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Effect of Alcohol on Timing Behavior in the Pigeon

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EFFECT OF ALCOHOL ON TIMING BEHAVIOR IN THE PIGEON

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CHAPTER I

INTRODUCTION

One of the initial studies on the effect of alcohol on timing behavior was reported by Sidman (1955) and was concerned with error-evaluation of the timing behavior by using a differential reinforcement of low rates (DRL) schedule of reinforcement. The DRL reinforces only certain responses that occur a specific length of time apart (Ferster and Skinner, 1957). For example, an animal on a DRL20 is reinforced for responses that occur at least 20 seconds apart. This requires the animal to learn the lowest response rate while providing him with the maximum possible amount of reinforcement (Zeier, 1969). Performance on the DRL schedule is usually determined by the analysis of the interresponse times (IRT) which is the length of time between responses (Anger, 1956). Sidman concluded that injections of 1gm/kg ethyl alcohol in rats resulted in nearly a 50 percent decline in lever pressing behavior; but there was no significant difference between pre- and post-alcohol IRTs. IRTs can remain unchanged while lever pressing declines since IRTs of unusual length are not usually considered in evaluation (Laties and Weiss, 1962). For example, a rat can respond nine times on a

DRL20 with a 20.5 second average and then allow five minutes to lapse before responding again. Van Laer, Jarvik, and Van Laer (1965) have shown that the primary effect of alcohol in studies that require a time delay between reinforced responses is to interfere with processes of perception and attention, but not to impair retention; thus long IRTs can probably be attributed to the alcohol's effect upon the rat's test cage behavior rather than his retention of time.

Laties and Weiss (1962), in a series of experiments aimed at studying the effects of alcohol on timing behavior in rats and humans, replicated Sidman's study, using 1gm/kg ethyl alcohol, with the addition of three other treatment levels: saline, .25gm/kg, and .50gm/kg ethyl alcohol. The results of their replication confirmed Sidman's conclusions at the 1gm/kg alcohol level, but there was no pre- or post-alcohol difference at the three additional levels for either number of lever presses or IRTs. Thus the reduction of lever pressing was a result of the level of alcohol injected rather than the injection itself. When generalizing these results to other species, the stability of the animals' performance on the DRL must be taken into consideration.

Blough (1966) showed that pigeons can perform stable and predictable IRTs, and yet their base-line is sensitive, the base-line being the IRTs the subject normally

scores. Reynolds (1964), Staddon (1965), and Kramer and Rilling (1969) suggest that the pigeon be exposed to various DRLs, e.g., 10, 15, 25, 30, and 40 seconds, to facilitate training. Because of the pigeon's sensitivity to the DRL and the more elaborate procedures required to train the pigeon to a stable DRL, this study used pigeons instead of rats and replicated the procedure of Laties and Weiss in the replication of Sidman's study.

Since no data concerning the effect of alcohol on pigeons could be found, a preliminary study was done to determine the effects of the highest and lowest alcohol levels to be used. For the preliminary study two pigeons were trained to a FR29; that is, the subjects were reinforced after they pecked the key light 29 times. This schedule was selected for the stable key peck behavior it produces and so the subjects would not become satiated early in the test hour. Forty-eight hours after the last training trial the subjects were tested on the FR29 and the total number of reinforcements received by each subject was recorded for each ten-minute period of the test hour. Forty-eight hours after the first test one subject was injected intraperitoneally with .25gm/kg ethyl alcohol and the other with 1gm/kg ethyl alcohol. Both injections were a 1cc mixture of ethyl alcohol and saline. Five minutes after the injections the subjects were again tested. Figure 1 shows the results of the pre- and

