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Discrimination learning with rhythmic and nonrhythmic background music.

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DISCRIMINATION LEARNING WITH RHYTHMIC AND NONRHYTHMIC BACKGROUND MUSIC

by

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ABSTRACT

This study was an investigation of the effect of music, and more specifically, rhythm, upon the acquisition of a visual discrimination response. Thirty water deprived, adult male, Hooded rats were divided into six treatment groups each containing five subjects (Ss), and each exposed to a different background auditory condition while learning the discrimination. The six treatment groups were: Mozart (M), Schoenberg (S), control or quiet (C), amelodic Mozart rhythm (AMR), amelodic Schoenberg rhythm (ASR), and white noise (WN). The M and AMR groups were classified as rhythmical, while the S and ASR groups were classified as nonrhythmical. The learning task was the same for all Ss, discriminating a correct pattern on 1 of 4 doors which led to a reward of water.

Analyses of the data indicated that music did not increase performance on the discrimination task. The rhythmical subjects (M and AMR) did not perform any better than the control or quiet animals; however, the nonrhythmical subjects (S and ASR) performed reliably more poorly, as did the WN subjects. Two subgroups were formed, each composed of 3 conditions: the M, AMR, and C groups formed one common stream of responding, while the S, ASR, and WN groups formed another response pattern. Therefore, it appears that while rhythmical presentations do not affect a discrimination learning task, the presence of nonrhythmical stimulation suppresses performance. The amelodic rhythmical compositions (AMR and ASR) had the same effects as did their originals, thus indicating rhythm as a determining component of any musical effect. The results were discussed in terms of redundancy and complexity of the stimuli.

PREFACE

This study began as the result of a magazine article concerning the effect of music on animal behavior. The author's interest in classical music also played a major role in the selection of such a study.

The author would like to express grateful and sincere appreciation to Dr. Theodore Horvath for his direction and countless suggestions for improvement, and also to Dr. A. Arthur Smith for his statistical and suggestive consultation. Thanks are also extended to Dr. J. R. Dougherty for being a reader, and to Mr. John Dorner, who transposed the original compositions into the amelodic stimuli.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Music has been studied for many reasons in the various areas of psychology. Podolsky (1954) used music as a therapeutic tool in the treatment of patients with personality disorders, and discovered that it lessened the problems of patient management. Van de Wall (1926) employed music as an activating agent in psychotherapy, and attributed his success in reaching withdrawn and other disturbed patients to the presence of the music. Weigl (1959) reported that music can be an important therapeutic aid when used with retarded children. Murphy (1957) has suggested that the type of response to rhythmic music given by retarded children may have some diagnostic potential.

Kerr (1945) investigated the quantity and quality of work performed under conditions of no music and in the presence of different music types. Although the workers voiced a preference for the music, he found no significant differences between the amount nor the quality of work performed under the different conditions. Hough (1943) introduced musical programs into shops with records of high accident proneness and fatigue. While he did not attribute his results entirely to music, there was a notable decrease in accidents after three months of music presentation. In 1952, Moies reported that 20-30 minutes of music every two hours reduced boredom in monotonous work situations.

Roberts (1959) suggested that music acts to engage excess mental capacity which otherwise may result in apathy, brooding, idle conversation, and mistakes. His studies have indicated that the presence of music reduces boredom, increases production, reduces worker tension, reduces errors, decreases absenteeism, and lessens worker turnover. This interpretation is consistent with the findings of Kerr (1945), Hough (1943), and Moies (1952). In summary, the presence of music, in addition to being pleasurable, appears to result in more efficient performance of some tasks.

Additional evidence along this line is found in the classroom where music appears to promote a good learning atmosphere. Schmidt (1958) has reported that music in a classroom increases creativity, establishes a good classroom atmosphere, aids in imagination and abstract thinking, and increases teamwork. An investigation by Capurso (referred to in Weigl, 1959) has suggested that an individual's attention span can be prolonged by music. In 1952, Hall presented background music to eighth and ninth grade students as they performed a test in reading comprehension. Not only did the students enjoy the music, but there was an increase in reading accuracy as compared to the same test under quiet conditions.

A number of investigators have used music as a "distractor" variable. Baker (1937) had students add the numbers 6, 7, 8, and 9 successively under conditions of dance music and quiet. No difference was found in the addition performance under either condition. Engel and Engel (1962) also had students perform addition problems under conditions of music and no music, and no performance differences were found. In 1937, Fendrick administered a reading task to college students under conditions of music and quiet. Upon answering questions on the reading material, the quiet condition reported significantly more correct answers than the music group. Fendrick attributed this to the fact that the music acted as a "distractor". Henderson, Crews, and Barlow (1945) also presented a reading test to college students under conditions of popular music and classical music. For vocabulary testing, neither music condition indicated a performance difference, but in paragraph understanding, the popular music produced a performance decrement as compared to the classical music. The authors suggested that the complexity of the music and the task influenced the results. Freebourne and Fleischer (1952) found a significantly higher reading rate with jazz music, but other music types did not change the rate. They suggested that the regular rhythm in the jazz music acts as an aid in making a better task effort, or perhaps that the extra effort was made to overcome the musical distraction. However, the latter explanation does not explain why the other music types did not alter the reading rate.

The above studies have generally failed to show an increased performance pattern under the music conditions, as compared to the no music conditions, but these results could be attributed to the experimental design. Almost without exception, the subjects were informed that the music was an important feature of the experiment (Baker, 1937; Fendrick, 1937; Henderson, Crews, & Barlow, 1945; Engel & Engel, 1962). Therefore, the music situation became a distracting variable, because the subjects were instructed to pay attention to it. Concentration may thus have been diverted from the task to the music, resulting in a failure to show better performance.

Rhythm can be defined as either a stimulus or a response. When acting as a stimulus, it may be seen as a "temporal pattern of indivisible unit groups" (Ludin, 1953), and when acting as a response, in terms of a Gestalt, as an "organizational response of the organism" (Ludin, 1953). Music is, of course, based partly upon rhythm, and the rhythmic qualities are those which most affect the listener.

