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The purpose of this study was to determine if there was a significant difference in performance of a simple reaction time task when executed by subjects who voluntarily selected their preferred sensory modality as a channel to receive augmented feedback and subjects who were assigned a sensory modality through which to receive feedback. The subjects were 45 volunteer women physical education majors enrolled at The University of North Carolina at Greensboro during the 1973 spring semester. The subjects were divided into three groups of 15 subjects each. Group I elected to receive auditory feedback. Group II elected visual feedback. Group III, the control group, was assigned either auditory or visual feedback. Each group received 10 practice trials followed by 50 test trials. The scores used in the analysis were the mean of the first five test trials, trials 1-5, compared with the mean of the last five test trials, trials 46-50. A one-way analysis of variance indicated that there were no significant differences among the scores of the three groups. On the basis of the analysis, it was concluded that subjects who selected an augmented feedback channel did not perform significantly different from those subjects to whom a modality was assigned. Within the limits of the study, it was concluded that subjects perform equally well on a simple reaction time task regardless of the modality through which feedback is received.

PERFORMANCE ON A SIMPLE REACTION TIME TASK

AS A FUNCTION OF INDIVIDUALLY

SELECTED FEEDBACK

by

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Chapter I

Introduction

One of the primary areas of emphasis in the instruction of motor skills is how to learn motor skills most efficiently. A majority of teachers in the field of Physical Education are concerned with providing an environment conducive to effective learning and performance of motor skills. The concern of the author has been in the area of learning and performance of physical skills. More specifically, a look at one aspect of the learning process has been undertaken in this study to examine students' effectiveness in determining their own limitations.

Understanding information processing is vital to comprehension of how one learns most efficiently. A generally accepted fact is that man's ability to process information is limited by his ability to sense, attend to, process, store and transmit information. One of the elements involved in the processing of information is feedback, which is the phenomenon under consideration in this study.

Statement of the Problem

The purpose of this study was to determine if there was a significant difference in performance of a simple reaction time task when executed by subjects who voluntarily selected their preferred sensory feedback modality as a channel to receive augmented feedback and subjects who are assigned a sensory modality through which to receive augmented feedback.

The following hypotheses were tested:

1 $H_o : U_1 = U_3$

2 $H_o : U_2 = U_3$

Null hypothesis 1 is to determine that there is no significant difference in experimental Group I (auditory feedback) and control Group III (assigned feedback).

Null hypothesis 2 is to determine that there is no significant difference in experimental Group II (visual feedback) and control Group III (assigned feedback).

Definition of Terms

Performance: Phenomenon which may be thought of as a temporary occurrence, fluctuating from time to time because of many potentially operating variables. (Singer, 1969)

Learning: Defined as the relatively permanent change in performance or behavioral potential resulting from practice or past experience in the situation. Learning must be inferred on the basis of observations of change in performance. (Singer, 1968)

Feedback: Phenomenon which provides the information with which to compare output to a reference or standard established by the experimenter, teacher or learner. (Robb, 1972a)

As a result of the abundance of studies carried out dealing with feedback, many definitions of feedback abound, not to mention the terminology used interchangeably with feedback. Frequently found in print are reward, knowledge of results and reinforcement, to name but a few. For the sake of clarity and precision the author has selected to use the term feedback throughout the study and to set forth an explanation of the word.

The writer interprets the intent of feedback to make available information as to appropriate adjustment or modification of behavior, it provides error information. It is a reference from which performance can be compared and regulated.

Knowledge of Results: A form of reinforcement, for the individual is informed as to the correctness or incorrectness of his response. This information may come from an external source, e.g., the teacher, or from the person's own performance on a skill in which he knows right from wrong. (Singer, 1968)

Internal Feedback: Information received from receptor organs that are stimulated by the action of the body itself, i.e., proprioception. (Robb, 1972a)

Intrinsic Feedback: Information inherent in a task, information specific to a task. (Annett & Kay, 1957)

Augmented Feedback: Information which is given, generally by the teacher, to supplement the information contained in the task. (Robb, 1971)

Terminal Feedback: A summary score or error information given at the end of a specified performance. (Robb, 1971)

Delayed Feedback: Feedback, often termed distorted, that does not arrive concurrently with performance, a time lag is often involved before feedback is presented. (Fitts & Posner, 1967)

Auditory Augmented Feedback: Feedback, which is received by the subject in the form of a sound, i.e., a tone or buzzer.

Visual Augmented Feedback: Feedback, which is received by the subject in the form of a light or visual stimulus, i.e., a red or green light.

Simple Reaction Time: The elapsed interval of time from the presentation of a single stimulus to the initiation of a single response. (Singer, 1968)

Assumptions

Certain assumptions were made before investigation of the problem was initiated. Included was the fundamental premise that man is capable of processing information and has decision making aptitudes. Essential to the study was that feedback is an important variable controlling performance and learning. Contained in this control of performance of learning, feedback has properties of motivating, reinforcing and/or regulating behavior. Other basic assumptions to the problem were that subjects' responses to selection of feedback preference were honestly given. The output by the subjects was the best possible effort over the duration of the study was another assumption. A final assumption was that the subjects had normal limited of visual and auditory sensory acuity.

Scope of the Study

Several factors set the limits for the present investigation. The study was conducted during the spring semester, 1973, at The University of North Carolina at Greensboro, involving a sample of 45 undergraduate women as subjects and the author as the tester. A limitation of the study was the nature of the task, simple reaction time, and the instrumentation involved. The lack of control of measurement over the variable of intrinsic feedback was another important element. The author acknowledges that due to the stated limitations, generalizations cannot be made to a larger population.