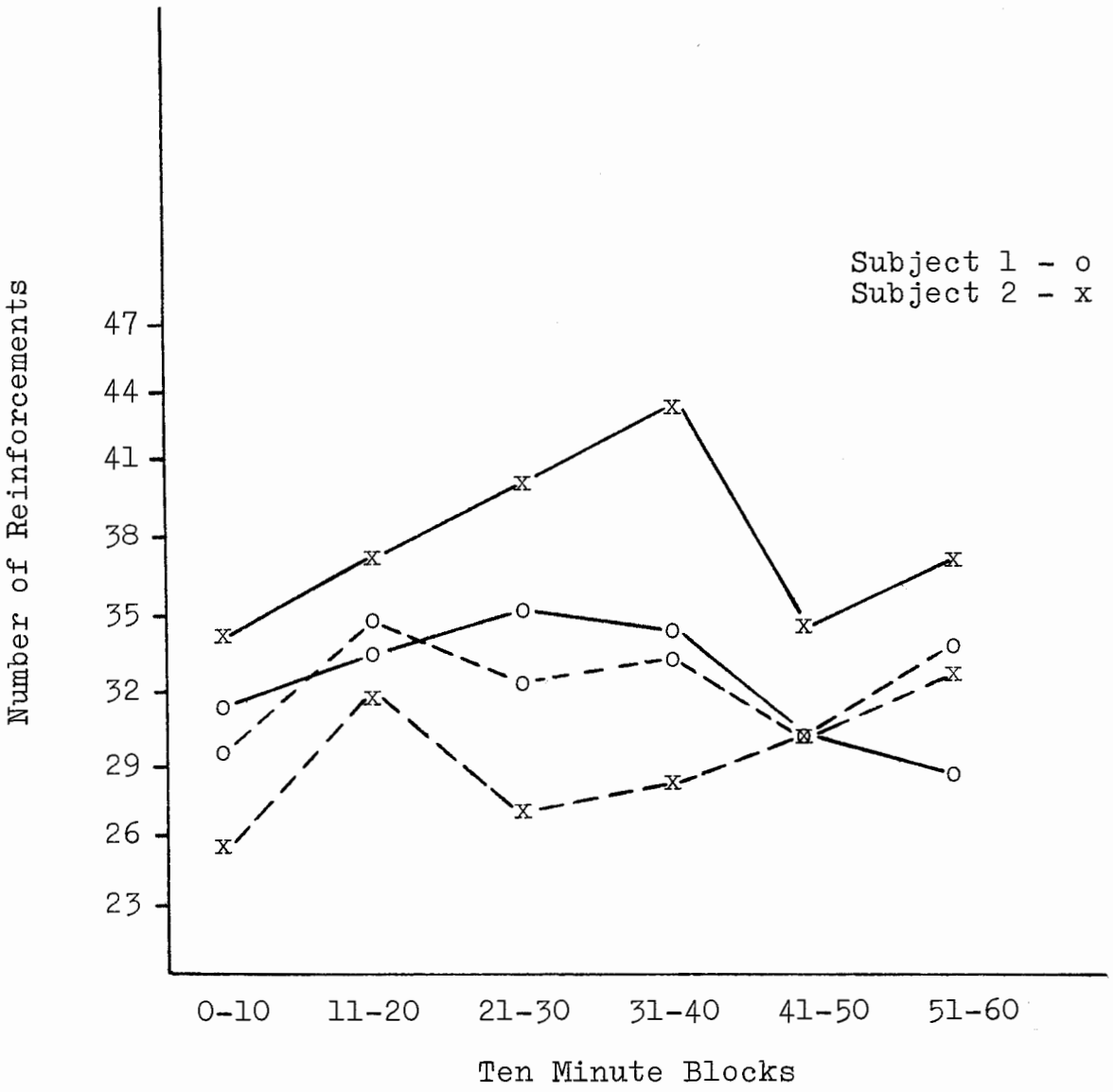

Figure 1. Results of pre- (solid lines) and post- (dashed lines) alcohol injections for both pigeons for each ten minute period. Subject 1 ($\underline{S}_1$) received .25gm/kg and $\underline{S}_2$ received 1gm/kg ethyl alcohol.

post-alcohol trials for each of the ten-minute periods. Subject 1 received 201 reinforcements on his pre-alcohol test and, after the .25gm/kg injection, he received 197 reinforcements. Subject 2 received 225 reinforcements on his pre-alcohol test and, after the 1gm/kg alcohol injection, he received 173 reinforcements. The behavior recorded for these subjects was interpreted as indicating that pigeons can perform under the levels of alcohol used, and further, the data from these two subjects, though admittedly incomplete, suggest a dose response curve. Thus, it was decided to continue the study.

CHAPTER II

METHOD

Subjects

The subjects were four male pigeons of undetermined age and breed and had previously been trained to various fixed ratio schedules of reinforcement for color discrimination experiments. The subjects were deprived to 80 percent of their ad. lib. weight for training and testing.