> If melody possesses a strong and familiar objective rhythm, the listening is in terms of that rhythm....where the tonal structure is more obvious, the listener's anticipations are whetted even more (Farnsworth, 1958, p. 73).

Roberts (1936, p. 406) in investigating the integrative and disintegrative effects of sound stimuli says:

> The stimulus of the rhythm creates a growing tension demanding a physical release by motor activity which for best effect naturally attunes itself to the pulsations of the stimulus.

It

It may be noted in passing that many learning tasks have a procedural rhythm,i.e., associative tasks on a memory drum, pursuit-rotor learning, and fixed intervals to name a few.

The experiments reviewed above generally used music per se as the independent variable and did not investigate the possible effects of rhythm. In an industrial setting, Mechan (1955) reported that music must be adapted in style and rhythm to the type of work being done, but rhythm is the more important factor. In the area of mental retardation, Weigl (1959) reported that lively tunes caused rhythmical hand clapping or marching in retarded children. Children with speech impairments were often found to be capable of singing entire lines of a familiar song as the rhythm carried them along. With this musical therapy, Weigl reported that 70% of the children had developed better peer and parent relationships, better coordination, an increased attention span, and improved memory.

Cross, Halcomb, and Matter (1967) investigated the preference of rats to the music of Mozart (rhythmic) and Schoenberg (non-rhythmic). Groups of rats reared under conditions of constant exposure to the music of either Mozart or Schoenberg for the first 52 days of life were tested for their preference at 67 days of age. In the test situation, the animals could determine which music was played (selections of the two composers not previously heard) by moving to one side of the other of the test compartment.

It was found that subjects exposed to Mozart overwhelmingly preferred Mozart, but animals exposed to Schoenberg, and control animals reared without music, exhibited no preference. Although recognizing the fact that the two stimuli used differ in many respects other than rhythmic quality, and consequently that a variety of interpretations are possible, the authors suggested that possibly the Mozart subjects learned to prefer this music because of its rhythmic quality. Put another way, perhaps the nonrhythmic music of Schoenberg did not provide a sufficiently stable stimulus situation for learning to occur. A further possibility is that nonrhythmical auditory stimulation may somehow inhibit or interfere with learning.

In summary, it appears that organisms prefer, or can learn to prefer, the presence of certain types of music (Cross, Halcomb, & Matter, 1967; Hall, 1952; Hough, 1943; Kerr, 1945). Two of the studies reviewed above (Hough, 1943; Roberts, 1959) suggested that the presence of music may result in more efficient performance of motor tasks. In addition, several authors report that the presence of music tends to promote and facilitate learning (Schmidt, 1958; Capurso, 1959; Weigl, 1959; Hall, 1952; Cross, Halcomb, & Matter, 1967; Freebourne & Fleischer, 1952). Finally, evidence was presented which suggested that the rhythmic aspect of music may be the fundamental performance variable (Mechan, 1955; Weigl, 1959; Cross, Halcomb, & Matter, 1967).

It is evident that what is now required is a well-controlled study examining the effects of music upon learning and the role of the rhythmic component in producing these effects. In the present study, groups of rats will learn a visual discrimination task while exposed to selections of rhythmic and nonrhythmic music, amelodic rhythmic and amelodic nonrhythmic compositions, white noise,aand quiet conditions. The hypotheses being tested are: (1) The presence of music tends to facilitate the acquisition of a visual discrimination response, (2) Music with relatively more pronounced rhythmical qualities will produce relatively greater facilitation, and (3) The rhythmical component of any given musical stimulation is a vital contributor to the effect of the musical stimulus.

CHAPTER II

METHODOLOGY

Subjects

The subjects (Ss) were 30 male Long-Evans Hooded rats obtained from Canadian Research Animal Farms, Bradford, Ontario. They were individually housed in standard size, 9½ x 7 x 7¼ in., stainless steel cages, and maintained under a 24 hour light-dark cycle; such that the period from 12:00 noon to midnight was the dark phase. The Ss were obtained three weeks before testing began, and were placed on 23½ hour water deprivation one week after arrival. All Ss were on ad lib. feeding, and they ranged in age from 95 to 105 days at the beginning of testing.

Apparatus

The experimental apparatus consisted of a rectangular visual discrimination chamber measuring 18 x 15 x 20 in., colored flat gray, and constructed of wood with a ½ in. mesh floor and a plexiglas top. A 5 inch speaker was centered on the back wall ½ in. from the ceiling. At floor level across the front wall were four plexiglas doors, 4½ x 4 in., spaced 3/4 in. apart. Each door was mounted on a metal rod, 1/8 in. in diameter and five inches tall. These rods were positioned behind and ½ in. to the left of each left edge of the door openings. To mount the doors and yet make them easily interchangeable, small ½ in. screw-eyes were screwed into the left edge of each door. The screw-eyes were then dropped over the rod; the door was easily pushed open by the rat, and quickly lifted off the rod for changing. Beyond the doors and exterior to the apparatus was a plexiglas strip that sat flush with the floor of the chamber. Four round water wells were drilled into this strip so that each well was in the middle of a doorway. The well was large enough to hold two drops of water. Thus an animal could push open a door, put his head through the opening, and drink from the water well. All doors were constructed so that they could be easily locked. Inside the apparatus, 1/8 in. back from the front wall, was a gray wooden slide (opaque) that could be raised and lowered by means of a cord fastened to it through an overhead pully. A slide of transparent plexiglas sat 2½ in. back from the opaque slide and was raised by the same method. Both slides sat and moved in grooves made on the side walls of the apparatus. A diagram of the apparatus is presented in Appendix A.

Paper bedding was placed under the mesh floor of the apparatus to keep the experimental area clean. This bedding was changed whenever urination or defecation occurred. An eye dropper was used to place the water into the water wells.

A Sony, Model TC-105, tape recorder was used to record and present the experimental stimuli. The musical stimuli were taped from RCA phonograph records of Mozart's Symphony No. 41 and Schoenberg's Chamber Symphony No. 2. The sheet music of Mozart's Symphony No. 41 and Schoenberg's Chamber Symphony No. 2

was used to create the amelodic compositions for each. A Farfisa electric organ was used to record the two amelodic auditory stimuli. The white noise stimulus was taped from a Lehigh Valley, Model 1524, white noise generator. A Scott, Model 412, sound level meter was used to measure the intensity of the auditory stimuli in decibels (db).

