THE EFFECTS OF VARIOUS VERBAL REINFORCEMENT PROGRAMS UPON THE SIMPLE REACTION LATENCIES OF PRE-PUBERTAL CHILDREN

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ABSTRACT

THE EFFECTS OF VARIOUS VERBAL REINFORCEMENT PROGRAMS UPON THE SIMPLE REACTION LATENCIES OF PRE-PUBERTAL CHILDREN

By

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This experiment was designed to study the effects of various verbal reinforcement programs upon the simple reaction latencies of pre-pubertal children of both sexes. A secondary objective of this study was to determine what type of stimulus (light, sound, or light + sound) produced the fastest reaction time for children within the educational level of kindergarten through second grade.

The experiment was conducted to test the following hypotheses:

1. Reaction time responses decrease with age (in this case between kindergarten and Grade two).
2. There is no improvement in reaction time if no verbal reinforcement is given.
3. Positive verbal reinforcement is more effective than negative verbal reinforcement in reducing reaction time.

4. The fact that males are regarded as having generally faster reaction times than females will be accentuated by the reinforcement programs (for a particular age level).

5. Reinforcement relating directly to performance, i.e., fast responses warrant positive verbal encouragement, is more effective than a set pattern of encouragement or censure.

To test the above hypotheses, a sample of 367 subjects was drawn by convenience from the Battle Creek Curriculum Project. The subjects were divided into sex-age groups and assigned to one of the three experimental groups. Each subject was given twenty trials of a simple index finger lift response, after receiving one of three stimulus modes. The first ten trials were given with no verbal cues; the second ten trials were conducted according to the experimental group the subject was assigned.

The results of these experiments provide support for the hypothesis that, with an increase in age, there is a corresponding increase in the speed of reaction time.

The presence of multiple stimuli appeared to accelerate a subject's reaction time in relation to the simple light and sound stimuli. Both the boys and girls produced significantly faster response for the light + sound stimulus than for the other two stimulus modes.

The results provided support for the hypothesis that verbal reinforcement increases the speed of reaction time. All three experimental groups had significantly faster responses when compared to the control group, which received no verbal cues. However, no clear pattern emerged as to the relative importance played by the various reinforcements. There was no significant difference between those subjects receiving the reinforcement which related directly to performance and those receiving a set pattern of reinforcement.

From the results obtained, there was a suggestion that the girls' performance was adversely affected by negative reinforcement. The boys, on the other hand, were not adversely affected and may even have improved the performance when compared to the mean of their first ten trials.

The results of this experiment clearly demonstrated that both boys and girls respond to reinforcement of both a positive and negative type. It is suggested that the control group with no verbal cues experienced boredom and fatigue far earlier in the test than the experimental groups. The results indicate verbal feedback in relation to a test of this kind will have some arousal effect on the performance of the subject.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

> In the struggle for survival, primitive man of necessity focused attention upon developing those abilities required for obtaining food, shelter, and protection. Modern man no longer lives in such intimate contact with toil, sweat, and physical violence. His world is one of implements, machines, and gadgets. When work is to be done, a labour saving device is available (Rarick [22]).

It is evident that as man's technology advances, he no longer relies entirely on his motor mechanisms and physical fitness. However, it should not be forgotten that even in a highly mechanized culture man must call upon his neuromuscular system in order to accomplish many of the manipulative skills found in industrial labor and the gross motor skills found in recreative activities. Thus, as part of a child's development, attention must be paid to the learning of motor as well as mental skills. Total development is dependent upon the mastery by the individual of skills that will facilitate the fulfillment of his physical and psychological needs and assist him to avoid harmful experiences (Crow and Crow [4]). If we subscribe to this statement, we also assume that it is necessary to

provide the opportunity for children to learn the skills of their culture.

Some of the problems facing children with poor motor development will affect their later life unless they are not remedied or corrected. A child's proficiency in motor skills determines to some degree the extent to which he or she will be successful in social, educational, and vocational areas. The child's judgment of himself is shaped in part by his association with his peer group. If he cannot compete on an equal basis, regardless of the skill involved, it is likely to be reflected in his estimation of self-worth. Havighurst [8] has emphasized a child's concept of himself is related to the motor skills he possesses. As a child becomes part of an activity group, he contributes certain skills and knowledge. This is the time when he has a chance to test his skills against those of his peers.

Beginning with middle childhood, enhanced motor competence becomes a major source of primary status. The child's world is abruptly changed when the ability to move about with freedom has been attained. The child is able to move independently and freely explore its environment with some feeling of competence. Children with motor handicaps not only feel more timorous in this respect but also find it difficult to maintain a level of aspiration when faced with motor tasks (Ausubel [1]). Rarick and McKee [23] have

shown that third grade children who showed proficiency in motor skills were found to be more active, popular, calm, resourceful, attentive, and cooperative than children who lacked such proficiency. Thus, it may be surmised that the development of adequate motor skills is an important goal in the education of young children.

Statement of the Problem

Simple reaction time may be defined as the time interval between the onset of a stimulus and the initiation of a response, with standard instructions to respond as quickly as possible.

This study will attempt to determine if verbal reinforcement is effective in the instrumental conditioning of reaction time in children, with the following specific purposes in mind:

1. To study the relationship between positive verbal reinforcement and response speed.
2. To study the relationship between negative verbal reinforcement and response speed.
3. To determine whether children learn to respond faster with practice even though no reinforcement is administered.

4. To determine if age is a factor in the relative success of positive or negative reinforcement in the lowering of the subject's reaction time.

5. To study the differences between male and female response speeds under positive and negative reinforcement programs.

With reference to research findings, the following hypotheses were made:

1. Reaction time will not improve if no reinforcement is given.

2. Positive reinforcement following fast reaction times will increase the overall speed of reaction time in contrast to the speed of the reaction time if no reinforcement is given.

3. Negative verbal reinforcement will increase the speed of reaction time.

4. Reaction time is indirectly related to age (as age increases, reaction time decreases), regardless of reinforcement given.

5. The difference between male and female reaction times will be accentuated by the reinforcement programs.

6. Reinforcement given according to performance (i.e., fast response warrants positive verbal

encouragement), is more effective than a set pattern of encouragement or censure.

There are no conclusive data for this age group pertaining to the type of stimulus (light, sound, or light and sound simultaneously) which ellicites the fastest response. Therefore, this study will also attempt to determine which type, or combination of stimuli, produces the fastest response for this age group.

The Need for the Study

The importance of motor skills in the life of a child has already been indicated. What, then, is the role of the teacher in this critical aspect of a child's development? This study is concerned with a component of motor performance; namely, simple reaction time. As this may be taken as a representative motor function, what is the effect upon performance of both positive and negative verbal reinforcement?

It may be trite to suggest that words influence our actions. However, no one has yet fully accounted for this phenomenon and only recently has this problem received attention. As a result of the work conducted by Skinner [29] and Greenspoon [7], there has developed an area of research called verbal conditioning. This form of conditioning is an integral consideration in the establishment of a theory for the socialization process in children.

However, most of the research in the form of reinforcement has been concerned not with words but with material reinforcers.

Similarly, during the past few years there has been a considerable amount of educational and psychological research directed towards aspects of reaction time. However, what research has been completed has been mostly directed to adults and adolescents. It is questionable whether one can infer that a similar relationship between stimulus and reaction will exist across the span of years between childhood and maturity. Basically this study is concerned with the influence of verbal reinforcement on a child's performance of a motor skill at a critical period in the development of a motor performance repetoire.

Limitation of the Study

This particular study is part of a larger curriculum project carried out in the Battle Creek school system (Vogel [31]). The sample for the whole project was drawn randomly from all the schools in the system and consisted of six hundred pupils. The sample utilized in this study is a part of that larger sample and selected according to the availability of the subjects at the time of testing. The subjects included in this study comprise approximately sixty-one percent of the original sample. The testing was done in a variety of schools and at various times of the

day; however, an effort was made to standardize conditions as far as light intensity, seating positions, and amount of noise were concerned.

When studying the age parameter in this problem, no attempt was made at grouping the subjects by mental, skeletal, or biological age. For ease of administration the grouping was determined by the grade of the subject. In addition, no attempt was made in this study to account for individual performances in a psychological context. However, the relationship between a subject's performance under varying forms of reinforcement and their psychological make-up may provide avenues of inquiry for further study.

CHAPTER II

REVIEW OF LITERATURE

A tremendous volume of work has been completed in the field of reaction time in psychological, phsiological, and educational contexts. The literature to be reviewed here comes mainly from four areas of research related to reaction time: the effect of age, the effect of sex, the effect of differing stimuli, and the effect of differing types of reinforcement programs. Because of the tremendous number of experiments produced in these areas, a complete review would be impractical since it would far exceed the purpose and the scope of this study. Only literature that has direct pertinence to the problem will be reviewed.

The simplest, most typical and time honored model for the objective observation of the effect of a stimulus upon a motor response is the classic simple reaction time experiment. Simple reaction time is defined as the time interval between the onset of the stimulus and the initiation of a response, with standard instructions to respond as quickly as possible.