Apparatus

A 1578 Lehigh Valley Electronics Bird Test Cage was used with other standard Lehigh Valley Electronics equipment, with the exception of a Gerbrands Harvard C3 Cumulative Recorder. The food magazine was available for three seconds at all reinforcements; Purina Pigeon Top Flight Grains served as reinforcement for training and testing. The subjects pecked a key light which was on during testing. A variable resistor controlled the intensity of the key light during training to facilitate shaping the subjects to the DRL20. A 28 volt #1819 lamp was inserted in the factory punched hole in the top of the test cage. A clock was used to separate the testing hour into six ten-minute blocks, and a stopwatch was used

along with an internal timer to measure IRTs; that is, the stopwatch was used to measure IRTs beyond 20 seconds.

Response Measures

The subjects were trained on the DRL20 until they reached a criterion of 70 percent of their IRTs falling within a one second base-line, e.g., if a subject reached a base-line of 21.5 seconds, 70 percent of his responses would fall between 21 and 22 seconds. This one second base-line was used to insure stability (Ferster and Skinner, 1957). It was decided that each subject could attain his own base-line as long as the mean of his interval fell between 20.5 and 23.5 seconds. The number of reinforcements received by each subject were recorded simultaneously with the IRTs so that response trends could be analyzed in terms of both IRTs and number of reinforcements. Since Laties and Weiss (1962) excluded IRTs that were over 40 seconds and less than 10 in their evaluation of their data, it was decided to follow their practice in this study, thus eliminating the possibility of unusually long or short IRTs affecting the data.

Experimental Design

All four subjects were tested under all four treatment levels: saline, .25gm/kg, .50gm/kg, and 1gm/kg ethyl alcohol. All injections were intraperitoneal, with

a total volume of 1cc mixture of alcohol and saline. The IRTs and the number of reinforcements were recorded for all six ten-minute blocks for each test hour, thus making the design a 4 x 4 x 6 factorial. The subjects were randomly assigned to their initial treatment level and then progressed through the sequence. For example, if a subject was randomly assigned to .50gm/kg treatment level, he would next receive 1gm/kg, and then saline followed by .25gm/kg. In order to control for a possible order effect, each subject was tested 48 hours after each test, and if his IRT fell within 10 percent of his base-line criterion, he was tested at his next treatment level 48 hours later. If his retest did not fall within 10 percent of his criterion, he was retested every 48 hours until it did, thus controlling for a possible carryover effect caused by the previous alcohol injection. The 10 percent criterion for the carryover effect tests was decided upon because it seemed likely that any large change in IRTs between trials would result from previous alcohol injections. Since variables other than previous alcohol injections could have some effect, 10 percent was considered to be sufficient to cover these and still not great enough to hide serious carryover effects.

Procedure

The subjects were trained to the DRL20 by using

a variable resistor that controlled the key light. The key light was on when reinforcement was available, and as training continued, the intensity of the cue light was gradually lessened until the subjects reached criterion of 70 percent of their IRTs falling within a one second interval without the aid of the light. When this was achieved, the light was turned on and the variable resistor was removed. Testing began when the subjects reached this criterion with the light on at all times. Training was facilitated by exposing the subjects to DRLs of 10, 15, 25, and 30 seconds for various lengths of time during training (Reynolds, 1964; Staddon, 1965; and Kramer and Rilling, 1969). All four subjects reached criterion with 75 to 150 hours of training.

Testing began 48 hours after each subject reached criterion and the test trials lasted one hour. Each test was followed by the tests to control for possible order and carryover effects; but none of the subjects' IRTs on the control tests exceeded the 10 percent criterion; thus, all subjects received their alcohol injections 96 hours apart.

CHAPTER III

RESULTS

The IRTs and the number of reinforcements (see Appendix) were analyzed with separate 4 x 4 x 6 factorial analysis of variance. Table 1 shows the source table for the analysis of the IRTs. This analysis tested the effects of the Alcohol Levels (A), Time Blocks (B), and the A x B interaction. Only Time Blocks reached statistical reliability (F=16.48, df=5/15, p<.01). A trend analysis (Figure 2) showed the Time Blocks to be significantly quadratic (F=30.48, df=1/90, p<.01), and a Newman-Keuls comparison of means (Table 2) showed there were eight significant pairwise comparisons among the six means for the Time Blocks. Of these eight significant pairwise comparisons, indicated by asterisks, seven are found when Time Blocks 0-10 and 51-60 are compared to the middle four Time Blocks, 11-20, 21-30, 31-40, and 41-50. This is a result of the subjects performing longer IRTs during the first and last Time Blocks than they did for the middle four, with the exception of Time Block 41-50 differing from Time Block 21-30.