Preliminary testing of the apparatus revealed that there was only slight variation in intensity, in various parts of the chamber, for auditory stimuli presented through the speaker. At an average of 70 db, the intensity level used in the experiment, the variation was less than 1 db in either direction.

Procedure

The rats were randomly assigned to the six treatment conditions, with five Ss in each group. Two of the groups learned the discrimination in the presence of the musical stimuli used by Cross, Halcomb, and Matter (1967), i.e., Mozart's Symphony No. 41 (M group) and Schoenberg's Chamber Symphony No. 2 (S group). An additional two groups learned the discrimination in the presence of an amelodic composition based on the stimulus used for the M and S groups. Specifically, the Mozart Symphony No. 41 and Schoenberg Chamber Symphony No. 2 were re-recorded such that the original melodic pattern of each composition was transposed to a monotonic pattern (G minor) but with the retention of the original composition's rhythm. Thus, two amelodic-nonrhythmic compositions were produced: the amelodic Mozart rhythm (AMR group) and the amelodic Schoenberg rhythm (ASR group). The remaining two treatment groups learned the discrimination under conditions of white noise (WN group) and quiet (control or C group) respectively. The auditory stimuli used for the M, S, AMR, ASR, and WN subjects were presented at an average intensity of 70 db.

Each day before testing, the sound level meter was used to confirm the volume setting on the tape recorder as maintaining a 70 db output. The sound level meter was placed at floor level in different areas of the chamber, and the tape recorder's volume output was adjusted to provide an average intensity of 70 db.

Prior to commencing the discrimination training itself, a six day habituation procedure was followed. For the first two days, the S was placed in the apparatus with the transparent slide raised and the opaque slide in the lowered position. Four full water bottles were placed on an incline outside the four doors of the apparatus so that the spouts protruded ½ in. through each door. The opaque slide rested on the spouts to keep them stationary. The S was permitted to drink for 15 minutes a day from any of the spouts. The following two days, S was placed in the apparatus with both slides in the lowered position, all the doors removed, and the water wells filled. A trial consisted of raising the opaque slide, waiting three seconds, and then raising the transparent slide. After S had gone to one of the doorways and drank, the opaque slide was lowered, and after S had moved behind the transparent slide, it was lowered. The water well was refilled and another trial given; S was given 20 trials a day for two days. The final two days S was placed in the apparatus with the slides lowered and the wells filled. The doors were attached, and on each door was a 1 sq. in. black square, centered on a 4 sq. in. white background. All doors were unlocked. A trial consisted of the same slide manipulation as in the second stage of habituation, and S was permitted one response of pushing open a door and drinking from the well. After a response, the opaque slide was lowered, the transparent slide was lowered, the well rebaited, and another trial given; S was given 20 trials a day for two days. None of the Ss exhibited any preference for any of the doors during habituation training. Thus, it was not necessary to artificially impose a balanced exposure to the four doors.

In discrimination training, S was placed in the apparatus with all slides lowered and the appropriate auditory stimulus being played. The test stimuli were a black triangle, 1 in. per side (correct) and three black circles, 1 in. in diameter (incorrect) centered on white backgrounds of 4 sq. in., one stimulus to a door. The correct stimulus door was always unlocked while the other three were locked; a table of random numbers was used to vary the position of the correct door. A trial consisted of raising the opaque slide, waiting three seconds, and then raising the transparent slide for the S to make a response. A response consisted on either pushing open the correct door and drinking, or touching the nose to one of the incorrect doors. Following a response, the opaque slide was lowered, the transparent slide was lowered, the doors switched, the water wells rebaited, and another trial given. Each S was given 20 trials a day for ten days. The doors were regularly wiped clean to prevent the accumulation of mucous deposits which might act as an olfactory cue, although previous experience with this apparatus indicated that rats show no tendency to respond to previously touched doors.

The Ss were tested in a random sequence each day during their dark cycle, from approximately 12 p.m. until 7:30 p.m. The Ss were tested in a different random order each day to avoid possible confounding of the data by time of testing as it can be seen that the testing period spanned a large portion of the diurnal activity cycle. Thus, the Ss were tested at an average of 23½ hr. water deprivation with a possible range of 17 to 31 hours. They were carried by the experimenter (E) to and from the testing room in their home cages. All Ss were given their daily ration of ½ hour of water immediately upon being returned to the colony room after testing. For each S, the number of correct responses, pushing open the door with the triangle, was recorded for each testing day. The E was present throughout the testing period and recorded responses on a data sheet.

CHAPTER III

RESULTS

For individual Ss for all treatment groups, the total number of correct responses for each testing day was recorded. The mean number of correct responses given on each testing day by each treatment group is presented in Table 1, p. 15. The number of correct responses shown by individuals on successive testing days was subjected to a 6 x 10 repeated measures analysis of variance. The results of this analysis are presented in Table 2, p. 16. It can be seen from Table 2 that there was a reliable effect for treatment groups ($F = 13.95$, $p < .01$). This result is taken to mean that there were reliable differences between the total number of correct responses given by the treatment groups over the ten testing days. The group total column in Table 1 shows that the M, AMR, and C groups had higher overall correct response scores than did the S, ASR, and WN groups. Table 2 also shows a reliable difference between the testing days ($F = 186.19$, $p < .01$). Therefore there were reliable differences in the total number of correct responses shown by the six treatment groups on different testing days. Inspection of the day total row in Table 1 indicates that the number of correct responses tended to increase as the testing days progressed. This result simply means that the animals gradually learned the discrimination problem as measured by the number of correct responses. A reliable treatment group