Significance and Justification of the Study

Teachers of skill acquisition know that individuals differ in the manner in which they process and assimilate information. (Lawther, 1968) Knowing that individuals' learning strategies differ, the most effective methods of presenting material will also differ, depending on the task and the student. Some students learn most efficiently from verbal cues and guides. Hints and suggestions from the instructor are quickly acted upon and successfully applied by such students. Others may depend more on visual guidance as a method of learning. They profit more from demonstrations which provide a picture of the movement or skill desired. (Murphy, 1962) It is necessary to understand how man operates in order to comprehend the execution of a skill. Therefore, a responsibility of the instructor of skill acquisition is understanding the learner's capacities and limitations of processing and assimilating information. (Robb, 1972a)

Interest for the present study was initiated during work on two previous studies involving one aspect of information processing and its effect upon learning. The phenomenon under investigation was feedback and its role in learning and performance.

Fitts and Posner (1967) state that organization, goal directedness and utilization of feedback are the basic characteristics of skilled performance. Skills are an organized sequence of goal-directed responses. Information is constantly transmitted throughout the organism arising from the current response, previous response, and consequences of responses made on the environment. These sources of information are termed feedback.

Feedback has been labeled one of the most important elements in learning. Two noted learning psychologists, Bilodeau and Bilodeau (1969) state that "feedback is the most important variable controlling performance and learning (p. 261)." Another researcher, Wiener (1961), further suggests that feedback is an essential element in the control of human movement. Annett (1969) terms feedback, or knowledge of results, as it is often called, a feature general to all learning. Most recently (1973), Rushall and Siedentop comment that manipulation of feedback is the most effective manner of controlling behavior.

There has been an extensive amount of research conducted in past years dealing with feedback. Research efforts have differentiated types and kinds of feedback, among which are: action, learning, intrinsic, artificial, concurrent, terminal, immediate, delayed, non-verbal, verbal, separate and accumulated. (Holding, 1965) However, among the vast number of studies involving feedback, none could be located which dealt with the issue to allowing the subject to select his own preferred feedback channel.

Referring to the fact that we know there are individual differences in learning, the author postulated that there must also be differences in feedback preference. The attempt of this study was to allow students to select their preferred feedback modality and analyze the subsequent performance.

Chapter II

Review of Literature

Reaction Time Research

Time is a concept that pervades throughout all aspects of life. All movement requires the consideration of space, energy and time. Timing is vital to the initiation of movement and the sequential ordering of movement. The development of timing occurs as one learns how movement relates to other movement.

The ease of measurement of time, range of applicability of time, and control of time lends itself to extensive analysis. Because time is easily applied to concepts related to movement, it has become an often studied phenomenon, particularly in the fields of behavioral science and education.

One aspect of time, reaction time, has been defined as the passage of time between the presentation of a stimulus and the beginning of a response. (Drowatzky, 1975) This particular measure of time has been utilized extensively in experiments in physical education.

The study of reaction time began approximately 125 years ago. Hermann vonHelmholtz studied the speed of neural impulses to travel at the rate of 50-100 meters per second in the human body. Fitts and Posner (1967) conclude from this and other studies that reaction time itself causes most of the delay in central processing, not the transmission of the impulse in the nervous system.

An astronomer, by the name of Bessel (Bilodeau, 1969) investigated the differences in measurements of time taken by fellow astronomers. He attributed the differences in measurement to processes within the individual observers. Bessel further observed that response times decrease with increased illumination of stars, and that response times increased with an increase in the delay of an event's occurrence.

As more research was carried out, the need for more reliable and standardized equipment was obvious. Some influential and noted classical researchers in the study of reaction time are: Hirsch, Donders, Exner, Wundt, Cattell, Kulpe, Pierson, and Hipp. (Woodworth and Schlosberg, 1963) More recent experimenters are Fleishman (1954), Henry (1961), Teichner (1954), and Woodworth and Schlosberg (1963). These five men have compiled extensive works on studies dealing with reaction time.

There are many factors which affect an individual's reaction time. One of the most important factors which was under consideration in designing this study was the stimulus to initiate the reaction time. The sensory modality which is stimulated in order to initiate the response has been investigated thoroughly. Cattell (1947) determined that each sensory modality stimulated produced a difference in response time. Reaction to an auditory stimulus produces the fastest reaction time, down to a speed as low as .140 milliseconds, visual stimulation is somewhat slower, as high as .180 milliseconds. Stimulation of other modalities such as touch, taste and smell produce increasingly higher response times. Rangazas (1957) verified Cattell's finding that reaction to sound is faster than reaction to light.

Cattell (1947) also verified the fact that the intensity of the stimulus causes change in the speed of reaction time. The more intense the stimulus, the faster the response; conversely, the weaker the stimulus, the slower the response. Rangazas (1957) supported this claim, as do Woodworth and Schlosberg (1963).

Another factor having an effect on learning is the amount of practice by a subject. Woodworth and Schlosberg (1963) state that average subjects continue to improve their response times over several hundred trials spaced over several days; however, the improvement is not large after the first 50-100 trials. Some researchers have found an improvement of 10 per cent after one day of testing has occurred.

The variable of a preparatory period before the presentation of the response stimulus has produced varying research. Researchers have well established that if the preparatory period is too short, then the subject will not be ready to respond to the stimulus; however, if the preparatory period is too long, the subject's readiness will be lost. One field of thought well documented with testing conditions similar to those employed in this study is one adhering to a preparatory stimulus 1-4 seconds before the response.