Table 3 shows the source table for the analysis of variance for the number of reinforcements. This

Table 1

Analysis of Variance: IRT scores

Source	df	MS	F
Alcohol Levels (A)	3	.086	.48
Time Blocks (B)	5	.758	16.48*
Subjects (C)	3	20.673	
A x B	15	.053	.51
A x C	9	.178	
B x C	15	.046	
A x B x C	45	.103	
Total	95		

*$p < .01$

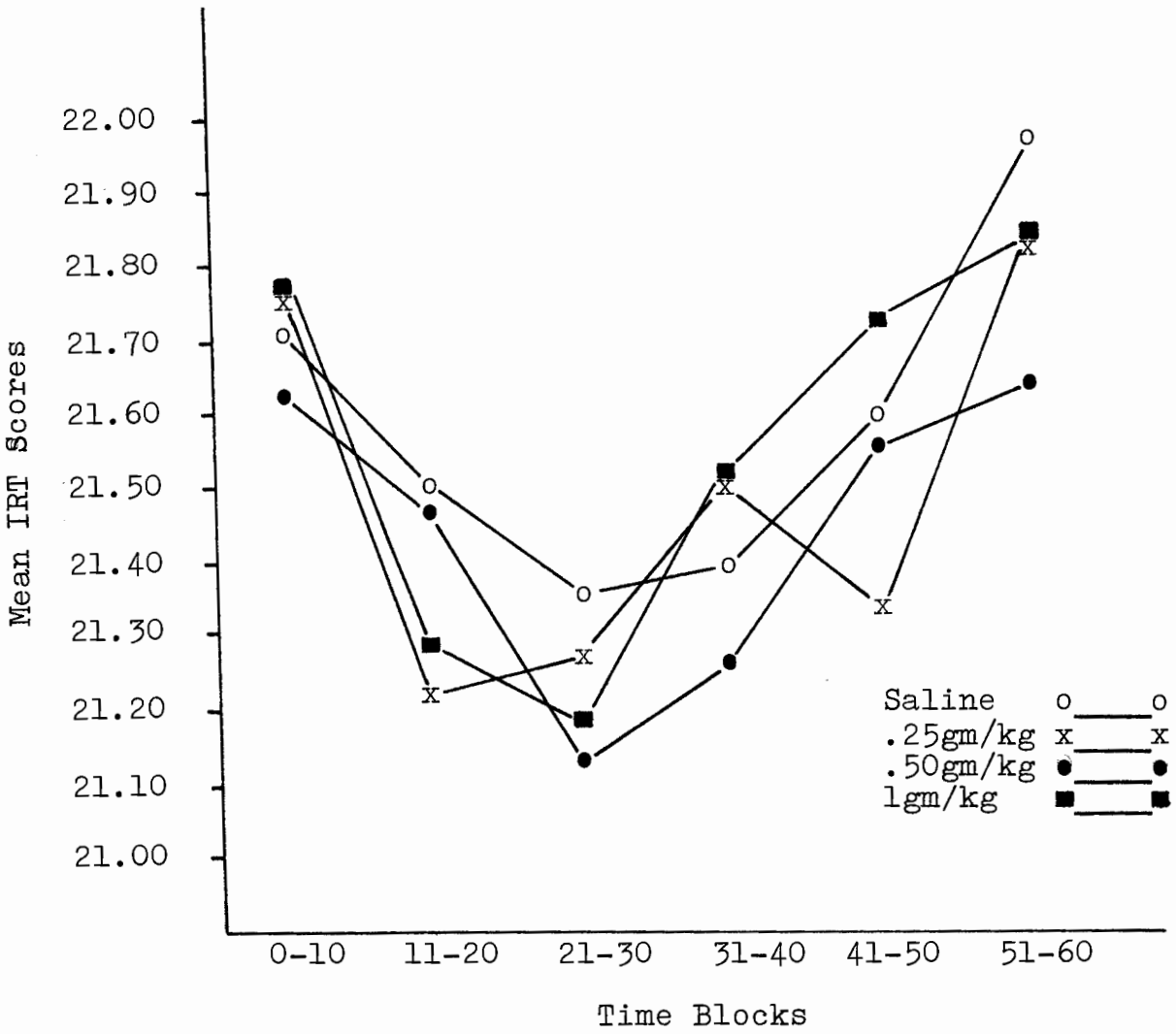

Figure 2. Quadratic trend of IRTs across time blocks. Each point is the mean of the four subjects' IRTs under each alcohol level for each time block.