TABLE 1

Mean Correct Responses by Treatment Groups
by Testing Days

Group	Days 1	2	3	4	5	6	7	8	9	10	Group Total
M	4.6	5.2	6.6	5.6	8.4	8.8	10.8	14.2	16.4	17.4	98.0
AMR	5.4	5.2	6.2	5.8	8.2	8.8	11.6	15.6	17.4	17.8	102.0
C	6.8	4.8	4.8	5.8	8.2	8.4	11.4	13.6	15.6	16.6	96.0
S	4.8	4.6	5.4	5.4	4.2	6.6	7.8	10.0	10.0	10.4	69.2
ASR	5.2	3.8	3.4	3.0	3.6	5.2	7.0	8.4	9.8	11.0	60.4
WN	5.2	5.4	4.2	5.2	4.2	6.2	7.0	9.0	10.6	11.2	68.2
Day Total	32.0	29.0	30.6	30.8	36.8	44.0	55.6	70.8	79.8	84.4	

TABLE 2

Analysis of Variance of Number of Correct Responses by Treatment Groups by Testing Days

Source of Variation	SS	df	MS	F
Between Subjects				
Treatment Groups (G)	836.15	5	167.23	13.95*
Error between Ss	287.68	24	11.99	
Within Subjects				
Testing Days (D)	3543.16	9	393.68	186.19*
G x D	427.42	45	9.50	4.50*
Error within Ss	456.72	216	2.11	

* $p < .05$

by testing day interaction was also obtained as seen in Table 2 ($F = 4.49$, $p < .01$). This result is taken to indicate the presence of differences between the treatment groups in the rate at which responding improved over the testing days.

A diagram showing the mean number of correct responses of each treatment group on each testing day is presented in Figure 1, p. 18. From Figure 1, it can be seen that from the fifth day of testing onward the six treatment groups tended to form two sub-groups; the M, AMR, and C groups show a similar response pattern, and the S, ASR, and WN groups tend to exhibit a different response pattern. The data presented in Figure 1, p. 18, and Table 1, p. 15, suggest that the treatment group by testing day interaction may, in large part, be accounted for by this tendency of the six treatment groups to form two sub-groups with differing response patterns. To test this possibility, it was decided to perform a 3 x 10 repeated measures analysis of variance on the number of correct responses over testing days given by the M, AMR, and C groups, and a similar analysis of the scores of the S, ASR, and WN groups. The results of these two analyses are presented respectively in Table 3, p. 19, and Table 4, p. 20.

As can be seen in Table 3, a reliable effect for testing days was obtained ($F = 211.26$, $p < .01$). This result indicates a reliable overall change in the responding of the Ss over the ten testing days. It is noted in Table 3, however, that no

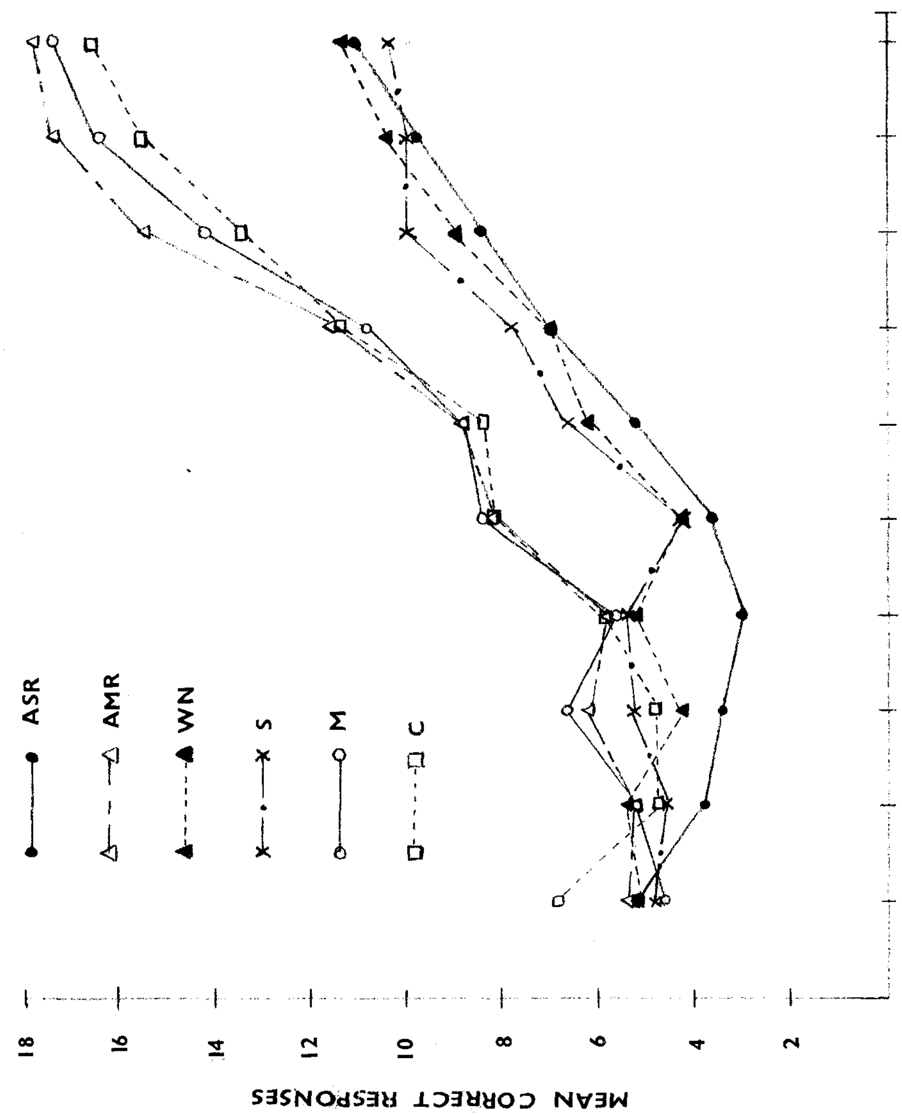


Fig. 1. Mean correct responses by treatment groups by testing days.

