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THE CONDITIONED LICKING RESPONSE IN RATS AS A
FUNCTION OF THE CS-UCS INTERVAL

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Robert Boice

1964



THE CONDITIONED LICKING RESPONSE IN RATS
AS A FUNCTION OF THE CS-UCS INTERVAL

By

ROBERT BOICE

ABSTRACT OF A MASTER'S THESIS
COMPLETED SUMMER TERM, 1964
DEPARTMENT OF PSYCHOLOGY

Using Weisman's new method of classically conditioning the licking response in rats, the acquisition of test trial responses and anticipatory CR's was compared over five CS-UCS intervals (0.5", 1", 2", 4", 6"). It was expected that the optimal interval would be longer than one half second because of the nature of the UCR and the type of organism employed. In addition, a comparison between two strains of rats, albino and grey, was made.

The results were as follows: (a) The optimal interval was two seconds with four seconds being nearly as good. (b) The one-half, one, and six second groups were not significantly different from one another. (c) The two optimal intervals were significantly better than each of the other three intervals. (d) Data for CR's and test trials indicated the same trends although the differences were greater

Robert Boice

for the CR's. Reasons for that difference were discussed.

(e) There was no genetic difference or interaction over temporal groups.

Approved: M. Ray Denny
Committee Chairman

Date: Aug. 13, 1964

Thesis Committee:

M. Ray Denny, Chairman

John King

Thomas Nelson

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1. The first step is to identify the problem.

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2. The second step is to analyze the problem.

3. The third step is to develop a solution.

4. The fourth step is to implement the solution.

5. The fifth step is to evaluate the results.

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6. The sixth step is to monitor the results.

THE CONDITIONED LICKING RESPONSE IN RATS
AS A FUNCTION OF THE CS-UCS INTERVAL

By
ROBERT BOICE

A THESIS

Submitted to the College of Social Science of
Michigan State University of Agriculture
and Applied Science in partial fulfillment
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1964

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1. Introduction

The purpose of this study is to investigate the effects of various factors on the performance of a system.

The study is organized as follows: Section 2 describes the methodology used in the study.

Section 3 presents the results of the study, and Section 4 discusses the conclusions.

The study is based on a series of experiments conducted over a period of six months.

The results of the study are presented in the following sections.

The study is based on the following assumptions:

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

INTRODUCTION

The notion that there is no single optimal CS-UCS interval in classical conditioning dates back to Pavlov (1927) who found a variety of temporal intervals up to five seconds to be equally efficacious. American investigations in the interim, however, have largely neglected using the consummatory response as a UCR. A preponderance of data from eyelid and finger withdrawal conditioning studies has consistently indicated an optimal one-half second interval. Exceptions are evident in procedures utilizing the responses of pupillary dilation and GSR (Jones, 1962). In work with other organisms, an optimal interval of a different length is often found. Table 1 lists a cross section of the various procedures and organisms employed in classical conditioning.

TABLE 1
EXPERIMENTAL STUDIES OF CS-UCS INTERVAL EFFECTS

INVESTIGATOR	UCR	ORGANISM	OPTIMAL CS-UCS INTERVAL
Kimble (1947)	Eyeblink	Human	.4"
Kimble, Mann, and Dufort (1955)	Eyeblink	Human	.5"
Schneiderman and Gormezano (1964)	Nictitating Membrane	Rabbit	.25"
Cohen (1950)	Flexion	Sheep	0
Kappauf and Schlosberg (1937)	Respiration	Rat	1.5"
Gerall and Woodward (1958)	Pupillary Dilation	Human	1.5"
Bierbaum (1959)	GSR	Human	3"
Jones (1962)	GSR	Human	1"
Spooner and Kellogg (1947)	Finger Withdrawal	Human	.5"
Wolfe (1930)	Finger Withdrawal	Human	.5"
Pavlov (1927)	Salivation	Dog	0" - 5"
Goldstein <u>et al.</u> (1964)	Nictitating Membrane	Frog	2"

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods used to collect and analyze data, ensuring that the information is reliable and up-to-date.

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3. The third part of the document discusses the impact of the changes on the organization's overall performance. It presents data and analysis showing the positive outcomes of the implementation, such as increased efficiency and cost savings. This section also highlights the areas for further improvement and the ongoing commitment to excellence.

4. The fourth part of the document provides a summary of the key findings and conclusions. It reiterates the importance of the changes and the commitment to maintaining high standards of performance. This section also includes a list of recommendations for future actions and a timeline for implementation.

5. The fifth part of the document is a conclusion, summarizing the main points of the document and expressing the organization's confidence in the future. It also includes a statement of appreciation for the support and cooperation of all stakeholders throughout the process.

In recent work at this university, R. G. Weisman has developed a new method of classical conditioning in the rat. The UCR is the consummatory response of licking for water. Weisman's doctoral thesis (1964) is based on a concurrent technique which allows comparisons of classical conditioning and instrumental conditioning using the same licking response. His data on successive acquisitions and extinctions, on partial reinforcement effects, and the controls for pseudo-conditioning and superstitious behavior combine to demonstrate evidence for a genuine classical conditioning procedure.

