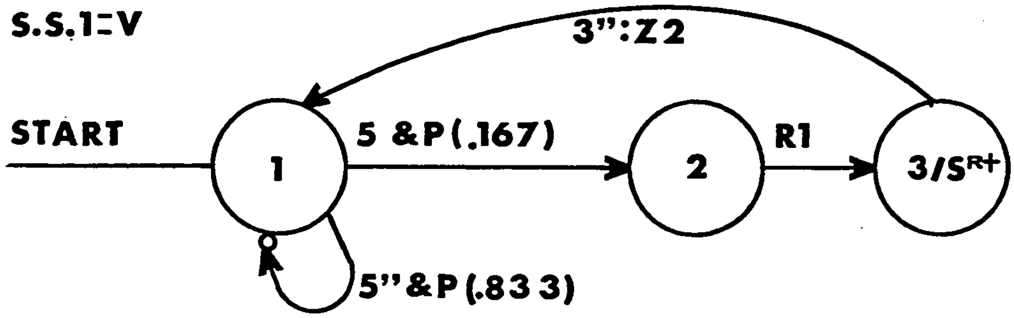
State set three gates a probability of 0.250 with a pulse Z6 to set up a punishment trial. Note that no trial can occur in the first 3 minutes and that the maximum number of trials in a session is five.

State set four turns on the CS and if 8 seconds later the rat is not receiving reinforcement, a 1 milliampere shock with duration of .12 second is delivered and the CS terminated. However, should the animal be receiving the reinforcer at that time, the shock is postponed until the dipper has been lowered.

Figure 2 contains the state diagram for Group II. All state sets except state set four are identical to those for Group I. State set four produces an 8 second delay instead of the CS, at the end of which a shock is produced only when the rat is not consuming the reinforcer.

Figure 1: State diagram of the procedure for Group I.

S.S.1=V



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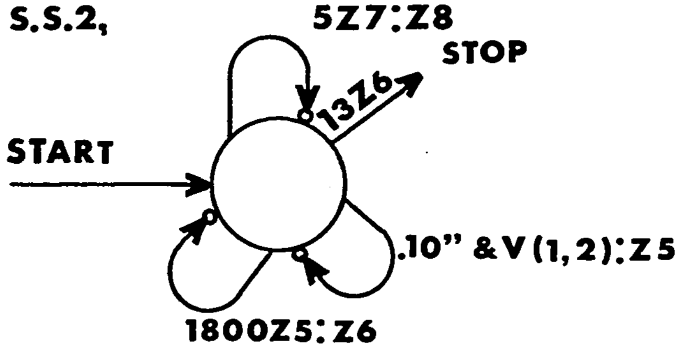

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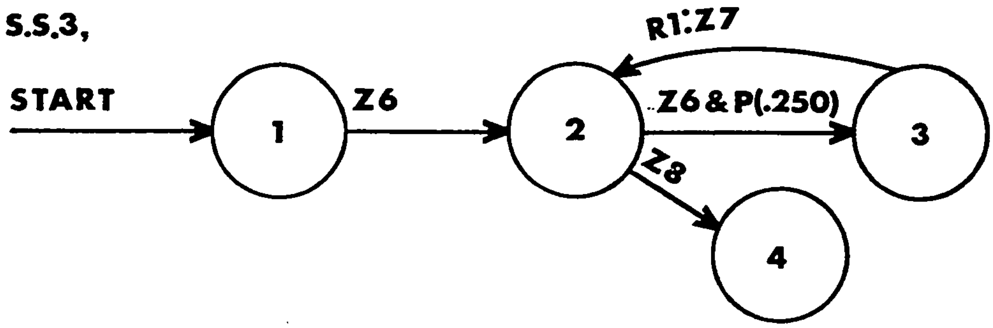

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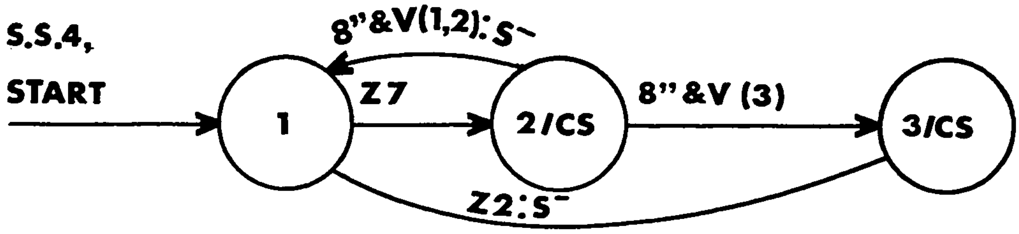
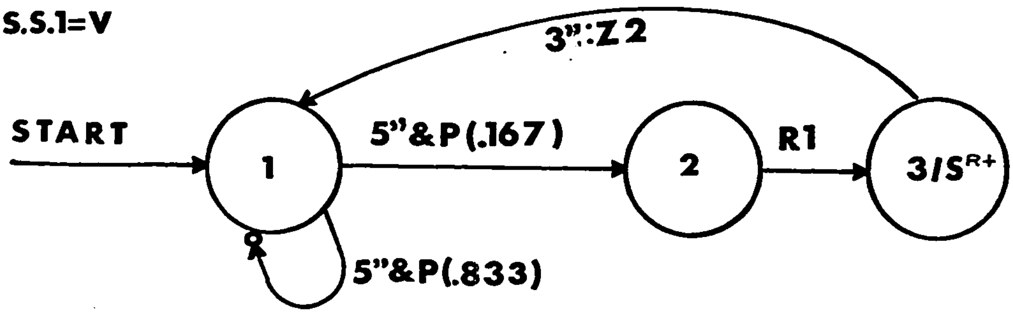


Figure 2: State diagram of the procedure for Group II.