TABLE 3

Analysis of Variance of Number of Correct Responses of M, AMR, & C Groups by Testing Days

Source of Variation	SS	df	MS	F
Between Subjects				
Treatment Groups (G)	9.33	2	4.67	.58
Error between Ss	96.80	12	8.07	
Within Subjects				
Testing Days (D)	2996.53	9	332.95	211.26*
G x D	37.47	18	2.08	1.32
Error within Ss	170.20	108	1.58	

* $p < .05$

TABLE 4

Analysis of Variance of Number of Correct Responses of S, ASR, & WN Groups by Testing Days

Source of Variation	SS	df	MS	F
Between Subjects				
Treatment Groups (G)	23.21	2	11.61	.73
Error between Ss	190.88	12	15.91	
Within Subjects				
Testing Days (D)	906.46	9	100.72	103.09*
G x D	30.12	18	1.67	1.71
Error within Ss	105.52	108	.98	

* $p < .05$

reliable effect was observed either for the treatment groups factor or for the treatment group by testing day interaction. These results are taken to mean that the M, AMR, and C groups showed no overall differences in their total number of correct responses, nor did they differ in the rate of change of correct responding over the testing days. In other words, the M, AMR, and C groups performed indiscriminably throughout the experiment. An identical result was observed in the analysis of the scores for the S, ASR, and WN groups where again the testing days effect was reliable ($F = 103.09$, $p < .01$), but no differences between treatment groups and no treatment group by testing day interaction were obtained (see Table 4, p. 20). Taken together, the above results clearly support the earlier observation that the six treatment groups formed two streams of responding, each composed of three of the treatment groups and within which no between group differences were observed. The data in Table 1, p. 15, and Figure 1, p. 18, show that the M, AMR, and C groups acquired the discrimination response more quickly and maintained a performance increment over the S, ASR, and WN groups throughout the remainder of the experiment.

In order tommore clearly delineate this sub-group separation, it was decided to perform an analysis for simple effects on the treatment group factor on each of the ten testing days using a pooled error term taken from the analysis presented in Table 2 (sum of squares error between Ss plus the sum of squares error within Ss divided by the degrees of freedom error between Ss plus the degrees of freedom error within Ss). Where appropriate, these tests for simple effects were followed by an orthogonal comparison (Winer, 1962) which partitioned the total between treatment groups variation into two parts, i.e., that part attributable to the difference between the M, AMR, and C, and the S, ASR, and WN sub-groups, and that part attributable to differences within the sub-groups. The results of these analyses are presented in Table 5, p. 23.

It can be seen from Table 5, p. 23, that reliable differences between treatment groups occurred on testing days 3, 5, 6, 7, 8, 9, and 10. In each case, when this variation was partitioned in an orthogonal comparison, it was shown that the between sub-groups effect was reliable. In no case was a reliable within sub-groups effect observed. These results are taken to mean that on testing days 3, 5, 6, 7, 8, 9, and 10 the observed differences between treatment groups was largely attributable to the difference between the M, AMR, and C and the S, ASR, and WN sub-groups.

The results presented above and the data given in Figure 1, p. 18, confirm the view, taken earlier, that the six treatment groups in this study tended to form two sub-groups consisting of the M, AMR, and C and the S, ASR, and WN groups respectively. It can be seen that Ss which learned the discrimination response

TABLE 5

Analysis of Variance of Simple Effects for Treatment Groups, and Orthogonal Partitions, by Testing Day

Testing Day	Source of Variation	SS	df	MS	F
1	Treatment Groups	15.07	5	3.01	0.97
2	Treatment Groups	8.57	5	1.71	0.55
3	Treatment Groups	36.70	5	7.34	2.37*
	Between Sub-groups	17.63	1	17.63	5.69*
	Within Sub-groups	19.07	4	4.77	1.54
4	Treatment Groups	28.67	5	5.73	1.85
5	Treatment Groups	137.87	5	27.57	8.89*
	Between Sub-groups	136.53	1	136.53	44.04*
	Within Sub-groups	1.34	4	0.34	0.11
6	Treatment Groups	59.07	5	11.81	3.81*
	Between Sub-groups	53.33	1	53.33	17.20*
	Within Sub-groups	5.74	4	1.44	0.46
7	Treatment Groups	123.87	5	24.77	7.96*
	Between Sub-groups	120.00	1	120.00	38.71*
	Within Sub-groups	3.87	4	0.97	0.31
8	Treatment Groups	230.40	5	46.08	14.86*
	Between Sub-groups	213.33	1	213.33	68.81*
	Within Sub-groups	17.07	4	4.27	1.38
9	Treatment Groups	310.70	5	62.14	20.05*
	Between Sub-groups	300.83	1	300.83	97.04*
	Within Sub-groups	9.87	4	2.47	0.80
10	Treatment Groups	312.67	5	62.53	20.17*
	Between Sub-groups	301.20	1	301.20	97.16*
	Within Sub-groups	11.47	4	2.87	0.93
	Pooled Error	744.30	240	3.10	

* $p < .05$

in the presence of Mozart, amelodic Mozart rhythm, and quiet conditions exhibited superior performance relative to the Schoenberg, amelodic Schoenberg rhythm, and white noise animals.

To determine if all the Ss were approximately of equal weight and thus in a similar state of general health, a single factor analysis was performed on the weights of the Ss one day before testing began. The summary of this weight analysis is presented in Table 6, p. 25. It is seen that no weight differences were found between the Ss by treatment groups, thereby indicating that all Ss were of a similar weight before testing began ($F = .068$, $p > .01$). Finally, to compare the weight change of each S after testing, a single factor analysis was performed on the weight change of each S after testing was completed. The results of this weight change analysis are shown in Table 7, p. 26, and again no differences by treatment groups were observed ($F = .0003$, $p > .01$). Thus the Ss in the various treatment groups experienced no differential weight loss or gain throughout the experiment.