Indications that the licking response in the rat is highly reflexive (a good UCR) can be found in studies by Davis and Keehn (1959) and Keehn and Arnold (1960). They found the mean licking rate in adult rats to be a consistent six or seven licks per second -- over various levels of thirst, for water, sucrose, saccharin, and saline solutions. The question of innateness was answered by Schaffer and Premack (1961) who observed weanling rats to lick in the same range as adults upon first contact with water.

With a new procedure of classical conditioning available and the obvious critics awaiting data (Kimble, 1964), the need for a CS-UCS interval study was present. A standardized CS-UCS study would permit comparisons with other techniques and also establish the most efficient ISI for this method. The apparatus designed by Weisman was

easily modified to allow variance of stimulus intervals and confinement of the S to insure minimal competing responses during the delay of reinforcement period (after Carlton -- in Spence, 1956). In view of the research done with the other consummatory response, salivation, the expectancy of results was only that the optimal interval need not be 0.5 seconds to reflect a true classical conditioning method.

METHOD

Subjects - The S's were forty experimentally naive rats about four months of age, which were divided equally into two groups of Long-Evans greys and Spartan Colony albinos. Strict conditions of deprivation were imposed on all S's as follows: First, five days of ten minutes of water per day; second, two days of four minutes of water per day; third, on training days, only two minutes of water outside the apparatus. All S's were maintained in individual cages for the twelve day period with ad lib. food. Each animal was run at approximately the same time each day, and all training was administered in the evening.

Apparatus - The apparatus used was basically that built by Weisman to test concurrent classical and instrumental conditioning. Two matched systems were incorporated to allow the simultaneous conditioning of two animals. During the experimentation, each licking apparatus was enclosed in a converted refrigerator to insure proper sound insulation. Each refrigerator contained a 60 ft./min. exhaust fan and a white noise speaker for masking apparatus clicks. An idealized representation of one of the "licking boxes" is shown in Figure 1. The wooden insert in the licking box was designed to permit more confinement of the animal than in Weisman's case. The resultant interior dimensions were five inches in length, one and three-quarters inches in

