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AN INVESTIGATION OF THE EFFECT OF INITIAL
ELECTRICAL STIMULUS UPON REACTION
AND MOVEMENT TIME

Thesis for the Degree of M. A.
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Lawrence R. Daniels
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AN INVESTIGATION OF THE EFFECT OF INITIAL
ELECTRICAL STIMULUS UPON REACTION
AND MOVEMENT TIME

by

Lawrence R. Daniels

A THESIS

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L.R.D.

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AN ABSTRACT

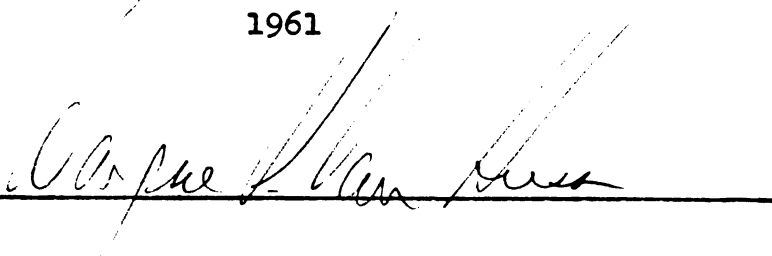
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Approved

A handwritten signature in dark ink, appearing to read "Clayton R. Van Dusen", is written over a horizontal line.

ABSTRACT

Statement of the Problem. To determine the effect of low grade initial electric shock administered as the initial stimulus and continued through the completion of movement upon reaction and movement time.

Methodology. Sixteen students from Williamston High School ranging in age from eleven to fourteen served as subjects. They were divided into two groups A and C. Group A was then designated as an experimental group. Group A received an electrical and auditory stimulus simultaneously while group C was maintained as a control group and received only the auditory stimulus.

Subjects were given twenty-five trials two times weekly over a three month period. For the first fifteen trials the subjects (Group A) were stimulated by a thirty volt electrical shock and by a auditory stimulus (buzzer). These trials were designated as preliminary trials. During trials sixteen through twenty the subjects (designated as group B) responded only to auditory stimulus. During trials twenty-one through twenty-five the subjects (designated group A) were stimulated by a simultaneous thirty volt initial electrical shock and the buzzer. These trials were averaged weekly.

Group C weekly average was determined from trials fifteen through twenty-five.

To study retention the subjects were given a two week break then were retested with only the auditory stimulus (buzzer).

Reaction and movement time was measured by two electrical chronoscopes calibrated in milliseconds.

All of the data were statistically analyzed using the analysis of variance technique.

Conclusions.

1. Reaction Time: Training with a low voltage initial electrical stimulus decreases the time necessary for the subject to react.
2. Movement Time: Training with a low voltage initial electrical stimulus continued though the movement does not alter movement time significantly.
3. Total Time (reaction and movement time): Differs significantly when a group trained on low grade electric shock is tested with and without shock. This is attributed to a cumulative effect of the two variables.
4. Retention Time: During two weeks of inactivity reaction, movement and total times do not shift significantly.

CHAPTER I

INTRODUCTION

Experiments concerning the study of reaction and movement time, using various kinds of stimuli, have been carried on for more than one hundred years. However, much of this experimentation has used varying types of stimuli only as a matter of greatest conveniences, for the purpose of cross-checking, or to study reenforcement and motivation.

Henry's¹ recent studies concerning reaction time have established that low voltage shock when administered as a secondary stimulus can decrease the time necessary for the subject to react.

The hypothesis of this study is that training with an initial electrical stimulus produces a faster reaction time than training with an initial auditory stimulus and that such differences are retained for several weeks after cessation of training. The effect of initial electrical stimulus as related to movement time will be considered.

¹ Franklin M. Henry, "Increase in Speed of Movement by Motivation and by Transfer of Motivated Improvement", Research Quarterly, 22:219-228 (May 1951)

Statement of the Problem

This study was conducted to determine the effect of a low grade electric shock administered as the initial stimulus and continued through the completion of movement upon reaction and movement time in boys eleven to fourteen years of age.

Importance of the Study

Henry's² evidence has indicated that electrical shock administered as a secondary stimulus can cause definite improvement in reaction timing. Independent confirmation of this study is needed because of the importance of these findings. Further, study is needed to determine the effect of the same type of electrical shock administered as initial stimulus.

If reaction and movement times can be improved by such training, and the improvement retained, it means that there must be some change brought about in the nerve pathways. The implications to sports and other activities involving rapid reaction and movement are many.

Definition of Terms Used

Reaction Time. For the purpose of this study

²Ibid.

reaction time is defined as that measured interval of time between the onset of the stimulus and the beginning of the action required for movement time. This was calibrated at 1/100 of a second.

Movement Time. Movement time is that time required to move the right hand sixteen inches from the release key directly forward breaking the beam of an electric eye. This was calibrated at 1/1000 of a second.

Electrical Shock. Electrical shock is a thirty volt shock administered to the subject's left arm through electrodes fastened to the arm by means of a perforated rubber band.

Buzzer. The buzzer is an auditory sound of undetermined intensity given by a battery device.

Initial Stimulus for Groups B and C. Initial stimulus for Groups B and C consisted of the buzzer of undetermined auditory intensity.

Initial Stimulus for Group A. Initial stimulus for Group A consisted of the thirty volt electrical shock.

Mean Frequency. Mean frequency for group B is determined by the sum of the trials sixteen through twenty divided by five. Mean frequency for group A was determined by the sum of the trials twenty-one through twenty-five divided by five. Mean frequency for group C was determined by the sum of trials fifteen through twenty-five divided by ten. Individual frequencies were

totalled weekly to determine group mean frequency.

Limitations of the study

In testing reaction and movement time in this study only the right hand was used in a forward motion. A thirty volt electrical charge only as compared with an auditory sound of undetermined intensity was used as the means of stimulus. Retesting to determine retention was conducted only once after a lapse of two weeks.

CHAPTER II

REVIEW OF THE LITERATURE

A study of reaction time was first undertaken by astronomers (as early as 1822) for the purpose of determining individual differences in recording times of stellar transits. A short time later (1850) with the publication by Helmholtz³ of the first simple reaction time measurements, physiologists became interested in reaction time as a measurement of the speed of nerve conduction.

This interest spread to psychologists and resulted in experimentation such as that reported by Wundt in his *Grundzerge der Physiologischen Psychologie* and further led to additional studies such as those by Donders and deJaagers on discrimination and choice⁴.