TABLE 6

Analysis of Variance of Initial Testing Weights of Treatment Groups

Source of Variation	SS	df	MS	F
Between Groups	1.43	1	1.43	.07
Within Groups	582.40	28	20.80	

$p > .05$

TABLE 7

Analysis of Variance of Pre-Test and Post-Test Weights by Individual Subjects

Source of Variation	SS	df	MS	F
Between Groups	.10	1	.10	.0003
Within Groups	14940.50	58	257.59	

p >.05

CHAPTER IV

DISCUSSION

The first hypothesis that music tends to facilitate the acquisition of a visual discrimination response was not supported by the results. If the presence of music had been a facilitative stimulus, the M and S groups would have been expected to show better performance on the task than the other groups, or at least the control and white noise subjects. However, neither the M nor the S animals demonstrated faster acquisition of the discrimination as measured by the number of correct responses. Instead, the M subjects performed quite similarly to the control subjects thus indicating that performance was not facilitated by the presence of the Mozart music (see Tables 1 and 3). Subjects experiencing the Schoenberg music responded in a similar manner to the subjects hearing the white noise (see Tables 1 and 4). Comparing this to the normal quiet condition, the Schoenberg music had somewhat of an inhibitory, or suppressing, effect on performance. Thus, no facilitation of performance by the music was observed, but a differential effect of the different music types was found such that the presence of Mozart's Symphony No. 41 did not affect the acquisition of a visual discrimination response while the presence of Schoenberg's Chamber Symphony No. 2 appeared to retard this behavior. It is evident that the make-up of the music is a vital factor in determining its effects on organisms.

Considering musical make-up leads into the second hypothesis that music with relatively more pronounced rhythmical qualities will produce relatively greater facilitation. If this hypothesis were true, the Mozart subjects should have shown a higher number of correct responses when compared to the Schoenberg animals. This hypothesis was verified as the M subjects performed at a reliably higher number of correct responses as compared to the S animals (see Table 1 and Figure 1). However, the M subjects performed almost identically to the AMR and C group subjects (see Table 3) thus indicating no facilitative quality. It is apparent that the M subjects did out-perform the S subjects, but if this had been because of a facilitative function, why would the AMR and C subjects' performance be almost identical to the performance of the M subjects? Observing the results in Table 4, p. 20, it is seen that the Schoenberg subjects also performed quite similarly to the ASR and WN subjects. In other words, the musical effects are apparently not on a continuum of facilitation, but rather they are on one of inhibition. This inhibitory continuum runs from no inhibition (M) to reliably inhibitory (S). This hypothesis thus presents a paradox in the fact that it is partly supported and refuted. In reality, the second hypothesis was only partially verified, as the M subjects did out-perform the S subjects, but not because of any facilitative quality possessed by the Mozart presentation. It must be noted, however, that only two points of measurement exist so that any mention of "relationship" between a certain music type and the inhibition of performance must be made quite cautiously.

The third hypothesis that the rhythmical component of any given musical stimulation is a vital contributor to the effect of the musical stimulus was supported. Thus, the AMR subjects were identical in performance to the M subjects, and the ASR animals had the same performance pattern as the S animals (see Tables 1, 3, and 4). Therefore, the rhythmic component of each composition produced the same effect on performance as its corresponding original piece.

In the present experiment, neither the presence of music nor its rhythmical component had a facilitative effect on the learning of a visual discrimination task. The results instead indicate that the rhythmical stimulation produced no change in performance when compared to the control or no stimulation (quiet) condition (see Table 3 and Figure 1). However, the non-rhythmical stimulation appeared to hinder performance, as did the white noise condition, when compared to the control condition (see Table 1 and Figure 1). Both of these suggestions need clarification.

Many experiments have suggested that the presence of music, if not facilitative to output, was at least enjoyed by the subjects. Kerr (1945), Moies (1952), Hough (1943), and Roberts (1959) all came to the above conclusion when music was presented in an industrial setting; they felt that the music reduced boredom and mistakes. Mechan (1955) has reported, in an industrial setting, that the rhythm of the music must be adapted to the type of work being done for improvement to occur. Perhaps the rhythmical presentations in the present study were not adapted to the task. The M and AMR presentations maintained a constant time, but perhaps this timing was too slow or too fast to be adapted to learning the discrimination. Cross, Halcomb, and Matter (1967) interpreted their results as the formation of a preference or attachment behavior to the Mozart music. They felt that this preference behavior could be attributed to some form of exposure learning since the rats had a long attachment with the Mozart presentations. However, there was no prolonged exposure to the M and AMR stimuli in the present study, so it appears that the rats simply adjusted to their presence. Thus, it is indicated that the rhythmical presentations did not alter the situation sufficiently as compared to the control or quiet condition to affect response acquisition. Perhaps Weigl's (1959) results with mentally retarded children cannot be attributed entirely to the rhythmical qualities of the music. Possibly the introduction of the music into the setting simply reduced boredom and the children found it pleasurable. Therefore the music really would not have any therapeutic quality. Since Weigl used only what was termed "lively" music, it is difficult to predict how the children would have responded to nonrhythmical music. In the case of the control animals in the present study, it is possible to say that the quiet condition also had its rhythmical components. Such things as heart rate, breathing, and the lifting and lowering of the slides could all be considered rhythmical in a sense, but these are still not as obvious as the auditory presentation of the musical compositions. In summary, the present study indicates that the rhythmical aspects of music do not facilitate performance.

The nonrhythmical and white noise animals presented a completely different performance pattern from that of the rhythmic and quiet subjects. If the quiet condition can be considered a normal response situation, then the nonrhythmic and white noise conditions appeared to suppress performance on learning the discrimination. In other words, the S, ASR, and WN stimulations appeared to inhibit the learning of the discrimination task. Again using Mechan's viewpoint (1955) that the presented rhythm must be adapted to the task at hand, it can be said that perhaps the lack of any standard rhythm in these presentations led to an inhibitory effect. It could therefore be indicated that the nonrhythmical and white noise presentations were somewhat aversive. To make this statement, it is necessary to ascertain if white noise is truly aversive. Barnes and Kish (1957) found that mice would spend the majority of their time on or off a platform if it controlled the onset or termination, respectively, of white noise. From their results, it appears that white noise can act as an aversive agent, and that a mouse will learn how to avoid it. Many other experimenters have also used and regarded white noise as aversive; some are: Gray (1965), Broadhurst (1957), Doyle and Pratt-Yule (1959), and Harrington and Hanlon (1966). Therefore in the present study, the S and ASR stimulation, because of its similarity in performance to the WN condition (see Figure 1 and Table 4), might imply it to be somewhat aversive.