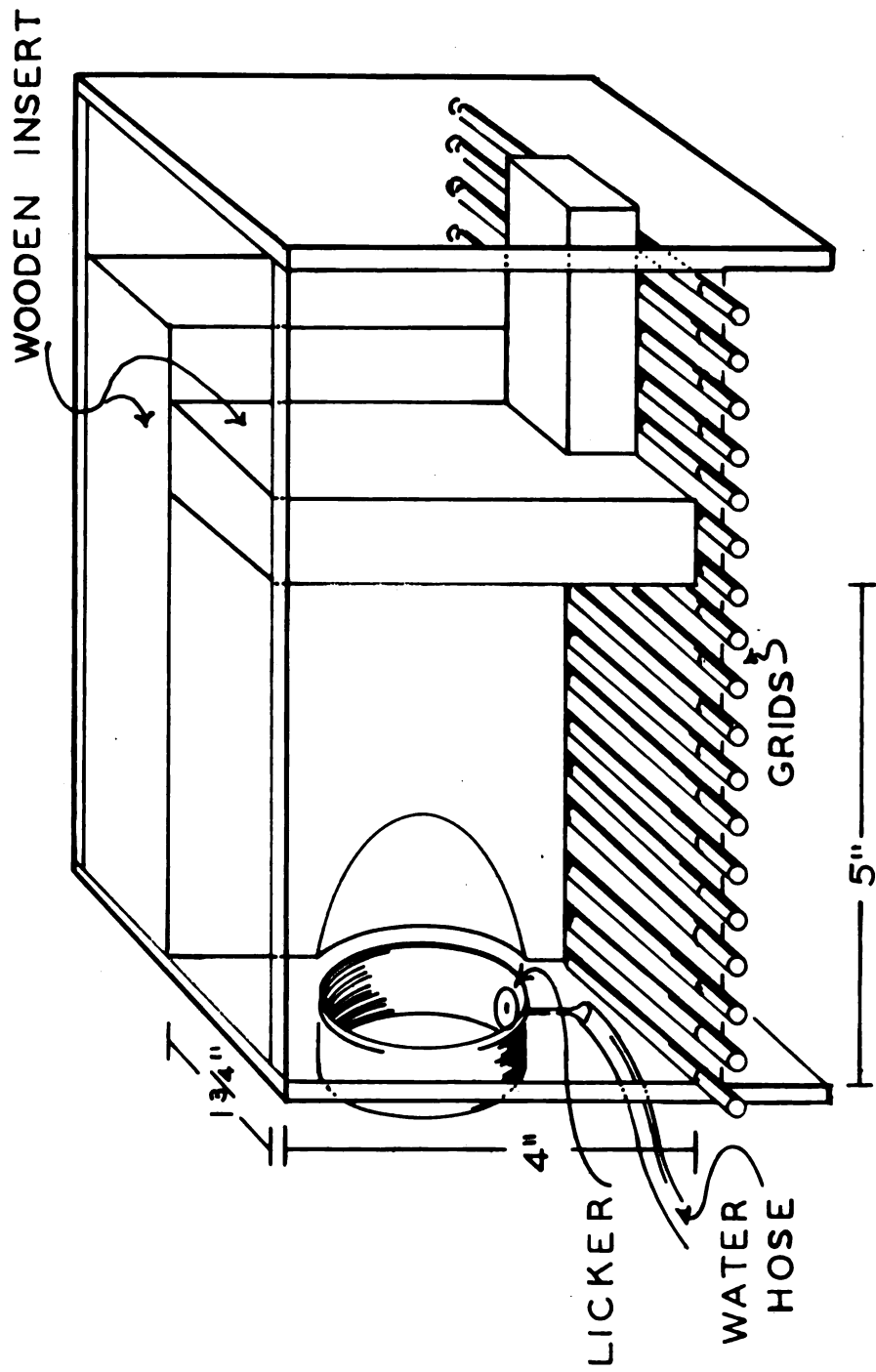


FIGURE 1. THE PLASTIC LICKING BOX

width and four inches in height. The drinking well side and front face were constructed of plexiglass. The floor consisted of a one-eighth inch stainless steel grid.

The drinking well was a fully enclosed one and one-half inch extension on the front face of the box. Water was presented in small quantities, controlled by a solenoid valve, one drop per trial through a #11 needle (ground flat and smooth) which projected through a small opening at the bottom of the well. A small copper ring encircled this opening to prevent gnawing and to measure licking. The CS was a ten watt bulb mounted on the outside of the box next to the well. The general level of illumination in the boxes was 5 ft. c.

Licking was measured by Grason-Stadler drinkometer, Model E 4690A, and recorded with a Gerbrands event recorder. Hunter timers and a Gerbrands punch tape timer provided the temporal intervals. A stepping switch was installed to allow randomized test trials.

Design - The two experimental groups of albinos and greys were randomly divided into five groups of four each, making a total of five interval groups with eight S's each. The five CS-UCS intervals chosen on the basis of pilot work were one-half second, one second, two seconds, four seconds, and six seconds. All CS-UCS presentations were of the delayed type and had a two second overlap.

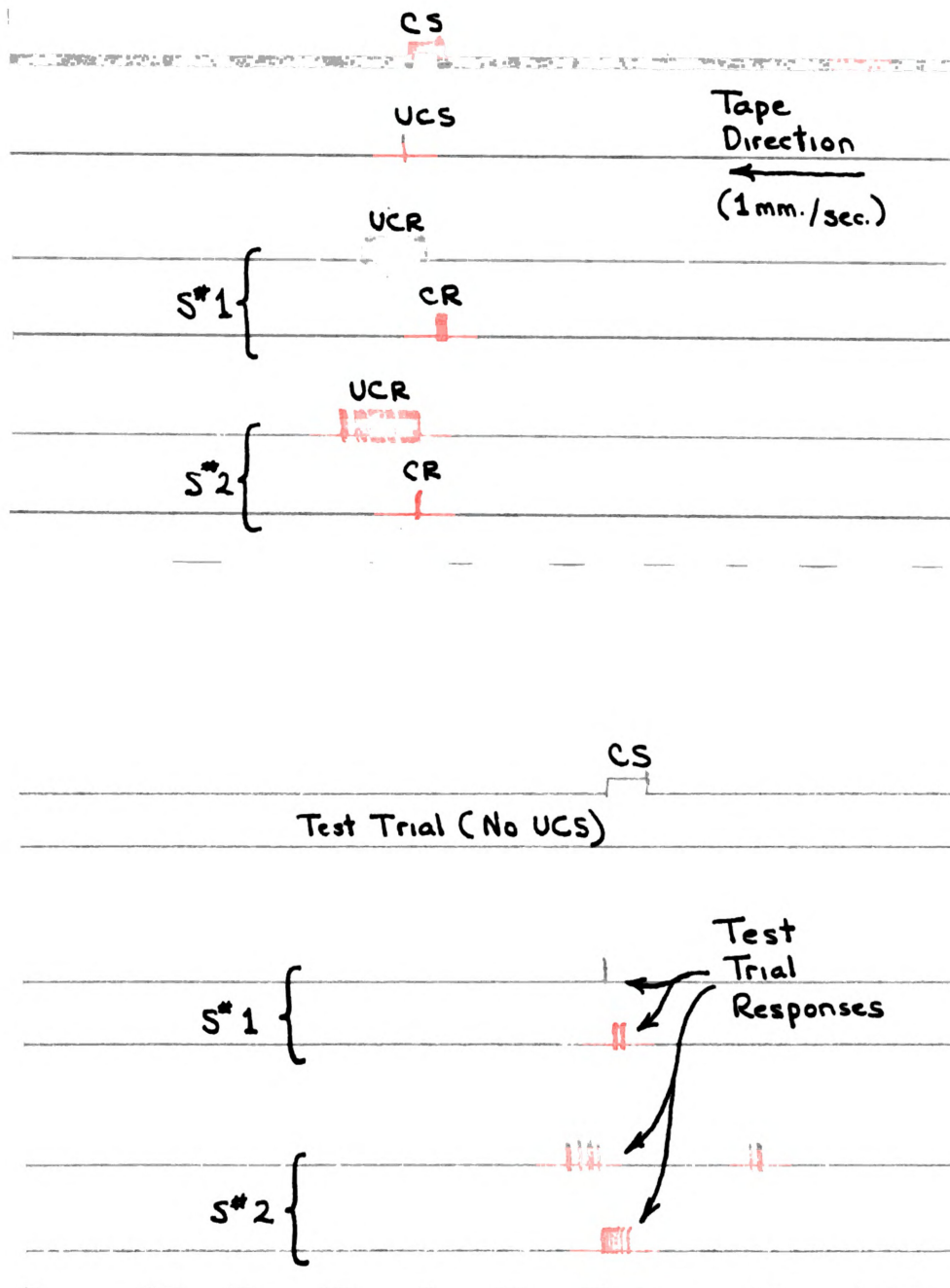
Procedure - The basic procedure consisted of four days of training for all S's. The animals were habituated on the first day in order to familiarize the animal with the apparatus and to insure that the UCS (water) would be a consistent elicitor of licking, once acquisition trials were begun. The criterion of habituation for all S's was fifty UCR's on a one-hundred and twenty second V.I. schedule with no CS present. The three days of conditioning followed immediately, utilizing various ISI intervals as previously indicated.