At successive stages during this early period major interest centered around, (1) time relationships and their variations with quality, intensity, and complexity of stimuli (1865-1888), (2) the effect of the direction of attention upon reaction times (1888-1905), (3) the introspective analysis of the reaction (1905-1912). Present day interest in reaction time seems not to be limited to any particular field, but ranges widely over all aspects of the problem.

³Helmholtz, (original reference not given) as cited in V. A. C. Henmon, "Professor Cattell's Work on Reaction Time," Archives of Psychology, 4 (1913-1915), p. 1

⁴Ibid., pp. 1-3.

In 1865-68 after experimentations of their own and study of the experimentation of their peers Donders and de Jaager⁵ pointing out the difficulties involved in the measurement of reaction time, stated that the reaction method is essentially modified by the kind of stimulus employed, as well as by the mode of reaction and degree of attention. Thus the original purpose of their experiments dealing with the speed of nervous conduction as measured by the reaction was proved too variable to be valid. It is significant to note that in later experiments these two men used two different stimuli for the purpose of the study of discrimination and choice in order to isolate and measure by the reaction method the time of complex mental processes. Two methods were used to isolate the processes. In Donders B method two stimuli were employed and reaction was made with the right hand if one stimulus appeared and with the left hand if the other appeared. In Donders C method two stimuli were presented and reaction was made if one of the two appeared and no reaction if the other appeared. A method consisted of simple reaction. Donders believed that the C method added to simple reaction (A method) the process of discrimination and he concluded that time of discrimination could be determined by simple subtraction while in B method there was involved discrimination and choice and that time

⁵Ibid.

of choice could be determined by subtracting the time by the C method from that by the B method.⁶ There are, however, no published studies indicating that they carried on any study directed to the discovery of the degree of difference which the various kinds of stimuli caused in reaction time.

The early numbers of the Philosophische Studien are largely given over to reports of experiments on the relationship of the stimulus to sensation and to reaction time measurements, however, the stimulus in these studies was considered only as a means of control and isolation in determining the factors involved in reaction.

Hall and Kries⁷ (1879) in their studies of stimulus centered on the response effected by the place of stimulus but it seemed not to consider the same effects as influenced by the various kinds of stimuli to further analyze their data in relation to type of stimulation.

Cattell, one of the first experimenters to reduce the sources of error involved in earlier experiments due to control and mode of stimulation as well as lack of regard for non typical systems, is important to this study because of his regard for the influence of the quality and intensity of the stimuli as well as for his systematic approach, somewhat lacking in earlier experiments. His observations along with Kries, Aurebach, Rene and Buccola

⁶Ibid., p. 3.

⁷Ibid.

of choice could be determined by subtracting the time by the C method from that by the B method.⁶ There are, however, no published studies indicating that they carried on any study directed to the discovery of the degree of difference which the various kinds of stimuli caused in reaction time.

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⁶Ibid., p. 3.

⁷Ibid.

stated that reaction time to electrical stimuli became shorter with increasing intensity but these observations were incidental as were the variations reported in the intensity of auditory stimuli by Exner and in visual stimuli by Wundt.⁸

Berger and Cattell made limited further experiments with visual, auditory, and electrical stimuli using eight intensities of visual stimulation, four of auditory stimulation and four intensities of electrical stimulation. The limited results showed that the greater intensity of each individual stimulus caused shorter reaction time. However, no comparison seems to have been made between the stimuli themselves as individual units affecting reaction time. Cattell's further studies with Dolly (1893) used both electrical and tactile stimulus to determine the effect of intensity. They again concluded that the reaction time to electrical and tactile stimulation decreases with increasing intensity. Still, as in previous studies conducted by these men and others no specific comparisons of the two kinds of stimuli are indicated.⁹

G. R. Wells¹⁰ was one of the first to investigate the influence of duration of visual and auditory stimuli on the time required for simple reactions. His auditory

⁸ Ibid., p. 12.

⁹ Ibid., p. 26.

¹⁰ G. R. Wells, "The Influence of Stimulus Duration on Reaction Time," Psychological Monographs, 15 (1913, p. 69.

stimulus was supplied by the sound of an electric buzzer to which two subjects gave response under five compared durations. These trials completed, he experimented with a visual stimulus, that of a plaster surface with the brightness of 0.41 candles per square meter. Testing six subjects at five hundred different times with ten degrees of the stimuli he concluded that the degree or intensity of stimuli does have an effect upon the subject. While he used neither electrical shock nor measured the results of the two stimuli against each other he is important as one of the first to study intensity, which is in effect a different kind of stimuli as the degree is changed, and because his work led others to investigate this problem of degree and intensity.

Eight years later Wells, with Kelley and Murphey¹¹ became interested in the relation between the intensity of the stimulus and the ratio of the reaction time to light with respect to the reaction time to sound. In experimentation the intensities of the visual and auditory stimuli were not measured, but study concentrated on checking the ratio-relationship between two stimuli, light and sound. These joint experiments concluded that the relation between reaction time to sound and light is dependent upon the magnitude of the stimuli.

¹¹G. R. Well, C. M. Kelley, and G. Murphey,
"Comparative Simple Reactions to Light and Sound,"
Journal of Experimental Psychology, 4 (1921), pp. 57-62.

The method of experimentation involved the use of thirteen subjects, using Klopsteg's method of timing and allowing an interval separating the warning signal from the stimulus 1.2 seconds in half of the cases and increasing the interval to about 3.1 seconds in the other half of the cases.

The ratio between the median reaction time to light and the median for sound were, (1) eleven untrained observers 1.15 seconds, (2) subject K 1.34 seconds, and (3) subject W 1.45 seconds. The correlation between the ratios and the median reaction time to sound in the untrained group was found to be 0.52 seconds. Those with a quicker reaction to sound tended toward a relatively slower reaction to light.

Woodrow¹² compared variation in the preparatory interval and changes in the intensity of stimuli as second order differences in simple reactions to light, sound and touch of "moderate" but unmeasured intensities. He found that the average effect was about eleven percent greater for sound than for touch and about eleven percent greater for light than for sound. He concluded however, that the differences lay not in the various kinds of stimuli but rather in the degree of attention given by the subjects to the mode of stimuli.

