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HUMAN IMPULSIVITY: EFFECTS OF REINFORCEMENT PROCEDURE

by

Catherine A. Karas

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Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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HUMAN IMPULSIVITY: EFFECTS OF REINFORCEMENT PROCEDURE

Catherine A. Karas, Ph.D.

Western Michigan University, 1997

In this study, positive and negative reinforcement procedures were directly compared across subjects to determine whether more impulsive responding would occur with one reinforcement procedure when compared to the other, under a discrete-trial choice procedure. For both reinforcement procedures, taped music served as the reinforcer. For the positive reinforcer, subjects brought in their own music, from which tapes were made for use in the study. Subjects then ranked the tapes according to their preferences. For the negative reinforcers, the investigators made tapes of various types of music, and all subjects ranked their preferences for these tapes. Subjects were then presented with a choice between a smaller reward available immediately, or a larger reward that was delayed in time.

Statistical analysis did not indicate that there was a significant difference in the amount of impulsive responding generated under each reinforcement procedure. A visual inspection of the data however, did suggest a strong pattern in the responses under the negative reinforcement procedure that did not occur under the positive reinforcement procedure. This pattern of responding under the negative reinforcement procedure reflected more impulsive responding as a function of the increased delays to the larger reinforcer. These results of this study support previous findings that suggest that

subjects will emit self-controlled responding under reinforcement procedures when the stimulus is of a secondary-type. The results of this study also extend our knowledge about the effects of negative reinforcers of a secondary-type.

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TABLE OF CONTENTS

LIST OF TABLES	iv
LIST OF FIGURES	v
CHAPTER	
I. INTRODUCTION AND LITERATURE REVIEW	1
Impulsive Responding	2
Self-Controlled Responding	4
II. METHODOLOGY	8
Subjects	8
Setting	8
Materials	8
General Procedure	9
Music Preference	9
Positive Reinforcement Procedure	14
Negative Reinforcement Procedure	15
III. RESULTS	18
IV. DISCUSSION	25
Future Studies	30
APPENDICES	
A. Informed Consent Form	32

Table of Contents--Continued

APPENDICES

B. Letter of Approval From HSIRB	35
C. Data Sheets and Music Preference Record	37
D. Subject Recruitment Script	41
E. Directions for Subjects	43
F. Randomization Schedule	45
G. Group Data Summary	47
H. Schemata and Flow Chart	50
I. Data Summary for Individual Responses	54
REFERENCES	56

LIST OF TABLES

1. Group Data Summary: Delay vs. Intermediate, Reinforcers Equal	19
2. Wilcoxon Matched-Pairs Signed-Ranks Test	20
3. Group Data Summary: 30" vs. 60" Larger Reinforcer	20
4. Group Data Summary: Delay - Larger vs. Intermediate - Smaller	22

LIST OF FIGURES

1. Group Data Summary: Delayed-Larger vs. Immediate-Smaller	24
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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Experimental evaluation of the concept of self-control was initially explored in laboratory analogues with nonhumans (Ainslie, 1974, 1975; Grosch & Neuringer, 1981; Rachlin, 1974; Rachlin & Green, 1972). In these analogues, self-control is defined as choosing the larger, more delayed reinforcer over the smaller, more immediate reinforcer when given a choice. Conversely, impulsivity is defined as choosing the more immediate, but smaller reinforcer over a larger, but more delayed reinforcer when given a choice. Later, several studies (Logue, Pena-Correal, Rodriguez, & Kabela, 1986; Millar & Navarick, 1984; Navarick, 1982) demonstrated the potential applicability of these analogues and concepts with humans. Laboratory analogues of impulsivity and self-control with humans typically utilize either positive or negative reinforcement procedures and employ the use of either primary reinforcers such as food deliveries or noise termination, or secondary reinforcers like earning toys or points for money.

Despite the continued utilization of both positive and negative reinforcement procedures to study self-control, there are no studies which directly compare the two reinforcement procedures to investigate whether self-controlled responding is more likely to occur under one procedure as compared with the other, or if certain types of reinforcers are more likely to be associated with self-controlled responding. The absence

of such studies is important given the overall inconsistent findings from studies utilizing laboratory analogues of self-control in humans. Several researchers (Logue et al., 1986; Navarick, 1982; Ragotzy et al., 1988) have noted that the nature of the procedure and reinforcer may contribute to the contrasting results obtained with these analogues. The following section reviews available studies for relevant issues and tentative conclusions regarding impulsive responding.

Impulsive Responding

The negative reinforcement procedures typically employed to study self-control in humans appear to evoke impulsive responding. Solnick, Kannenberg, Eckerman and Waller (1980) examined self control in humans utilizing the termination of 90 d.b.a. of white noise as the reinforcing event. The study examines preference shift when subjects are presented with a choice between a small, immediate reward (-90-sec noise off with no delay) and a larger, delayed reward (-120-sec noise off after a 60-sec delay). The results of the three experiments in this study suggest that when given a choice, subjects generally behave impulsively and indicate a preference for the smaller more immediate reward. The results of this study also indicated that this preference could be shifted to the larger, but delayed reward by adding a 15-sec delay to both alternatives. Some subjects who were asked to commit to an alternative before being exposed to the choice point (point at which both alternatives are available simultaneously) were also able to indicate a shift in preference to the larger but more delayed reward. These results extend and confirm the results obtained with nonhumans under similar conditions as reported by

Ainslie (1974) and Rachlin (1972).

In a related study, Navarick (1982) investigated impulsive responding in choice conditions under a negative reinforcement procedure with noise offset as the reinforcer. The results indicate that immediate reinforcement was preferred to delayed reinforcement when the amount of reinforcement was equal, that a large reinforcer was preferred to a smaller one when both were available immediately, and that the preference for the smaller more immediate reward was increased as a function of increasing the delays to the larger reinforcer.

Impulsive responding in humans has also been demonstrated in studies that employ positive reinforcement procedures and utilize food deliveries as reinforcers.

Dziadosz and Tustin (1982) examined impulsive responding in mentally retarded children under two types of choice conditions: free operant and commitment. This study differs from the negative reinforcement studies in that it employs a positive reinforcement procedure using deliveries of potato chips as the reinforcing event. The results indicate that more impulsive responding occurred under the free operant choice condition as compared with the commitment condition. That is, the smaller more immediate reinforcer (1 potato chip delivered immediately) was preferred over the larger more delayed reinforcer (4 potato chips delivered after a 30 minute delay). Similarly, using a positive reinforcement procedure with food deliveries (pieces of cereal) as the reinforcing event, Ragotzy, Blakely, and Poling (1988) examined choice preference in mentally retarded adolescents. Results from this study indicate that subjects did behave impulsively, choosing the smaller, more immediate reinforcer (1 piece of cereal), under conditions

where the larger reinforcer (3 pieces of cereal) was delayed. Increasing the delay to both options resulted in subjects shifting their preference to the larger reinforcer. The point at which the shift in preference was made varied for each subject across delay values.

In summary, impulsive responding appears more likely to occur than self-controlled responding in studies utilizing negative reinforcement procedures with reinforcing events such as noise termination. The other documented condition that appears to be associated with impulsive responding is a positive reinforcement procedure that utilizes food as the reinforcing event.

Self-Controlled Responding

In the preceding section, results of studies evoking impulsive behavior were described. The next section describes results of studies which demonstrate self-controlled responding or reinforcer maximization behavior. These studies have typically utilized positive reinforcement procedures and conditioned reinforcers such as earning points to be exchanged for money or toys.

Logue, Pena-Correal, Rodriguez, and Kabela (1986) utilized a positive reinforcement procedure with points exchangeable for money as the conditioned reinforcing event. Subjects in this study demonstrated self controlled behavior in that they preferred the larger, more delayed reinforcer to the smaller and more immediate reinforcer, allowing for maximization of obtained reinforcers. It appears reinforcer amount rather than reinforcer delay was the controlling variable for subject responding, which is in contrast to the pattern of responding predicted by the ideal matching equation.

Several researchers (Millar & Navarick, 1984; Navarick, 1986; Rappaport, Tucker, DuPaul, Merlo, & Stoner, 1986) have extended the argument that the procedure as well as the nature of the reinforcer are critical variables in occasioning impulsive responding. As a result, several studies have extended the traditional operant methodologies with the use of novel reinforcers and procedures. By utilizing a novel reinforcer (playing video games) and a positive reinforcement procedure, Millar and Navarick (1984) attempted to extend the procedures under which impulsive behavior could be demonstrated. The rationale for choosing video game playing was based on the seemingly intrinsically reinforcing properties of the video game as compared with points exchangeable for money. The authors also suggest that playing video games is similar to other consumable reinforcers (primary reinforcers) in that it has the property of requiring extended contact to obtain it as do food and water which require drinking and eating. The authors note that such consumable reinforcers are most often the type utilized in nonhuman studies which demonstrate impulsive responding.