Cattell (1947) suggests a period of 2-4 seconds following the stimulus as the period for maximum response times. Woodworth and Schlosberg (1963) favor a preparatory period of about 2 seconds, slightly varied from trial to trial to prevent the subject from learning to anticipate the cue. Telford (1931) found a time between 1-2 seconds was optimal for fast response times. Breitwieser (1911) found 1-4 seconds to produce the fastest response times. Woodrow (1915) verified the results of Breitwieser's study and agreed with a time of 2-4 seconds to produce maximum readiness. He also favored varying the preparatory time to check against learning to anticipate the signal. This study by Woodrow is a classic in studies of the preparatory period for reaction time.

There are many other factors which also have an effect upon response time. Among those are age, sex, task complexity, mental ability, alcohol, drugs, motivation, and the physical condition of the body. Concise summaries of the research for these variables can be found in Singer (1970), Drowatsky (1975), and Oxendine (1968).

In summary, there exists an extensive amount of research on reaction time and the variables which affect it. The purpose of this review of literature was to set forth a basis from which this experiment was conducted and where the rationale for the conditions in the testing situation were obtained. It must be recalled, however, that reaction time was only the means by which the dependent variable, feedback, was investigated.

Feedback Research

The feedback literature reviewed for this study was selected in an attempt to illustrate the important role of feedback in performance and learning. The study of feedback, or knowledge of results, was initiated as was most of the research concerning educational principles, by those in psychology. Feedback has been under investigation since the turn of the century and the thrust of feedback research has taken different directions several times.

There is considerable evidence in the literature that feedback improves performance and learning in many perceptual-motor skills. One of the earliest studies was conducted by Judd (1905). He found subjects involved in learning to hit an underwater target lost interest in their performance when not provided with a knowledge of results.

The effect of knowledge of results on performance was further examined in (1938) by Elwell and Grindley. The task was was learning a two-handed movement to direct a spot of light onto the bullseye of a target. Knowledge of results consisted of seeing the beam of light in relation to the target after the movement had been completed. Under the condition of absence of knowledge of results, the beam remained off and the subject was unable to see what part of the target he reached. Analysis showed that knowledge of results led to an improvement in three ways: it caused a tendency to repeat successful actions; it caused a tendency to correct unsuccessful actions in the appropriate direction; and it resulted in an attitude that was conducive to accurate performance. Removal of knowledge of results produced an attitude that was not favorable for accurate performance, and did, in fact, lead to a deterioration in performance.

Later, Grindley (1948) co-authored another study with MacPherson and Dees in which they continued to study the effect of feedback on simple motor skills, such as: line drawing, timed key pressing, lever pressing and timed lever pressing. They concluded that a knowledge of subjects' results improved performance scores in all the tasks and a lack of knowledge of results led to lower scores.

The latter two studies mentioned are typical of studies involving simple tasks and the effect of knowledge of results on performance and learning up to the time of the 1950's. At about this time many tracking studies began to predominate the feedback literature.

Seashore, Underwood, Houston, and Berks (1949) engaged in a gunnery tracking study in which augmented knowledge of results was provided subjects after performance. It was noted that the group receiving the knowledge of results performed better than the control group in their tracking task.

Further investigation by Morin and Gagne (1951) undertook to examine influence of type and amount of knowledge of results in a gunnery tracking task similar to that used by Seashore, Underwood, Houston and Berks (1949). These authors concluded that results may depend on the usefulness of knowledge of results supplied to subjects, depending on the task and the subject's ability to utilize the information.

Bilodeau (1951) and (1954) noted from two tracking studies similar to those previously cited that enhanced performance resulted from knowledge of results supplied to subjects. He also noted that performance proficiency disappeared when knowledge of results was eliminated.

Goldstein and Rittenhouse (1954) carried out a study involving the effect of knowledge of results on a tracking task. By this time, it was clearly established that knowledge of results improved performance. Variations of types and frequencies of knowledge of results were not being studied. This study presented knowledge of results concurrently during the tracking task or terminally after the task. The scores varied in treatments but were not significantly different. This was contributed to inherent knowledge of results, not the task itself. Speculation may be offered here that the nature of the task was not one which allowed for significantly different results. Armstrong (1970) reviewed similar studies and his analysis was that the effect of concurrent knowledge of results on tracking apparatus would affect performance but not learning.

Reynolds and Adams (1953) performed an experiment with the pursuit rotor in which they found all groups receiving augmented knowledge of results performed consistently better than control groups. In 1958, Archer and Namikas attempted to replicate the results obtained by Reynolds and Adams (1953). Although their research design was slightly different, Archer and Namikas concluded that augmented knowledge of results in addition to the visual feedback normally available in pursuit rotor tracking was not an effective variable in performance.

Later Bilodeau and Rosenquist (1964) attempted to solve the conflicting results in the later two studies. Their scores agreed with Archer and Namikas (1958) that rotary pursuit is not sensitive to supplemental knowledge of results, above and beyond that already available in the task itself.

In the latter part of the 1950's, the number of significant studies involving the effect of knowledge of results on motor tasks increased. All of the studies arrived at the same conclusion that knowledge of results is an essential variable in successful performance and learning of skills.