S.S.1=V



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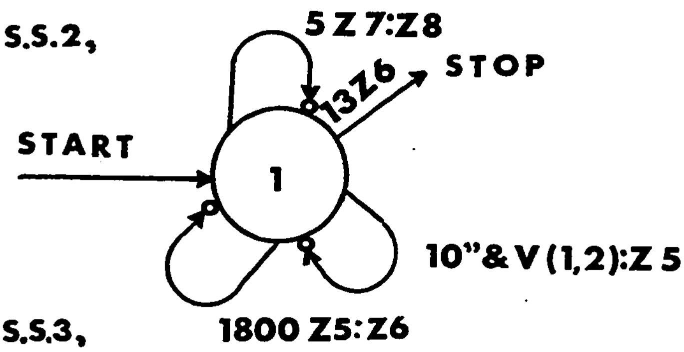

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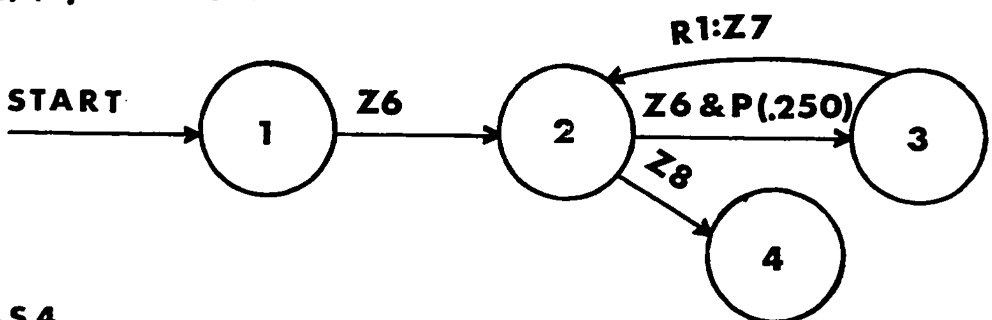

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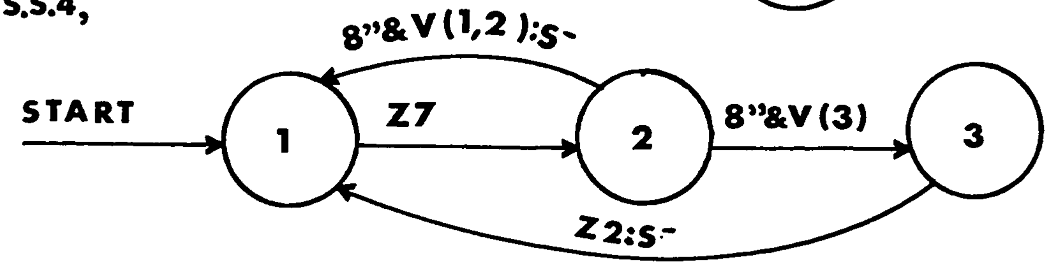


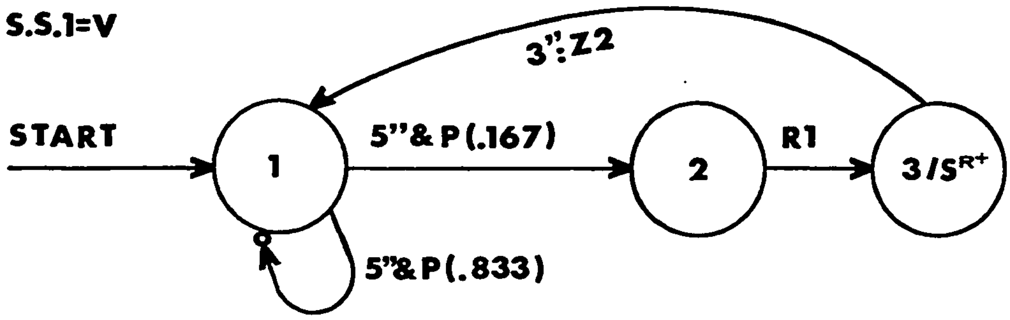
Figure 3 shows the state diagram for Group III. For this group the only different state set is number four which in this case activates the CS during 8 seconds and delivers the shock at the end regardless of the animal's behavior.

The state diagram in Figure 4 corresponds to the procedure for Group IV. Here again, the only difference from the other group is in state set four. This time it produces a delay of 8 seconds following a response and at the end of each delay a shock is given independent of the behavior of the subjects. This phase was in effect for 22 days in all groups.

Phases II, III, and IV consisted of the same set of contingencies for each group except that the duration of the CS for Groups I and III and the length of the delay for Groups II and IV were reduced to 4 seconds for 13 days, followed by 1 second for 11 days, and finally by 0 seconds for 14 days.

Figure 3: State diagram of the procedure for Group III.

S.S.1=V



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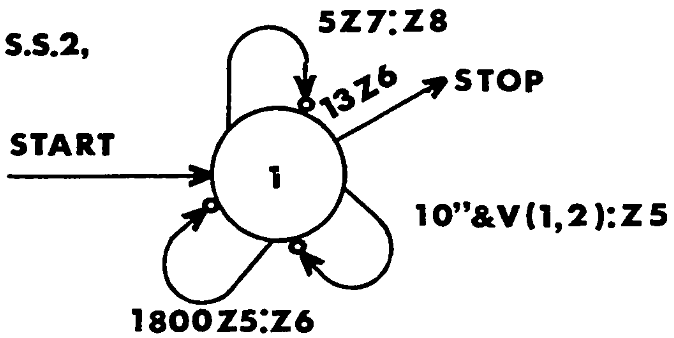