¹²H. Woodrow, "The Measurements of Attention", Psychological Bulletin, 20 (1923), p. 565

In 1923 a study of the works of these men and of others led Johnson to the hypotheses that "the speed of reaction depends first on the adequacy of the stimulus as to intensity, area, duration to excite the sensory receptors".¹³

Lanier¹⁴ in his studies of the interrelations of speed in various activities used three kinds of stimulus in his first experiment to measure simple reaction time and in his conclusions points out that there may be a varying effect on nerve impulses from the higher motor centers by variations in the source and nature of the stimulus, but the author knows of no reported further studies carried on by him to answer the question posed by this experiment.

With the work of Henry interest in experimentation concerning reaction times expanded to the consideration of improvement in reaction time effected by motivation.

Henry¹⁵ in early experimentation studying motivation used an apparatus which measured simple reaction

¹³H. M. Johnson, "Reaction Time Measurements", Psychological Bulletin, 20 (1923), p. 565.

¹⁴Lyle H. Lanier, "The Interrelation of Speed of Reaction Measurements", Journal of Experimental Psychology, 17 (April, 1954), pp. 371-399.

¹⁵Franklin M. Henry, "Increase in Speed of Movement by Motivation and by Transfer of Motivated Improvement", Research Quarterly, 22 (May 1951), pp. 219-228.

time (finger press), speed of coordinated movement (snatching a ball), and speed for a less complicated movement (treadle press). An adjustable electronic delay circuit provided for administering a mild electric shock for slow responses, after the initial visual stimuli were used.

Henry concluded as a result of these experiments that regardless of the explanation adopted motivation due to administering electric shock during the period of a reaction or movement that is slower than that of an individual's own average reaction has a significant facilitating influence in speeding up the reaction or movement.

In a later experiment concerned with two problems the relationship of reaction time and speed of movement in individuals and the role of sensory stimuli that function to improve speed during the slower half of his responses to a reaction signal, Henry¹⁶ used sixty college men as subjects dividing them into groups of ten. One group was used as a control; the others were motivated by dim or bright light, electric shock plus bright light, or sound. Henry found that all groups improved in reaction time and most of them in movement time by whatever stimulus received.

¹⁶Franklin Henry, "Independence of Reaction and Movement Times and Equivalence of Sensory Motivators of Faster Response", Research Quarterly, 23 (1952), pp. 43-53.

Significant to this study he does state that the effects of light plus shock were of questionable significance but on analyzing the data as a whole feels that it fails to yield any evidence of a differential effect as between the various motivating stimuli.

Carrying the study of motivation further Hipple¹⁷ studied sixty boys in equal numbers of white and negro race using experimental and control groups to determine if racial differences were present with respect to the motivating agent, and concluded that the white significantly increased their speed of response and their muscle tension while the improvement was not significant enough to be obvious in the negro subjects.

¹⁷Joseph E. Hipple, "Racial Differences in the Influence of Motivation on Muscular Tension, Reaction Time and Speed of Movement", Research Quarterly, 25 (1954), pp.297-305.

CHAPTER III

METHODOLOGY

For the purpose of this study which was conducted to determine the effect of low grade shock administered as the initial stimulus and continued through the completion of movement upon reaction and movement time sixteen male students were used as the subjects in this study. Subjects ages ranged from eleven years old to fourteen years of age, the subjects were from the Williamston High School, Williamston, Michigan.

Tests were administered to these subjects over a three month period, beginning in February and ending in early May of 1960. Subjects were tested twice a week generally on Mondays and Tuesdays between the hours of 12:30 and 2:30 P. M.

These sixteen students were chosen from a group of thirty-five. The original thirty-five were all given a simple auditory reaction and movement test consisting of twenty-five trials with the mean score taken from the last ten trials. Those students having the lowest reaction time scores were chosen as subjects. The range in reaction time varied from 224 milliseconds to 457 milliseconds. Movement Time varied from 91 milliseconds to 304 milliseconds.

The final sixteen were next divided into two groups A and C. Group A received electrical and auditory stimulus, while Group C was maintained as a control group and received only auditory stimulus.

The subjects were separated into groups on the basis of their reaction scores. Subjects, 1, 4, 5, 8, 9, 12, 13, and 16 in reaction time measurement were designated to group A while subjects ranking 2, 3, 6, 7, 10, 14, and 15 comprised group C. For all intents and purposes the subjects were matched pairs.

Group A subjects were given twenty-five trials two times weekly for seven weeks over a period of three months. For the first fifteen trials the subjects was stimulated by a thirty volt electrical charge and by an auditory stimulus (buzzer). These trials were designated as preliminary trials. During trials sixteen through twenty the subjects (then designated Group B) responded only to auditory stimulus. These trials were averaged weekly. During trials twenty-one through twenty-five the subjects (designated Group A) were stimulated by a simultaneous thirty volt electrical charge and a buzzer. These five trials were averaged weekly.

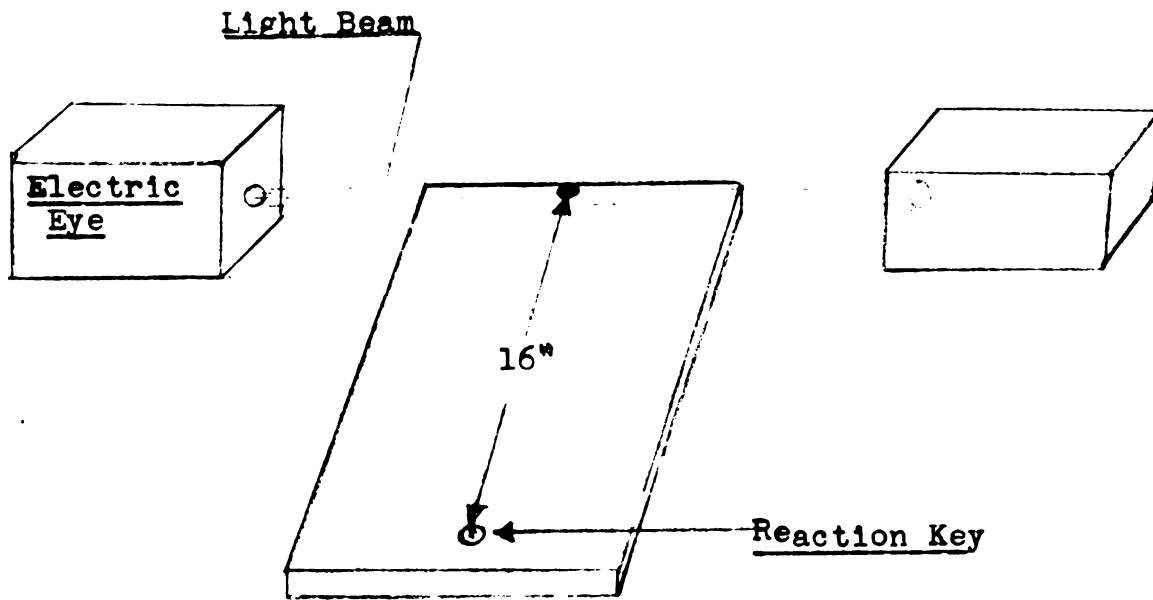


Figure 1 The Apparatus

Group C was given twenty-five trials two times weekly for seven weeks over a period of three months. These subjects were stimulated with the auditory stimulus (buzzer). The first fifteen trials were designated as preliminary trials. The weekly average was determined from the trials sixteen to twenty-five.