Two pairs of S's were run each evening and the three hour session for each had trials presented on an ITI of one-hundred and twenty seconds, V.I. Test trials were inserted on the average of one in ten trials during the three ninety-trial sessions.

Measures - The two basic measures of conditioned responses were recorded on paper tape by the event recorder. Two samples of that tape appear in Figure 2.

FIGURE 2

RESPONSE TAPES SHOWING A CR AND TEST TRIAL RESPONSE



Anticipatory responses were scored as CR's on the non-test trials if they occurred during the CS-UCS interval and were discriminatory in nature (not part of intertrial responding). To compensate for the obvious disadvantage of measuring anticipatory CR's with the two shortest intervals, test trials were instituted as the primary measure of performance. The criteria for a test trial response were that it also be discriminatory in nature and occur during the presence of the CS. Both measures, CR's and test trials, were used for all groups.

RESULTS

The results are graphically presented in terms of cumulative acquisition curves (Figure 3), as parametric functions by days (Figure 4), and as total parametric functions (Figure 5). In Figure 5 test trial responses were totaled for all three days of acquisition, whereas CR responses represent only the third day of acquisition.

A visual examination of the three graphs indicates a marked superiority of the two and four second groups in acquisition rates and final levels of conditioning. In fact, two seconds appears to be generally optimal -- although probably not significantly so. The one-half, one, and six second intervals show no important differences at any level. The CR levels for those three intervals are much lower than the corresponding test trial levels in Figure 5. Test trial functions for the three days in Figure 4 seem to maintain the same general relationship among the intervals. In the two and four second groups, the level of anticipatory CR responding on the third day was seventy-four percent. The CR function in Figure 5 does not include the first one hundred and eighty trials because the three less optimal groups showed little conditioning (CR's) during that period.

The design of the experiment was a 2 X 5 factorial with an organismic variable. The same appropriate analysis