It is apparent from the outset that there are many influences acting upon reaction time performance at any one time. Even diurnal variations, as Elbel [5] discovered, have an effect on response times. His investigation compared time of day with the response time of twenty-three male subjects in a stimulus-hand response. Elbel was able to isolate the following factors: slowest responses are obtainable at twelve noon, maximum speed in early afternoon, and a near maximum in mid-morning. Thus, the time of the day in which the testing takes place has an effect on performance.

People supervising pre-adolescent physical activity may unknowingly have unattainable expectation levels set for their charges due to incompletely developed sensorimotor capacities. One of the capacities is reaction time. Therefore, for each age range, it is necessary to know how fast a child will react to a certain stimulus. Unfortunately, most of the research completed hitherto has been confined to studies of chronological age, leaving the more accurate measures of maturity, namely mental and skeletal age, largely unused. Pierson and Montoye [19] measured the reaction and movement time in four hundred male subjects, aged eight to eighty-three. They found that movement time and reaction time are significantly related to chronological age. In both reaction and movement time, the fastest response was shown to be greatest around age

thirty. These findings suggest that one could expect consistent responses with young people (adolescents), but would expect wide inter-individual differences in children of kindergarten age. Botwinik and Thompson's [2] study on the components of reaction time, in relation to age and sex, would seem to substantiate the previous study. Unfortunately, the age range was post adolescence (eighteen years old) to eighty-seven and did not include young children. The reaction, pre-motor, and motor times, were calculated from data collected from a single finger lift response. It was shown that the elderly group was slower in all three categories and also that both elderly and young males had faster response times than their female counterparts. The research completed by Hodgkins [9] reported results similar to the two previously discussed topics. Nine hundred and thirty men, women, and children ranging from six to eighty-four years were tested to determine the differences between males and females of various ages in their speed of reaction and movement time. Results indicate that: (a) males were faster than females in both reaction and movement time; (b) speed of both functions increased up to early adulthood and then decreased; (c) peak speed was retained longer by males in movement time and by females in reaction time.

The age parameter appears more complex when considering the study by Philip [18] on the reaction times

of children grades four to eight. Although he found that reaction time decreased with age, he also found that the improvement in coordination which enables this decrease to be brought about by maturation is not confined to infancy and early childhood. Further, he found that in the older age ranges, i.e., grade eight there was a definite slowing down of the reactive processes apparent in girls but not in boys.

Goodenough [6], in her study of the development of the reactive process from early childhood to maturity, selected subjects ranging in age from two and one-half years to eleven and one-half years and also fifty-six college students. She found that the development of reactive processes not only improves the speed of response, but even more marked is the degree of gaining voluntary control over motor activity, which manifests itself in fewer signs of bodily tension as the subjects increase in age.

To summarize the above points, reaction time decreases with age during childhood and adolescence; however, the rate of decrease is still open to question. The effects of involuntary motor movements in very young children further complicate this picture.

Most of the studies dealing with reaction time differences due to sex show that boys are usually superior to girls. Mather [13], in his study using visual stimuli

and children aged eight to eleven years, found that boys reacted quicker than girls of comparable ages. Also, boys surpassed girls in the improvement of reaction time with increase in age. Pomeroy [20] also found that boys elicited a faster response than girls; and, in addition, their intra-sex variability was lower. Goodenough [6] and Jones [11], in their studies of young children and reaction times, also found that boys were superior to girls; but the differences were small and not statistically significant.

A variable which has a profound effect on reaction time is the type and intensity of the stimulus. Colgate [3] showed that simple reaction and movement times were fastest for an auditory stimulus, closely followed by a visual stimulus, and slowest of this particular set was the electro-shock stimulus. Robinson [24], however, suggests that a visual stimulus elicits the fastest response and that reaction time further decreases with increased liminance or area under equal energy conditions.

The effects of practice on reaction time has been studied by M. L. Norrie [16]. Her study of complex and simple reaction time on the effects of practice revealed that simple movements showed relatively small improvements compared with the complex group. She also reported that the simple task improvement occurred in the first ten trials. This statement is substantiated by Jones [11], who found that after the first five warm-up trials, there was

evidence of improvement through the next ten trials. Norrie also showed that complex movements showed improvements through the fifty trials. Lewis, Aiken, and Lichtenstein [12] studied the relationship between the foreperiod length (the time between the preparatory warning and the onset of the stimulus), and mean reaction time at the asymptote of the reaction time practice curve. Unfortunately, their sample consisted of only four adult males. However, they found that there was an increasing function which reaches an asymptote at a different time interval for each subject.

Further work or pre-stimulus variables was conducted by Rubenstein [25]. He found that the presentation of irrelevant stimuli prior to the reaction stimulus produced response retardation. In contrast to Robinson's work, he found that stimulus intensity had little to do with the absolute amount of lengthening of the reaction time. However, he agreed that both the percentage and total change in response was greatest if both the stimuli were visual as opposed to auditory.

When considering the fourth variable, namely, the effect of reinforcement on reaction time, one finds a large amount of literature which is, unfortunately, directed at adult subjects. Owen [17], in one of the few studies involving "normal" children, discussed the effects of ranging motivational techniques on the performance of

the subject's reaction time. One group was given the standard instructions; another was given urging instructions; and the third group was given relaxing instructions to ease the tension of the required task. In relation to pre-instructional level, the "urging" and "relaxing" groups showed an improvement; but the standard group showed no improvement. This demonstrates a fundamental difference between children and adults; for in the same situation, adults would not show a response retardation; thus, it would appear boredom might well be a factor when considering the appropriate incentive for children (Owen [17]). In a similar study, Holden [10] studied the response latencies of educable retardates obtained before and after the interjection of rest, reprimand, and reward, halfway through a simple reaction time task. Reprimand and reward both decreased reaction time significantly; however, only reward decreased the reaction time to a level significantly below that of the first pre-treatment trial block. In a comparative study by Pugh [2], normal and schizophrenic women were studied under the effects of praise and censure in relation to reaction time. The results, contrary to his hypothesis, revealed that normal women do not decrease their reaction time under praise or censure. This could possibly be due to the fact that older women are less susceptible to the effects of verbal reinforcement. This statement is supported by the results of McCullers and

Stevenson [14], who reported that verbal reinforcers are more effective with younger than older children. If, however, the verbal reinforcers stress the subject's failure, then Shankweiler [27] hypothesized that subjects with any degree of brain damage would experience the "Catastrophic Reaction," where the consistency of behavior is disorganized in the face of what would seem to be extremely mild stress. His subjects ranged from sixteen to sixty years old; and, thus, the effect of such stress on young children is not considered. In this particular study, information concerning both success and failure resulted in a significant acceleration of reaction time.

Adult verbal approval is an effective method of reducing a child's response speed to a given stimulus. Martinez [15] and Ryan and Watson [26], in their studies on kindergarten children, found that verbal reinforcement did have a facilitating effect on response latencies. Ryan and Watson further showed that one hundred percent verbal reward is less effective than partial positive verbal reward. It was found by Shekil [28] that the most effective time to administer verbal reinforcement was immediately after the completion of that trial.

To summarize the above points, it has been suggested that of the total number of reaction time studies, only a small percentage has been directed toward young children. Of these studies, the variables affecting the

child's response have been studied in ones or twos; for example, the effects of maturity on the response to a given stimulus. Most of the studies comparing the sexes and reaction time conclude that at all ages boys are faster than girls in reaction responses. The type and intensity of stimulus has received much attention from researchers; but their findings are far from unanimous as to the type of stimulus eliciting the fastest response or whether stimulus complexity accelerates or retards the response.

This concludes a review of the reaction time and verbal reinforcement literature. The area of verbal reinforcement has a relatively short history; there is much to be done regarding the establishment of reliable phenomena and the development of a theory which can account for these phenomena and guide research in a fruitful direction. One of the special problems facing the area of social conditioning is that the experimental task has been confined to material rather than verbal reinforcement. It would seem essential that more emphasis be placed on those tasks which have most to do with developmental adaptation, such as verbal reinforcement.

CHAPTER III

METHODOLOGY

A sample of children were drawn by convenience from the students engaged in the testing of the Battle Creek Curriculum Project. Subject bias was kept to a minimum by the specific sampling that use and availability of the subjects determined. The sample was stratified in the following manner: Kindergarten--Boys (N = 54), Girls (N = 52); First Grade--Boys (N = 65), Girls (N = 70); Second Grade--Boys (N = 71), Girls (N = 55).

The apparatus used to test the subjects' reaction times was the Dekan Athletic Performance Analyser. The control console consisted of the following parts: a stimulus initiation button which can be altered to give an irregular stimulus foreperiod from zero to two seconds; a key which was connected to the clock timer with an accuracy of one hundredth of a second; and lastly a clock reset button. The stimulus was presented in one of three modes: a light placed in front of the subject; a buzzer emanating from the Athletic Performance Analyser; or the light and sound stimuli being presented simultaneously.

In order to test the stated hypotheses, the design of the experiment called for the subjects in each age group to be divided according to sex. The subjects in each sex-age group were then randomly assigned to one of the following experimental groups.