In the first experiment, Millar and Navarick (1984) demonstrate that playing video games can function as a reinforcer. In the majority of the choice trials, subjects were found to prefer immediate reinforcement to delayed reinforcement and preferred larger amounts of reinforcement to smaller amounts. Subjects demonstrated only "weak" impulsivity in that they did not indicate a strong preference for the smaller, more immediate reinforcer over the larger, delayed reinforcer in choice trials, but the preference for the smaller reinforcer was stronger than when the smaller, more immediate reinforcer was made available at the same time a larger and immediate reinforcer was available.

The second experiment examined preference shift as a function of removing the choice point in time, thereby changing the preference for the smaller, more immediate reinforcer to the larger but delayed reinforcer. This removing of the point of commitment in time (Rachlin and Green, 1972) refers to requiring a subject to verbally choose or commit to the alternative prior to the presentation of the choice stimuli. Since no clear preference for the smaller, more immediate reinforcer over the larger, delayed reinforcer was established, this could not be shown directly. A preference shift was demonstrated under some conditions for some subjects as unequal delays were extended by equal intervals.

Another example of utilizing a novel reinforcer and a positive reinforcement procedure is a study by Navarick (1986) that examined impulsive responding and the effectiveness of picture viewing as a reinforcer. Subjects were exposed to discrete trials with choices between schedules which differed in amount of delay and reinforcement, and where the reinforcer was time spent viewing pictures of entertainment and sports personalities. Experiment 1 demonstrated that picture viewing can function as a reinforcer, and examined the extent to which impulsive responding occurred when subjects were given a choice between a small, immediate reinforcer, and a larger, delayed reinforcer. Experiment 2 examined preference shift as a function of delay to the immediate reinforcer. Overall, the results were similar to those obtained when playing video games served as the reinforcer, except that impulsive responding was even less evident. Since preference for the smaller more immediate reinforcer was never strongly established, preference shift manipulations were not done directly. Shifts in preference were established under some conditions for some subjects.

In conclusion, it appears that studies utilizing positive reinforcement procedures consistently produce more self-controlled responding than do studies utilizing negative reinforcement procedures, with the exception being procedures that utilize food as the positive reinforcing event. Under those conditions, impulsive responding occurs. To address whether the critical element in evoking impulsive responding is the nature of the reinforcement procedure or the nature of the reinforcer itself, a direct comparison of procedures utilizing the same reinforcer is necessary.

The hypotheses for this study are stated as follows:

Conceptual Hypothesis: There is a relationship between impulsive responding and type of reinforcement procedure.

Operational Hypothesis: There will be significantly more impulsive responding under a negative reinforcement procedure as compared to a positive reinforcement procedure under conditions utilizing the same reinforcer for both procedures.

Null Hypothesis: There will be no significant difference in the amount of impulsive responding that is generated by the positive reinforcement procedure as compared with the negative reinforcement procedure under conditions where the same reinforcer is utilized for both reinforcement procedures.

CHAPTER II

METHODOLOGY

Subjects

Eight undergraduate students were recruited via a flyer posted in the department as subjects and were paid \$5 cash for each 60 minute interval spent in session. Three subjects were dropped from the study due to surpassing the number of allowed aborts per session.

Setting

The study was conducted in an 6 foot by 10 foot room without carpeting, one table measuring 2 and one half foot by 5 foot , 3 chairs, and no windows.

Materials

The choice cards were presented on a 22 inch by 28 inch silver piece of poster board. On the bottom of the board, as it faced the subjects three 7 inch by 7 inch squares were drawn with heavy black marker(one in the left bottom corner, one in the middle and one in the right bottom corner). In the middle of the poster board was another 7 inch by 7 inch square. Three cards measuring 3 inches by 5 inches were used. The cards were cut from construction paper and were either white, green or blue. The blue, green, and

white cards all had the words “Touch Here” written on them. Subjects listened to music from a manually operated stereo cassette player that had forward-mounted speakers that faced the subject. All musical selections were played on a volume level of 7 on a ten point volume scale as indicated on the tape player. Data sheets and materials were blocked from the subjects’ view by black cardboard barriers that stood 12 inches high, and were 22 inches long. A standard stop watch was utilized for timing.

General Procedure

Prior to participating in any experimental phase of this study, all eight subjects were exposed to one test session during which they categorized their music preferences. Subjects had been asked to provide several CD’s or tapes that they liked and were told that they would listen to these during the study. The experimenter then recorded the music onto blank tapes and labeled them “X”, “Y”, or “Z”.

Music Preference

During the music preference session, subjects listened to 3 tapes of their favorite music and were asked to rank the tapes by placing them on a chart that had 4 slots labeled “Best”, “Very Good”, “Good”, and “Just Okay”. In this same session, subjects were asked to rank order their preferences for tapes of music that they did not like. Five tapes were created by the experimenter and were used for all eight subjects. The music on the aversive tapes included the children’s character Barney singing children’s songs, excerpts from the Peking Opera, an international tape that was a mixture of traditional

folk music from India and Egypt, a tape of the bushmen of Kalahari mixed with traditional folk music from Japan, a tape featuring western opera singers and an acid rock or heavy metal tape. Each of these tapes were given a label of “A”, “B”, “C”, “D”, or “E”. Subjects were asked to place these tapes on a chart that had slots which read “Worst”, “Very Bad”, “Bad” and “Not So Bad”. Tapes rated as “Not So Bad” were not utilized in the study, therefore, only 3 aversive tapes were used throughout the study.

For purposes of rank ordering the tapes, subjects listened to 30 seconds from each of the tapes. They then placed the tape next to the slot which best described their preference. Subjects were told they could move the tapes into another slot at any point during the music preference session (allowing only one tape per slot) and could also ask to have any tape replayed. Since there were 5 aversive tapes and only 3 were used per subject throughout the study, the experimenter played 4 tapes at a time for each subject. The subject then rank ordered these tapes and the experimenter removed the tape ranked least aversive. The fifth aversive tape was then played and the subject ranked it along with the 3 remaining tapes. From these 4 tapes, the 3 most aversive tapes for each subject were chosen for use throughout the study.

Throughout the experiment, each subject was not allowed to complete more than 2 half hour sessions in any one twenty-four hour period. Each subject was paid \$5 cash after every 60 minutes spent in session. At the end of each session, subjects were given 1 ticket with a number on it that allowed them to enter a drawing which was conducted at the end of the study for a cash prize of \$100.

After the subjects' music preferences were recorded, each subject was assigned

to one positive reinforcement and one negative reinforcement condition per session. A randomization procedure determined whether or not the positive reinforcement condition preceded the negative reinforcement condition for each session. The order in which each subject was exposed to the five positive reinforcement phases as well as the 5 negative reinforcement phases was also randomly assigned. In addition to randomizing the assignment of all the experimental conditions, the color of the card associated with each schedule, and whether a card appeared in the left or right corner for any given session was randomized as well.

In each condition, the subject was exposed to a minimum of 16 trials. Of the 16 trials, the first 6 trials were forced choice trials, followed by 10 choice trials. Each session began with the subject seated at a table with the silver poster board in front of them. The experimenter read the instructions for either the positive reinforcement procedure or the negative reinforcement procedure. The instructions for the positive reinforcement procedure were as follows:

You will have a choice about how you spend your time today. Remember the music you picked out that you said you liked? Well, today you will get to listen to some of it. By touching either the green or blue card, you will get to spend some time listening to some of that music. It will either come on right away or it will come on after some time passes but then it may stay on longer.

The instructions for the negative reinforcement procedure were as follows:

You will have a choice today about how you spend your time. Remember the music you picked out that you said you did not like? Well, today you will spend some time listening to some of that music and you will get a chance to turn it off. By touching the green or blue card, you can have the music turned off right away, or by waiting to turn it off, it may be turned off for a longer time.

The experimenter would then place the white card that has written on it "Touch

Here" in the center square of the choice board. This signaled the onset of a trial and a touch by the subject to the white stimulus within 5 seconds of its presentation, signaled that the stimulus had been observed. If the subject did not touch the stimulus in 5 seconds, the white card is removed from sight for 5 seconds and presented again until a response occurs within 5 seconds. If the subject failed to make a correct observing response in 5 seconds after 20 consecutive presentations, then the subject was told to take a five minute pause. After five minutes had elapsed, the directions for that session were read again. If the subject earned a third five minute pause, they were terminated from the study. The white card was associated with a fifteen second preliminary period that occurred prior to the presentation of the choice stimuli. The presentation of the white card signaled the start of the preliminary period. After a correct observation response, the experimenter moved the white stimulus to the upper most middle square on the choice board and turned it over, so it was blank. The remainder of the fifteen seconds elapsed with the white stimulus in that location. After 15 seconds, the white card was removed from sight, and choice stimuli were presented.