Cross, Halcomb, and Matter (1967) interpreted their results in the sense that the Schoenberg music was perhaps too complex for attachment behavior (recognizing) to occur. Because the Schoenberg music was considered nonrhythmical, perhaps it lacked the necessary redundancy for the rat to be capable of recognizing it. The authors state that attachment behavior may require some level of stimulus complexity appropriate to the experiential and/or developmental level of the organism. Perhaps in the present study therefore, the nonrhythmical stimulation may have been too complex for the rat, and it is possible that this complexity may account for any aversive quality that the stimulation may present. Very complex musical selections containing rhythm should be presented to rats in a similar situation to observe if the presence of rhythm would counteract the complexity.

It could be said that the nonrhythmical situations contained distracting elements, a term somewhat similar to what Broadbent

(1957) would call "competing responses." That is, stimuli compete for the subject's attention by eliciting responses in competition with the task response. Broadbent would interpret the nonrhythmical stimulation used in the present study as "noise", and would predict a disrupting effect. The task response was pushing open the correct door, but if the nonrhythmical stimulation did produce competing responses then the total number of correct responses would be expected to decrease. In general, the animals experiencing the S, ASR, and WN conditions were slower to respond than those animals experiencing either the M, AMR, or C conditions. This perhaps could imply that there was competition for the subject's attention, but a more detailed study along these lines would help clarify this idea. In this sense, the distraction studies by Fendrick (1937); Henderson, Crews, and Barlow (1945); and Freebourne and Fleischer (1952) may have been pointed in the right direction in assuming that the presence of music is in itself a distracting agent. However, a much more sophisticated methodology is needed before these designs can be put to full use. If this competition of responses was present in the present study, then perhaps this would explain the interference with performance as compared to the rhythmical situations. The redundancy in the rhythmical selections may be the key to the lack of competing responses in those situations, as the stimulation was presented over and over and therefore the competing responses may perhaps extinguish earlier in the experiment. Nonrhythmic stimulation may continue to elicit the competing responses because the rat could not continually recognize the situation, i.e., it was constantly changing.

Perhaps the most obvious finding in the present study is the need for further experimentation. The areas of complexity and redundancy must especially be investigated as they appear to be two of the most important factors in considering the results of the present study. In complexity of experiments, musical stimulation should be presented that ranges from very simple make-up to a highly complex composition. These differing musical complexities could be presented in a learning situation comparable to the one used in the present study, and any changes in the speed of performance could be used as the measure of the effect of the music's complexity. Using these differing complexities could help answer the question raised in the present study concerning the fact that the complexity found in the Schoenberg music may perhaps have been a cause for its lower performance. Experiments on redundancy should also be done in order to help clarify the effect of redundancy found in the present study. Musical stimulation should be presented to the subjects in a learning situation, and it should consist of that music that is highly redundant on down to that music containing little if any redundancy. In this way, a continuum of redundancy effects could be obtained in a learning situation, and their effects could be judged in a more conclusive manner. In both of these suggested experiments, the subjects would not be introduced to their musical condition until they were placed in the learning situation, and the effects of the complexity and/or redundancy could then be measured on the subject's performance on the learning task. Perhaps with further information in these areas, the questions raised in the present experiment could be explained in more complete and informative detail.

CHAPTER V

SUMMARY AND CONCLUSIONS

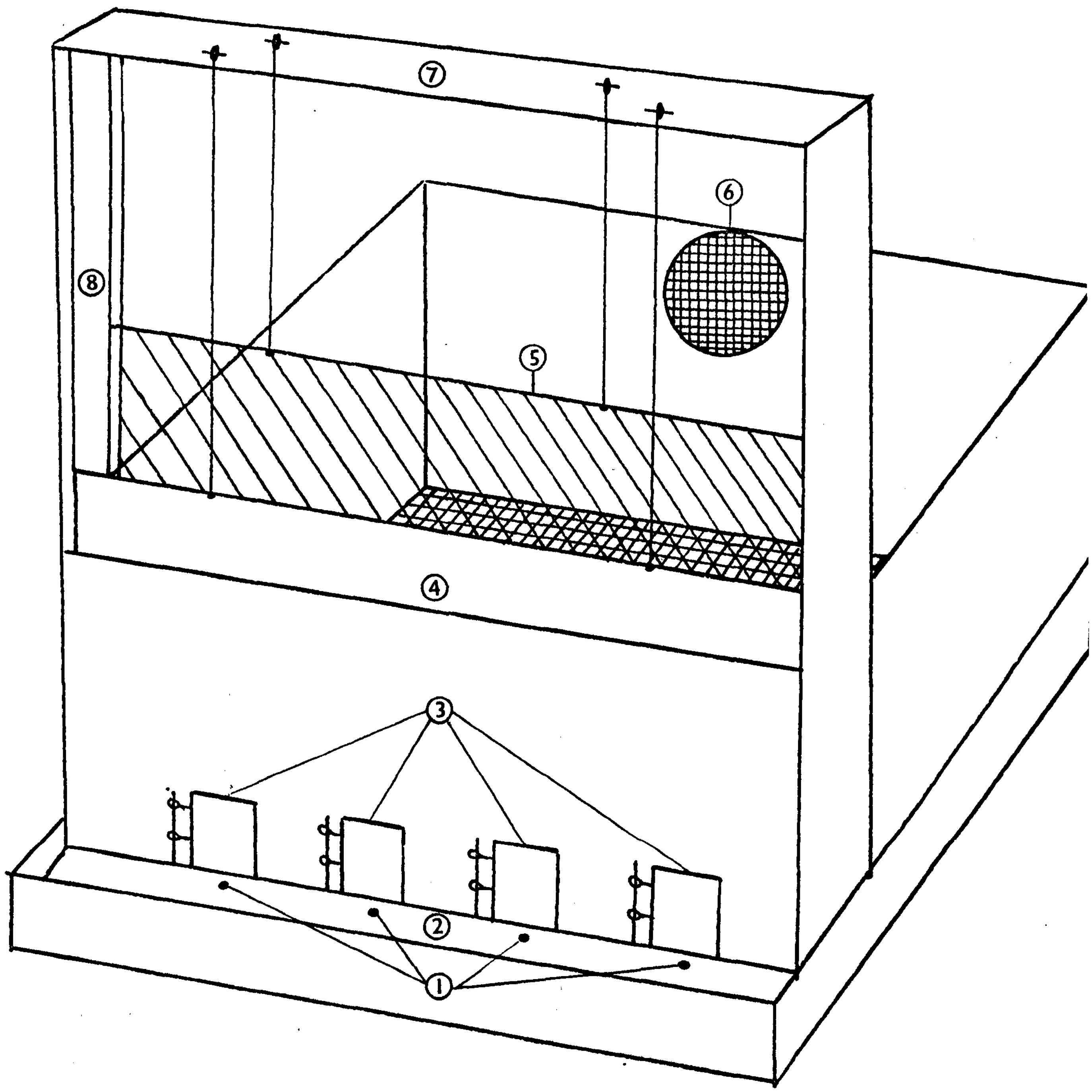
This study was an investigation of the effect of music, and more specifically, rhythm, upon the acquisition of a visual discrimination response. Groups of adult male rats learned a visual discrimination response while exposed to one of the following auditory stimuli: Mozart's Symphony No. 41 (M), an amelodic rhythmical composition based on this symphony (AMR), Schoenberg's Chamber Symphony No. 2 (S), an amelodic rhythmical composition based on this symphony (ASR), white noise (WN), and quiet or control (C). The M and AMR groups were classified as rhythmical, while the S and ASR groups were termed nonrhythmical. When the subject was placed into the apparatus, the appropriate stimulation was being played into the apparatus by means of a tape recorder. The Ss had to learn to discriminate a triangle from three circles randomly positioned on the doors of the apparatus. Pushing open the door with the triangle resulted in a reward of two drops of water found in a well outside the door. Twenty trials a day were given for ten consecutive days.