Light Stimulus Control.--The subject was given twenty trials with the light stimulus and no verbal cues were given by the tester.

Sound Stimulus Control.--The subject was given twenty trials with the sound stimulus and no verbal cues were given by the tester.

Light and Sound Stimulus Control.--The subject was given twenty trials with the light and sound stimulus and no verbal cues were given by the tester.

For each stimulus type, the control groups provided standards against which comparisons could be made as to the effectiveness of the verbal reinforcement.

Light Stimulus--Experimental Group 1.--The mean was taken of the subjects' first ten trials with the light stimulus. On the basis of this mean, the tester then administered "warranted" reinforcement for performance, i.e., if a subject did better than the mean score, he received positive reinforcement immediately after that trial. If the child did not attain the mean score, the

negative reinforcement was administered. This reinforcement was continued for the next ten trials, making a total of twenty trials.

Sound Stimulus--Experimental Group 1.--The mean was taken of the subjects' first ten trials with the sound stimulus. On the basis of this mean, the tester then administered "warranted" reinforcement for performance following the procedure outline for Light Stimulus--Experimental Group 1.

Light and Sound Stimulus--Experimental Group 1.--The mean was taken of the subjects' first ten trials with the light and sound stimulus. On the basis of this mean, the tester then administered "warranted" reinforcement for performance following the procedure outline for Light Stimulus--Experimental Group 1.

Experimental Group 1 was designed to test the hypothesis that verbal reinforcement is more effective than no reinforcement in the acceleration of the subjects' reaction time. Secondly, Experimental Group 1 was designed to compare the effectiveness of warranted verbal reinforcement with a set pattern of verbal reinforcement (Experimental Group 2A and 2B).

Light Stimulus--Experimental Group 2A.--The first ten trials were administered as usual with a light

stimulus. From the eleventh to the fifteenth trials, positive reinforcement was administered, regardless of the score that was obtained. For the final five trials, negative reinforcement was given after each trial.

Sound Stimulus--Experimental Group 2A.--The first ten trials were administered as usual with a sound stimulus. From the eleventh to the fifteenth trials, positive reinforcement was administered, regardless of the score that was obtained. For the final five trials, negative reinforcement was given after each trial.

Light and Sound Stimulus--Experimental Group 2A.--The first ten trials were administered as usual with a light and sound stimulus. From the eleventh to the fifteenth trials, positive reinforcement was administered, regardless of the score that was obtained. For the final five trials, negative reinforcement was given after each trial.

Light Stimulus--Experimental Group 2B.--The first ten trials were administered as usual with a light stimulus. In this group, the subjects received negative reinforcement from the eleventh to fifteenth trials, regardless of the score attained. For the final five trials, positive reinforcement was administered.

Sound Stimulus--Experimental Group 2B.--The first ten trials were administered as usual with a sound stimulus. In this group, the subjects received negative reinforcement from the eleventh to fifteenth trials regardless of the score attained. For the final five trials positive reinforcement was administered.

Light and Sound Stimulus--Experimental Group 2B.--The first ten trials were administered as usual with a light and sound stimulus. In this group, the subjects received negative reinforcement from the eleventh to fifteenth trials, regardless of the score attained. For the final five trials, positive reinforcement was administered.

When a subject received positive verbal reinforcement, the phrases "Good"; "That's fine"; "Good, keep it up," were used. These phrases were given by the reinforcer immediately after the appropriate trial and were used in a random order.

The phrases used to give negative reinforcement were as follows: "You can do better than that"; "That was not very good"; "That was not as good as you can do--try harder." Again, these were said immediately after the appropriate trial but were not used in a degrading or intense manner.

TABLE 1.--Group experimental conditions.

	Light			Sound			Light & Sound		
	Grades			Grades			Grades		
	K	1	2	K	1	2	K	1	2
	Boys		Girls	Boys		Girls	Boys		Girls
	Control								
N =	22		19	21		19	28		24
	Experimental Group 1								
N =	21		15	22		19	24		24
	Experimental Group 2A								
N =	10		10	9		10	6		9
	Experimental Group 2B								
N =	10		10	9		10	6		9

The subjects entered the testing area from their classroom and were tested individually. The subjects were required to give their name, grade, and experimental number. From this information, the experimenter determined the experimental group to which the subject belonged. The subject was positioned a comfortable distance from a table upon which was placed the light bulb stimulus. At right angles to this table was the recorder's table upon which was the Athletic Performance Analyser. Thus, the experimenter could observe the subject, but the subject could not observe the experimenter. The experimenter's assistant sat beside him while recording the reaction times (see Figure 1).

The reaction key button was placed in the subject's dominant hand with the index finger resting on top of the button. The subject was then given the following instructions: "As soon as the light (or sound) (or light and sound) comes on, I want you to see how fast you can press the button." The experimenter then pressed the stimulus button; and after the time had been recorded, pressed the clock reset button. The experimenter, by means of the random time selector (from immediately to two seconds), varied the commencement of the stimulus after the pressing of the stimulus button. Each score was recorded immediately after each trial; and where appropriate, the experimenter was supplied with mean

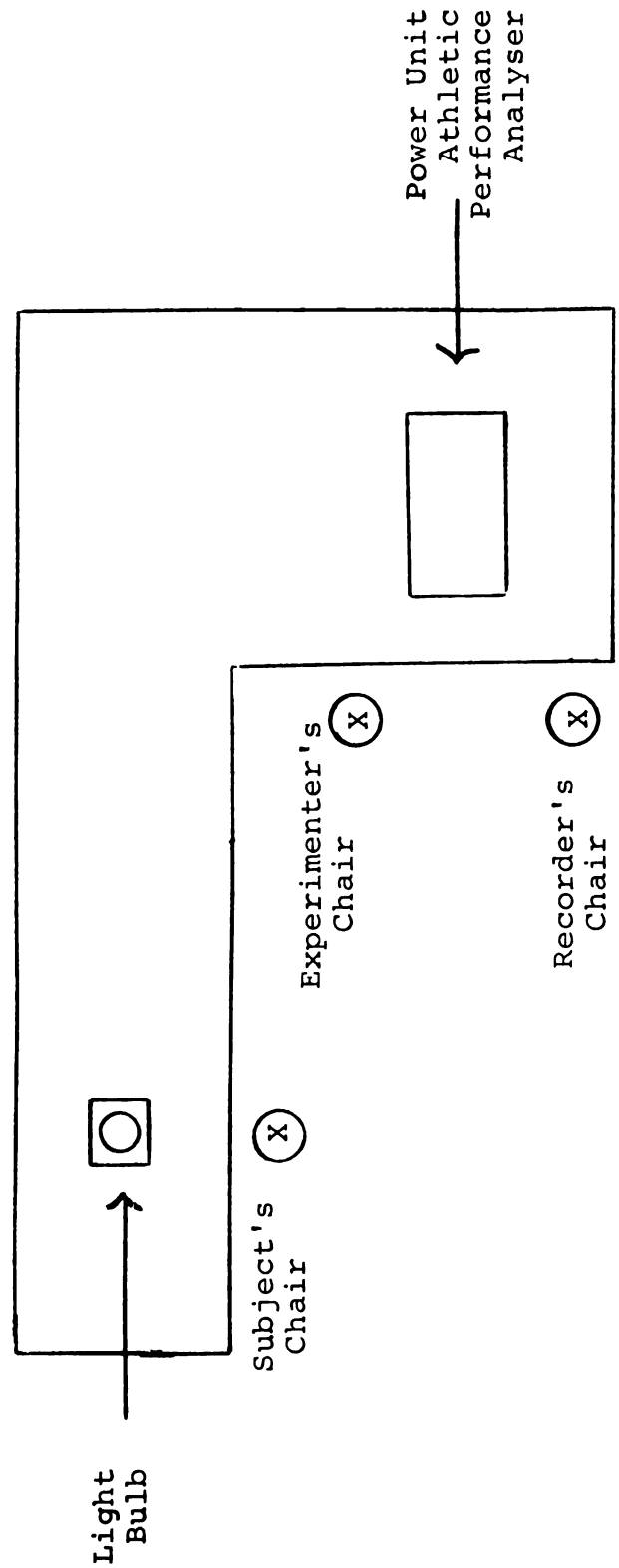

FIGURE 1.--The Experiment Setting.

scores. Each subject completed twenty trials of reaction time under one of the previously described experimental conditions.

The design of the experiment did not provide for a statistical check on sampling errors in assigning subjects to the various experimental groups; although the reaction times of the first ten trials for all subjects within a stimulus type group were obtained under identical conditions.

Due to the complexity of design, no one statistical treatment would encompass all the raw data; therefore, a series of One Way Analyses of Variance was used to determine if variability existed. Duncan Multiple Range Tests were employed to determine the source of the variability.

CHAPTER IV

ANALYSIS AND PRESENTATION OF DATA

The results are reported in two parts: firstly, the effects of sex, age, and stimulus type on the subjects' reaction times; and secondly, the effect of the reinforcement programs on the second ten trials of each sub group. Attention is drawn to the relationship between all variables and their effect on subject groups.