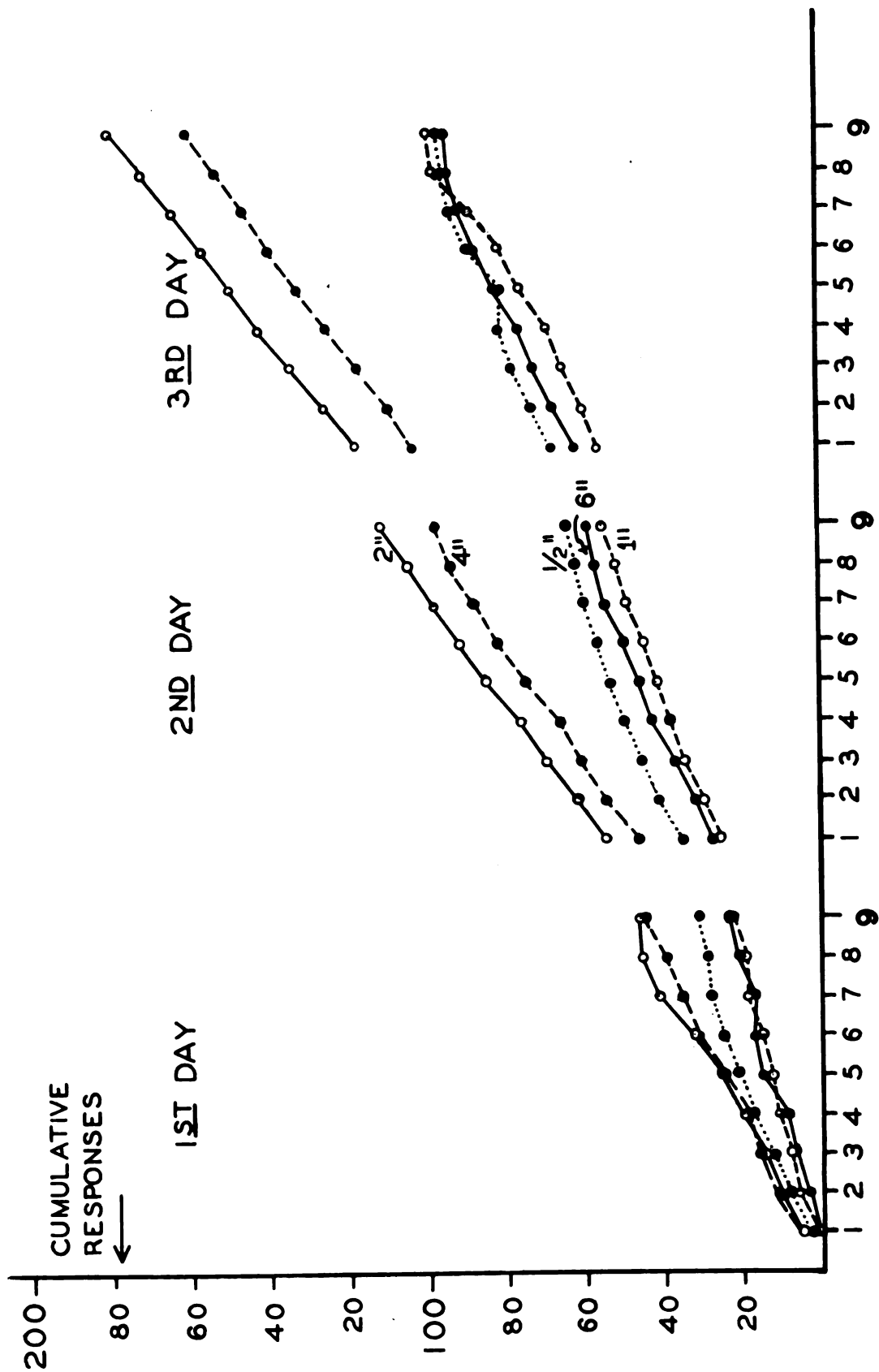


FIGURE 3. CUMULATIVE LEARNING CURVES FOR TEST TRIAL RESPONSES

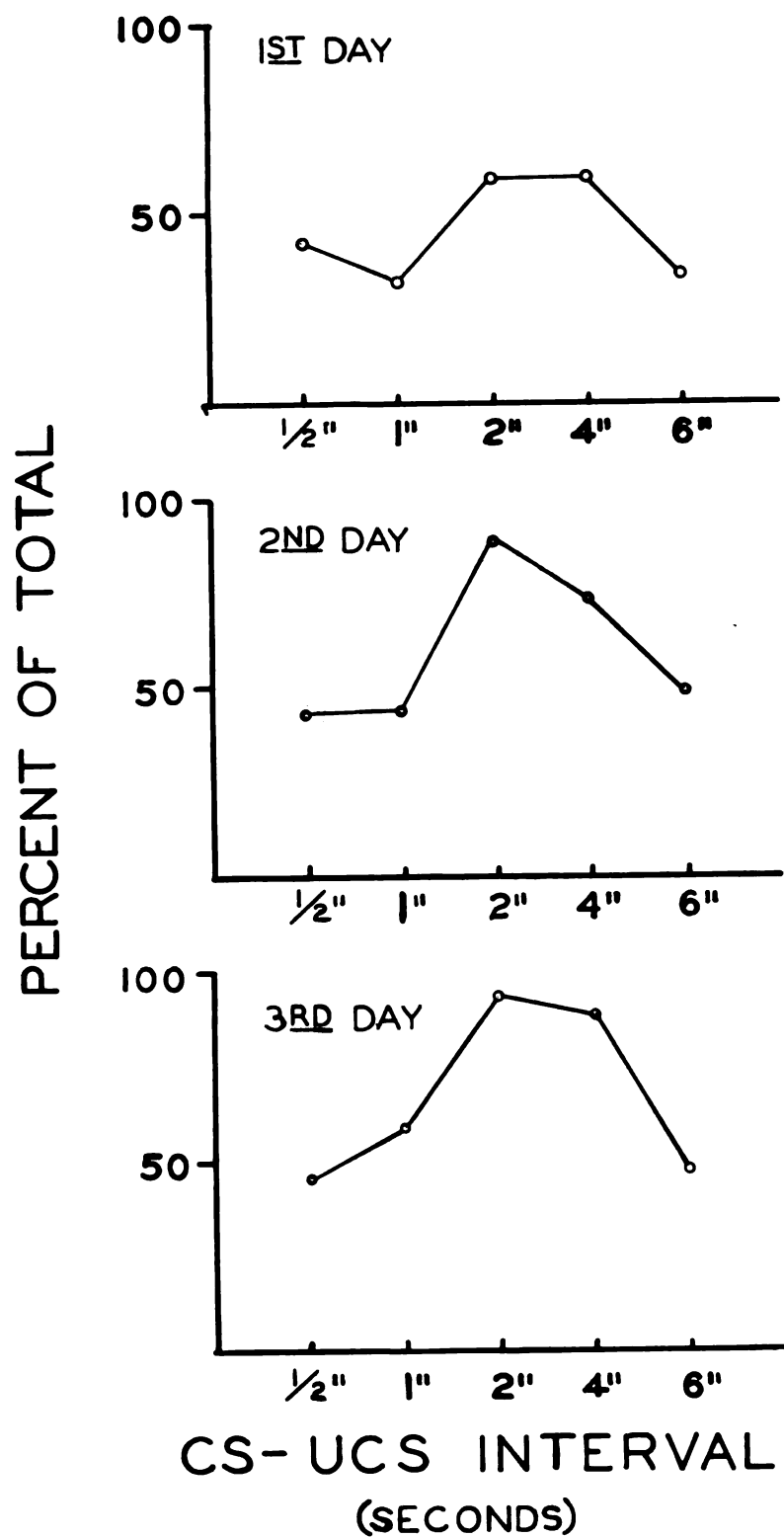


FIGURE 4. PARAMETRIC FUNCTIONS BY DAYS