Three hypotheses were tested: (1) The presence of music tends to facilitate the acquisition of a visual discrimination response, (2) Greater facilitation will be produced by music with more pronounced rhythmical qualities, and (3) The rhythmical component is a vital contributor to the effect of the musical stimulus. Analyses of the data indicated that music did not increase performance on the discrimination task, thus failing to verify the first hypothesis. The rhythmical subjects (M and AMR) did not perform any higher than the control or quiet subjects. However, the nonrhythmical animals (S and ASR) showed a reliably lower number of correct responses than did the rhythmical, and the pattern of responding was quite similar to that produced by the WN subjects. The second hypothesis was thus partly verified in the fact that the M subjects did outperform the S subjects, but it was also partly disproved because this increased performance was not attributed to facilitation. The third hypothesis was fully supported in that the subjects exposed to the amelodic compositions performed as well as the subjects exposed to the originals.

Therefore, it appears that while rhythmical presentations do not affect a discrimination learning task, the presence of nonrhythmical stimulation may inhibit performance. One feature which appeared quite readily from the results was the formation of two sub-groups composed of three conditions each, i.e., the M, AMR, and C groups formed one common stream of responding, while the S, ASR, and WN groups formed another response pattern. The results were discussed in terms of redundancy and complexity of the stimuli. It appears that the Schoenberg compositions may have been too complex for the subjects to recognize, and therefore the performance of these animals was limited. The complexity did not allow for relaxation in the situation, and thus may have competed with the response pattern. However, the Mozart compositions were quite redundant, and thus the subject's could more easily recognize them and respond better in the situation. Further experimentation along the lines of complexity and redundancy was suggested.

APPENDIX A

Discrimination Learning Apparatus
(Legend on following page)



Discrimination Learning Apparatus
Legend

1. Water Wells
2. Plexiglas Strip
3. Discrimination Doors
4. Opaque Slide
5. Plexiglas Slide
6. Speaker
7. Overhead Bar with Pullys
8. Grooved Slide

APPENDIX B

Number of Correct Responses by Subject by Treatment Groups by Testing Days

Group	Subject	Days 1	2	3	4	5	6	7	8	9	10
	12	3	5	6	4	7	7	11	15	18	18
	15	7	5	5	6	10	11	11	15	17	17
M	32	2	5	7	8	9	10	11	13	15	16
	100	6	5	7	6	8	7	9	12	14	16
	106	5	6	8	4	8	9	12	16	18	20
	1	6	4	8	4	10	9	11	14	16	16
	4	6	6	6	9	10	8	12	15	17	17
AMR	19	5	4	5	4	11	13	14	19	20	20
	20	6	5	4	5	4	7	10	13	16	17
	37	4	7	8	7	6	7	11	17	18	19
	3	5	3	3	2	9	8	10	12	15	16
	5	6	4	5	4	6	6	11	14	16	18
C	25	8	8	7	8	7	8	12	13	16	17
	101	6	4	5	7	9	10	12	14	15	16
	103	9	5	4	8	10	10	12	15	16	16
	21	4	5	5	5	5	7	9	11	11	11
	27	7	6	7	6	5	7	6	9	7	8
S	33	4	2	5	4	4	5	7	8	10	12
	40	7	6	6	7	3	7	8	10	11	10
	105	2	4	4	5	4	7	9	12	11	11

APPENDIX B
(cont.)

Group	Subject	Days 1	2	3	4	5	6	7	8	9	10
	2	8	2	2	1	2	4	5	7	8	8
	7	6	7	5	4	5	4	6	7	10	12
ASR	9	3	5	3	3	4	7	9	10	12	13
	10	5	4	4	5	4	5	7	9	9	11
	36	4	1	3	2	3	6	8	9	10	11
	8	6	6	3	5	4	7	6	8	10	11
	23	4	2	0	2	0	3	5	7	9	9
WN	31	6	10	8	9	6	10	9	10	12	14
	38	6	4	5	4	7	6	9	12	12	11
	102	4	5	5	6	4	5	6	8	10	11

APPENDIX C

Pre-Test and Post-Test Weights of Individual Subjects

Subject	Pre-Test	Post-Test
1	225	223
2	210	213
3	245	241
4	190	193
5	190	190
36	225	227
7	190	186
8	210	212
9	205	205
10	195	198
101	205	204
12	225	220
103	215	217
40	215	214
15	220	221
106	190	198
37	215	213
38	230	225
19	195	195
20	215	214
21	215	215
32	195	195
23	220	220
102	200	210
25	225	214
31	195	195
27	240	244
33	185	183
105	215	215
100	240	238

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