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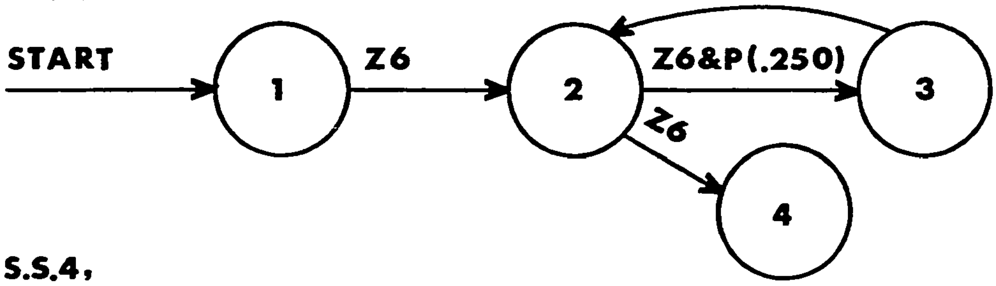

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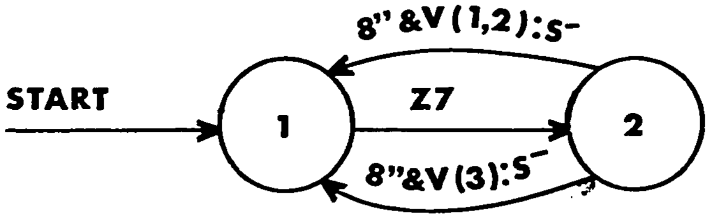
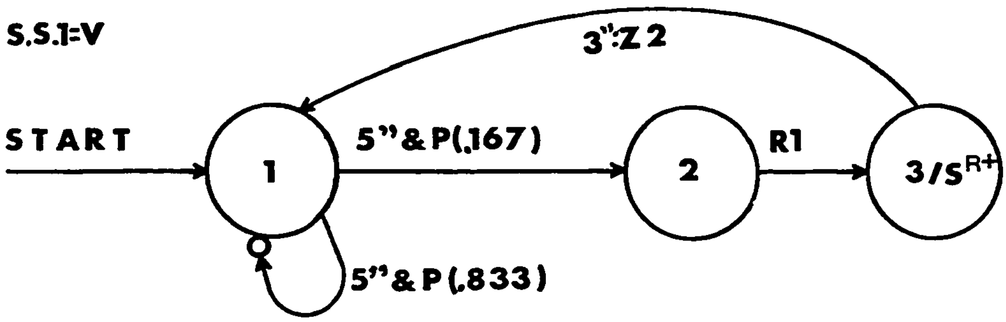


Figure 4: State diagram of the procedure for Group IV.

S.S.1=V



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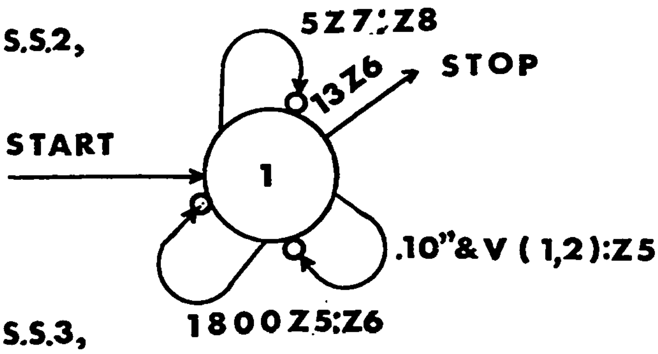

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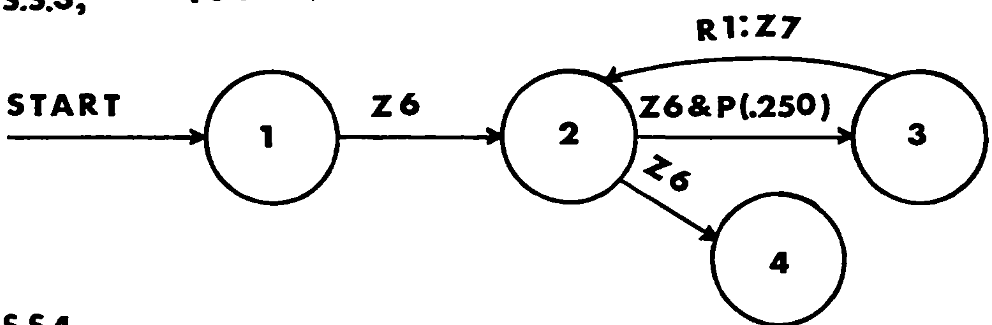

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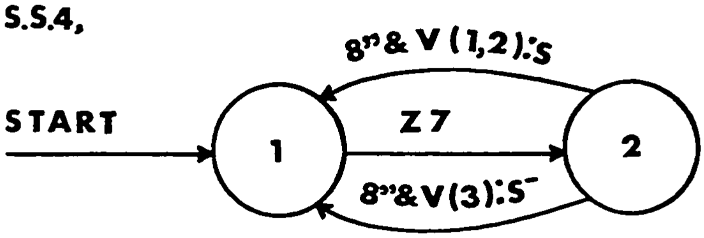

Results

Comparison of the amount of suppression caused by initial exposure to punishment show that uncued delayed punishment (Groups II and IV) causes more suppression than cued delayed punishment (Groups I and III). There was no systematic effect, however, due to different CS durations greater than zero. As can be seen in Figure 5, which contains the mean percent of baseline rate of the last 5 days as a function of CS duration for subjects in Group I, subjects S1, S2, and S4 show very similar functions (CS of 0 seconds) while S3 remained almost completely suppressed during all four CS durations. Note that the ordinates vary across subjects due to the extensive inter-subject differences in the magnitude of suppression.