Table 2

Comparison of Time Block Means for IRTs. $\bar{X}_1$ refers to Time Block 0-10; $\bar{X}_2$ to 11-20; etc.

	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_4$	$\bar{X}_5$	$\bar{X}_1$	$\bar{X}_6$
$\bar{X}_3$=21.22	-	.14	.20	.32*	.49*	.56*
$\bar{X}_2$=21.36		-	.06	.18	.35*	.42*
$\bar{X}_4$=21.42			-	.12	.25*	.36*
$\bar{X}_5$=21.54				-	.17	.24*
$\bar{X}_1$=21.71					-	.07
$\bar{X}_6$=21.78						-

*p<.01

Table 3

Analysis of Variance: Number of Reinforcements

Source	df	MS	F
Alcohol Levels (A)	3	307.82	27.73*
Time Blocks (B)	5	38.27	6.32*
Subjects (C)	3	67.03	
A x B	15	5.87	1.21
A x C	9	11.10	
B x C	15	8.76	
A x B x C	45	4.85	
Total	95		

*$p < .01$

analysis tested the effects of the Alcohol Levels (A), the Time Blocks (B), and the A x B interaction. The effects of the Alcohol Levels (F=27.73, df=3/9, $p<.01$) and the Time Blocks (F=6.32, df=5/15, $p<.01$) showed significant F values. A trend analysis (Figure 3) showed Time Blocks to have a significant quadratic trend (F=27.72, df=1/90, $p<.01$) and a Newman-Keuls comparison of means (Table 4) showed there was one significant pairwise comparison among the six means for the Time Blocks. This one significant pairwise comparison was for Time Block 21-30, the Time Block with the largest number of reinforcements, being compared to Time Block 51-60, the Time Block with the least number of reinforcements. A trend analysis (Figure 4) showed Alcohol Levels to be significantly linear (F=114.24, df=1/72, $p<.01$) and quadratic (F=68.49, df=1/72, $p<.01$). A Newman-Keuls comparison of means (Table 5) showed there were three significant pairwise comparisons among the four means, which was a result of Alcohol Level 1gm/kg differing from the other three levels (refer to Figure 4).