Figure 2 illustrates the relationship between the first ten trials and the second ten trials. The figure shows the graphical relationship between the sex, age, and stimulus groups from the slowest (kindergarten, girls, light stimulus) to the fastest (second grade, boys, light and sound stimulus). In all comparisons, the second ten trials are faster than the first. This is, in part, due to a learning effect; but the difference in relative position must be due to some other factor, possibly reinforcement type. If no reinforcement programs were introduced in the second ten trials, one would expect each group's second ten trials would maintain the same relative

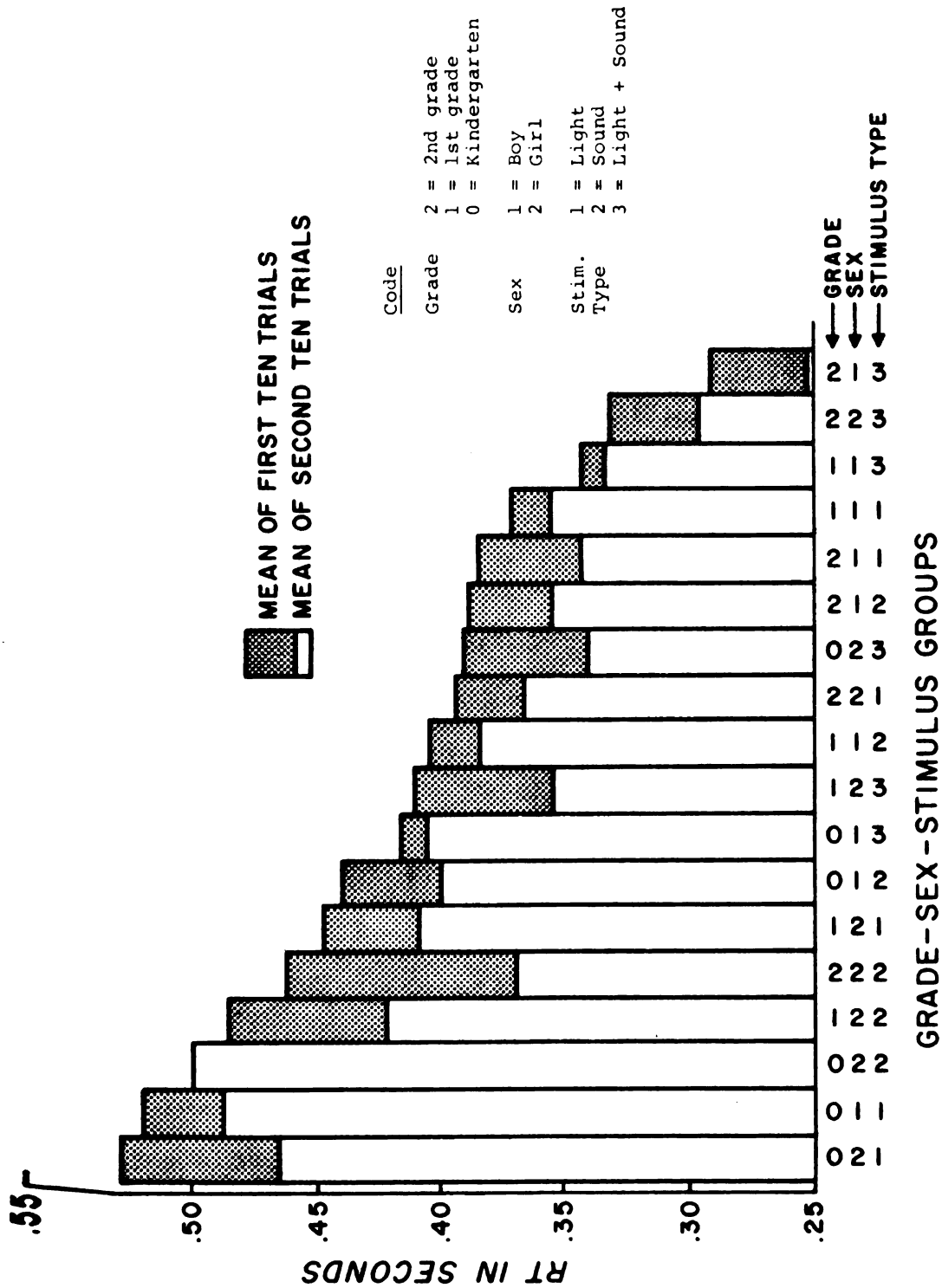

Figure 2. A comparison of mean scores of the first ten trials compared with the second ten trials for each grade+sex+stimulus group.

position to the groups faster and slower than it. Considering Figure 2, it is obvious that the second ten trials do not follow that pattern. For example, in the case of second grade, girls, sound stimulus, the first ten trials rank fourteenth among all the groups. However, when one looks at the second ten trials, this group ranks ninth. Therefore, some other variable than grade, sex, and stimulus type must have had an effect on the second ten trials; possibly the type of reinforcement was responsible for the change. It will be seen from Table 2 that the between-groups variance is higher for the first ten trials than for the second ten. This would indicate that the subjects' responses are erratic during the first ten trials but become more stable during the second ten trials as the subjects become accustomed to the experimental conditions.

Sex differences apparently do not account for a great deal of variance in these data. In the first ten trials, there is a significant difference between the mean at the .002 level of significance. However, in the second ten trials, at the .5 level, this variance is absent. The boys, in both cases, are slightly faster and appear to be more stable over the twenty trials (see Table 3).

The effect of age on the reaction times of the subjects is shown in Table 4. All three grades differ significantly at the .005 level of significance. As

TABLE 2.--One way analysis of variance, grade x sex x stimulus type for first and second ten trials.

Source of Variance	dF	SS	MS	F	P
		First Ten Trials			
Between groups	17	1.3955	0.0820	6.41	.0005
Within groups	349	4.4713	0.0120		
Total	366	5.8669			
		Second Ten Trials			
Between groups	17	1.4932	0.0878	5.20	.0005
Within groups	349	5.8930	0.0168		
Total	366	7.3863			

Dependent variable--1st 10 trials
Category variable--grade, sex, stim. type

Dependent variable--2nd 10 trials
Category variable--grade, sex, stim. type

TABLE 3.--One way analysis of variance, boy x girl for first and second ten trials.

Source of Variance	dF	SS	MS	F	P
		First Ten Trials			
Between groups	1	0.1523	0.1523	9.73	.002
Within groups	365	5.7145	0.0156		
Total	366	5.8669			
		Second Ten Trials			
Between groups	1	0.0721	0.0721	3.60	.5
Within groups	365	7.3142	0.0200		
Total	366	7.3863			

Dependent variable--1st 10 trials
Category variable--sex

Dependent variable--2nd 10 trials
Category variable--sex

TABLE 4.--One way analysis of variance, kindergarten x first grade x second grade for first and second ten trials.

Source of Variance	dF	SS	MS	F	P
First Ten Trials					
Between groups	2	.0555	0.2776	19.02	.0005
Within groups	364	5.3166	0.0145		
Total	366	5.8669			
Second Ten Trials					
Between groups	2	.7147	0.3573	19.49	.0005
Within groups	364	6.6715	0.0183		
Total	366	7.3863			

Dependent variable--1st 10 trials
Category variable--grade

Dependent variable--2nd 10 trials
Category variable--grade

expected, the fastest age group was the second grade and the slowest, the kindergarten (see Table 5).

When considering the interaction of sex and age, there is only one significant difference ($P < .05$) from the expected pattern. First grade boys exhibit a faster mean response than second grade girls in the first ten trial blocks (see Table 6).

At face value, the analysis of the stimulus type would account for a very great degree of variance in these results: $F(\frac{2}{364}) = 18.66$ $P < .005$. However, on further inspection, it is apparent that the variance is almost totally due to one particular type of stimulus, the light + sound Mode. The Duncan Multiple Range Test shows that there is no significant difference between the two stimuli; namely, the light and sound, and the third, namely, the light and sound simultaneously. The latter elicits the fastest mean response (see Table 7). The interaction of sex and stimulus type also brings out this marked variance between the light and sound stimulus (L + S) and the other two types. Both the boys and girls with the L + S stimulus are significantly different from the other sex-stimulus groups (see Table 8). Even the significant ranking of the grades (second, fastest → Kindergarten, slowest) is masked when considering the stimulus type and age (see Figure 3). Kindergarten subjects with the L + S stimulus produce a faster

TABLE 5.--Mean data for each grade.

	Mean	Standard Deviation
	First Ten Trials	
Kindergarten	0.47	0.13
First Grade	0.41	0.12
Second Grade	0.36	0.11
	Second Ten Trials	
Kindergarten	0.43	0.18
First Grade	0.38	0.12
Second Grade	0.32	0.10

Dependent variable--1st 10 trials
Category variable--grade

Dependent variable--2nd 10 trials
Category variable--grade

TABLE 6.--Mean data for grade + sex, first ten trials.

	Mean	Standard Deviation
Kindergarten Girls	0.48	0.10
Kindergarten Boys	0.46	0.11
First Grade Girls	0.44	0.12
Second Grade Girls	0.39	0.13
First Grade Boys	0.38	0.10
Second Grade Boys	0.35	0.10

Dependent variable--1st 10 trials
Category variable--grade + sex

TABLE 7.--Duncan Multiple Range Test, second ten trials by stimulus type.