In the choice trials, two colored cards that have "Touch Here" written on them were simultaneously presented in the bottom corners of the apparatus. In the forced choice trials, only one card was presented after the 15-second preliminary period had elapsed. For every session, the color (Blue or Green) and location (Left or Right) associated with each schedule of reinforcement was determined randomly prior to each session. In the first forced trial, the colored stimulus associated with one schedule appeared in either the left or right location as determined previously, and was associated with that

color and location for that entire session. During the forced choice trials, the subject was first exposed to two consecutive trials with each stimulus and then one alternating trial of each stimulus. The purpose of these trials was to ensure that subjects have contacted each schedule of reinforcement prior to providing a choice opportunity. The color and location associated with the individual schedules of reinforcement were varied across sessions to address subject bias regarding location and color. A touch to a colored stimulus within 5 seconds after their presentation resulted in the removal of the unchosen stimulus from sight and the chosen stimulus was turned over so that it was blank. The onset of the schedule that is associated with the chosen stimulus for that session as was previously determined was then immediately initiated. The end of that trial, and the onset of a new trial was signaled by the presentation of the white card, and the initiation of another 15 second preliminary period.

For any trial, the subject must emit a response within 5 seconds after the colored stimuli were presented or the trial was aborted, and the white stimulus was again presented. The stimulus touched, determined the schedule in effect for that trial. Should the subject contact the second stimulus after making his or her initial response, or touch both stimuli simultaneously, the trial was aborted.

For any given session, one of three research assistants recorded the data. A reliability check was conducted on each of the three observers by the principal experimenter. The principal experimenter observed one session for each subject, and was consequently able to observe each of the three data recorders one at least one occasion. The results indicated that the data recorded by principal experimenter for purposes of a

reliability check matched the data obtained by the data recorder 100% for 7 of the 8 sessions that were monitored. For one session, for one data recorder, the agreement was only 70%. Inter-rater reliability was determined to be 96% for the 8 sessions that were monitored across eight subjects and the three data recorders. This was calculated by adding up the percentage of agreement for the 8 sessions (7 sessions with 100% agreement plus the one session with 70% agreement gave a grand total of 770%) and dividing this sum by the total number of sessions observed which was 8. 770% divided by 8 yields 96%. It should be noted however, that the one data recorder who obtained the 70% agreement only served as a data recorder that one time. That recorder was assigned to other duties and the other two data recorders were responsible for all other sessions.

Positive Reinforcement Procedure

Randomization procedures determined the order in which the five experimental phases for this procedure were presented for each subject. All three experimental phases under this procedure involved the presentation of music that the subject had previously indicated a preference for, by being asked his preference directly.

Summary of Phases

Phase I: Equal Magnitude of Reinforcers, delay one choice. The purpose of this phase was to evaluate the effect of a simple delay to one choice when reinforcement amounts were equal. In this phase subjects chose between 30 seconds of music-on

followed by 10 seconds of music-off or 10 seconds of music-off followed by 30 seconds of music-on.

Phase II: Delays were equal, magnitude of reinforcers varied. The purpose of this experiment was to ascertain what effect reinforcer magnitude had when delays were equal. Subjects chose between 60 seconds of music-on or 30 seconds of music-on followed by 30 seconds of music-off.

Phase III: Magnitude of reinforcers was varied, with 3 delay values to the larger reinforcer. The purpose of this experiment was to evaluate the effects of longer delays to the larger reinforcer. In the first condition, subjects chose between 30 seconds of music-on followed by 40 seconds of music-off or 10 seconds of music-off followed by 60 seconds of music-on.

In the second condition, subjects chose between 30 seconds of music-on followed by 50 seconds of music-off or 20 seconds of music-off followed by 60 seconds of music-on.

In the third condition, subjects chose between 30 seconds of music-on followed by 60 seconds of music-off or 30 seconds of music-off followed by 60 seconds of music-on. The purpose of the post reinforcement delay following the immediately available, smaller reinforcer is to equalize the amount of time spent under each choice schedule. This controls for a potential bias for the smaller reinforcer.

Negative Reinforcement Procedure

Randomization procedures again determined the order of the presentation of this

procedure for each subject. All three experimental phases under this procedure involved the termination of music that the subjects had indicated a specific dislike for by being asked directly. The presentation of the white card that signals the onset of a 15 second inter-trial-interval was now associated with the onset of aversive music for 15 seconds.

Conditions conducted under this phase closely parallel the conditions established under the positive reinforcement phase. The important difference is that the contingent event for touching a colored stimulus was the termination of music that the subject had expressed a dislike for, and the automatic onset of the aversive music during the preliminary period that is associated with the presentation of the white card. Prior to each trial, the white card was presented along with the onset of a 15 second aversive music stimulus. The white card was then removed and the music was terminated. The two colored cards were then presented.

Phase I: Equal magnitude of reinforcers, delay one choice. Subjects chose between 30 seconds of music-off followed by 10 seconds of music-on or 10 seconds of music-on followed by 30 seconds of music-off.

Phase II: Delays are equal, magnitude of reinforcers varies. Under this phase, subjects chose between 30 seconds of music-offset followed by a 30 sec of aversive music or 60 sec of music-offset that was available immediately.

Phase III: Magnitude of reinforcers varied, with 3 delay values to the larger reinforcer. The purpose of this experiment was to investigate the effects of increasing the delays to the larger reinforcer.

In the first condition under this phase, subjects chose between 30 sec of

immediate music-off followed by 40 seconds of music-on or 10 seconds of music-on followed by 60 sec of music-off.

In the second condition, subjects chose between 30 sec of music-off followed by 50 sec of music-on, or 20 seconds of music-on followed by 60 seconds of music-off.

In the third condition, subjects chose between 30 seconds of music-off followed by 60 seconds of music-on or 30 seconds of music-on followed by 60 seconds of music-off.

CHAPTER III

RESULTS

This study was designed to investigate three primary hypotheses. The first hypothesis, the conceptual hypothesis, stated that there is a relationship between impulsive responding and the type of reinforcement procedure. The second hypothesis, the operational hypothesis, stated that there will be significantly more impulsive responding under a negative reinforcement procedure under conditions utilizing the same reinforcer for both procedures. The final hypothesis, the null hypothesis, stated that there will be no significant difference in the amount of impulsive responding that is generated by the positive reinforcement procedure under conditions where the same reinforcer is utilized for both reinforcement procedures.

Both hypotheses 1 and 2 address the idea that a relationship exists between impulsive responding and the nature of the reinforcement procedure. Additionally, these two hypotheses rest on the assumption that a single type of stimulus can function as both a positive and negative reinforcer. Phases 1 and 2 of this study were designed to investigate whether the stimulus chosen in this study, that being music, actually functioned as both a positive and negative reinforcer.

Subjects in phase 1 were given a choice between a 30" reinforcer that was available either immediately or after a 10" delay. As seen in Table 1, under the positive

Table 1

Group Data Summary: Delay vs. Intermediate, Reinforcers Equal

Choice	# of Responses	% of Responses
P1		
10" Delay / 30" Reinforcer	34	43%
0" Delay / 30" Reinforcer	46	57%
N1		
10" Delay / 30" Reinforcer	58	73%
0" Delay / 30" Reinforcer	22	27%

reinforcement procedure, 57% of the responses made were for the immediate reinforcer, while under the negative reinforcement procedure, there were 27%. The Wilcoxon Matched-Pairs Signed-Ranks test was conducted to determine if the amount of responding to the immediately available reinforcer was statistically significantly different across reinforcement procedures at a .05 level of significance. The results are shown in Table 2. The analysis indicates that the number of responses made for the immediately available reinforcer was not statistically different across reinforcement procedures. The obtained 2-tailed p value was .26.

In phase 2, subjects were given a choice between two reinforcers that were both available immediately. One reinforcer amount was 30", the other was 60". As can be seen in Table 3, 92% of the responses in the positive reinforcement and 89% of the responses in the negative reinforcement procedure indicated a preference for the larger reinforcer when both are available immediately. The results from The Wilcoxon Matched-Pairs

Table 2
Wilcoxon Match-Pairs Signed-Ranks Test

Pairs	2-Tailed P value obtained
P1, N1	0.26
P2, N2	0.72
P3, N3	0.14
P4, N4	0.85
P5, N5	0.11

Table 3
Group Data Summary: 30" vs. 60" Larger Reinforcer

Choice	# of Responses	% of Responses
P2		
30" Reinforcer	6	8%
60" Reinforcer	74	92%
N2		
30" Reinforcer	9	11%
60" Reinforcer	71	89%

Signed-Ranks test as shown in Table 2, indicate that the difference between the number of responses made for the larger reinforcer under both the positive and negative reinforcement procedures, was not statistically significant at a .05 level of significance. The obtained 2-tailed p value was .72.