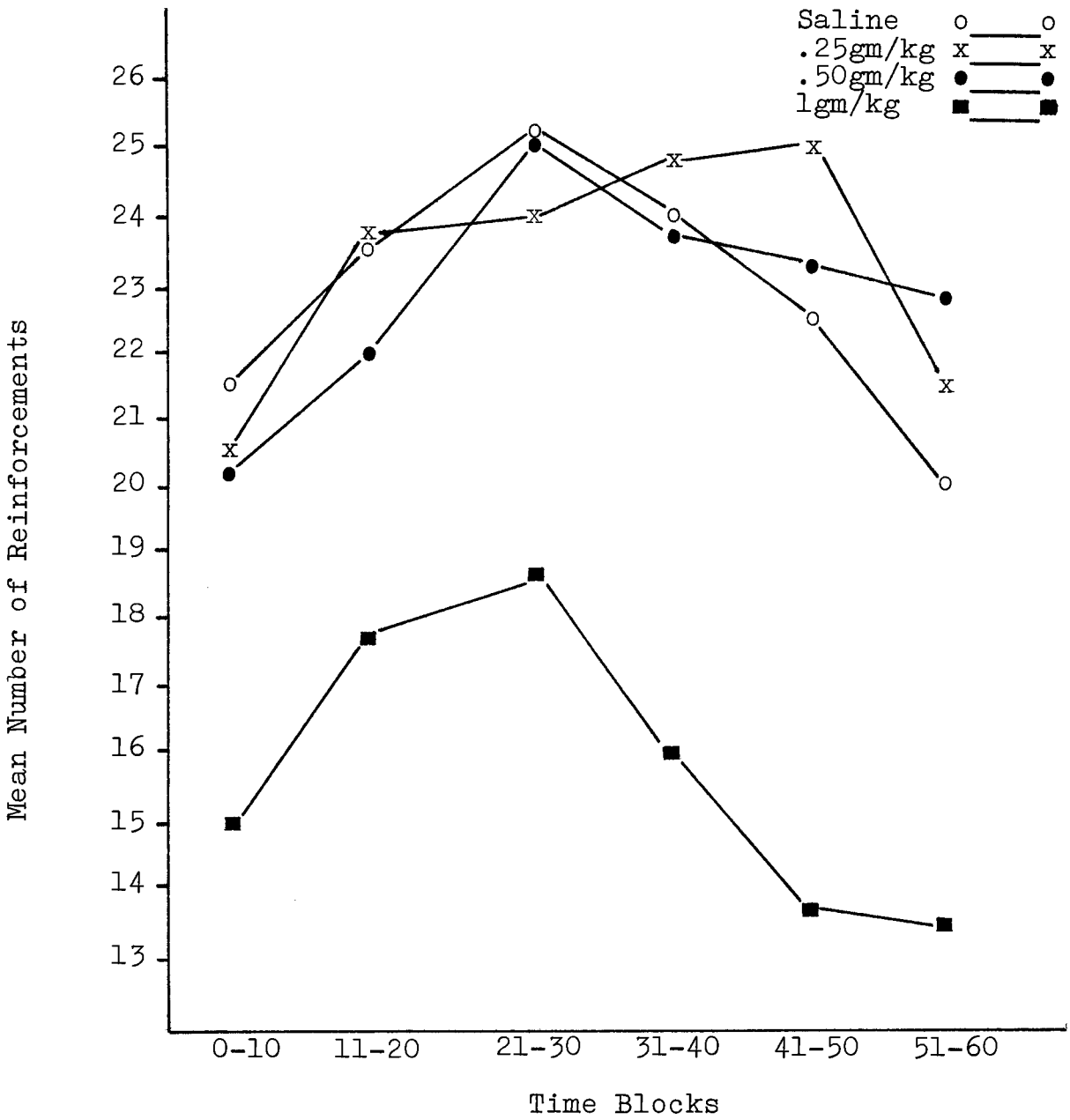

Figure 3. Quadratic trend of number of reinforcements for time blocks. Each point is the mean of the subjects' number of reinforcements under each alcohol level for each time block.

Table 4

Comparison of Time Block Means for Number of Reinforcements. $\bar{X}_1$ refers to Time Block 0-10; $\bar{X}_2$ to 11-20; etc.

	$\bar{X}_6$	$\bar{X}_1$	$\bar{X}_5$	$\bar{X}_2$	$\bar{X}_4$	$\bar{X}_3$
$\bar{X}_6$=19.43	-	1.13	1.69	2.25	2.69	3.82*
$\bar{X}_1$=20.56		-	.56	1.12	1.16	2.69
$\bar{X}_5$=21.12			-	.56	1.00	2.13
$\bar{X}_2$=21.68				-	.44	1.57
$\bar{X}_4$=22.12					-	1.13
$\bar{X}_3$=23.25						-