		Entries which differ significantly from the left hand entry	
Entry	Mean	Entry	Mean
Light + Sound	0.32	Sound	0.41
		Light	0.40
Light	0.40	Light + Sound	0.32
Sound	0.41	Light + Sound	0.32

Note: Significant level = .05.

TABLE 8.--Duncan Multiple Range Test, second ten trials by sex + stimulus type.

		Entries which differ significantly from the left hand entry	
Entry	Mean	Entry	Mean
Boys, L + S	0.31	Boys, S	0.38
		Boys, L	0.39
		Girls, L	0.41
		Girls, S	0.44
Girls, L + S	0.33	Boys, S	0.38
		Boys, L	0.39
		Girls, L	0.41
		Girls, S	0.44
Boys, S	0.38	Boys, L + S	0.31
		Girls, L + S	0.33
		Girls, S	0.44
Boys, L	0.39	Boys, L + S	0.31
		Girls, L + S	0.33
Girls, S	0.44	Boys, L + S	0.31
		Girls, L + S	0.33
		Boys, S	0.38

Note: Significant level = .05.

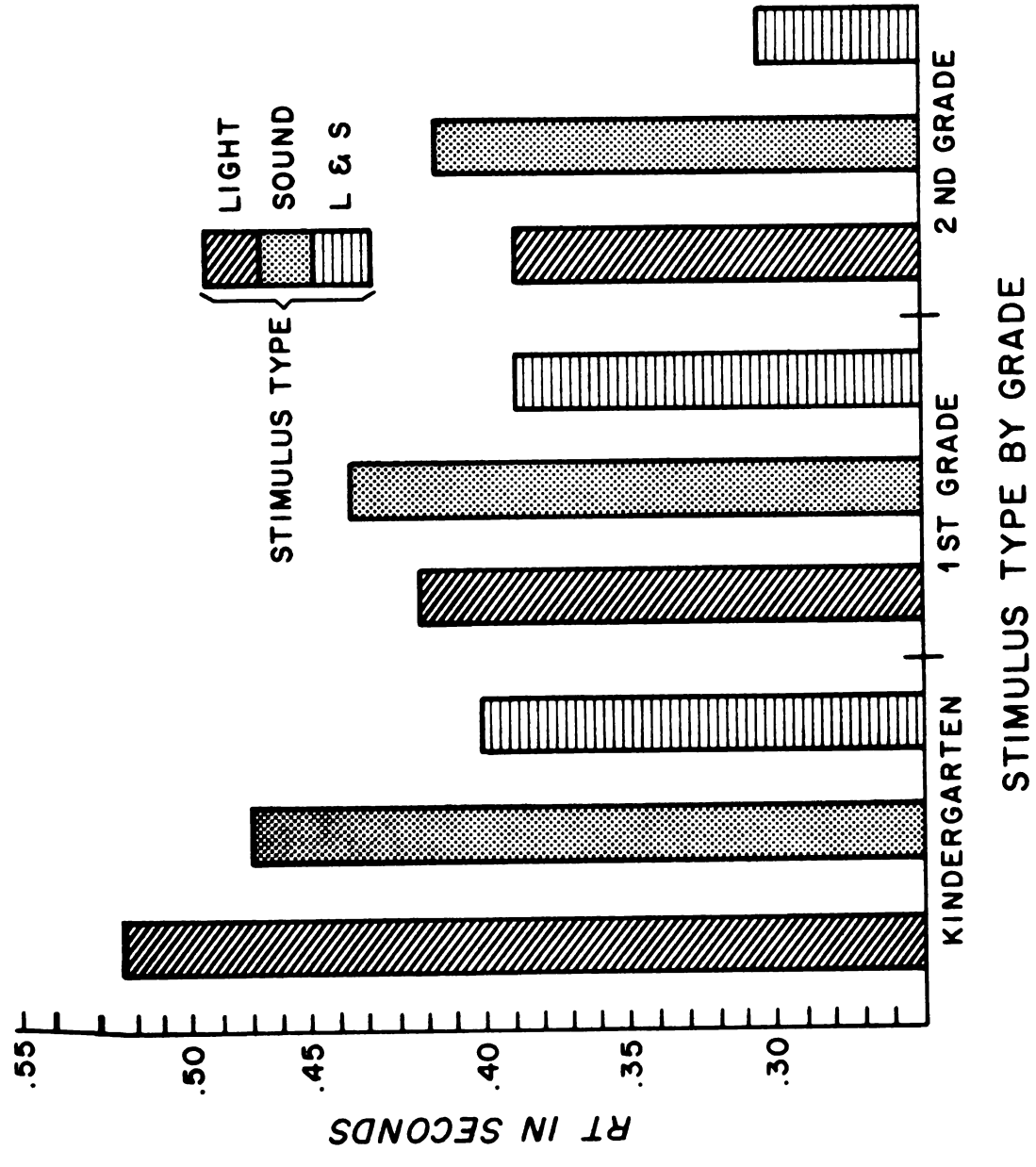

Figure 3. A comparison of stimulus types by grade using mean scores.

response than one second grade group reacting to the sound stimulus and two first grade groups reacting to light and sound stimuli, respectively.

To summarize the above results, it would appear that the L + S stimulus has accounted for the greatest amount of variance in the data. The other two stimulus types, namely, sound and light individually, did not produce any significant variance. Sex was also found to be non-significant in its effect on reaction latencies. Chronological age was the other factor which contributed to the variance in the data.

The reinforcement groups used in the following discussion are as follows:

Control group--the subject was given twenty trials with no verbal cues being given by the tester.

Experimental group 1--the mean was taken of the subjects' first ten trials. On the basis of this mean, the tester then administered "warranted" reinforcement for performance, i.e., if a subject did better than the mean score, he received positive reinforcement immediately after that trial. If the child did not attain the mean score, the negative reinforcement was administered.

Experimental group 2A--the first ten trials were administered as usual. From the eleventh to the fifteenth trials, positive reinforcement was administered, regardless

of the score obtained. For the final five trials, negative reinforcement was given after each trial.

Experimental group 2B--the first ten trials were administered as usual with the subjects receiving negative reinforcement from the eleventh to the fifteenth trials. For the final five trials, positive reinforcement was administered.

These four reinforcement programs will be known hereafter as the control group, the warranted group, the + ve group, and the - ve group, respectively.

The variance shown in the Analysis of Variance (see Table 9) for reinforcement types is quite marked, $F(\frac{3}{729}) = 7.66$, $P = .005$. However, on referral to the Duncan Multiple Range Test (see Table 10), it can be attributed to one of the groups rather than a uniform variance between all four types. At the .05 level of significance, only the control group showed variance from the warranted and the + ve reinforcement groups. This would suggest that any verbal reinforcement program will accelerate the subject's response speed when compared to those subjects receiving no verbal reinforcement. The three experimental treatments, the warranted, + ve, and - ve groups, were not significantly different from one another indicating that no one verbal conditioning program is more effective than the other two.

TABLE 9.--One way analysis of variance, time by reinforcement type.

Source of Variance	dF	SS	MS	F	P
Between categories	3	.0505	0.1684	7.66	.0005
Within categories	729	16.0408	0.0220		
Total	732	16.5461			

Dependent variable--time
Category variable--reinforcement type

TABLE 10.--Duncans Multiple Range Test, time by reinforcement type.

		Entries which differ significantly from the left hand entry	
Entry	Mean	Entry	Mean
Warranted	0.34	Control	0.41
+ ve rein.	0.37	Control	0.41
- ve rein.	0.38		
Control	0.41	Warranted	0.34
		+ ve rein.	0.37

Note: Significant level = .05.

Within each grade level, only the control group was significantly different from the warranted reinforcement type at the .05 level of significance (see Table 11). However, it is interesting to note the relative order of the four groups for each grade. In the kindergarten and first grade, the order was as follows: slowest response-control, followed by - ve, then + ve, and the fastest was the warranted group. Only in the second grade did this order vary, the - ve reinforcement obtained a faster response than the + ve group. The overall difference between grade and reinforcement type was significant: $F(\frac{11}{721}) = 8.42$, $P = .005$.

The significant factor in the relationship of sex to reinforcement type is that only the control groups varied from the warranted groups for both sexes. The boys and girls acted as an homogeneous group in their reaction to the experimental treatments. There was no significant difference between the warranted, + ve, and - ve groups. The Duncan Multiple Range Test of Time vs. Reinforcement Type and Sex shows an interesting order of ranked means. Figure 4 illustrates that the girls under - ve reinforcement obtained the second slowest mean response, whereas the boys under the same reinforcement obtained the second fastest response; but these differences were not significant at the .05 level. The overall variance between Reinforcement Type and Sex is significant (see Table 12): $F(\frac{7}{725}) = 4.52$, $P = .005$.

TABLE 11.--Duncans Multiple Range Test, time by reinforcement type and grade.