After attempting to meet the assumption that music is able to function as both a

positive and negative reinforcer, the final or null hypothesis was investigated by Phases 3 through 5.

In phase 3 for both the positive and the negative reinforcement procedures, subjects had a choice between a 30" reinforcer that was available immediately, versus a 60" reinforcer that was available after a 10" delay. Impulsive responding is defined as choosing the immediate, but smaller reinforcer, over the larger, but delayed reinforcer. As seen in Table 4, under the positive reinforcement phase, 20% of the total number of responses made, were impulsive. Under the negative reinforcement procedure, 1% of the total number of responses were impulsive. A Wilcoxon Matched-Pairs Signed-Ranks Test was performed to determine if the difference between the number of impulsive choices made under the positive reinforcement schedules was significantly different from the number of impulsive choices made under the negative reinforcement schedule. The results from this analysis can be seen in Table 2. A 2-tailed p value of .14 was obtained indicating that the difference between the number of impulsive responses for the positive reinforcement schedules as compared with the negative reinforcement schedules was not statistically significant at a .05 level of significance.

In phase 4 for both the positive and the negative reinforcement schedules, subjects had a choice between a 30" reinforcer that was available immediately, versus a 60" reinforcer that was available after a 20" delay. In Table 4, it can be seen that under the positive reinforcement procedure, 4% of the total number of responses were impulsive as compared with 12% under the negative reinforcement procedure. The results of the Wilcoxon Matched-Pairs Signed-Ranks Test as shown in Table 2, indicate that

Table 4

Group Data Summary: Delay - Larger vs. Intermediate - Smaller

Choice	# of Responses	% of Responses
P3		
10" Delay / 60" Reinforcer	64	80%
0" Delay / 30" Reinforcer	16	20%
N3		
10" Delay / 60" Reinforcer	79	99%
0" Delay / 30" Reinforcer	1	1%
P4		
20" Delay / 60" Reinforcer	77	96%
0" Delay / 30" Reinforcer	3	4%
N4		
20" Delay / 60" Reinforcer	70	88%
0" Delay / 30" Reinforcer	10	12%
P5		
30" Delay / 60" Reinforcer	76	95%
0" Delay / 30" Reinforcer	4	5%
N5		
30" Delay / 60" Reinforcer	55	69%
0" Delay / 30" Reinforcer	25	31%

there was no statistically significant difference in the amount of impulsive responses between the positive and negative reinforcement procedures for this phase at a .05 level of significance. A 2-tailed p value of .85 was obtained.

For phase 5, subjects were given a choice between a 30" reinforcer that was available immediately and a 60" reinforcer that was available after a 30" delay. The results in Table 4, indicate that under the positive reinforcement procedure, 5% of the total number of responses made were impulsive, and under the negative reinforcement procedure, 31% of the responses made were impulsive. As seen in Table 2, the results from the Wilcoxon Matched-Pairs Signed-Ranks indicate that the obtained 2-tailed probability value was .11, indicating that the difference in the number of impulsive responses made under the positive and negative reinforcement procedures was not statistically significant at a .05 level of significance.

In summary, the results from phases 3 through 5 which investigated the null hypothesis indicate that there is no statistically significant difference in the amount of impulsive responding across reinforcement procedures, thus the null hypothesis is not rejected.

Although statistical analysis did not provide sufficient evidence to reject the null hypothesis, a post hoc analysis revealed that the percentage of impulsive responses did increase under the negative reinforcement procedures from 1% to 12% to 31% as the delays to the larger reinforcer increased from 10" to 20" to 30" respectively. This trend can be observed most readily in Figure 1. As can be seen in Figure 1, this same trend did not occur under the positive reinforcement schedule.

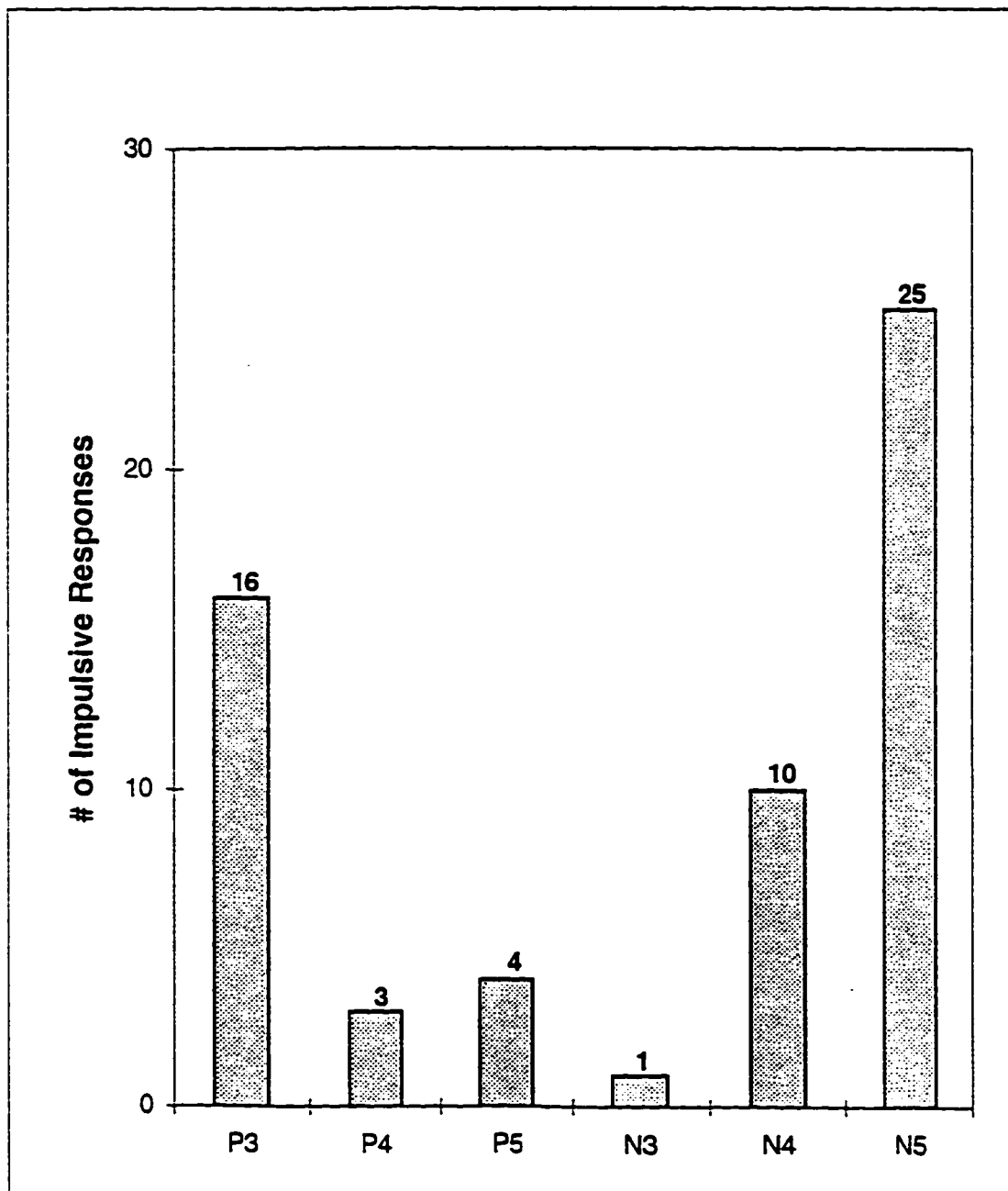


Figure 1. Group Data Summary: Delayed-Larger vs. Immediate-Smaller.

CHAPTER IV

DISCUSSION

The principal outcome of this study indicated that there was no statistically significant difference in the amount of impulsive behavior in humans under a positive reinforcement procedure when compared with a negative reinforcement procedure. One aspect of the results however, deserves much closer scrutiny: there was an obvious pattern in the responses under the negative reinforcement procedure that indicated an increase in impulsive behavior. The impulsive responses increased from 1% to 12% to 31% as a function of the increase in delays to the larger reinforcer. No such pattern occurred under the positive reinforcement procedure. This result is consistent with earlier findings of studies that utilized negative reinforcement procedures (Deluty, 1978; Navarick, 1982; Solnick, Kannenberg, Eckerman, & Waller, 1980).

The absence of a stronger pattern of an increase in the impulsive responding under the negative reinforcement procedure and the absence of any similar pattern under the positive reinforcement schedule, may be due in part to the limited number of trials under each condition for each subject, as well as the relatively small number of subjects used in this study. Also, had the delays been of greater duration to the larger reinforcer, or had equal amounts of delay been added to each choice option under both reinforcement procedures, stronger effects may have obtained.