As a study of retention after the three month period was completed and immediately following the subjects seventh week both groups A, B and C were given a test consisting of twenty-five trials stimulated only by the auditory stimulus (buzzer) with the average taken from test fifteen to twenty for Group B and for Froup A tests twenty-one to twenty-five. Group C was averaged from trials fifteen to twenty-five.

Again on the tenth week groups A, B and C were given a test consisting of twenty-five trials stimulated only by the auditory stimulus (buzzer) with the average taken from test fifteen to twenty for group B and for group A tests twenty-one to twenty-five. Group C was averaged from trials fifteen to twenty-five.

Test Environment. All test were administered in a room 10' X 10'. The testing apparatus was set upon a wooden table. The subject to be tested stood at the table facing the apparatus at all times, with his back to the operator. There was little outside distraction. The room was generally warm and humid.

Test Apparatus. The apparatus consisted of a stimulus unit, a response unit, and a recording unit.

Both the auditory (buzzer) and the electrical (30 volt shock) stimuli were supplied by the control box.

A reaction key and an electrical eye placed sixteen inches apart, mounted on a twenty by five inch board, comprised the response unit. See figure 1.

The recording unit consisted of two chronoscopes. Chronoscope A was graduated in 0.01 seconds and chronoscope B was graduated in 0.001 seconds. Henry¹⁸ has

¹⁸Franklin Henry, "Independence of Reaction and Movement Times and Equivalence of Sensory Motivators of Faster Response", Research Quarterly, 23 (1952), pp. 43-53.

demonstrated that chronoscope with an accuracy of 0.01 seconds is adequate for reaction and movement time measure.

The apparatus functioned as follows: Approximately two seconds after the preparatory signal of a bell was given to the subject to be tested the stimulus regulating switch was thrown by the operator. This caused chronoscope A to begin recording simultaneously with the advent of the release of the auditory or electrical stimulus. When the subject released the reaction time key (which he had depressed at the sound of the bell) chronoscope A made the final recording and chronoscope B started recording movement time until the subject passed his hand through the beam of the electric eye, causing the final recording by chronoscope B. The reaction time for each trial was read from chronoscope A and the movement time for the same trial was read from the chronoscope B.

Testing Procedures. The subject was standing before the apparatus situated on a table, and was instructed to place his middle finger of the right hand (only right handed subjects were considered for this testing) upon the reaction key. He was instructed to depress the reaction key as far as possible at the sound of the bell.

If the stimulus was to be electrical the thirty volt charge was supplied through two electrodes attached

to a perforated rubber band one inch wide which encircled the left arm, allowing the electrodes to touch the skin on the back and inside of the arm.

When he received the auditory or electrical stimulus the subject responded by releasing the reaction key and moved his right hand forward through the electric eye. He was instructed to react and move as quickly as possible.

CHAPTER IV

RESULTS

ANALYSIS OF DATA

This study was designed to determine the effect of an initial low grade electrical stimulus upon reaction time. The effect of this stimulus as related to movement time was considered.

Sixteen male junior high school students ranging in age from eleven to fourteen years of age were used as subjects for the study. These were divided into two groups, A and C. Group A simultaneously received a thirty volt electrical stimulus and an auditory stimulus supplied by a buzzer. Group C served as a control group and received only the auditory stimulus of the buzzer. The same buzzer was used throughout the experiment.

Group A subjects were given twenty-five trials two times weekly for seven weeks. For the first fifteen trials the subjects were simultaneously administered the initial stimuli consisting of the electrical charge and the buzzer. These trials were used for training and as preliminary trials prior to measurement. During trials sixteen through twenty the subjects (then designated group B) were administered the initial auditory stimulus only. These trials were averaged weekly and plotted accordingly. (See Figure II.

Reaction Time). During trials twenty-one through twenty-five the subjects (designated group A) were initially stimulated by the electrical charge and the buzzer. These trials were averaged and plotted.

Upon receiving the initial stimulus the subjects of groups A, B and C were required to release the reaction key as fast as possible and move the right hand through the electric eye which was located sixteen inches directly forward. (See Figure 1) Both reaction time and movement time were recorded by chronoscopes. The weekly mean scores for groups A, B and C were used in the statistical analysis.¹⁹

PLAN OF ANALYSIS

The analysis will be divided into three parts; Reaction Time, Movement Time and Total Times. Under each of these heading groups A vs B and groups A vs C are presented with the analysis of variance results and appropriate graphs. To determine if the training effect was retained during the two week lay off between the eighth and tenth week the "t" test was used.

Reaction Time.

Results of the statistical analysis between A vs C (See Figure II, Table I) shows the groups differed significantly

¹⁹Cyril H. Goulden, Methods of Statistical Analysis, (New York, John Wiley and Sons, Inc.), pp. 63-101. (1956).