Until the 1960's and even in many studies today, the term knowledge of results predominated in the writing. However, a few researchers began to use the term feedback in place of knowledge of results during the late 1950's and 1960's. The term feedback was introduced by Norbert Wiener (1949) in explanation of cybernetic theory. Many engaged in educational research have dealt with knowledge of results and feedback synonymously but as the terms have evolved they have acquired different meanings.

Knowledge of results involves information regarding the correctness or incorrectness of the outcome of a response that is based either upon standards set by an external course such as a teacher or experimenter, or upon an individual's internalized standards. It may be in the form of verbal information, visual confirmation of accuracy, speed or some other criterion, or through the feel of a successfully completed movement. (Cratty, 1967)

Feedback has been defined by Wiener (1961) as:

> . . . when we desire a motion to follow a given pattern the difference between this pattern and the actual performed motion is used as new imput to cause the part regulated to move in such a way as to bring its motion closer to that given by the pattern. (p. 6)

Most individuals agree with the definition set forth by Wiener and regard feedback as error information. It provides information from which an output may be compared to an established standard. Essentially, the difference between knowledge of results and feedback is that feedback encompasses a larger concept of error information or response proficiency. Feedback is not limited to type, frequency or time of arrival. Knowledge of results arrives after a response and involves only a correct or incorrect indication of how a subject performed.

During the 1960's there was an attempt by psychologists to set feedback in a more encompassing learning theory. The concept of feedback was regarded as essential to learning and performance.

Wiener (1961) stated that feedback is a very essential component in the control of human movement and behavior. Bilodeau and Bilodeau (1961) (1966), agree with Wiener in the importance of feedback:

> Studies of feedback or knowledge of results show it to be the strongest, most important variable controlling performance and learning. It has been shown . . . . that there is no improvement without knowledge of

> results, progressive improvement with it, and deterioration after its withdrawal. (1966: 214)

Other respected psychologists, Fitts and Posner (1967), state that organization, goal directedness, and utilization of feedback are basic characteristics of human skilled performance. Feedback often takes the form of a comparison between what was actually achieved with what was intended. The results of the comparison are then used to direct further organized responding toward achieving the goal.

It is now generally accepted that feedback influences human learning by serving to either motivate, reinforce and/or regulate behavior. It regulates providing moment-to-moment direction necessary to reorganization of the response. It reinforces by rewarding a successful response with information which serves to increase the probability of repeating a like performance. It motivates by providing incentive for further performance. (Robb, 1972)

Previously, research had been carried out as to the several roles of feedback. However, Holding (1965) presented a valuable classification of specified types of feedback which allows for a more clearcut definition of feedback. Holding draws from Miller's (1953) earlier breakdown of action and learning feedback, and uses this distinction as a point from which further divisions may be made. Action feedback is information which involves the changing state of an attempt to produce a limited response; it may not be a permanent change. Learning feedback, however, does imply a stable change in behavior.

Holding begins with knowledge of results as intrinsic, internal, or artificial, augmented. Intrinsic is defined as being inherent in a task, artificial knowledge of results defined as being extra information supplied from outside the task. Artificial or intrinsic feedback may be concurrent or terminal. The distinction between these terms is the time of presentation of the feedback, while the response is taking place (concurrent), or after the response has been completed (terminal). Terminal and concurrent may in turn be separated into verbal or non-verbal, words or scores (verbal) or in the physical form as pointers or buzzers (non-verbal). The final breakdown Holding presents is separate feedback or accumulated, having the property of single (separate) or a number of presentations (accumulated).

There have been other attempts at classifying feedback. Adams (1964) used the terms reinforcing and regulating feedback. Mowrer (1960) used passive and active avoidance learning in place of feedback. However, the breakdown presented by Holding seems the most encompassing. Bilodeau (1966) preferred in her writing to use the term "Information feedback: to simple "feedback." Smith and Smith (1966) used the term dynamic sensory feedback to describe interaction of information and self-regulatory movement. It is due to the extensive terminology involved in feedback research that confusion occurs.

Robb (1972) sums up the feedback research by stating factors that affect feedback are: the stage of the learner, the arrival time of the feedback, and the task to be learned. Robb states that subjects learning a new task need less feedback and do not profit from as much additional information as do subjects in later learning stages. The importance of the timing of the feedback is affected by the nature of the task. Without certain types of concurrent sensory feedback, performance in some tasks will be disrupted; other tasks profit more from immediate terminal feedback. Feedback must be specific to the task to be learned, and it must be useful to the learner, Robb states.

Until relatively recently, the late 60's and 70's, there have been few studies conducted in the field of Physical Education in which specific skills have been carefully examined with respect to feedback. A small number of studies in the late 1960's have dealt with the issue of video-tape replay and its purpose in the classroom which is an encouraging step in the right direction. On the other hand, there is one feedback area in particular that Physical Educators would like to study, and that is internal feedback or proprioceptive functions. This is an extremely difficult concept to measure or control because adequate devices are not at hand as yet. Cost and complexity of tools is one inhibiting factor, yet paradoxially there is the need for more sophisticated machines also.

Research efforts have been especially limited in looking at sensory modes through which individuals receive feedback. Demonstration, verbal explanation, and trial and error are the three major teaching devices, yet little is known about which modality is of maximum effectiveness in particular circumstances. Many psychologists refer to specificity in tasks and infer that all tasks are specific, or that each different skill may require very specific teaching techniques. (Lawther, 1968; Robb, 1972; Glencross, 1970) If that is true, then research efforts may be redirected to solving corresponding problems.