The mean percent of baseline rate during the last 5 days on each CS duration for Group II is presented in Figure 6. All four subjects suppressed almost completely upon introduction of uncued shock and remained suppressed for the rest of the experiment.

Data for Group III are presented in Figure 7. Subjects S10 and S14 suppressed almost completely upon introduction of shock and remained suppressed for the rest of the experiment. S11 and S13 showed a function similar to that of subjects S1, S2, and S4 in Group I, with the lowest response rate at the 0-seconds value.

Figure 8 shows data for Group IV. All subjects suppressed completely when the shock was introduced and remained suppressed across different CS durations.

Figure 5: Mean percent of baseline rate of the last 5 days in each CS duration for subjects in Group I.

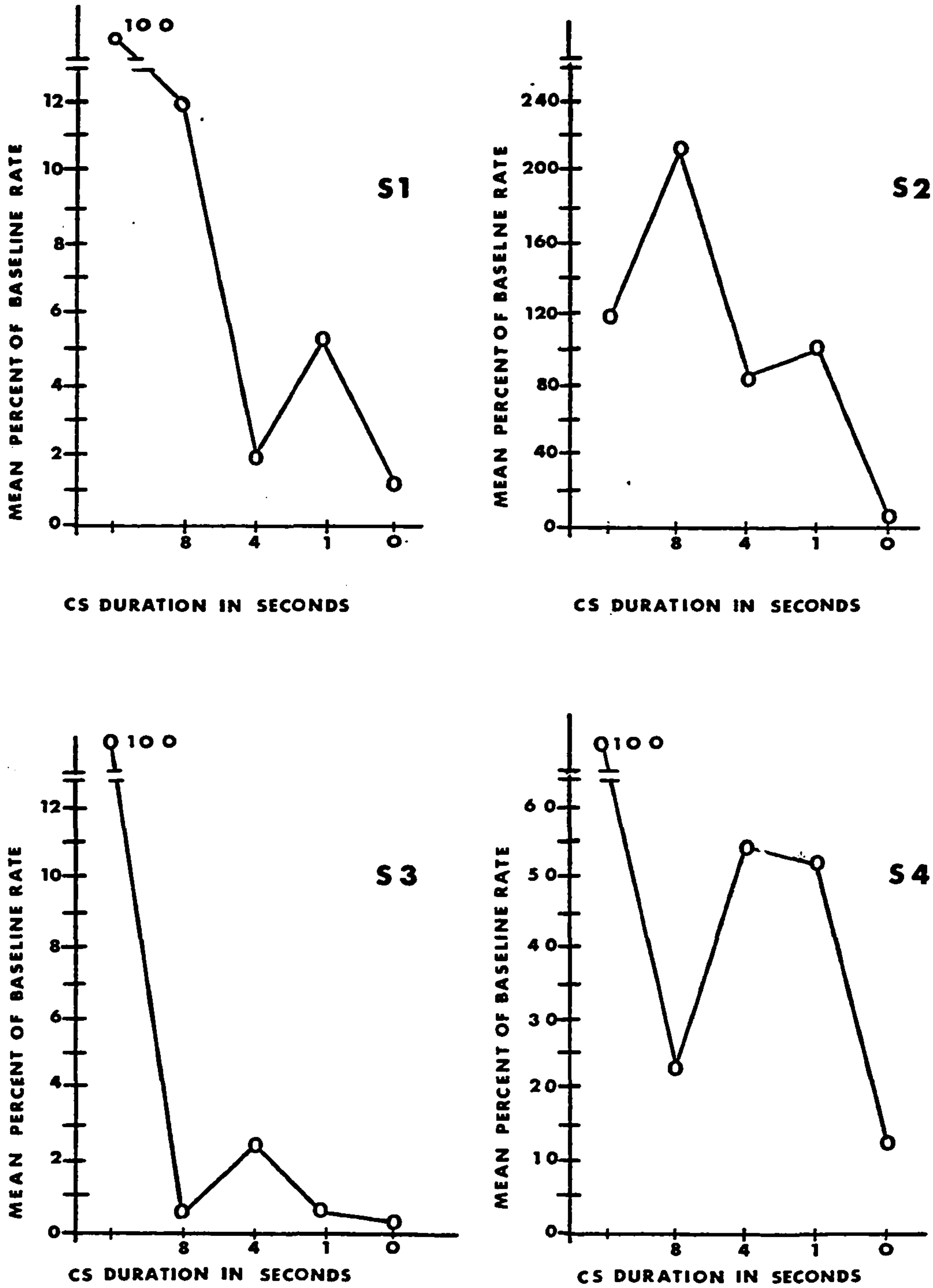
S1
S2
S3
S4
MEAN PERCENT OF BASELINE RATE
MEAN PERCENT OF BASELNE RATE
CS DURATION IN SECONDS
100
12
10
8
6
4
2
0
240
200
160
120
80
40
60
50
30
20
8
1
0

Figure 6: Mean percent of baseline rate of the last 5 days in each CS duration for subjects in Group II.