TABLE I

ANALYSIS OF VARIANCE: REACTION TIME

Experimental (A) vs Control (C) Groups

Source of Variance	D. F.	Sum of Squares	E. M. S.	F
Total	111	765.09	- - - -	- - -
Group	1	299.91	299.91	138.21**
Weeks	6	41.68	6.95	3.20**
Individuals	14	231.30	16.52	7.61**
Weeks X Groups	6	10.06	1.68	.77
Error	84	182.14	2.14	- - -

Experimental (A- Electric) vs Experimental (B-Non-Electric) Groups

Total	111	8,412.85	- - - -	- - -
Groups	1	152.29	152.29	.81
Weeks	6	42.16	7.03	.037
Individuals	7	212.20	30.31	.161
Weeks X Groups	6	10.20	1.70	.009
Group X Individuals	7	9.90	1.41	.007
Weeks X Individuals	42	108.29	2.58	.013
Error (G X W X I)	42	7,877.81	187.57	- - -

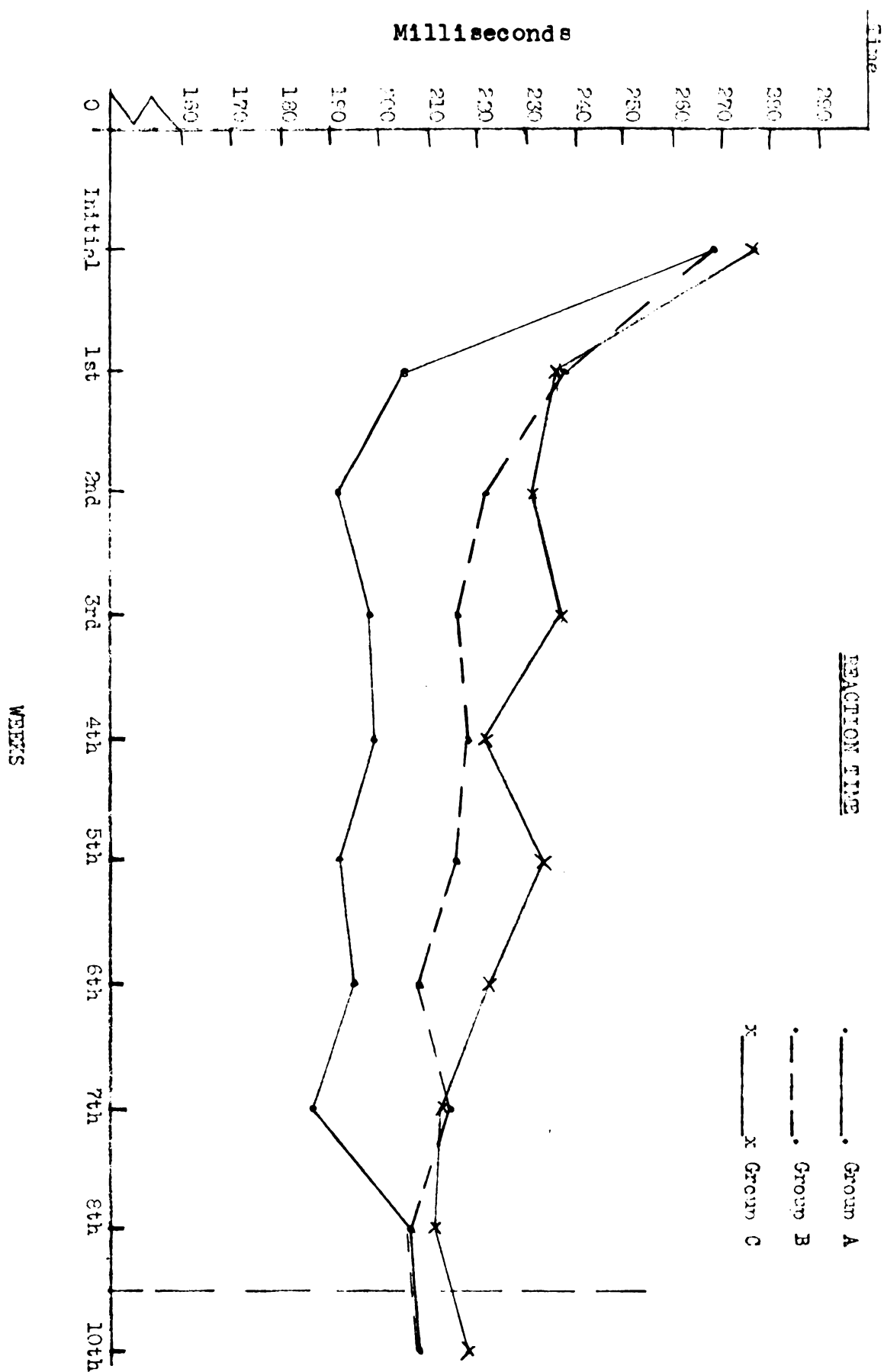
**P = < .01

*P = < .05

FIGURE II

MEAN FREQUENCY SCORES

REACTION TIME



as a result of the treatment although their response was not consistent as is indicated by the non-significant Groups X Weeks interaction. The significance in Weeks and individuals was expected since they were training and the Individuals were different. These results are in accord with Henry's²⁰ findings and indicate that reaction time may be improved by an initial low grade electrical stimulus.

In the analysis of A vs B no significant differences were found indicating that following training with electric shock the response differences when no shock was administered were attributable to chance.

Groups C and the experimentals were studied for retention of the training effects. Since no shock was used the two experimental groups' data were the same as they were for the same subjects. The differences between week eight and week ten for each of the group were used in calculating the "t". This was insignificant ($t .268$ $P .05$) indicating the retention of the training effects was not significantly different between the experimental and control groups.

Movement Time

In the analysis of A vs C (See the table II and Figure III) only the group X weeks interaction was significant. This difference is not clear cut in figure III and would appear to

²⁰Henry, loc. cit.