There is little doubt that feedback is vital to performance and learning, as has been cited throughout the literature. As pointed out by Robb (1972), there is a need for further study concerning the most efficient methods for training individuals to perform a memorized pattern. Modes and types of feedback need to be carefully defined and described. Task specific feedback, especially should be identified for its role in the execution of various skilled movements.

Feedback research in the future must attempt to determine which type of cues are most effectively utilized by the subject. It is clear that feedback must be in useful form to the subject. He must have feedback that is meaningful and provides information concerning what modifications to make, and at the level in the system they are to be made. (Glencross, 1970)

The effective teacher of Physical Education must be able to recognize the limits of his students' abilities to incorporate information. He must be able to transmit information by various channels to different individuals to ensure that the student is able to utilize the information. Feedback is one very important aspect of teaching and learning. It is the duty of the instructor to understand the concepts involved in this aspect of learning.

The future of feedback research is growing rapidly with the use of specialized investigators and modern research techniques available. There are many avenues left to study, and there remains an essential need for man to study feedback to ensure most efficient functioning.

The present study undertook to examine feedback in a manner that has not specifically been investigated. The purpose of this study was to determine if allowing subjects to select their preferred type of feedback, as opposed to assigning feedback, would significantly alter performance.

Chapter III

Procedures

This study explored the difference in performance of a simple reaction time task between subjects who voluntarily selected their preferred sensory modality as a channel to receive augmented feedback and subjects who were assigned a sensory modality through which to receive feedback.

Pilot Study

A pilot study was conducted one week prior to the actual testing of subjects participating in the experiment. The purposes of the pilot study were to determine the effectiveness of testing techniques, to calibrate instrumentation, to perfect the recording of data, and to standardize the administration of feedback. The subjects for the pilot study were eight graduate students enrolled at The University of North Carolina at Greensboro for the spring semester 1973. Each subject was given 10 practice trials and 50 test trials. All responded within the normal time range determined by Woodworth and Schlosberg (1965). Normal reaction time to a simple reaction time task has been found to be in the range of .150 - .250 seconds. There was no difference in the scores of those who selected a feedback channel and those who were assigned a channel. When asked if the feedback seemed to be significant to the speed of their response, all responded affirmatively. There were no significant changes in testing techniques as a result of the pilot study. Beneficial effects of the pilot study were that it acquainted the tester with recording data, administering feedback efficiently and resetting the equipment.

Selection of Instruments

The apparatus selected for this study consisted of a simple reaction time instrument, a timing device and feedback apparatus. The instrumentation was chosen because it would best facilitate investigation of the problem.

Lafayette Instrument Company, Model 63030 simple reaction time apparatus was utilized throughout the study. This reaction timer is designed for use with an external timer to measure simple reaction time. It is equipped with two lights for visual stimulation, a red and a white light. It has one buzzer for auditory stimulation and one response key. The unit has two parts, enabling the tester to separate herself from the subject, which eliminates the possibility of a cue prior to testing. Measurement of the reaction time was carried out by use of a timing apparatus, an electronic clock counter, Model 54014, Lafayette Instrument Company.

The feedback was delivered to the subject manually by the tester from a panel adjacent to the testing apparatus. Visual feedback was in the form of a red light or a green light. The lights were mounted on the top of the black shield facing the subject. Auditory feedback was in the form of a tone or a buzzer.

The auditory apparatus was built inside the shield, it was not visable to the subject.

The apparatus was mounted on a laboratory table, the top of which was 36 inches from the floor. The reaction timer was covered with a cardboard shield, painted black to reduce distractions of structure of the instruments. All that was visible to the subject was the response key, the lights for visual feedback and the black shield. The subject sat in a chair facing the shielded apparatus, out of view of the tester. The chair was fixed to the floor by means of four wooden moldings taped firmly to the floor around the base of the chair legs. This was to ensure that the subject could not move the chair or change her position relative to the response key. No other persons were present during the testing.

Figures 2 - 4 are diagrams of the testing area and apparatus. (See Appendix)

The instructions were given to all subjects on printed instruction sheets prior to testing. Time was given to the subject to read the instructions. (See Appendix) The instructions included the object of the study, the goal of the task, the directions subjects were to follow, the time periods of practice, rest and testing trials. The feedback element of the experiment was emphasized. The written instructions ensured that all subjects received like treatment.

Selection of Subjects and Division into Groups

Subjects were originally to be randomly selected by alphabetizing and using a table of random numbers to choose approximately 46 - 50 from a pool of 500 undergraduate women students who were residents of Cone Dormitory, a residence hall on the campus of The University of North Carolina at Greensboro. It proved to be impractical to continue this method of selection as only one person from the first 50 polled was willing to be a subject.

The actual subjects of the study were 45 undergraduate women Physical Education majors who volunteered when solicited personally by the tester.

After each subject read the instructions to herself, she was given the 10 practice trials. The odd numbered practice trials (1, 3, 5, 7, 9) were given auditory feedback, while the even numbered practice trials (2, 4, 6, 8, 10) were given visual feedback. Following these practice trials, 30 of the subjects chose which one type of feedback they preferred to receive for the remainder of the study.

Subjects were tested until there were the same number of subjects preferring auditory feedback (15) as preferring visual feedback (15). Subjects tested after the auditory and visual groups were completed were automatically assigned to the control group. If the subject indicated no preference, she was assigned to the control group. Eight of the control subjects were assigned auditory feedback for the duration of the study, the other seven subjects in the control group were assigned visual feedback throughout. There were 15 subjects in each of the three groups. Thirty of these subjects had selected the type of feedback they desired, auditory or visual. The other 15 subjects in the control group were allowed no preference but assigned one type of feedback. All groups received the 10 practice trials and the same number of test trials (50). All subjects were tested in the same manner.