Imposing greater delay values may have clarified the results in another area of this study. In phase 1, the subjects were asked to choose between two reinforcers of equal size, one of which was delayed by 10 seconds. In the positive reinforcement procedure, the subjects did not demonstrate a clear preference for either choice, suggesting that 10 seconds does have much impact on that choice situation. Even though the statistical analysis does not indicate that the number of choices for the immediately available reinforcers differed significantly across reinforcement procedures, a visual inspection of the data indicates that under the negative reinforcement procedure, a majority of the responses, 73%, were made for the delayed option as compared with 43% under the positive reinforcement procedure. It is unclear why a larger majority of responses were made for the delayed option under the negative reinforcement schedule. If the delay had been some value larger than 10 seconds, perhaps a stronger effect may have been obtained and this response pattern may have been more clearly understood. The data obtained in this study, are insufficient to explain this anomaly in the data. More studies will be needed to explore this anomaly further.

A direct comparison of the results from this study and prior research utilizing negative reinforcement procedures is difficult, due to the type of stimuli that other researchers have utilized to examine negative reinforcement effects in humans. Prior research has utilized the termination of white noise as the negative reinforcer. This stimulus may be more akin to a primary reinforcer in that termination of white noise is an attempt by a organism to resume homeostasis. Primary reinforcers, both positive and negative, have been more likely to generate impulsive responding as has been shown in

prior research (Deluty, 1978; Navarick, 1982; Solnick, Kannenberg, Eckerman, & Waller, 1980).

In general, the results from this study indicated that under a reinforcement procedure using a secondary reinforcer, subjects emitted self-controlled responding. There were no statistically significant differences in the number of impulsive responses between the positive reinforcement procedure and the negative reinforcement procedure, although a visual inspection of the data indicates that there was a consistent pattern indicating an increase in the impulsive responding that occurred under the negative reinforcement procedure.

Although these findings are generally consistent with previous findings, these results are divergent from the results of previous research in one noteworthy manner. Prior research findings suggest that when a positive, secondary reinforcer is utilized, subjects will most likely emit more self-controlled responses (Logue et al., 1986; Millar & Navarick, 1984). Secondary, negative reinforcers have not been studied. Most negative reinforcement procedures have utilized noise termination as the reinforcer. Thus, to date, not much is known about how such stimuli affect choice behavior in humans.

The results from the positive reinforcement schedule suggest that subjects did not behave impulsively, but rather emitted self-controlled behavior and waited for the larger, but more delayed reinforcer in the choice phases (P3, P4, and P5). This finding is consistent with previous research by Logue, Pena-Correal, Rodriguez, and Kabela, (1986) when rewards were points that were exchangeable for money. Studies that have not found that subjects emitted self-controlled behavior by waiting for a larger reward,

are studies in which the positive reinforcer is a consumable or primary reinforcer such as food (Ragotzy, Blakely, & Poling, 1988). A study by Millar and Navarick (1984) utilized access to a computer game as the reinforcer and a limited degree of impulsivity was obtained in 40% of the subjects. This study and a study by Navarick (1986) that utilized picture viewing as a reinforcer are studies that utilized novel reinforcers that are positive and secondary in nature, yet elicited more impulsive behavior than has been the case with other secondary, positive reinforcers. The argument has been made (Millar & Navarick, 1984) that perhaps reinforcers that require a subject to have considerable contact with the reinforcer have a consumable quality that may be compared to food or drink and thus may produce more impulsive behavior than would be the case with other positive reinforcers, that are less intrinsically rewarding. In the present study, music can hardly be considered as a primary reinforcer. It more closely resembles a secondary reinforcer in that the termination of this stimulus is not likely to be associated with a drive to maintain homeostasis in a given subject.

Sonuga-Barke, Lea, and Webley (1989) suggest that subjects will emit more impulsive responses under a positive reinforcement schedule using secondary reinforcers, points exchangeable for money, when the subjects are given a limited amount of time to obtain their points. However, when the same subjects are given a limited amount of trials instead of a time constraint, less impulsive responding occurred. In the present study, time was not a constraint, but the number of trials was predetermined for each session. The results from our study agree with the results of Sonuga-Barke et al. regarding the positive reinforcement procedure, but under the negative reinforcement procedure, more

impulsive responding occurred, even though the number of trials was predetermined for all sessions.

Flora and Pavlik (1992) found that in a study using a discrete-trial procedure with points exchangeable for money, subjects emitted self-controlled responding in all conditions where doing so maximized reinforcer density. The only impulsive responding that occurred was under conditions where no post-reinforcer delays were imposed, so choosing the more immediate reinforcer increased overall reinforcer density. In the present study, post-reinforcer delays were utilized, yet more impulsive responding began to occur under the negative reinforcement procedure, than the positive reinforcement procedure, even though the reinforcement densities were equal across those conditions.

Vollmer and Iwata (1991) explored the effects of establishing operations on the reinforcing effects of three classes of positive reinforcers; food, music and social interaction. The authors found that mean response rates increased during deprivation conditions for all subjects when compared with satiation conditions. The authors noted that they also observed an overall decrease in the mean response rate for subjects during the music assessment suggesting support for results from Rincover, Newsom, Lovaas, and Koegel (1977) who showed that the reinforcing effect of taped music decreased after a series of sessions. One striking difference in these studies utilizing music as a reinforcer and the present study is that in this study, the subjects chose their music and demonstrated clear preferences for their selections. Also in the study by Rincover et al., subjects were exposed to as many as 50 sessions utilizing the taped music which may have also contributed to the decrease in the efficacy of the music as a reinforcer.

Finally, Lattal and Neef (1996) discussed the role of behavioral history and the role of instruction on the schedule performance of humans. To the extent that in the present study, the subjects were randomly assigned to the experimental conditions that were presented in a random sequence, the role of behavioral history as it specifically relates to the present study was controlled for. In regards to the role of instruction, no attempt was made to address covert rule stating by subjects. Subjects in the present study may have developed a rule that came from the instructions that were read to them which suggested that waiting may be followed by a larger reinforcer. The exception that this may be the case is that under the negative reinforcement procedure, subjects began to respond more impulsively as the delay to the larger reinforcer increased.

Future Studies

The use of a single stimulus to directly compare positive and negative reinforcement effects is a novel design and the results of such a design could have important implications. Prior to this study, the comparison of the effects of reinforcement procedures was accomplished through comparing subjects exposed to one type of stimulus used as a positive reinforcer with a different group of subjects who were exposed to a different stimulus that functioned as a negative reinforcer. A direct comparison of subjects' performance across reinforcement procedures could be an important research design tool including further exploration of negative reinforcement procedures using secondary reinforcers.

The design utilized in this study may provide the underpinnings of a laboratory

analogue for the future study of impulsive behavior. If a stronger display of impulsive behavior can be generated under the negative reinforcement procedure, then this design may have useful implications about choice behavior under different types of reinforcement procedures. Likewise, this design has potential value with the use of clinical populations as a screening device for the exploration of impulse control issues. It may be interesting to use a version of this design to see if individuals with diagnoses of depression, for example, may be overly self-controlled under one reinforcement component as compared to another when compared with non-depressed individuals. Likewise, impulsivity has been associated with certain binge-eating disorders (Newton, Freeman, & Munro, 1993). It would be of interest to explore how that phenomenon would manifest using a design like the one in the present study. Additionally, assaying certain clinically relevant medications used to treat clinical disorders that have an obvious component of impulsivity or over-controlled behavior with this design may provide useful insight on the variability in efficacy of some pharmacotherapies.

This design then, may have use as a diagnostic tool, an assessment of treatment efficacy, and possibly serve as another vehicle to further our understanding of choice behavior in humans, as well as the many issues that remain un-investigated about the effects of secondary, negative reinforcers and humans.

Appendix A
Informed Consent Form

WESTERN MICHIGAN UNIVERSITY

Principal Investigator: Kevin J. Armstrong, Ph.D.

Research Associate: Catherine Karas, M.A.

I have been invited to participate in a research project entitled "Human Impulsivity: Effect of Reinforcement Procedures." I understand that the purpose of the study is to compare two types of reinforcement procedures to see how they affect making choices, thereby adding to the understanding of factors that influence impulsive or self-controlled behavior.

I understand that my consent to participate in this project indicates that I will be asked to attend six one-hour sessions in eight days. I understand that the study involves listening to music under different procedures that will affect choice behavior. I understand that all sessions are to take place at 312A West Hall on the Western Michigan University campus. I understand that in the first session, I will be asked to choose music that I like and dislike for use in this study. I understand that the remaining five sessions will involve listening to music that I have chosen, and making choices about how the music comes on and is turned off. I understand that I will be paid five dollars cash at the end of each hour-long session. I understand that I will also receive a raffle ticket at the end of every session to be entered in a drawing for a one hundred dollar cash prize. I understand that the drawing will take place when all subjects have completed the study. I understand that the entire study may last two to three months.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to me except as otherwise specified in this consent form. I understand that the only anticipated risks of my participation in this project are minor discomforts such as boredom or feeling slightly uncomfortable when listening to music that I dislike.