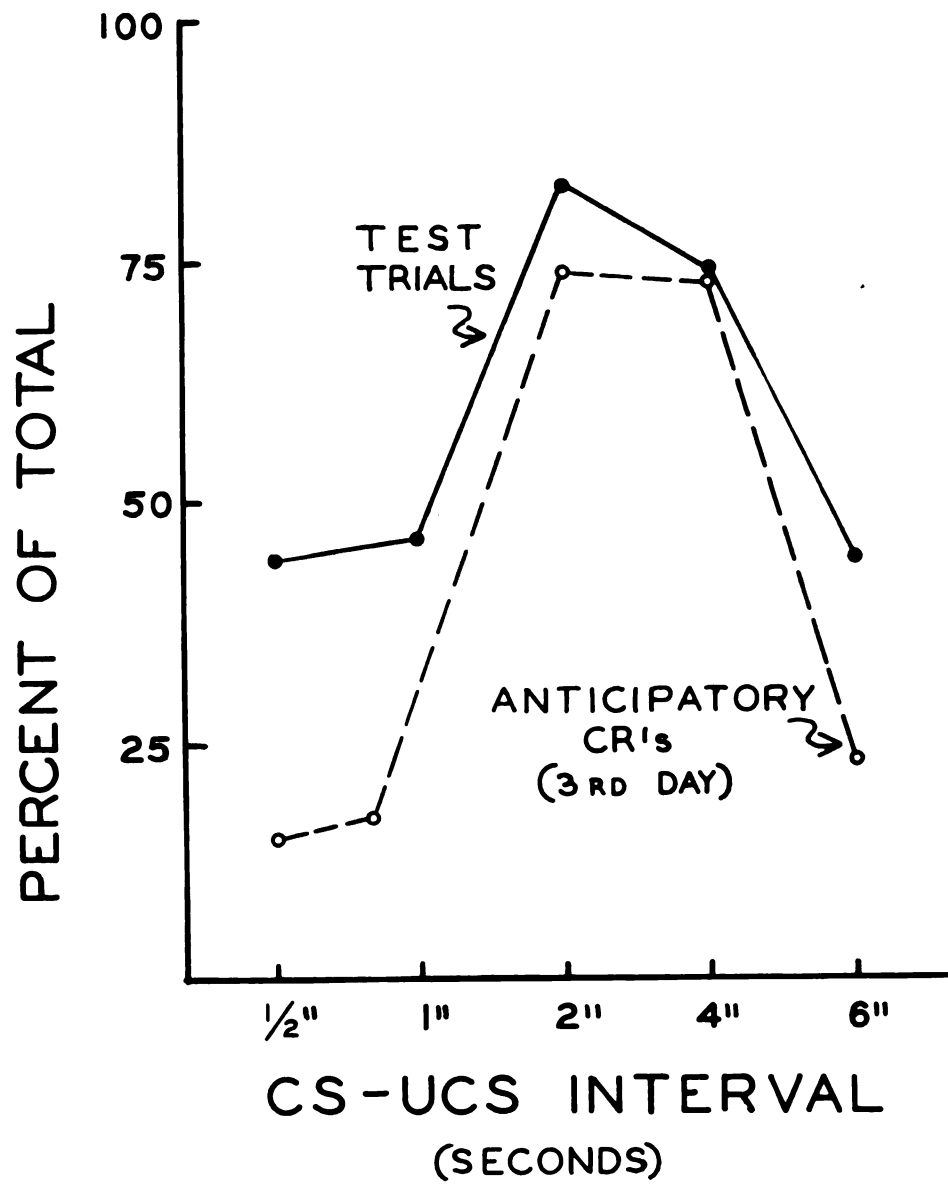


FIGURE 5. TOTAL PARAMETRIC FUNCTIONS

of variance was applied to both sets of data. The summary tables for both analyses appear in Table 2.