TABLE II
ANALYSIS OF VARIANCE: MOVEMENT TIME

Experimental (A) vs Control (C) Groups

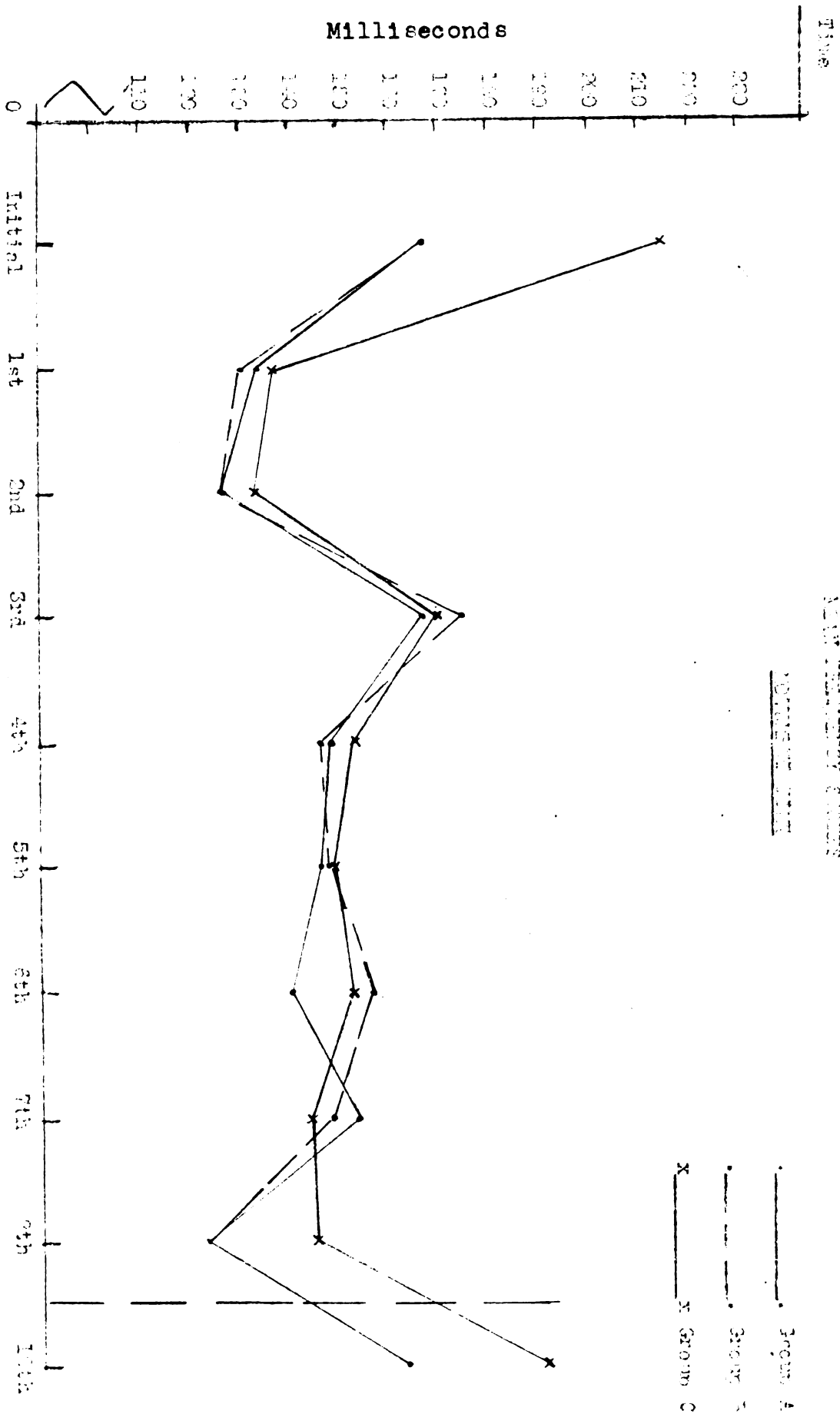
Source of Variance	D. F.	Sum of Squares	E. M. S.	F
Total	111	84,745.56	- - - -	- - -
Group	1	1,720.72	1,720.72	2.69
Weeks	6	1,146.52	191.08	.299
Individuals	14	15,850.27	1,132.16	1.77
Weeks X Groups	6	12,380.47	2,063.41	3.23**
Error	84	53.647.60	638.66	- - -

Experimental (A- Electric) vs Experimental (B-Non-Electric) Groups

Total	111	106,400.49	- - - -	- - -
Group	1	139.89	139.89	.269
Weeks	6	19,740.30	3,290.05	6.342**
Individuals	7	25,284.13	3,610.02	6.963**
Weeks X Groups	6	1,406.92	234.49	.452
Groups X Individuals	7	2,023.03	289.00	.557
Weeks X Individuals	42	36,018.56	857.58	1.653
Error (G X W X I)	42	21,785.66	518.71	- - -

**P = < .01

*P = < .05



be due to chance fluctuation.

The analysis of A vs B reflected no differences in groups. The weeks significance was expected probably reflecting a conditioning to the movement without shock, however, the individual responded differently to the absence of shock.

The "t" calculated to compare the groups on retention of movement time improvement was insignificant ($t = .352$) indicating the differences is contributable to chance.

Total Time

Results of the statistical analysis of A vs C (See Figure IV, Table III) indicate that groups differed significantly. This was expected because of carry-over from reaction time. The significance in weeks and individuals was expected since there was training and the individuals were different.

In the analysis of A vs B the group significance was expected due to the summary effect of reaction and movement times. Weeks and individuals showed the expected significances. This was probably due in part to the conditioning without shock. However, the individuals reacted differently to the absences of shock.

The "t" calculated to compare the group on retention of total time improvement was insignificant, ($t = .428$) indicating that the differences may be attributed to chance.

TABLE III
ANALYSIS OF VARIANCE: TOTAL TIME

Experimental (A) vs Control (C) Groups

Source of Variance	D. F.	Sum of Squares	E. M. S.	F
Total	111	187,276.25	- - - -	- - -
Group	1	45,927.00	45,927.00	57.547**
Weeks	6	16,414.87	2,735.81	3.428**
Individuals	14	54,843.52	3,917.39	4.906**
Weeks X Groups	6	3,052.63	508.77	.633
Error	84	67,038.23	798.07	- - -

Experimental (A-Electric) vs Experimental (B-Non-Electric) Groups

Total	111	188,795.92	- - - -	- - -
Group	1	18,283.58	18,283.58	23.57**
Weeks	6	17,002.35	2,833.73	3.65**
Individuals	7	68,023.53	9,717.65	12.53**
Weeks X Groups	6	466.30	77.72	.10
Groups X Individuals	7	3,518.24	502.61	.65
Weeks X Individuals	42	48,919.54	1,164.75	1.50
Error (G X W X I)	42	32,582.38	775.77	- - -