Description of Task

Performance on the simple reaction time task was the dependent variable. Reaction time was used as the mode by which the independent variable, feedback, was studied. Reaction time was not the phenomenon under examination but only the medium through which the results of feedback were examined. The justification for the task was that control of variables are most easily facilitated in a laboratory.

The test consisted of a simple reaction time task. The subjects read the instructions and participated in the practice period. They then either selected the preferred type of feedback or were assigned the type of feedback they would receive for the remainder of the testing period. Justification for printed instructions was to ensure consistency throughout the study. Justification for a practice period was to determine feedback preference and to ensure equal size groups.

The tester gave a preparatory cue of "Ready" followed by an auditory stimulus, in the form of a buzzer, following from 1.5 to 3.5 seconds after the verbal cue. The subject's response was in the form of a key depression. Justification for one stimulus, auditory, was that intensities of two different stimuli, visual compared with auditory, could not be equated. Justification for an auditory stimulus was that auditory stimuli have been found to produce the fastest reaction time. (Singer, 1968) Justification for varying the preparatory period from 1.5 to 3.5 seconds was to ensure against student's learning to anticipate a set time period prior to stimulus presentation.

Feedback was administered manually by the test administrator following the subject's response. The administrator checked the subject's response time, determined if it was fast or slow, and administered appropriate feedback. The time taken to administer the feedback was determined by the efficiency of the tester during the pilot study. During the actual testing, it took the tester from .5 to 2.5 seconds to check the subject's response time in relation to the fast-slow criterion, and administer the appropriate feedback to the subject.

Feedback occurred in one of two forms. The visual feedback was delivered in the form of two colored lights: red for a slow response time, and green for fast response time. The other type of feedback, auditory, also occurred in two forms: a tone for a fast response time, and a buzzer for a slow response time. The duration of the feedback was two seconds. Justification for the color choices was that the color red carries with it the connotation of a warning; many road signals of this color mean to stop or slow down. The color green, however, seems to denote all is clear, to go ahead. The auditory feedback justifications were theses; the buzzer had a harsh, lound sound compared with the tone, which was a lighter, more pleasant sound.

After administration of feedback, there was a rest period of ten seconds between trials. During this time, the tester recorded the previous score and reset the equipment.

All subjects sat in the chair with their dominant arm resting on the edge of the table directly in front of the response key. The subject's forefinger was to remain on the edge of the reaction timer, in front of the key, except when the auditory stimulation was administered and theywere to depress the key.

Scoring of the Task

The limits for scoring of the task were verified by scores obtained in the pilot study. The levels of fast versus slow response times were compared with those response times set forth on a simple reaction time task. (Woodworth and Schlosberg, 1965). Times of .150 - .200 seconds were considered fast response times, +.200 was slow. Justification for these limits were congruent with the fact that .150 - .250 was considered the normal range for reaction time. (Woodworth and Schlosberg, 1965)

Feedback appropriate to the subject's response time was administered following a response. A red light flashed if the response time was slow (+.200), a green light if the time was fast (.200 or under), or a tone sounded if the response time was fast (.200 or under), or the buzzer buzzed if the time was slow (+.200) seconds. Subjects received only one of these mediums, light or sound, throughout the test period of 50 trials.

The subject's individual performance score was the difference between the mean of the first five scores, trials 1 - 5, and the mean of the last five scores, trials 46 - 50. This was the score utilized in the analysis.

The group's score was the mean of all 15 subjects' scores. This score was compared with the means of the other two groups.

Testing Procedure

Subjects were tested on two separate days. The practice period of 10 trials and 25 test trials were administered the first day and 25 trials the second day. Justification for 50 trials was that the amount of improvement in simple reaction time continues over several hundred trials, however, the amount is not large after the first 50 trials. (Woodworth and Schlosberg, 1965)

Subjects were tested in one set of two-day blocks: Monday, Wednesday; or Tuesday, Thursday. The days testing was conducted were April 9, 11; 10, 12; 16, 18; 17, 19; 1973.

There were three groups of 15 subjects. Group I had an auditory feedback preference and Group III was assigned the modality through which they would receive feedback. The total number of subjects tested was 45.

The investigator carried out all the testing and recorded all scores on prepared score sheets. (See Appendix II) There were no malfunctions of any of the apparatus during the study.

Treatment of Data

The purpose of the analysis was to compare the scores obtained in the two experimental groups with those of the control group. To analyze the data obtained, a one way analysis of variance was computed.

To measure the learning that may have occurred, the mean of the first five scores was compared with the mean of the last five scores, Trials 1 - 5 with 46 - 50. This was done for every subject in the three groups. Then the group's score was compared to every other group; in this way all three groups were compared to each other. The .05 level of confidence was set as the criterion score to determine significance.

Chapter IV

Analysis and Interpretation of Data

The purpose of this study was to investigate if there was a significant difference in performance of a simple reaction time task when executed by subjects who voluntarily selected their preferred sensory modality as a channel to receive augmented feedback and subjects who were assigned a sensory modality through which to receive feedback.