TABLE 2

SUMMARY OF ANALYSIS OF VARIANCE FOR
TOTAL NUMBER OF TEST TRIAL RESPONSES

SOURCE OF VARIATION	SS	d.f.	M.S.	F	p
Between					
Genetic	18.8	1	18.8		
Temporal	856.1	4	214.0	8.77	.005
G X T	63.1	4	15.8		
Within	731	30	24.4		
TOTAL		39			

SUMMARY OF ANALYSIS OF VARIANCE FOR
THIRD DAY ANTICIPATORY CR'S

SOURCE OF VARIATION	SS	d.f.	M.S.	F	p
Between					
Genetic	14	1	14		
Temporal	19,742	4	4,936	30.85	.005
G X T	139	4	35		
Within	4,809	30	160		
TOTAL		39			

The organismic variable produced no significant difference between albino and grey rats over temporal groups and no interaction with temporal groups. For both responses the intervals produced significant differences beyond the .005 level.

To determine the differences between the group means, Duncan's Multiple Range Test was administered. The results of the comparisons appear in Table 3.

TABLE 3

SUMMARY OF MULTIPLE COMPARISONS BETWEEN
INTERVAL GROUP MEANS FOR TOTAL TEST TRIAL
RESPONSES APPLYING DUNCAN'S MULTIPLE RANGE TEST

Group Means	$\frac{1}{2}$ "Group A	1"Group B	2"Group C	4"Group D	6"Group E	Shortest Significant Ranges (.01 level)
A 11.8	11.8	12.4	22.5	20.0	11.8	6.8
B 12.4		.6	10.7	8.2	0	7.1
C 22.5			10.1	7.6	.6	7.3
D 20.0				2.5	10.7	7.4
E 11.8					8.2	



SUMMARY OF MULTIPLE COMPARISONS BETWEEN
INTERVAL GROUP MEANS FOR THIRD DAY CR'S
APPLYING DUNCAN'S MULTIPLE RANGE TEST

GROUP MEANS	$\frac{1}{2}$ "Group A	1"Group B	2"Group C	4"Group D	6"Group E	Shortest Significant Ranges (.01 level)
A 13.1		.8	49.2	45.4	5.8	17.23
B 12.3			50.0	46.2	6.6	17.88
C 62.3				3.8	43.4	18.42
D 58.5					39.6	18.83
E 18.9						

As indicated in all previous comparisons, the means for both measures were significantly higher in the two and four second groups. The two optimal intervals were not significantly different according to Duncan's Test.

DISCUSSION

Effects of CS-UCS interval on test trial response acquisition - Hughes and Schlosberg (1938) found asymptotic levels of conditioning in rats to occur at about seventy-five trials. This investigation used a different modality and technique and the peak of performance was not reached in the two second group until beyond two hundred trials. The three non-optimal intervals reached only about a fifty percent level of conditioned responding during test trials. An interesting characteristic of these three groups was the inconsistency of responding over trials which resembled a sort of inattention on the part of the S. The two and four second groups, on the other hand, displayed almost perfect consistency in responding over all three hour sessions. Gormezano (1964) has mentioned some similar lapses in unconditioned salivary responding.

The effect of introducing some partial reinforcement during acquisition by omitting one tenth of the UCS's was felt to be negligible in view of extensive pilot work where no differences were observed.

Effects of CS-UCS interval on anticipatory CR acquisition - The fact that the shorter interval CR's reached a much lower level than their test trial counterparts was expected because longer temporal intervals allow more random licks and because of the latency of the licking response

when the animal's head is slightly removed from the lick. Base rates for responses randomly falling in the CS-UCS interval during habituation (no CS) appear in Table 4.

TABLE 4

BASE RATES OF RANDOM CR RESPONDING

<u>INTERVAL</u>		<u>RATE</u>
0.5"	--	2 %
1 "	--	4 %
2 "	--	6 %
4 "	--	8 %
6 "	--	7 %

The marked inferiority of CR's as compared to test trials in the six second group was a bit more surprising. The cumulative function for the CR's (not shown) in the longest interval showed a leveling-off to the rate of the shorter intervals. Examination of the latency of response on the paper tapes indicated that a process similar to Pavlov's inhibition of delay might be the cause for the decrement in later trials. Pavlov (1927) mentioned that with intervals over five seconds the onset of the UCR is delayed in a manner proportional to the interval's length. In other words, when the animal learns to wait for the UCS before licking, there will be a decrease in anticipatory CR's.

Effects of genetic strain on conditioning measures -

The analyses of variance and a visual inspection of the data indicate a remarkable similarity in performance between the grey and albino rats.