**P = < .01

*P = < .05

ECG

Time

Milliseconds

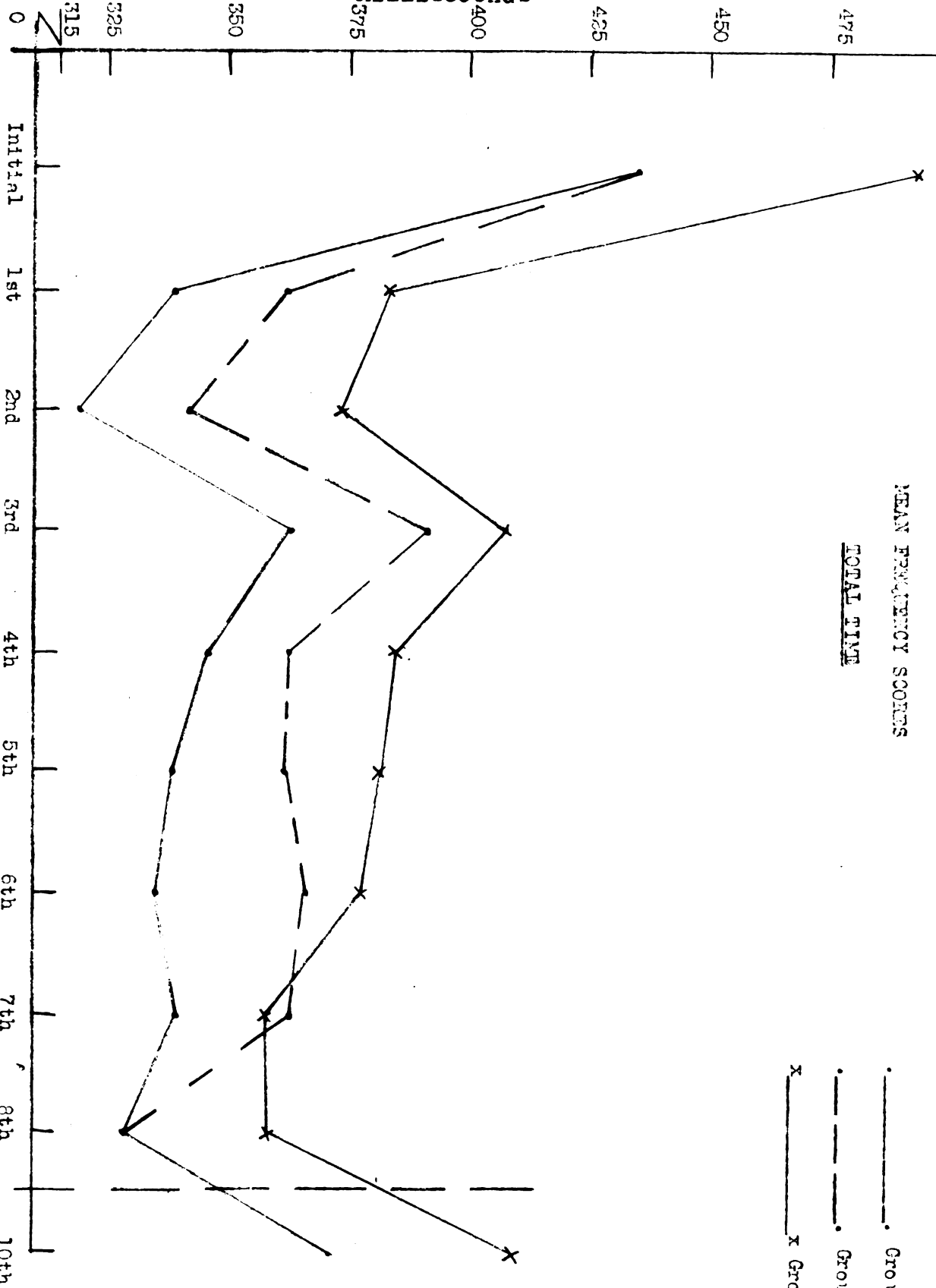
FIGURE IV
MEAN FREQUENCY SCORES
TOTAL TIME

..... Group A,
..... Group B
x..... Group C

0
315
325
350
375
400
425
450
475

Initial 1st 2nd 3rd 4th 5th 6th 7th 8th 10th

WEEKS



Discussion of Results

Before the introduction of electrical shock all groups were adjusted equally for reaction time.

With the introduction of electrical shock group A mean frequency for reaction time was 196 milliseconds. Control group C mean frequency was 228 milliseconds. Group B mean frequency was 219 milliseconds. This indicates that the introduction of a initial low voltage electrical shock can decrease the time necessary for reaction. (See Figure II, weeks one to seven).

Mean frequency for movement time for Group A was 145 milliseconds. Control group C showed a mean frequency of 152 milliseconds while group B mean frequency was 147 as indicated in figure III. This indicates only slight improvement which is unaccounted for in this analysis.

Total time mean frequency was 341 milliseconds for group A, 381 milliseconds for control group C and 366 milliseconds for group B.

Statistical analysis indicated a statistically significant decrease in reaction time, but an insignificant improvement in movement time as the result of a low grade initial electrical shock.

In a study of retention from week eight to week ten mean frequency for reaction time for groups A and B was 208 milliseconds, while group C was 216 milliseconds as indicated in figure II. Mean frequency for movement time for groups A

and B was 143 milliseconds while group C indicated a mean frequency of 178 milliseconds as indicated in figure III. Total time mean frequency for groups A and B was 350 milliseconds and 394 milliseconds for group C, as indicated in figure IV. Statistically insignificant changes were found after a two week lay-off from training. There is a need to extend this period to determine how long the retention period is.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

It was the purpose of this study to determine the effects of a low grade electrical stimulus upon reaction time and upon movement time.

For the purposes of this study sixteen male subjects were divided into two groups; a control and an experimental group. The initial stimulus which was used as the basis of the study was a thirty volt electrical shock as compared with an auditory stimulus (buzzer) of undetermined intensity.

The data were analyzed using the analysis of variance technique. The experimental group receiving electric shock during training significantly improved in reaction time over and above the training improvement of the control group. With electric shock training, however, there was no difference in reaction time whether the subjects were tested with or without shock.

The experimental and control groups did not differ significantly in movement time.

In the total time analysis the experimental group differed significantly from the control, indicating improvement attributable to electric shock training. These differences were due to the reaction time or to the

cumulative effects of both reaction and movement times. The cumulative effect seems important because in the comparison of the two experimental group's data, the differences were significant even though individually reaction and movement time had not been significant.

Conclusions

1. Reaction Time: Training with a low voltage initial electrical stimulus decreases the time necessary for the subject to react.

2. Movement Time: Training with a low voltage initial electrical stimulus continued though the movement does not alter movement time significantly.

3. Total Time (reaction and movement times): Differs significantly when a group trained on low grade electric shock is tested with and without the shock. This is attributed to a cumulative effect of the two variables.

4. Retention Time: During two weeks of inactivity reaction, movement and total times do not shift significantly.

Recommendations

1. In future study retention time should be further considered and the subject should be re-tested over a longer period of time.

2. Further study should be conducted concerning the effect of a low voltage electrical stimulus upon movement time. Reasons why movement time does not decrease significantly in training as reaction time does should be considered.