		Entries that differ significantly from the left hand entry	
Entry	Mean	Entry	Mean
Warranted - second	0.30	Control second	.34
		Warranted first	.36
		Warranted Kinder.	.38
		- ve first	.38
		Control first	.40
		+ ve Kinder.	.42
		- ve Kinder.	.44
		Control Kinder.	.47
- ve second	0.31	Warranted Kinder.	.38
		Control first	.40
		+ ve Kinder.	.43
		- ve Kinder.	.44
		Control Kinder.	.47
- ve second	0.33	Control first	.40
		+ ve Kinder.	.43
		- ve Kinder.	.44
		Control Kinder.	.47
Control second	0.35	Warranted second	.30
		Control first	.40
		+ ve Kinder.	.42
		- ve Kinder.	.44
		Control Kinder.	.47
Warranted - first	0.36	Warranted second	.30
		Control first	.40
		+ ve Kinder.	.42
		- ve Kinder.	.44
		Control Kinder.	.47
+ ve first	0.36	- ve Kinder.	.44
		Control Kinder.	.47
Warranted Kinder.	0.38	Warranted second	.30
		- ve second	.31
		Control Kinder.	.47

TABLE 11.--Continued

Entry	Mean	Entries that differ significantly from the left hand entry: Entry	Mean
- ve first	0.38	Warranted second	.30
		Control Kinder.	.47
Control first	0.40	Warranted second	.30
		- ve second	.31
		+ ve second	.33
		Control second	.35
		Warranted first	.36
		Control Kinder.	.47
+ ve Kinder.	0.43	Warranted second	.30
		- ve second	.31
		+ ve second	.33
		Control second	.35
		Warranted first	.36
- ve Kinder.	0.44	Warranted second	
		- ve second	
		+ ve second	
		Control second	
- ve Kinder.	0.44	Warranted first	.36
		+ ve first	.36
Control Kinder.	0.47	Warranted second	.30
		- ve second	.31
		+ ve second	.33
		Control second	.35
		Warranted first	.36
		+ ve first	.36
		Warranted Kinder.	.36
		- ve second	.38
		Control second	.40

Note: Significant level = .05.

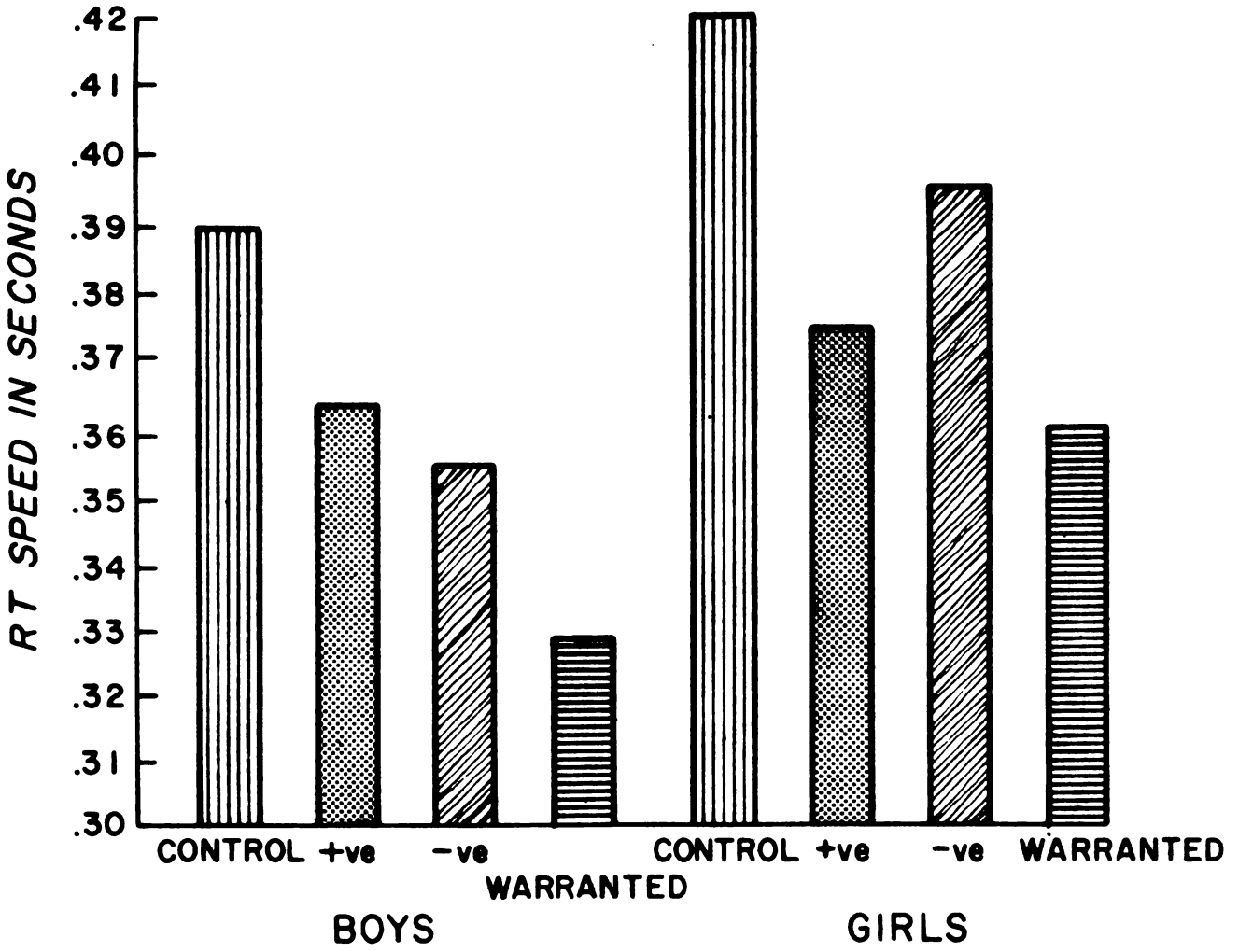

Figure 4. A comparison of reinforcement types by sex using mean scores.

TABLE 12.--One way analysis of variance time by reinforcement type + sex.

Source of Variance	dF	SS	MS	F	P
Between categories	7	0.931	0.0990	4.53	.0005
Within categories	725	15.8530	0.0218		
Total	732	16.5461			

Dependent variable--time
Category variable--reinforcement type + sex

The high degree of variability apparent when considering Reinforcement Type and Stimulus Type: $F(\frac{11}{72}) = 8.77$, $P = .0005$, is once again due to the effect of the L + L stimulus type. Even the control group with the L + S stimulus achieved a significantly faster response than three out of four L stimulus-reinforcement groups and the control-sound group (see Figure 5). The Duncan Multiple Range Test at the .05 level of significance shows that there is no significant difference between all the reinforcement type groups having the L + S stimulus (see Table 13). Again, referring to Figure 5, it will be noted that the sound control - ve and + ve groups are significantly slower than all but one of the remaining stimulus type reinforcement groups; namely, the light control group.

Within each grade there were significant differences for each reinforcement type-sex group at the .05 level of significance. The slowest group in each grade was the control-girls, and they were significantly different from the fastest group in their grade. The fastest group within each grade varied; in the second grade, the - ve reinforcement boys had the lowest mean; in the first grade, the warranted boys; and in the kindergarten, the slowest times were recorded by the warranted girls. The Duncan Multiple Range Test of ranked means shows clearly that there was no pattern to the order of the kindergarten and first grade mean responses; that is, the means of those

Figure 5. A comparison of reinforcement types by stimulus types using mean scores.

TABLE 13.--Duncan Multiple Range Test, time by reinforcement type and stimulus type.

		Entries which differ significantly from the left hand entry	
Entry	Mean	Entry	Mean
Warranted L + S	0.30	Warranted Light	.37
		Warranted Sound	.37
		- ve Sound	.38
		+ ve Light	.41
		Control Light	.42
		- ve Light	.42
		Control Sound	.48
- ve L + S	0.31	+ ve Light	.41
		Control Light	.42
		- ve Light	.42
		Control Sound	.48
+ ve L + S	0.32	+ ve Light	.41
		Control Light	.42
		- ve Light	.42
		Control Sound	.48
Control L + S	0.34	+ ve Light	.41
		Control Light	.42
		- ve Light	.42
		Control Sound	.48

Note: Significant level = .05.

two grades have no apparent hierarchy (see Table 14). The second grade, on the other hand, shows far more stability in performance. Eight of the top nine places in the ranked means are taken by the second grade; only the first grade warranted group differs from the pattern (they ranked sixth in the mean scores).

The Analysis of Variance for the variables reinforcement type, grade, and stimulus type, shows that a significant variance does exist (see Table 15); but it is difficult to establish any clear pattern. There is significant variance with the L + S stimulus groups. The - ve reinforcement, warranted, and control second grade groups differ significantly from the kindergarten and first grade control groups for this stimulus type. Therefore, as far as the control groups are concerned, it would appear that grade is the prime cause of the variance in this set of results (see Table 16).

The interaction of the variables, reinforcement type, sex, and stimulus type, again brings out the lack of within-group variance for those groups having the L + S stimulus (see Table 17). The girls' groups with the sound stimulus exhibited significant within-group variance. The warranted, + ve, and - ve reinforcement types were significantly different from the control group at the .05 level (see Table 18). There was, however, no significant difference between the experimental groups. In the boys'

TABLE 14.--Duncan Multiple Range Test, ranked means by reinforcement type, grade, sex.