Forty-five women Physical Education majors were divided into three treatment groups of 15 subjects per group. Subjects in Group I selected auditory feedback as their preferred sensory modality. Subjects in Group II selected visual feedback as their preferred sensory modality. Group III served as the control group. Eight of the control subjects were assigned auditory feedback for the duration of the study, the other seven subjects in the control group were assigned visual feedback throughout. Subjects in all three groups received 10 practice trials and 25 test trials the first day of testing, and 25 test trials the second day of testing.

Analysis

Two null hypotheses were formulated, and the .05 level of confidence was set as the criterion for determining whether or not the hypotheses were tenable. The two hypotheses were as follows:

1. There is no significant difference between Group I, auditory feedback, and Group III, the control feedback group. The data for the comparison are based on the means of the first five test trials and the means of the last five test trials.
2. There is no significant difference between Group II, visual feedback, and Group III, the control feedback group. Again, the means of the first five test trials were compared with the means of the last five test trials.

To determine whether or not the above hypotheses were tenable, a one way analysis of variance was computed. Table I indicates the results of the computation. No significant differences were found to exist among the three groups. The F value was considerably lower than that necessary for significance.

TABLE 1

Analysis of Variance Among Total Scores of All Groups

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between	.00187	2	.00093	1.26959
Within	.03092	42	.00074	
Total	.03279	44		

Table II sets forth the mean difference scores among the three groups and the standard deviation of the difference scores for the three groups. By inspection of this table, it is obvious why the ANOVA F score was far from the significant level. The mean difference scores and standard deviations indicate how similar all the response times were and how little range there was among scores.

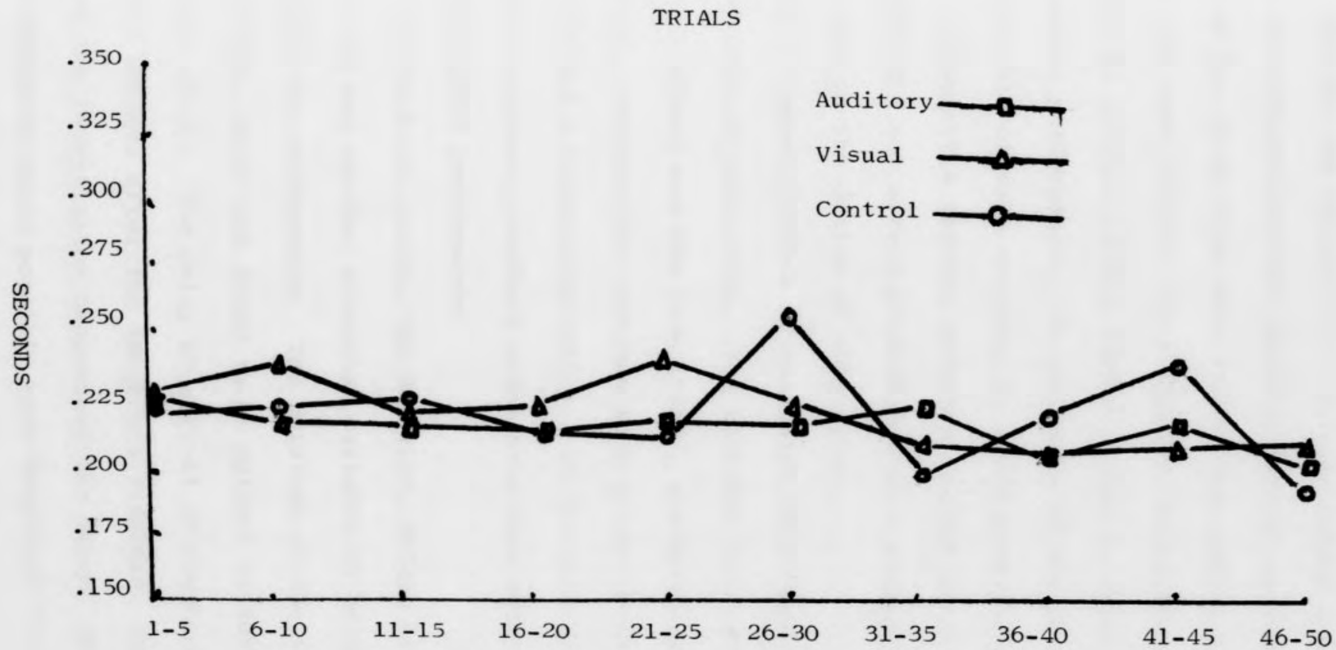
TABLE 2

Mean Difference Scores

	Auditory Group	Visual Group	Control Group
Number	15	15	15
Mean difference	.03175	.03589	.04701
Standard deviation	.011	.013	.010

For further analysis of the data, learning curves were constructed. (See Figure 1, page 34) Computed in this graph are the means of every five trials for each separate group. As can be seen, the curves are very close together and there is no significant difference in the range of the scores. All three groups performed at the same level with very slight deviation.

Raw data tables are available in Appendix B.



Points on the graph represent the X's in five trials intervals for each 15 subjects per group.

FIGURE 1

Mean Scores for Three Groups in a Graphic Representation

Interpretation of Data

The one way analysis of variance showed that no significant differences existed among the groups on the basis of the mean of the first five test trials compared to the mean of the last five test trials. This finding tended to support the conclusion by Lordahl (1961) that a change in sense modality would not change performance. On the basis of the 10 scores used in the analysis of each subject, it would seem that allowing subjects to select a sensory modality through which to receive feedback did not affect performance on a simple reaction time task used in the design of this study.

There were a number of variables which had an influence on the results of this study. The variable which probably had the greatest effect was the task itself, a simple reaction to a stimulus. Perhaps the task was such a fine motor skill that the feedback had a diminutive effect. If the task had been more complex in nature, feedback might have been more essential to the subsequent performance.