I understand that the results of this study will be communicated to me at the end of this study.

I understand that all information collected from me is confidential. That means that my name will not appear on any papers on which this information is recorded. The forms will all be coded, and Catherine Karas will keep a separate master list with the names of participants and the corresponding code numbers. Once the data are collected and analyzed, the master list will be destroyed. All other forms will be retained for three years in a locked file in the principal investigator's laboratory.

I understand that I may refuse to participate or quit at any time during the study without prejudice or penalty. If I have any questions or concerns about this study, I may contact either Dr. Kevin J. Armstrong at 387-8311, or Catherine Karas at 344-6488. I may also contact the Chair of Human Subjects Institutional Review Board at 387-8293 or the Vice President for Research at 387-8298 with any concerns that I have. My signature below indicates that I understand the purpose and requirements of the study and that I agree to participate.

Signature

Date

Appendix B
Letter of Approval From HSIRB

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3559
616 367-3293

WESTERN MICHIGAN UNIVERSITY

Date: Sept. 23, 1994

To: Catherine Karas

From: Christine Bahr, Acting Chair

A handwritten signature in black ink, appearing to read "Christine Bahr".

Re: HSIRB Project Number 94-08-04

This letter will serve as confirmation that your research project entitled "Human impulsivity: Effects of reinforcement procedures" has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you must seek specific approval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date. In addition if there are any unanticipated adverse or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: Sept. 23, 1995

xc: Armstrong, PSY

Appendix C

Data Sheets and Music Preference Record

Subject # _____ Session Code: _____

	LOCATION	COLOR	DELAY	RFCR AMT	RESP
Forced Trial #1	Left _____ Right _____	Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
Forced Trial #2	Left _____ Right _____	Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
Forced TRIAL #3	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
Forced TRIAL #4	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
Forced TRIAL #5	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
Forced TRIAL #6	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #1	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #2	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #3	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #4	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #5	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____

DATA SHEET

Date _____

Subject # _____

CHOICE TRIAL #6	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	Rfcr _____ _____	Resp _____ _____
CHOICE TRIAL #7	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #8	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #9	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #10	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
CHOICE TRIAL #	Left _____ Right _____	Blue _____ Green _____ Blue _____ Green _____	Delay _____ Delay _____	_____ _____	_____ _____
Tape code for this session: _____			Date:		

Music Preference Sheet

Subject # _____

Positive Rankings:

Best _____

Very Good _____

Good _____

Just Okay _____

Aversive Rankings:

Worst _____

Very Bad _____

Bad _____

Not So Bad _____

Appendix D
Subject Recruitment Script

Subject Recruitment Script

The study we're conducting involves listening to music and making choices. You'll be asked to rank order some tapes of music according to your preferences. Some of the music will be music you like and some will be music that you dislike. The music used throughout the study will be based on your preferences. After your first session where you establish the music preferences, you'll be asked to come in 5 more times for approximately 1 hour each time. A total of about six hours (or sessions) of your time is required. All six sessions must be completed within 8 days, and there must be at least 24 hours separating each hour(session).

The last five sessions will involve simply making choices about how the music comes on and is turned off during those sessions.

You'll be paid 5 dollars cash for every hour immediately after the session is over. Also, after every hour, you'll get 1 ticket for a drawing in a lottery with a hundred dollar prize that will be done at the end of the whole study, when all the subjects have finished.

There will be a consent form to sign before starting your first session.

Appendix E
Directions for Subjects

DIRECTIONS FOR SUBJECTS

POSITIVE SCHEDULES:

You will have a choice about how you spend your time today. Remember the music that you picked out that you said you liked? Well, today you will get to listen to some of it.

By TOUCHING EITHER the green or the blue card, you will get to spend some time listening to some of that music. You must only touch ONE card when the green and the blue are both present. It is a CHOICE.

By touching ONE of the two colored cards, the music will either come on right away or it may come on after some time passes, but then it may stay on longer.

REMEMBER: Only touch the blue OR the green card if both are present.

Do you need me to repeat these directions?

NEGATIVE SCHEDULES:

You will have a choice about how you spend your time today. Remember the music that you picked out that you said you didn't like? Well, some of that music will be played today.

By TOUCHING EITHER the green or blue card, you will get to turn off some of that music. You must only touch ONE card when the green and the blue are both present. It is a CHOICE.

By touching ONE of the two colored cards, the music will either be turned off right away, or it may stay on a little longer, but may stay off for a longer time.

REMEMBER: Only touch the blue OR the green card if both are present.

Do you need me to repeat these instructions?

Appendix F
Randomization Schedule

Randomization Schedule

Subject #1:

- 1) N5 - P3
- 2) N1 - P2
- 3) P4 - N2
- 4) N3 - P5
- 5) P1 - N4

Subject #2:

- 1) P1 - N1
- 2) P4 - N3
- 3) N5 - P2
- 4) N2 - P3
- 5) N4 - P5

Subject #3:

- 1) N5 - P3
- 2) P4 - N3
- 3) N4 - P1
- 4) P5 - N1
- 5) P2 - N2

Subject #4:

- 1) P3 - N5
- 2) N4 - P1
- 3) P5 - N2
- 4) N3 - P4
- 5) N1 - P2

Subject #5:

- 1) P4 - N5
- 2) P2 - N4
- 3) N3 - P3
- 4) N1 - P1
- 5) N2 - P5

Subject #6:

- 1) P1 - N5
- 2) P2 - N3
- 3) N2 - P3
- 4) P4 - N4
- 5) P5 - N1

Subject #7:

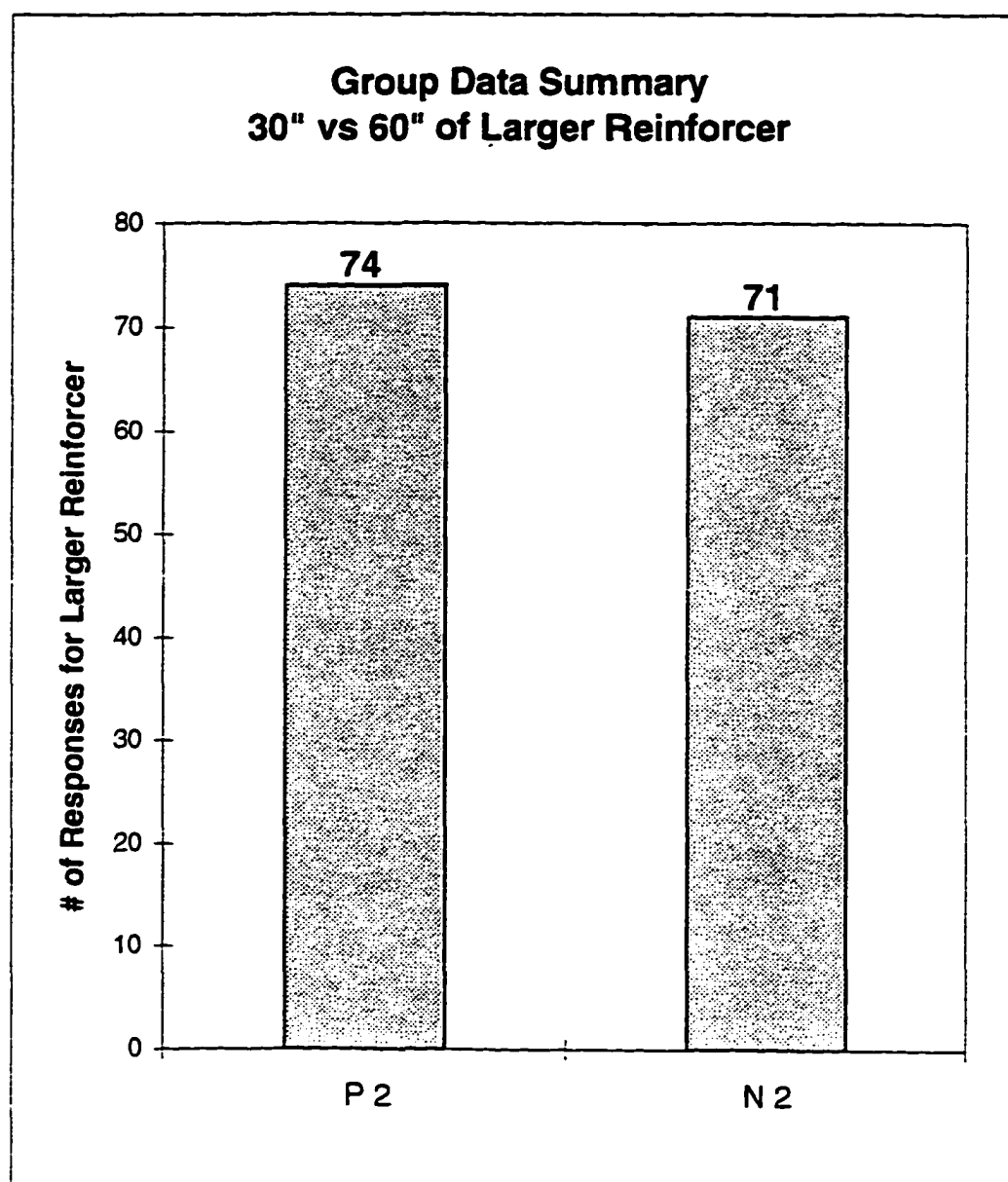
- 1) P4 - N1
- 2) N5 - P5
- 3) P1 - N2
- 4) P2 - N2
- 5) P3 - N3