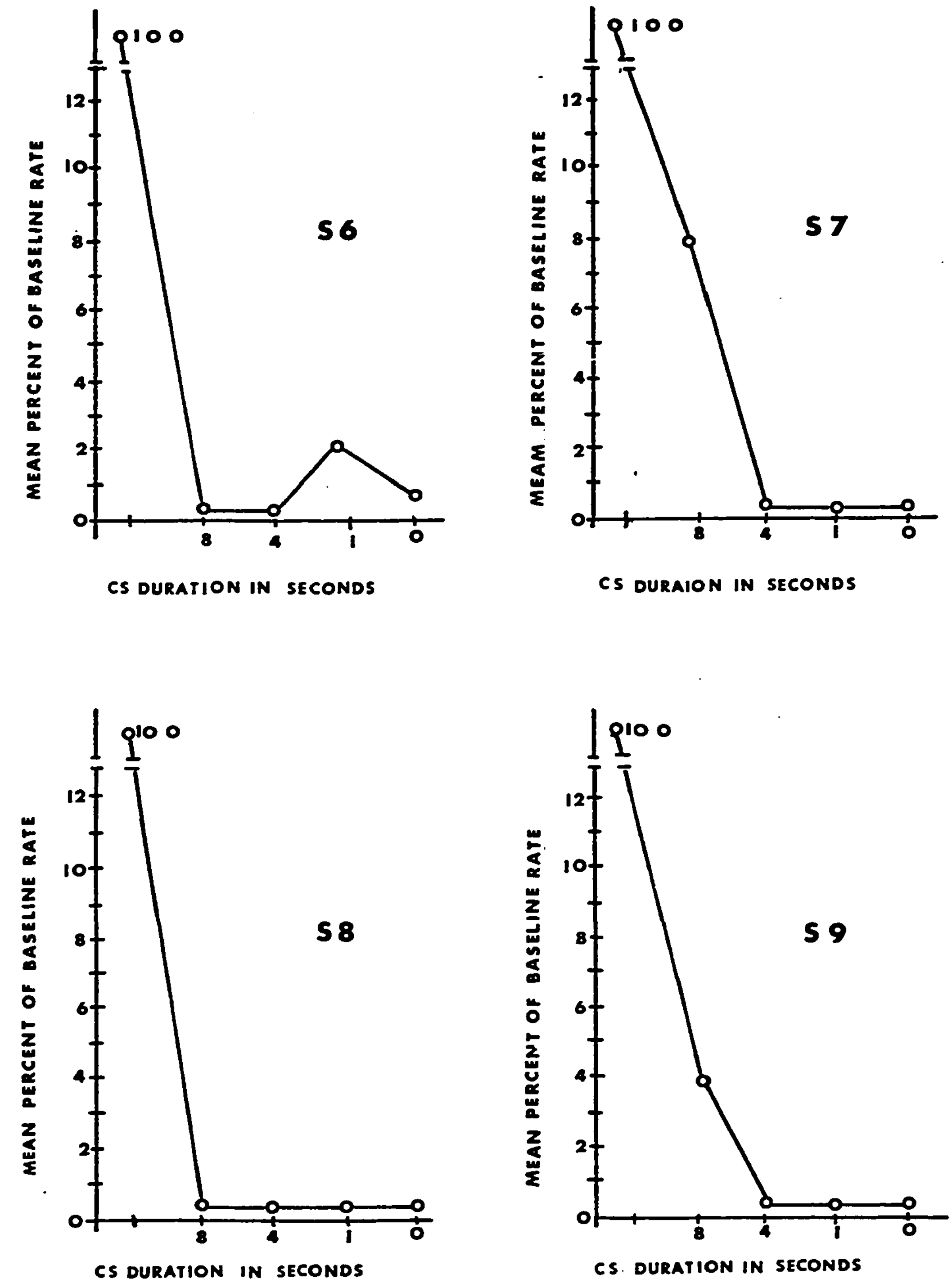
S6
MEAN PERCENT OF BASELINE RATE
100
0 2 4 6 8 10 12
8 4 1 0
CS DURATION IN SECONDS
S7
MEAM PERCENT OF BASELINE RATE
100
0 2 4 6 8 10 12
8 4 1 0
CS DURAION IN SECONDS
S8
MEAN PERCENT OF BASELINE RATE
100
0 2 4 6 8 10 12
8 4 1 0
CS DURATION IN SECONDS
S9
MEAN PERCENT OF BASELINE RATE
100
0 2 4 6 8 10 12
8 4 1 0
CS DURATION IN SECONDS

Figure 7: Mean percent of baseline rate of the last 5 days in each CS duration for subjects in Group III.