Entry	Mean
- ve second Boy	.28
Warranted second Boy	.29
+ ve second Boy	.31
Warranted second Girl	.32
Warranted first Boy	.32
- ve second Girl	.34
+ ve second Girl	.34
Control second Boy	.35
Control second Girl	.35
+ ve first Girl	.36
+ ve first Boy	.36
Warranted Kinder. Girl	.37
- ve first Boy	.37
Control first Boy	.38
Warranted first Girl	.38
Warranted Kinder. Boy	.39
- ve first Girl	.39
+ ve Kinder. Girl	.42
- ve Kinder. Boy	.42
Control first Girl	.43
+ ve Kinder. Boy	.43
Control Kinder. Boy	.46
- ve Kinder. Girl	.46
Control Kinder. Girl	.49

Note: Significant level = .05.

TABLE 15.--One-way analysis of variance, time by reinforcement type + grade + stimulus type.

Source of Variance	dF	SS	MS	F	P
Between categories	35	3.430	0.098	5.21	.0005
Within categories	697	13.115	0.018		
Total	732	16.546			

Dependent variable--time
Category variable--reinforcement type + grade + stimulus type

TABLE 16.--Duncan Multiple Range Test, time by reinforcement type + grade + stimulus type.

Entry	Mean	Entries which differ significantly from the left hand entry: Entry	Mean
- ve second L + S	0.25	Control first L + S	0.37
		Control Kinder. L + S	0.40
Warranted second L + S	0.26	Control first L + S	0.37
		Control Kinder. L + S	0.40
Control second L + S	0.27	Control first L + S	0.37
		Control Kinder. L + S	0.40

Note: Significant level = .05.

TABLE 17.--Duncan Multiple Range Test, time by reinforcement type + sex + stimulus type.

Entry	Mean	Entries that differ significantly from the left hand entry	
		Entry	Mean
Warranted Boy, L + S	0.28	Warranted, Girl, Light	.36
		Warranted, Boy, Light	.37
		- ve, Boy, Light	.39
		Control, Boy, Light	.41
		Warranted, Girl, Sound	.41
		+ ve, Boy, Light	.41
		+ ve, Girl, Light	.42
		- ve, Girl, Sound	.42
		Control, Girl, Light	.43
		Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52
- ve, Boy, L + S	0.30	Control, Girl, Light	.43
		Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52
+ ve, Boy, L + S	0.31	Control, Girl, Light	.43
		Control, Boy, Sound	.43
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52
- ve, Girl, L + S	0.31	Control, Boy, Light	.41
		Warranted, Girl, Sound	.41
		- ve, Girl, Sound	.42
		Control, Girl, Light	.43
		Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52
Warranted, Girl, L + S	0.32	Control, Boy, Light	.41
		Warranted, Girl, Sound	.41
		+ ve, Girl, Light	.42
		- ve, Girl, Sound	.42
		Control, Girl, Light	.43
		Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52

TABLE 17.--Continued

Entry	Mean	Entries that differ significantly from the left hand entry	Mean
+ ve, Girl, L + S	0.34	Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52
Control, Boy, L + S	0.34	Control, Girl, Light	.43
		Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52
Control, Girl, L + S	0.34	Control, Girl, Light	.43
		Control, Boy, Sound	.44
		- ve, Girl, Light	.45
		Control, Girl, Sound	.52

Note: Significant level = .05.

TABLE 18.--Duncan Multiple Range Test, time by reinforcement type + sex + stimulus type.

		Entries that differ significantly from the left hand entry	
Entry	Mean	Entry	Mean
Control, Girl, Sound	0.52	Warranted, Girl, Sound	0.41
		+ ve, Girl, Sound	0.36
		- ve, Girl, Sound	0.42
Control, Boy, Sound	0.44	- ve, Boy Sound	0.34
		Warranted, Boy, Sound	0.34
Warranted, Girl, Light	0.36	Warranted, Boy, L + S	0.28
		Control, Girl, Sound	0.52
Warranted, Boy, Light	0.37	Warranted, Boy, L + S	0.28
- ve, Boy, Light	0.39	Warranted, Boy, L + S	0.28
		Control, Girl, Sound	0.52
Control, Boy, Light	0.41	Warranted, Boy, L + S	0.28
		- ve, Girl, L + S	0.31
		Warranted, Girl, L + S	0.32
		Control, Girl, Sound	0.52
+ ve, Boy, Light	0.41	Warranted, Boy, L + S	0.28
		Control, Girl, Sound	0.52
+ ve, Girl, Light	0.42	Warranted, Boy, L + S	0.28
		Warranted, Girl, L + S	0.32
		Control, Girl, Sound	0.52
Control, Girl, Light	0.43	Warranted, Boy, L + S	0.28
		- ve, Boy, L + S	0.30
		+ ve, Boy, L + S	0.31
		- ve, Girl, L + S	0.32
		Control, Boy, L + S	0.34
		Control, Girl, L + S	0.34
		Control, Girl, Sound	0.52

TABLE 18.--Continued

Entry	Mean	Entries that differ significantly from the left hand entry	
		Entry	Mean
- ve, Girl, Light	0.45	Warranted, Boy, L + S	0.28
		- ve, Boy, L + S	0.30
		+ ve, Boy, L + S	0.31
		- ve, Girl, L + S	0.31
		Warranted, Girl, L + S	0.32
		+ ve, Girl, L + S	0.34
		Control, Boy, L + S	0.34
		Control, Girl, L + S	0.34

Note: Significant level = .05.

case, the control group differed from the warranted and the - ve reinforcement, but not from the + ve group. The light stimulus groups showed little within-group variance, but were significantly different from many of the L + S groups (see Table 18).

Three important trends emerged in the second portion of the investigation. The largest part of the variance was attributed to the difference between control and experimental groups, as was expected. It would appear, the concepts of arousal may be useful in explaining the relationship between the level of speed for the control groups and those for the experimental groups.

After the standard instructions, the groups continued their twenty trials. The control group with no verbal cues may experience boredom and fatigue far earlier in the test than the experimental groups. It may be that any spoken word in relation to the test will have some arousal effect on the subject, hence the lack of significant difference between the experimental groups.

There was, however, a suggestion of a difference between the relative success of the + ve versus the - ve reinforcement type between the sexes. The girls who received the - ve reinforcement in the third five trials, followed by the + ve reinforcement in the fourth five, obtained the second slowest mean response. The boys, on the other hand, under the same conditions had the second

highest mean response. This would suggest that the girls' performance was adversely affected when confronted with the - ve reinforcement after the first ten trials. The boys were not adversely affected and even improved slightly on their mean of the first ten trials. This was the only result which shows a differentiation between the boys' and girls' performance.

The remaining important factor in the results was the apparent homogeneity of the kindergarten and first grade children's performance for a particular reinforcement type. These two grades obtained the same order of ranked means; and as a group, were significantly different from the second grade groups. As already reported, this was not the case when considering the effect of age or reaction time with no account taken of reinforcement type. The reason for this difference is open to conjecture. One possible reason is that by the time the child has reached the second grade, his rate of socialization is accelerating. He may be increasingly able to cope with the - ve reinforcement, as indeed the Duncan Multiple Range Test shows (see Table 16). (This is the only grade in which the - ve reinforcement has a faster response than the + ve, although not at a significant level.)

CHAPTER V

SUMMARY AND CONCLUSIONS

This experiment was designed to study the effects of various verbal reinforcement programs upon the simple reaction latencies of pre-pubertal children of both sexes.

With reference to research findings, the following hypotheses were advanced:

1. Reaction time responses decrease with age; (in this case between kindergarten and grade two).
2. There is no improvement in reaction time if no verbal reinforcement is given.
3. Positive verbal reinforcement is more effective than negative verbal reinforcement in reducing the subjects' reaction times.
4. The fact that males are regarded as having generally faster reaction times than females will be accentuated by the reinforcement programs (for a particular age level).
5. Reinforcement relating directly to performance, i.e., fast response warrants positive encouragement,

is more effective than a set pattern of encouragement or censure.

A secondary objective of this study was to determine what type of stimulus produced the fastest response for this age range.

To test the above hypotheses, a sample of three hundred and sixty-seven subjects was divided into sex-age groups and were assigned to an experimental group. Each subject was given twenty trials of a simple index finger lift response, after receiving one of three stimulus modes. The first ten trials were given with no verbal cues; the second ten trials were conducted according to the experimental group he or she was assigned.

The results of these experiments provide support for the general hypothesis that with an increase in age there is a corresponding increase in the speed of reaction time for this age range. The performance of the grades agreed with the traditional concept that the older children produce the fastest response. This is the case for both boys and girls. Thus, kindergarten girls have slower reaction times than first grade girls, and these in turn have slower reaction times than second grade girls. The boys were generally faster than the girls for each age group, but this was not at a significant level (see Table 3). From the results, it would appear that for a

particular age level, the boys and girls act as a homogeneous group. The major differences in reaction time performance arose as a result of differences in age. Possibly the physiological-psychological mechanisms needed to produce a reaction response are at a similar stage of development for boys and girls at this early age. As Pierson and Montoye [20] point out, possibly in two or three years, the boys will improve their reaction time significantly faster than the girls.