Theoretical implications - As with much previous work which either classically conditioned a consummatory response or used subhuman organisms as S's, an optimal interval between the onset of the CS and UCS of more than one second was found. Pavlov (1927) considered intervals up to five seconds to be almost equally efficacious. This study singled out two and four second temporal intervals as being superior. Kappauf and Schlosberg (1937) found an optimum of over one second in rats.

Some superficial similarity of these results can be noted in instrumental studies where the ISI has been investigated. Bersh (1951), for example, found half-second, one second, and two second intervals to similarly influence the establishment of a secondary reinforcer. Most important in making a comparison to instrumental conditioning is the consideration that almost all delay of reinforcement (ISI) studies in operant techniques show a direct inverse relation of performance to interval in early learning if any competing responses are available (Spence, 1956).

SUMMARY

Using Weisman's new method of classically conditioning the licking response in rats, the acquisition of test trial responses and anticipatory CR's was compared over five CS-UCS intervals (0.5", 1", 2", 4", 6"). It was expected that the optimal interval would be longer than one half second because of the nature of the UCR and the type of organism employed. In addition, a comparison between two strains of rats, albino and grey, was made.

The results were as follows: (a) The optimal interval was two seconds with four seconds being nearly as good. (b) The one-half, one, and six second groups were not significantly different from one another. (c) The two optimal intervals were significantly better than each of the other three intervals. (d) Data for CR's and test trials indicated the same trends although the differences were greater for the CR's. Reasons for that difference were discussed. (e) There was no genetic difference or interaction over temporal groups.

BIBLIOGRAPHY

- Bersh, P. J. The influence of two variables upon the establishment of a secondary reinforcer for operant responses. J. exp. Psychol., 41, 62-73.
- Bierbaum, W.B. The temporal gradient in GSR conditioning. J. gen. Psychol., 1958, 59, 97-103.
- Cohen, J. Observations on strictly simultaneous conditioned reflexes. J. comp. physiol. Psychol., 1950, 43, 211-216.
- Davis, J.D., and Keehn, J.D. Magnitude of reinforcement and consummatory behavior. Science, 1959, 130, 269.
- Gerall, A.A., and Woodward, J.K., Conditioning of the human pupillary dilation response as a function of the CS-UCS interval. J. exp. Psychol., 1958, 55, 501-507.
- Goldstein, A.C., Spies, G., and Sepinwall, J. Conditioning of the nictitating membrane in the frog. J. comp. physiol. Psychol., 1964, 57, 456-458.
- Gormezano, I. Classical conditioning. In J.B. Sidowski (Ed.) Experimental methods and instrumentation in psychology. New York: McGraw-Hill, 1964.
- Jones, J.E. The CS-UCS interval in conditioning short and long-latency responses. J. exp. Psychol., 1961, 62, 612-617.
- Kappauf, W.E., and Schlosberg, H. Conditioned responses in the white rat. III. Conditioning as a function of the length of the period of delay. J. genet. Psychol., 1937, 50, 27-45.
- Keehn, J.D., and Arnold, E.M.M. Licking rates in albino rats. Science, 1960, 132, 739-741.
- Kimble, G.A. Conditioning as a function of the time between conditioned and unconditioned stimuli. J. exp. Psychol., 1947, 37, 1-15.
- _____ Hilgard and Marquis' conditioning. New York: Century Croft, 1961.
- _____ Comment. Psychon. Sci., 1964, 1, 40.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in the context of public administration and financial management.

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7. The final part of the document concludes with a statement of the audit committee's confidence in the organization's financial and operational performance, while also acknowledging the areas for improvement and the ongoing commitment to transparency and accountability.

- Kimble, G.A., Mann, L.I., and Dufort, R.H. Classical and instrumental eyelid conditioning. J. exp. Psychol., 1955, 49, 407-417.
- McAllister, W. Eyelid conditioning as a function of the CS-US interval. J. exp. Psychol., 1953, 45, 417-422.
- Moeller, G. The CS-UCS interval in GSR conditioning. J. exp. Psychol., 1954, 48, 162-166.
- Pavlov, I.P. Conditioned reflexes. (Translated by G.V. Anrep) London: Oxford Univ. Press, 1927.
- Schaeffer, R.W., and Premack, D. Licking rates in infant albino rats. Science, 1961, 134, 1980-1981.
- Schneiderman, N., and Bormezano, I. Conditioning of the nictitating membrane of the rabbit as a function of CS-US interval. J. comp. physiol. Psychol., 1964, 57, 188-195.
- Spence, K.W. Behavior theory and conditioning. New Haven: Yale University Press, 1956.
- Spooner, A., and Kellogg, W.N. The backward-conditioning curve. Amer. J. Psychol., 1947, 60, 321-334.
- Weisman, R.G. A new method of classical conditioning in the rat: Comparisons with an instrumental conditioning technique using the same response. (Unpublished doctoral dissertation. Michigan State Univ., 1964.)
- Wolfe, H.M., Time factors in conditioning finger withdrawal. J. gen. Psychol., 1930, 4, 372-378.

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