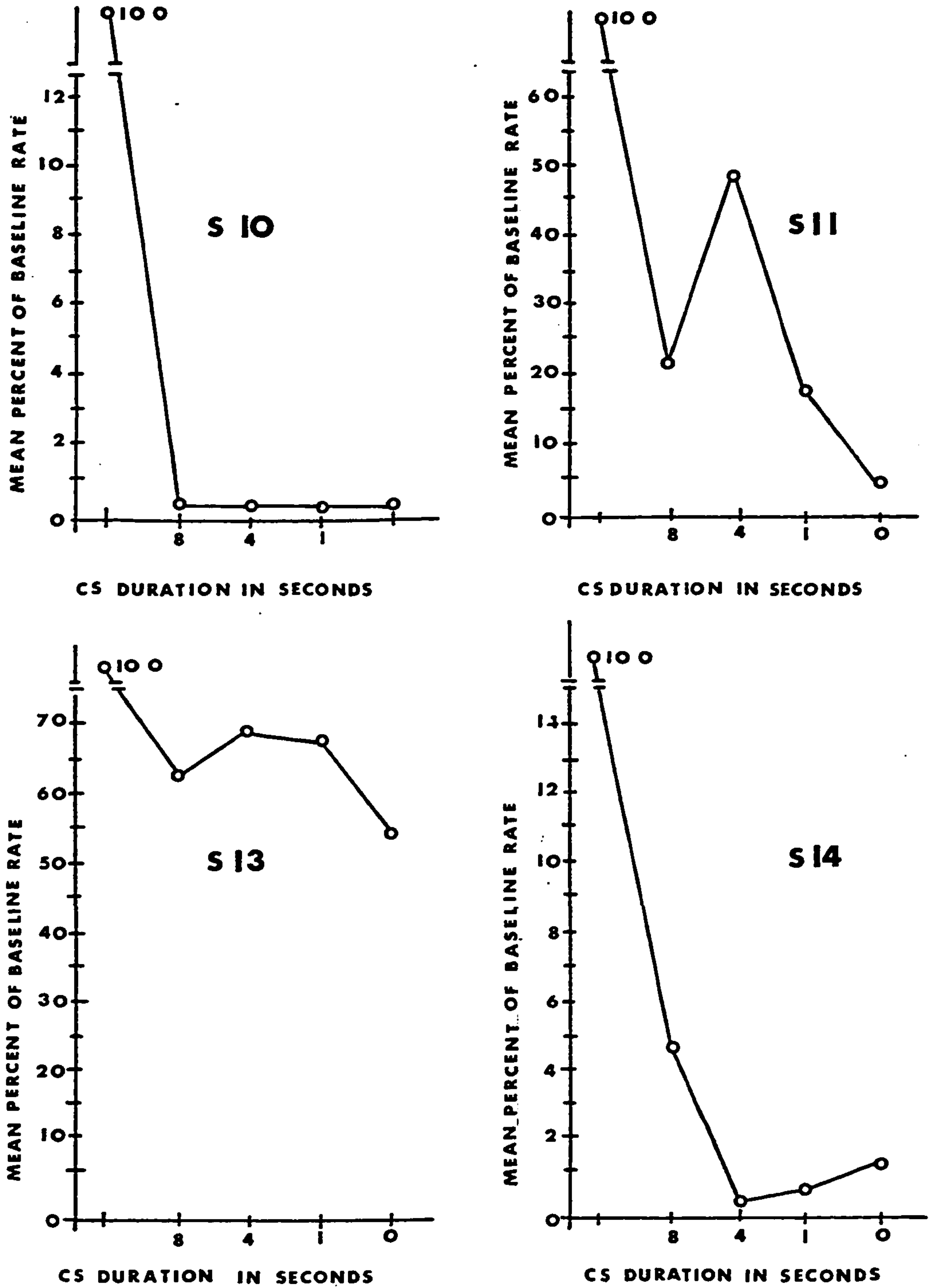
S 10
S 11
S 13
S 14
100
MEAN PERCENT OF BASELINE RATE
CS DURATION IN SECONDS
8
4
1
0
0
2
4
6
8
10
12
14
10
20
30
40
50
60
70

Figure 8: Mean percent of baseline rate of the last 5 days in each CS duration for subjects in Group IV.

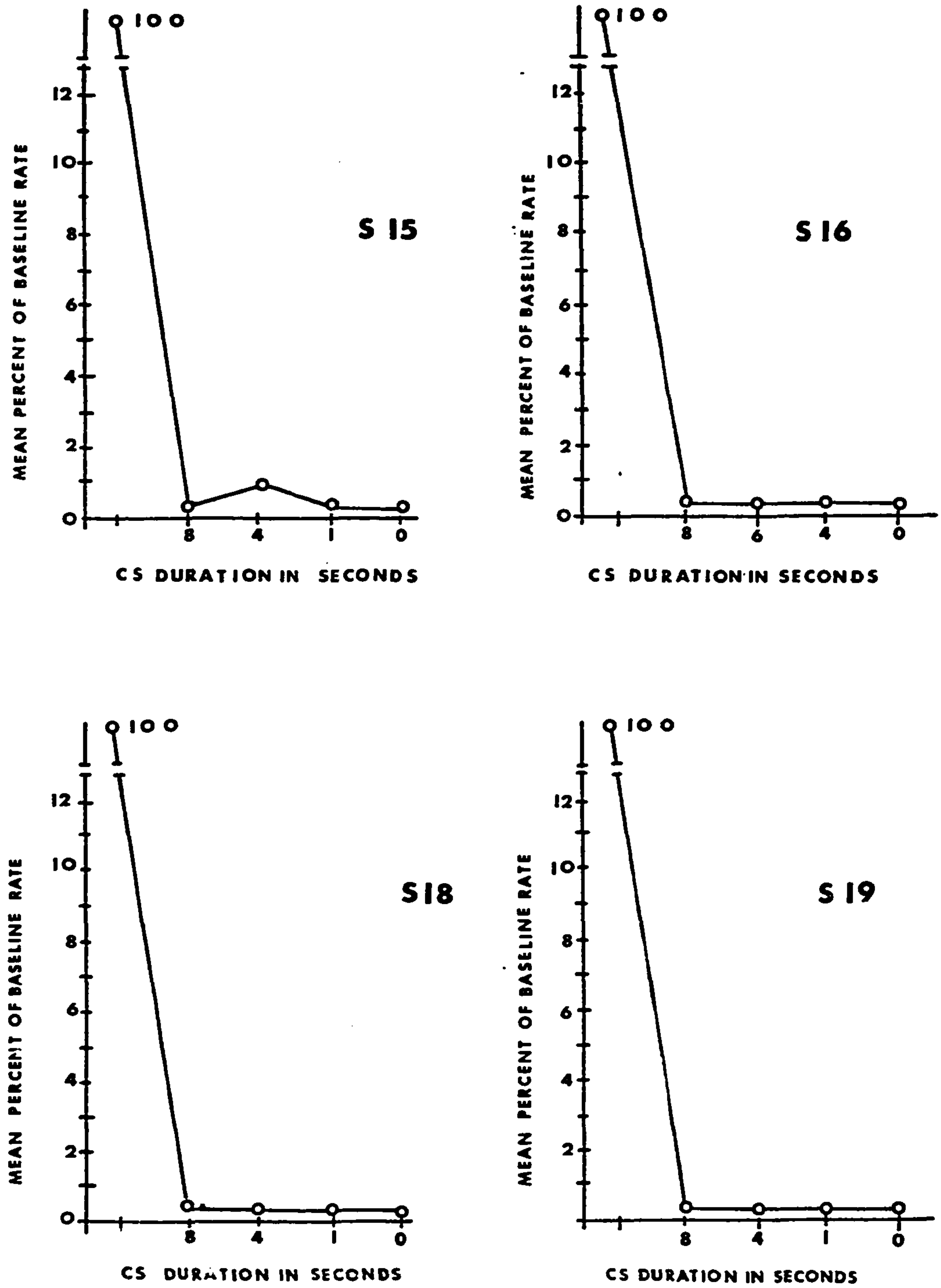
100
12
10
8
6
4
2
0
MEAN PERCENT OF BASELINE RATE
S 15
8
4
1
0
CS DURATION IN SECONDS
100
S 16
8
6
4
0
CS DURATION IN SECONDS
100
S18
8
4
1
0
CS DURATION IN SECONDS
100
S 19
8
4
1
0
CS DURATION IN SECONDS