*p<.01

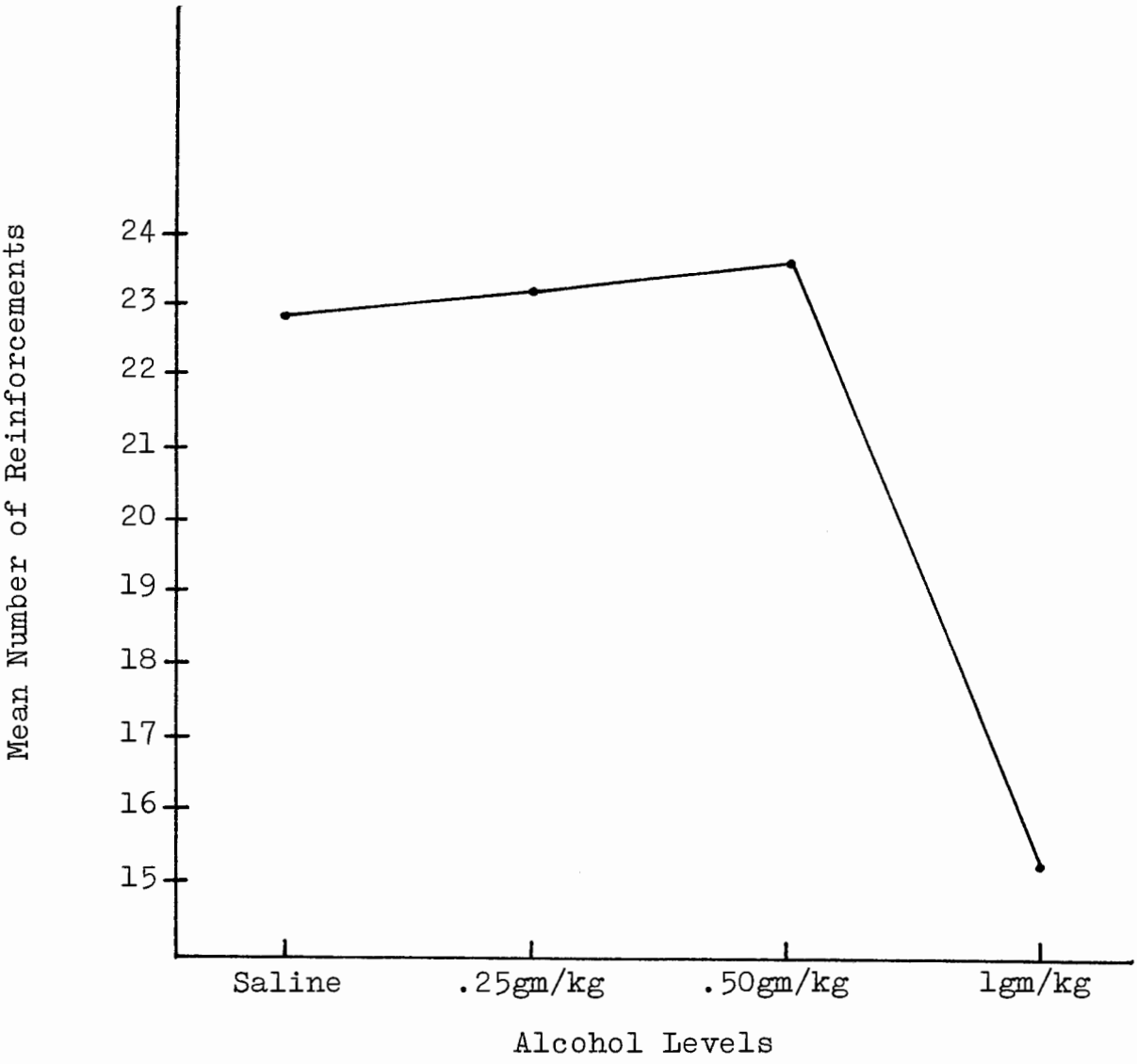

Figure 4. Quadratic and linear trend of number of reinforcements for alcohol levels. Each point is the mean of the subjects' number of reinforcements for each alcohol level.

Table 5

Comparison of Alcohol Level Means for Number of Reinforcements. $\bar{X}_1$ refers to Saline; $\bar{X}_2$ to .25gm/kg; $\bar{X}_3$ to .50gm/kg; and $\bar{X}_4$ to 1gm/kg.

	$\bar{X}_4$	$\bar{X}_1$	$\bar{X}_3$	$\bar{X}_2$
$\bar{X}_4$=15.79	-	7.00*	7.04*	7.41*
$\bar{X}_1$=22.79		-	.04	.46
$\bar{X}_3$=22.83			-	.31
$\bar{X}_2$=23.20				-

*$p < .01$

CHAPTER IV

DISCUSSION

The analysis of variance for the IRTs showed Time Blocks to be significant (Table 1) and a trend analysis showed the Time Blocks to be significantly quadratic (Figure 2). This quadratic trend is a result of the subjects' performing more stable IRTs for the middle Time Blocks and less stable IRTs at the beginning and the end of the test hour. Since the interaction was not reliable, this pattern of responding was independent of alcohol injections.

The analysis of variance for the number of reinforcements showed Time Blocks and Alcohol Levels to be significant (Table 3). A trend analysis showed Time Blocks to be significantly quadratic (Figure 3) and a comparison of means (Table 4) showed that Time Block 21-30 ($\overline{X}_3$), the Time Block with the highest number of reinforcements, differed significantly from Time Block 51-60 ($\overline{X}_6$), the Time Block with the lowest number of reinforcements. Since Alcohol Levels and Time Blocks showed no significant interaction, it appears that the quadratic trend may have been a result of the effect of injections on the first Time Block and satiation on the

last Time Block. Another possible explanation for the lower number of reinforcements for the first Time Block would be a warm-up factor as the subject adjusted to the test cage. As he adjusted, he performed more stable IRTs (refer to Table 2), and thus increased his number of reinforcements.