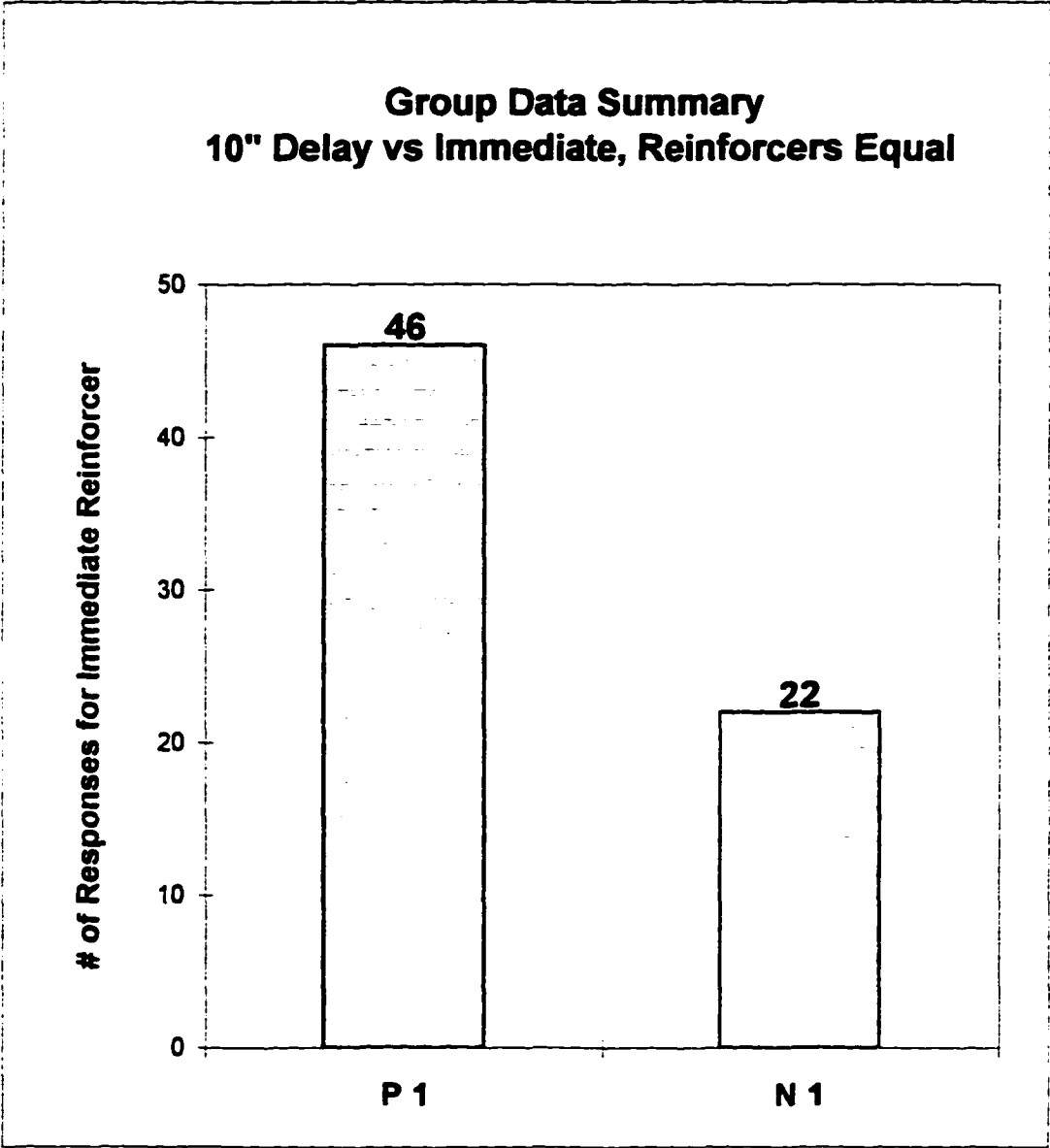
Subject #8:

- 1) P5 - N4
- 2) P1 - N2
- 3) N5 - P3
- 4) P4 - N3
- 5) N1 - P2

Phase order was determined using Table of Random Numbers.
Positive or Negative sequencing was determined by flipping a coin.