Table 1 contains the ratio of number of shocks delivered to each subject during each phase of the experiment divided by the number of shocks expected if no suppression had occurred (three per session). As can be seen, the number of shocks received during each CS duration corresponds to the amount of suppression of response rate.

Tables 2 and 3 contain the percent of baseline rate, total number of shocks and number of shocks postponed during reinforcement for all subjects in Groups I and II during the last 10 days of each phase. It is important to note that the number of shocks delivered holds a close relationship with response rate when compared on a day to day basis, and that there were many instances in which the shock had to be postponed to avoid presentation during reinforcement delivery.

Tables 4 and 5 contain the percent of baseline rate, total number of shocks and shocks delivered during reinforcement on the last 10 days of each CS duration for subjects in Groups III and IV. It should be noted, again, that in many instances the shock was delivered while the animals were receiving the reinforcer.

A suppression rate was calculated to measure the amount of suppression during CS for Groups I and III. The formula used was that proposed by Church (1969): A/A+B in which A equals the rate of response during CS and B equals the rate of response during an equal period prior to the CS presentation. During the initial baseline sessions in which tone was presented without shocks, suppression ratios were approximately .3, but they recovered to .5 by the end of 10 sessions of the control procedure.

Table 1

Ratio of the number of shocks delivered to each subject in each CS duration divided by the number of shocks expected

CS DURATION	GRUPO 1				GRUPO 11			
	S 1	S 2	S 3	S 4	S 6	S 7	S 8	S 9
8"	.33	.88	.06	.24	.25	.09	.24	.09
4"	.35	.74	.07	.43	.07	.02	.05	.07
1"	.30	.10	.03	.60	.12	0	0	0
0"	.09	.76	.02	.23	.04	.02	.02	.07
	S 10	S 11	S 13	S 14	S 15	S 16	S 18	S 19
8"	.13	.42	.47	.24	.51	.10	.30	.07
4"	.05	.61	.90	.15	.54	.05	.20	.10
1"	.03	.33	.80	.18	.18	.03	.09	.09
0"	.0	.12	.86	.09	.14	.02	.07	.07
	GRUPO III				GRUPO IV			

Table 2

Percent of baseline rate, total number of shocks and number of shocks postponed during reinforcement for subjects in Group I

CS DURATION	S1 %	S1 n. shocks	S1 shocks PostP	S2 %	S2 n. shocks	S2 shocks PostP	S3 %	S3 n. shocks	S3 shocks PostP	S4 %	S4 n. shocks	S4 shocks PostP
8"	1			258	4							
				209	3			1			1	
	4	1		230	3							
	3	1		176	3							
	1			221	1							
	15	1		213	4					44	1	
	3	1		221	1					55	1	
	3	1		217	4					16	3	
	3	1		250	1							
	1			197	1						1	
4"				172	3					5	1	
	1	1		143	3							
	1			165	4							
	21	3		139			22	1		74	2	
	1	1		90	3		26			8	1	
	1	1		82	1		13	2		19	4	
	4	2		70	2					16	2	
	1	1		94	2					58	3	
	4	2		98	2					121	0	
				86	3					63	2	
1"	7	2	1	119	3					90	2	
	1			168	3	2				8	2	2
	4	1	1	114	4	1				93	3	1
	3			172	2							
	6	1	1	164	1					90	3	2
	4	1		102	3	1				16	2	1
	11	2	1	90	3	1	3	1		60		
	3	1		98	5					96	1	
	4	1		119	5	2				8	2	1
	4	1		106	3	1				88	2	
0"				61	4	1				16	1	1
	3			57	3					16		
	1			12	3	3					1	
	1			21	2	1				14	1	
	14	2	1	8	2	2				11	1	
	1				2					5		
	6	1			2	2				5		
					1	1				41	1	1
					2	2				8	1	
					1	1				8		

Table 3

Percent of baseline rate, total number of shocks and number of shocks postponed during reinforcement for subjects in Group II

CS DURATION	S6 %	S6 n shocks	S6 shocks Post P	S7 %	S7 n shocks	S7 shocks PostP	S8 %	S8 n shocks	S8 shocks PostP	S9 %	S9 n shocks	S9 shocks PostP
8"		1								4		
		1										
										5		
				10								
		1								2		
										5		
				29	1					2		
										4		
4"												
		1										
											1	
		1			1							
								1			1	
											1	
		1						1				
1"												
	27	2	1	1								
	5											
	2	1	1	1								
	3											
0"	1											
		1	1	1								
											1	
	2										1	
	2										1	1
								1	1			