The effect of the L + S stimulus type on the sex-age groups was clearly significant. As already reported, the L + S stimulus provoked a significantly faster response than the other two stimulus modes. Both the boys and girls produced their fastest response when stimulated by the combination of the light and sound stimuli (see Table 7).

Stimulus complexity appears to enhance a subject's reaction time in relation to the simple light and sound stimuli. Even at this early stage of motor development, there was no confusion concerning the response to more than one stimulus mode presented simultaneously. The difference between the simple light and sound stimuli on the performance of the subjects proved inconclusive at all age levels studied.

The results of this experiment provides support for the general hypothesis that verbal reinforcement increases the speed of simple reaction time. All three

experimental groups had significantly faster responses when compared with the control group, which received no verbal cues of any kind.

No clear pattern emerged as to the relative success of the experimental groups. There was no significant difference between those subjects receiving the warranted, + ve or - ve reinforcement. However, for each sex, only the warranted group proved significantly different from the control groups. The Duncan Multiple Range Test for reaction time vs. grade also showed that the warranted group obtained the fastest response for the kindergarten and first grade, but this was not at a significant level. The results suggest that in the kindergarten and first grade, the reinforcer "good" following a fast response by the subject, tended to keep the subject's responses close to his or her maximum speed. Similarly, if the subject's response speed fell below that of the mean of the first ten trials, the mild censure brought the response speed up to that of the mean value for the subject's first ten trials.

The results were that the girls' performance was adversely affected by negative reinforcement. The boys, on the other hand, improved on the mean of their first ten trials (although not at a significant level).

From the results of this study, several avenues are open for further research. Social status and its

interaction with reinforcement in the production of a reaction time, would seem a logical progression from the experiment described in this study. It seems that social and ethnic background may well have an effect on the way a subject reacts to a positive or negative reinforcement. In order to make a study feasible, it would be necessary to draw a small N from a variety of ethnic and social backgrounds. Firstly, the degree of socialization achieved and the psychological make-up of each subject, would have to be studied; then a test of their responses to a verbal reinforcement program could be conducted. In addition, the socio-psychological status of the subject could be correlated with the effectiveness of the reinforcement programs.

Similarly, experiments using verbal reinforcement could be adapted to studies involving more complex motor skills where movement time and reaction time are measured. Such a study could have more practical value to physical educators who are teaching young children.

In conclusion, the observed relationship between verbal reinforcement and reaction time has the likelihood of contributing to a more satisfactory theory of social reinforcement of children's behavior.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Ausubel, D. Theory and Problems of Child Development. New York: Greene and Stratton, 1958, p. 509.

2. Botiwinik, J. and Thompson, L. W. "Components of Reaction Time in Relation to Age and Sex." Genetic Psychology, 1966, Vol. 108, pp. 175-183.

3. Colgate, T. P. "Reaction Times of Individuals Reacting to Auditory, Visual, and Tactile Stimuli." Research Quarterly, 1968, Vol. 39, pp. 783-785.

4. Crow, A. and Crow, L. Child Psychology. New York: Banes and Noble, 1959, p. 34.

5. Elbel, E. R. "A Study in Variation in Response Times." Research Quarterly, 1939, Vol. 10, pp. 49-50.

6. Goodenough, F. L. "The Development of the Reactive Process from Early Childhood to Maturity." J. Exp. Psychology, 1935, Vol. 18, pp. 431-450.

7. Greenspoon, J. "The Reinforcing Effect of Two Spoken Sounds of the Frequency of Two Responses." Am. J. of Psych., 1955, Vol. 68, pp. 409-416.

8. Havighurst, R. J. Human Development and Education. New York: Longmans, 1953, p. 139.

9. Hodgkins, J. "Reaction Time and Speed of Movement in Males and Females of Various Ages." Research Quarterly, 1963, Vol. 34, pp. 454-461.

10. Holden, E. A. "The Effects of Rest, Reprimand, and Reward on Simple Reaction Time in Educable Retardates." Am. J. of Mental Deficiency, 1966, Vol. 1, pp. 427-432.

11. Jones, H. E. "Reaction Time and Motor Development." Am. J. of Psych., 1937, Vol. 50, pp. 181-194.

12. Lewis, R., Aikan, B., and Lichtenstein, M. "Reaction Times to Regularly Recurring Visual Stimuli." Perception and Motor Skills, 1964, Vol. 18, pp. 713-720.

13. Mathur, V. K. "Sex Differences in Reaction Time." Indian J. of Psych., 1964, Vol. 39, pp. 31-34.

14. McCullers, J. C. and Stevenson, H. W. "Effects of Verbal Reinforcement in a Probability Learning Situation." Psychology Rep., 1960, Vol. 7, pp. 434-445.

15. Martinez, A. R. "An Investigation Into the Relationship Between Positive Verbal Reinforcement and Simple Reaction Time in Children." Ph. D. Thesis. University of Houston, 1966.

16. Norrie, M. L. "Practice Effects on Reaction Latency for Simple and Complex Movements." Research Quarterly, 1967, Vol. 38, pp. 78-85.

17. Owen, W. A. "Effect of Motivating Instructions on Reaction Time in Grade School Children." Child Development, 1959, Vol. 30, pp. 261-267.

18. Philip, B. R. "Reaction Times of Children." Am. J. of Psych., 1934, Vol. 46, pp. 379-396.

19. Pierson, W. R. and Montoye, H. H. "Movement Time, Reaction Time, and Age." J. of Geron., 1958, Vol. 13, pp. 418-421.

20. Pomeroy, J. E. "The Relationship Between Reaction Time and Intelligence." Child Development, 1938, Vol. 9, pp. 281-283.

21. Pugh, L. A. "The Effects of Praise, Censure, and Noise on Electrodemal and Reaction Time Measures in Chronic Schizophrenic and Normal Women." Ph. D. Thesis. University of Oklahoma, 1965.

22. Rarick, G. L. Motor Development During Infancy and Childhood. College Printing and Typing Co., Inc., Madison, Wisconsin, 1961, pp. 1-3.

23. Rarick, G. L. and McKee, R. "A Study of Twenty Third Grade Children Exhibiting Extreme Levels of Achievement of Tests of Motor Proficiency." Research Quarterly, 1949, Vol. 20, pp. 142-152.

24. Robinson, D. N. "Visual Reaction Time and the Human Alpha Rhythm: The Effects of Stimulus Liminance, Area, and Duration." J. of Exp. Psych., 1966, Vol. 71, pp. 16-25.

25. Ribenstein, L Intersensory and Intrasensory Effects on Simple Reaction Time, Perception, and Motor Skills, 1964, Vol. 18, pp. 159-172.

26. Ryan, T. J. and Watson, P. "Children's Response Speeds as a Function of Sex and Verbal Reinforcement Schedule." Psychoanalytic Sci., 1966, Vol. 6, pp. 271-272.

27. Shankweiler, D. P. "Effects of Success and Failure Instructions on Reaction Time in Patients with Brain Damage." J. of Comp. Physiol. Psych., 1959, Vol. 52, pp. 546-549.

28. Sheikl, A. A. "Response Speeds as a Function of Different Reinforcement Conditions and a Ready Signal." Child Development, 1967, Vol, 38, pp. 857-867.

29. Skinner, B. F. Verbal Behavior. Harvard University Press, 1948.

30. Spence, K. W. Behavior Theory and Learning. Prentice-Hall, 1960.

31. Vogel, P. "Battle Creek Physical Education Project." J. of Health, Physical Education, and Recreation, 1969, Vol. 40, pp. 25-29.

32. Willgoose, C. E. Evaluation in Health, Education, and Physical Education. McGraw-Hill, 1961, pp. 15-16.

APPENDIX

APPENDIX

RAW DATA PRINT OUT--EXPLANATION OF CODE BY COLUMNS

Column 1	Subject Number
Column 2	Grade - 0 = Kindergarten; 1 = 1st Grade; 2 = 2nd Grade
Column 3	Sex - 1 = Boy; 2 = Girl
Column 4	Mean of 1st 5 trials in 1/100th's of a second
Column 5	Mean of 2nd 5 trials in 1/100th's of a second
Column 6	Mean of 3rd 5 trials in 1/100th's of a second; Control, Experimental Groups 3 and 4
Column 7	Mean of 4th 5 trials in 1/100th's of a second; Control, Experimental Groups 3 and 4
Column 6	Mean of 3rd 5 trials in 1/100th's of a second; Experimental Group 1
Column 7	Mean of 4th 5 trials in 1/100th's of a second; Experimental Group 1
Column 8	Deck Number

Column 9	Stimulus Type - 1 = Light; 2 = Sound; 3 = Light + Sound
Column 10	Reinforcement Type - 1 = Control; 2 = Experimental Group 1 (Warranted); 3 = Experimental Group 2A (+ ve); 4 = Experimental Group 2B (- ve)

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