A trend analysis showed Alcohol Levels to be both quadratic and linear (Figure 4) and a comparison of means (Table 5) showed that the mean of 1gm/kg ($\overline{X}_4$) differed significantly from the means of saline ($\overline{X}_1$), .25gm/kg ($\overline{X}_2$), and .50gm/kg ($\overline{X}_3$). The quadratic and linear trends of the Alcohol Levels can be seen in the similarity of number of reinforcements for saline, .25gm/kg, and .50gm/kg (Figure 4), coupled with the reduction for the 1gm/kg Alcohol Level.

The lack of alcohol effect on the IRTs is consistent with Sidman's (1955) and Laties and Weiss' (1962) conclusions. Also, the effect of the 1gm/kg Alcohol Level on the number of reinforcements was similar to that reported by Sidman and Laties and Weiss, thus indicating that the effect of alcohol on timing behavior is much the same for pigeons as it is for rats. This similarity is consistent with data Dews (1958) reported for various species when amphetamines are used in timing behavior studies. Also, the effect of alcohol in reducing the number of reinforcements supports Van Laer, Jarvik, and

Van Laer (1965) in their conclusion that alcohol interferes with perception and attention, but not retention over delay periods.

Since the apparatus could not record unusually short IRTs, such as bursting, it was not possible to analyze all of the subjects' responses to determine whether alcohol might increase variability with or without a change in the mean IRT. A future experimenter, with access to more sensitive measuring devices and a large number of subjects, may want to consider such a possibility. Although no one knows how alcohol affects an animal's perception or why it does not appear to affect his retention of time, this study, analyzing the IRTs that were between 10 and 40 seconds, supports the conclusions of previous studies and indicates that the effect of alcohol is much the same for pigeons as it is for rats.

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APPENDIX

APPENDIX

TIME BLOCKS ACROSS ALCOHOL LEVELS INCLUDING ALL FOUR SUBJECTS' NUMBER OF REINFORCEMENTS AND IRTs (Number of Reinforcements in Parenthesis)

Subject	Alcohol Levels			
	Saline	.25gm/kg	.50gm/kg	1gm/kg
		Time Block 0-10		
1	21.63 (25)	22.37 (18)	21.80 (22)	21.52 (17)
2	23.85 (14)	22.43 (21)	23.07 (17)	22.81 (11)
3	20.42 (27)	20.83 (23)	20.51 (26)	21.83 (14)
4	20.94 (20)	21.38 (20)	21.20 (16)	20.88 (18)
		Time Block 11-20		
1	21.39 (25)	21.43 (23)	21.67 (25)	21.34 (19)
2	23.62 (17)	22.16 (23)	22.82 (18)	22.38 (13)
3	20.29 (28)	20.37 (26)	20.39 (26)	20.79 (19)
4	20.72 (24)	20.91 (22)	21.06 (19)	20.60 (20)
		Time Block 21-30		
1	21.51 (26)	21.36 (22)	21.14 (25)	21.47 (16)
2	22.53 (22)	22.43 (25)	22.41 (21)	22.16 (15)
3	20.62 (26)	20.32 (28)	20.25 (28)	20.44 (21)
4	20.73 (28)	20.93 (21)	20.72 (26)	20.63 (23)
		Time Block 31-40		
1	21.72 (23)	21.39 (25)	21.49 (22)	21.92 (13)
2	22.87 (21)	22.90 (24)	22.47 (22)	22.54 (16)
3	20.57 (25)	20.59 (27)	20.29 (27)	20.58 (18)
4	20.59 (27)	21.14 (23)	20.80 (24)	21.00 (17)
		Time Block 41-50		
1	21.54 (22)	21.28 (26)	21.76 (23)	22.27 (15)
2	22.71 (22)	22.77 (24)	22.54 (20)	22.91 (10)
3	20.84 (22)	20.42 (24)	20.62 (26)	20.71 (13)
4	21.24 (24)	20.87 (26)	21.29 (24)	20.94 (17)
		Time Block 51-60		
1	22.40 (18)	21.68 (24)	21.93 (20)	22.66 (14)
2	23.01 (20)	23.13 (22)	22.40 (23)	22.83 (12)
3	20.70 (19)	21.17 (18)	20.78 (23)	20.61 (16)
4	21.73 (23)	21.26 (22)	21.49 (25)	21.18 (12)