3. Further study should be conducted using varying and increased amounts of voltage as initial stimulus.

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APPENDIX

1. Reaction Times Table IV
2. Movement Times Table V
3. Total Times Table VI

TABLE IV

REACTION TIME

Contol "C"		<u>WEEKS</u>								
	Initial	1st	2nd	3rd	4th	5th	6th	7th	8th	10th
B.W.	281	269	218	200	220	212	225	204	189	248
R.L.	304	209	192	236	197	201	190	169	185	177
R.G.	295	252	260	265	241	274	264	249	246	226
J.W.	294	260	283	277	246	246	217	212	217	247
M.W.	263	208	214	222	227	213	206	219	202	182
R.K.	253	234	233	218	196	246	219	204	208	220
R.O.	266	234	225	242	214	225	240	229	249	216
P.T.	255	232	223	232	234	254	221	224	206	224
ΣX	2211	1898	1848	1892	1775	1871	1782	1710	1702	1750
M	276	237	231	237	222	234	223	214	213	219
Group "B"										
B.L.	291	224	217	206	220	192	226	223	206	195
J.D.	285	255	240	216	249	227	175	196	215	201
M.G.	287	246	255	214	219	228	211	243	225	197
B.J.	254	256	200	209	216	217	206	223	208	199
C.B.	280	242	244	231	234	209	214	250	191	249
F.C.	224	192	191	191	162	194	218	176	187	234
M.L.	273	226	210	214	211	235	203	201	199	192
D.L.	257	255	208	250	233	223	219	208	221	198
ΣX	2151	1896	1765	1731	1744	1725	1672	1720	1652	1665
M	269	237	221	216	218	216	209	215	207	208
Group "A"										
B.L.	291	198	197	166	197	183	173	181	206	195
J.D.	285	205	195	179	207	184	183	190	215	201
M.G.	287	227	211	228	207	197	212	192	225	197
B.J.	254	199	177	178	174	185	207	189	208	199
C.B.	280	215	218	221	202	208	199	204	191	249
F.C.	224	166	148	173	185	163	168	152	187	234
M.L.	273	223	195	219	184	225	205	188	199	192
D.L.	257	205	197	218	233	201	213	198	221	198
ΣX	2151	1638	1538	1582	1589	1546	1560	1494	1652	1665
M	269	205	192	198	199	193	195	187	207	208

TABLE V

MOVEMENT TIME

Control "C"		<u>Weeks</u>								
	Initial	1st	2nd	3rd	4th	5th	6th	7th	8th	10th
B.W.	299	121	112	198	160	146	192	135	111	218
R.L.	190	171	165	149	172	148	117	143	132	185
R.G.	297	161	142	148	170	158	136	135	179	257
J.W.	226	120	110	159	157	149	183	178	202	203
M.W.	147	174	160	171	214	181	157	142	148	161
R.K.	157	105	144	184	156	117	145	148	131	219
R.O.	252	167	188	209	143	150	148	139	141	168
P.T.	154	150	124	144	133	133	145	133	119	120
ΣX	1722	1169	1145	1362	1305	1182	1223	1153	1163	1531
M	215	146	143	170	163	148	153	144	145	191
Group "B"										
B.L.	172	118	94	120	95	125	100	137	137	140
J.D.	101	110	106	175	119	180	198	114	110	132
M.G.	154	143	137	206	149	151	191	199	120	178
B.J.	162	153	167	188	148	124	150	157	85	151
C.B.	216	171	137	141	193	167	159	181	158	168
F.C.	153	132	118	219	176	133	140	134	108	141
M.L.	196	92	115	130	124	161	153	128	119	192
D.L.	178	123	130	218	162	131	141	142	144	198
ΣX	1332	1042	1004	1397	1166	1172	1252	1192	981	1300
M	167	130	126	175	146	147	157	149	123	163
Group "A"										
B.L.	172	180	94	115	96	136	82	140	137	140
J.D.	101	104	152	155	170	162	122	196	110	132
M.G.	154	149	120	234	163	161	166	168	120	178
B.J.	162	162	105	151	143	169	174	128	85	151
C.B.	216	164	128	173	160	158	160	148	158	168
F.C.	153	98	130	171	143	129	137	129	108	141
M.L.	196	105	122	129	114	140	135	193	119	192
D.L.	178	112	156	204	193	110	141	121	144	198
ΣX	1332	1074	1007	1332	1182	1165	1117	1223	981	1300
M	167	134	126	167	148	146	140	153	123	163

TABLE VI

TOTAL TIME

Control "C"

Weeks

	Initial	1st	2nd	3rd	4th	5th	6th	7th	8th	10th
B.W.	580	390	330	398	380	358	417	339	300	476
R.L.	494	380	357	385	369	349	307	312	317	362
R.G.	592	413	402	413	411	432	400	384	425	483
J.W.	590	380	393	436	403	395	400	390	419	450
M.W.	410	382	374	393	441	394	363	361	350	343
R.K.	410	339	377	402	352	363	364	352	339	439
R.O.	518	401	413	451	357	375	388	368	390	384
P.T.	409	382	347	376	367	387	366	357	325	344
ΣX	3933	3067	2993	3254	3080	3053	3005	2863	2865	3281
M	492	383	374	407	385	382	376	358	358	410

Group "B"

B.L.	463	342	311	326	315	317	326	360	343	335
J.D.	386	365	346	391	368	407	373	310	325	333
M.G.	441	389	392	420	368	379	402	442	345	375
B.J.	416	409	367	397	364	341	356	380	293	350
C.B.	496	413	381	372	427	376	393	431	349	417
F.C.	377	324	309	410	338	327	358	310	295	375
M.L.	469	318	325	344	335	396	356	329	318	384
D.L.	435	378	338	468	395	354	360	350	365	396
ΣX	3483	2983	2769	3128	2910	2897	2924	2912	2633	2965
M	435	367	346	391	364	362	366	364	329	371

Group "A"

B.L.	463	378	291	281	293	319	255	321	343	335
J.D.	386	309	347	334	377	346	305	386	325	333
M.G.	441	376	331	462	370	358	378	360	345	375
B.J.	416	361	282	329	317	354	381	317	293	350
C.B.	496	379	346	394	362	366	359	352	349	417
F.C.	377	264	276	344	328	292	305	281	295	375
M.L.	469	328	317	348	298	365	340	381	318	384
D.L.	435	317	353	422	426	311	354	319	365	396
ΣX	3483	2712	2545	2914	2771	2711	2677	2717	2633	2965
M	435	339	318	364	346	339	335	340	329	371

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