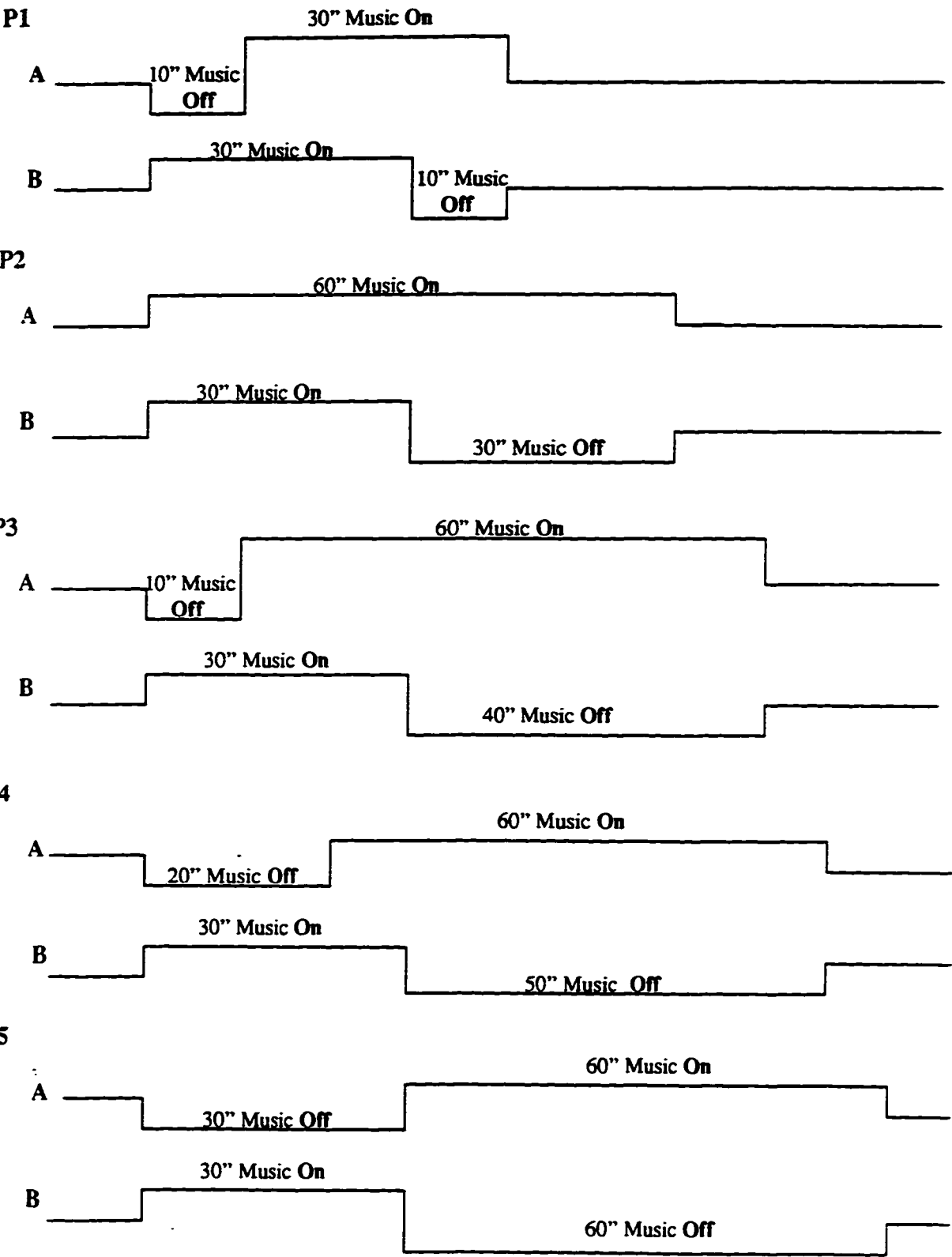
Appendix G
Group Data Summary





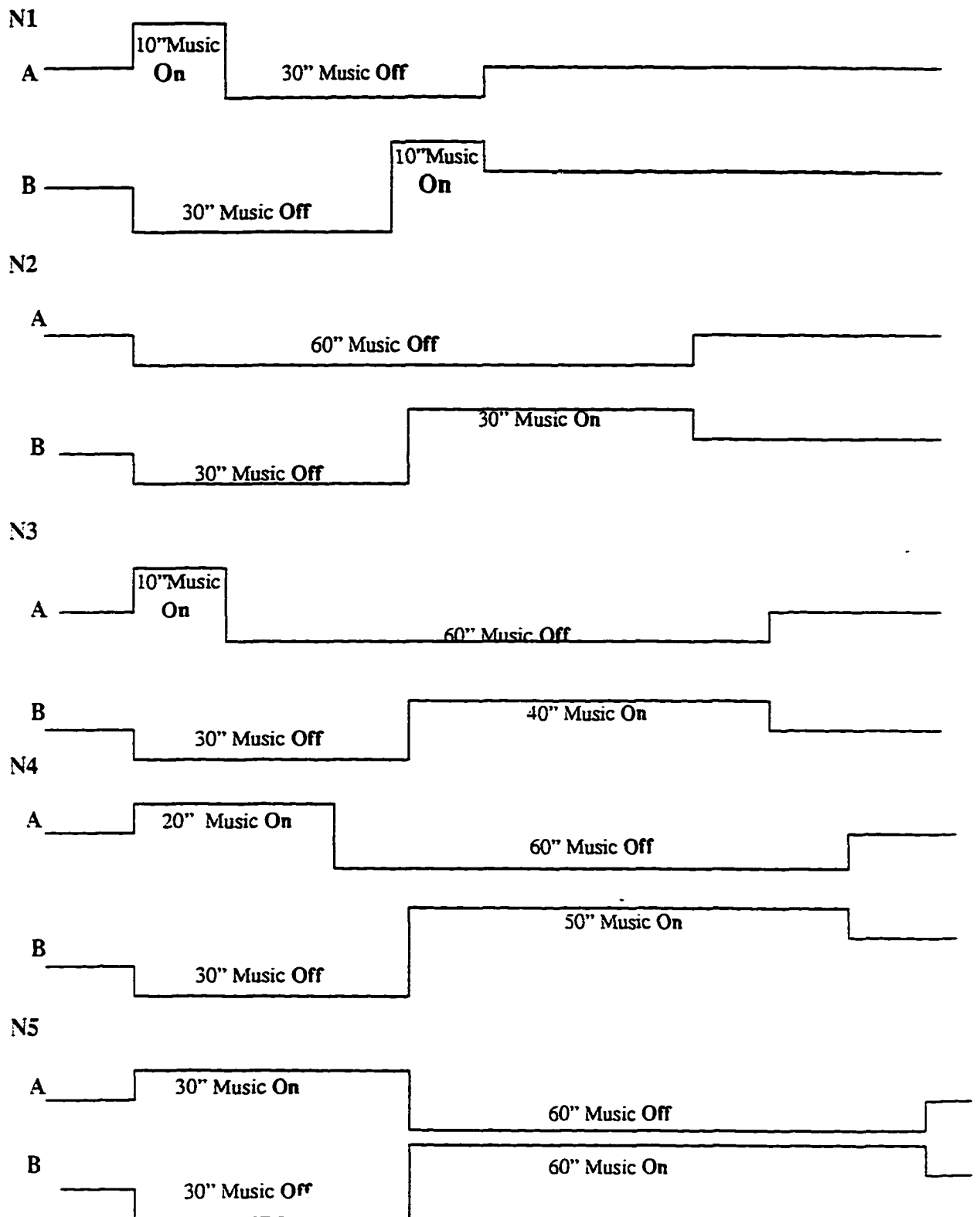
Appendix H
Schemata and Flow Chart

Schemata for Positive Reinforcement Schedules

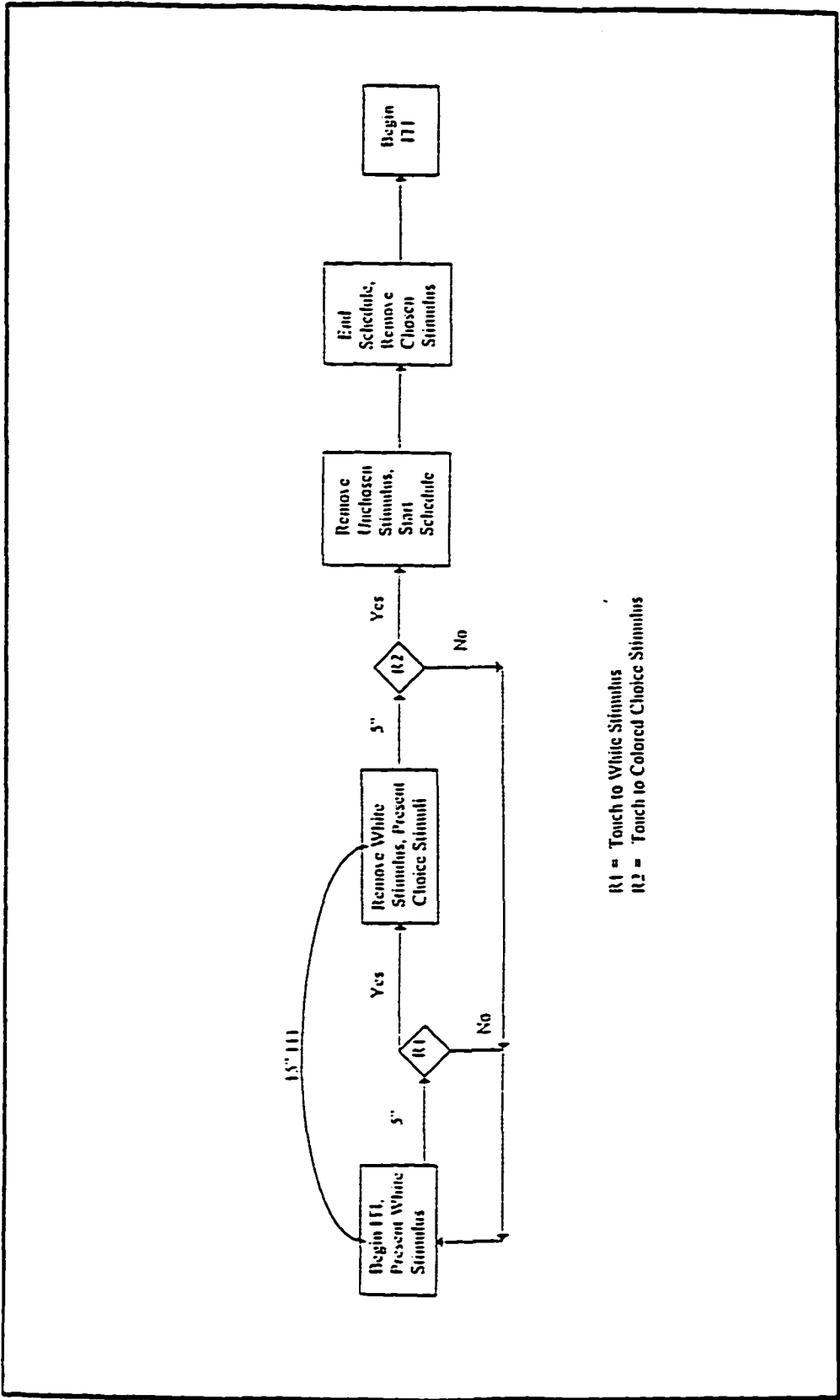


Schemata for Negative Reinforcement Schedules

52



Flow Chart of General Procedure



Appendix I
Data Summary for Individual Responses

Data Summary for Individual Responses

Schedule	Subject Number							
	1	2	3	4	5	6	7	8
P1A	1	5	1	0	8	8	7	5
P1B	9	5	9	10	2	2	3	5
N1A	9	4	10	10	4	5	6	10
N1B	1	6	0	0	6	5	4	0
P2A	0	0	8	10	10	10	9	7
P2B	10	10	2	0	0	0	1	3
N2A	0	0	10	10	10	1	10	10
N2B	10	10	0	0	0	9	0	0
P3A	8	0	10	10	10	10	10	6
P3B	2	10	0	0	0	0	0	4
N3A	10	10	10	10	10	10	9	10
N3B	0	0	0	0	0	0	1	0
P4A	10	9	10	10	10	10	10	8
P4B	0	1	0	0	0	0	0	2
N4A	9	10	10	10	10	1	10	10
N4B	1	0	0	0	0	9	0	0
P5A	10	8	10	10	9	10	10	9
P5B	0	2	0	0	1	0	0	1
N5A	5	10	10	4	10	1	9	6
N5B	5	0	0	6	0	9	1	4

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