Table 4

Percent of baseline rate, total number of shocks and number of shock delivered during reinforcement for subjects in Group III

CS DURATION	S10 %	S10 n shocks	S10 shocks PostP	S11 %	S11 n shocks	S11 shocks PostP	S13 %	S13 n shocks	S13 shocks PostP	S14 %	S14 n shocks	S14 shocks PostP
8"				5	1		78				1	
	2				1		65	2				
				14	1		32	2				
		1		28	1		50					
				9			7	3				
				28	3		28	4				
				23	1	–	58	1				
		1		18	3		73	2		16	1	
		1		14	1		86	1		8	3	
				18	1		71	2				
4"				14	2		51	3				
				18	2		49	5				
				23	2		73	2		1	1	
	12	1		50	2		85	3		1	2	
				41	1		119	2				
		1		41	2		9	4				
				32	2		85	1			1	
				37	2		86	3				
				101	2		88	3		1	1	
				37	4		80	2				
1"				69	3	3	63	2	1	14	1	
				32	2	1	8	3	2			
		1	1	18	1		77	2		5	2	2
				14	1	1	58	2	1			
				18	1	1	74	3	1			
				14			22	1		1	1	1
				18			98	1	1			
				9	1	1	74	5			1	1
				28	1	1	96	3				
				14	1		50	2		2	1	
0"				9			81	2				
				9	1	1	112					
				5	1	1	94	4				
				5			58	4	1			
				5			23	2				
				9			12	2	1			
				14	1	1	59	1		5	1	
							75	2		1	1	1
							50	4	1			
							74	3				

Table 5

Percent of baseline rate, total number of shocks and number of shocks delivered during reinforcement for subjects in Group IV

CS DURATION	S15			S16			S18			S19		
	%	n. shocks	shocks PostP	%	n. shocks	shocks PostP	%	n. shocks	shocks PostP	%	n. shocks	shocks PostP
8"	1	3										
		3						1				
		2										
	1	1						1				
		2						1				
		2						2				
								2			1	
	1	2			1			1				
		3									2	
		1										
4"		2									1	
		2						1				
								1				
	3	2									1	
	4	2						1				
	4	2						1				
		2						1			1	
		2		1	1			1				
		2										
1"								1	1			
		1	1									
											1	1
	1	1	1									
								1	1			
		3	3		1	1					1	1
		1	1									
											1	1
0"												
							19	2	1			
											1	1
		2	2									
		1	1									
		2	1				1	1	1		1	1
					1	1						

Discussion

The present experiment was designed to compare the relative amount of suppression of the response rate of subjects that could receive shocks at any point in the behavior stream with the amount of suppression of rate in subjects who were never shocked during reinforcer presentations. However, the choices of parametric values of shock intensity, baseline reinforcement schedule, and other variables led to complete suppression in subjects initially exposed to unsignaled shock both in Groups II (no stocks during reinforcement) preventing the crucial comparison.

One of the most critical variables in punishment experiments is the intensity of the punishing stimulus. Selecting the right intensity value for shock has been included as a part of the punishment experiment itself. Azrin (1956) reported that in order to select the appropriate shock intensity he tested the subject's performance with several intensities presented in ascending order prior to the actual experimental manipulations. This technique, however, may introduce new difficulties for the analysis of punishment variables. For example, Azrin and Holz (1966) reported that the sequence of exposure to shock is a very important variable in determining the amount of suppression produced. Exposure to gradual increases in intensity may produce resistance to the suppressive effects of punishment. It seems evident, then, that this method of selection of intensities cannot be used as a regular strategy on punishment procedures.

A second method for selection of appropriate shock intensities (in this case a level that would produce intermediate suppression) is to look in the literature for guidance. Church (1969) has conducted a number of studies on the effects of shock intensity. From his work with variable interval (VI 2') baseline, 1 milliampere should produce the appropriate levels of suppression. However, baseline variables, strain of rats, differences between experimental chambers and other variables that are difficult to control all contribute to the amount of suppression obtained. These considerations seem to lead to the design and use of pillt studies as a better way of selecting parameters of intensity of shock in the specific equipment to be used.

The baseline rates of the present experiment never achieved the stability that characterizes most performance under a variable interval schedule of reinforcement (Ferster and Skinner, 1957). There are at least two possible explanations for this variability. The deprivation level selected could have been insufficient to maintain steady responding. Alternatively, occasional mechanical problems with the reinforcement dipper occurred in the initial VI training and may have contributed to the observed variability. It is clear from a comparison of the intermediate amount of suppression in Groups I and III with the amount of complete suppression in Groups II and IV on 8 seconds delay that the cue was responsible for less suppression of response rate. This findings confirm the Raymond and Church (1969) study. The later dramatic increase in suppression when the cue was removed appears to strengthen this finding. However, it should be noted that as the cue duration decreased so did the delay between the response that produces the punishment and the shocks. When the cue duration is zero the procedure becomes immediate non-cued punishment. Church (1969) demonstrated that delay of punishment is a potent variable, with zero delay producing the most suppression, the results of removing the cue in Groups I and III are confounded by the delay variable.

In general, although the sudden decrease in responding found by Shimoff et al., (1969), the greater amount of suppression reported by Raymond and Church (1969), and the results of this experiment seem to suggest that the presence of the cue of several durations is qualitatively different from the 0-seconds duration or total absence, these results leave open the possibility of training subjects to maintain rates on uncued punishment by manipulating several dimensions such as the duration of the due, intensity of the cue, probability of the cue, etc. through the use of fading techniques.

Due to the excessive suppression of Groups II and IV on initial exposure to punishment, the mechanism by which the cue reduces the amount of suppression for the subjects of Groups I and III is still unclear.

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