The feedback itself, the duration, delay, and information it relayed was another essential variable to be considered in affecting the performance. The duration of the feedback was 1-2 seconds, which was found to be optimal to subjects during the pilot study. The delay of arrival of feedback ranged from .5 - 2.5 seconds after the subject's response. The effectiveness of the investigator determined the delay. More sophisticated equipment could possibly have shortened the arrival time of the feedback. An important aspect of feedback is the amount of information it provides concerning the previous response and possible adjustments to reduce error. (Bourne, 1951) Content of informative feedback in this study was simply "fast or slow" depending on the speed of the subject's response time. The informative content of the feedback used was limited to knowledge of the speed of the previous response; no information was given concerning adjustments for the subsequent trial.

The intertrial interval had an influence upon the results of the study, even though it was held constant for all subjects. The interval was a function of human effectiveness and averaged 10 seconds per trial. The duration of the intertrial interval was set based on the results of the pilot study. It was during that time period that the tester had to determine the speed of the subject's response measured against the criterion score (fast or slow), deliver the appropriate feedback, record the score, reset the equipment, and time the anticipatory cue for the next stimulus presentation.

There were many other less important variables which had an effect on performance, for example, time of day subjects were tested and amount of illumination in the room. However, the most important factors have been considered

Due to the statistical analysis of results of this study, it is concluded that subjects perform equally well on a simple reaction time task regardless of the modality through which feedback is received.

Chapter V

Summary and Conclusions

Summary

The purpose of this study was to investigate if there was a significant difference in performance of a simple reaction time task when executed by subjects who voluntarily selected their preferred sensory modality (visual or auditory) as a channel to receive augmented feedback and subjects who were assigned a sensory modality through which to receive feedback.

A summary of the literature indicated that feedback is of extensive importance to performance in learning a skill. It is crucial that the feedback be task specific and relevant to the learner. No published studies were found that involves the subject's selection of type of feedback.

The analysis of the scores obtained in the study clearly indicated that there were no differences in performance on the simple reaction time task. The author must conclude that allowing students to select a preferred sensory modality through which to receive feedback would not alter performance on a fine motor skill, such as the reaction time task designed for this study.

Conclusions

Physical Educators have always been interested in the acquisition of physical skills. There has been a dearth of contradictory material written on the optimal methods of presenting skills to students. Students do not seem cognizant of how they learn most efficiently. When confronted with the choice of selecting a sensory modality in this study, many subjects responded that they never consciously thought about how they best learned a skill. It is likely that students learn through three mediums: auditory, visual, and kinesthetic, but one sense may easily dominate, causing a majority of information to enter through that medium. If this is the case, Physical Educators need to be aware of this phenomenon. A duty of the instructor of skill acquisition is understanding the learner's capacities and limitations of information processing. (Robb, 1972a)

This study was an attempt to learn more about how students process and assimilate information. The numerical scores obtained in this thesis were statistically not significant, which could have resulted from a number of variables. Some of these variables have been mentioned which possibly contributed to the results. Among these variables was the task itself, simple reaction time. In addition, the use of a fine, as opposed to a complex, motor skill may have contributed to the negligible effect of feedback on improving performance. The precision of the movement involved in responding to the stimulus left a very limited area for readjustment of movement to improve reaction time.

The feedback administered in the study could be criticized for the delay in its arrival after the subject's response, its duration, and most important, the informational content the feedback contained. The time lapse before arrival of the feedback could have been corrected by more sophisticated equipment. The duration of the feedback could also have been more uniform if delivered mechanically, rather than by the tester. The importance of feedback is that it supplies the subject with information about her response and sets forth alternate methods for adjustment to improve performance. The feedback used in this study indicated the speed of the response with regard to a criterion score; it did not designate any alternatives to improve performance.

The intertrial interval of 10 seconds might have been lessened by the use of more automated equipment. This undoubtedly had an effect upon performance although no subjects complained of excessive time between trials.

The use of more sophisticated equipment has been mentioned several times. There is no question that excellent studies have been conducted with very simple equipment. However, with the ultra sensitive machines available, when a problem necessitates fine measurements, these devices should be utilized whenever possible. The limitation affecting this study was time and money.

The possibility of using a gross motor skill compared with the reaction time task was considered. Such a complex skill would have introduced a number of new variables, and the author felt the difficulty in controlling for those variables made the study of a gross motor skill unfeasible. The obvious difficulty with studying a fine motor skill lies in problems with regard to the transfer of principles from laboratory to gymnasium.

These limitations of this study can be used in the future as recommendations for different procedures for a similar study.

Although the results of this study were statistically not significant, the author remains certain that feedback is a vital key to understanding the learning process. When more information is obtained and we comprehend the learning process more thoroughly, students will be able to learn more efficiently and find learning more rewarding.

Feedback is an essential element in skill acquisition. Feedback motivates, regulates and reinforces performance; it provides vital information for the formation and adjustment of behavior. (Robb, 1972a) The importance of feedback in learning had been well documented in recent years. (Ammons, 1956; Bilodeau & Bilodeau, 1966; Fitts & Posner, 1967; Robb, 1972a; Singer, 1968; Smith & Smith, 1966; Welford, 1972; Whiting, 1969) Although many aspects of feedback have been investigated much still remains to be studied in the area of feedback and its application to motor skill learning.

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Appendix A

Apparatus

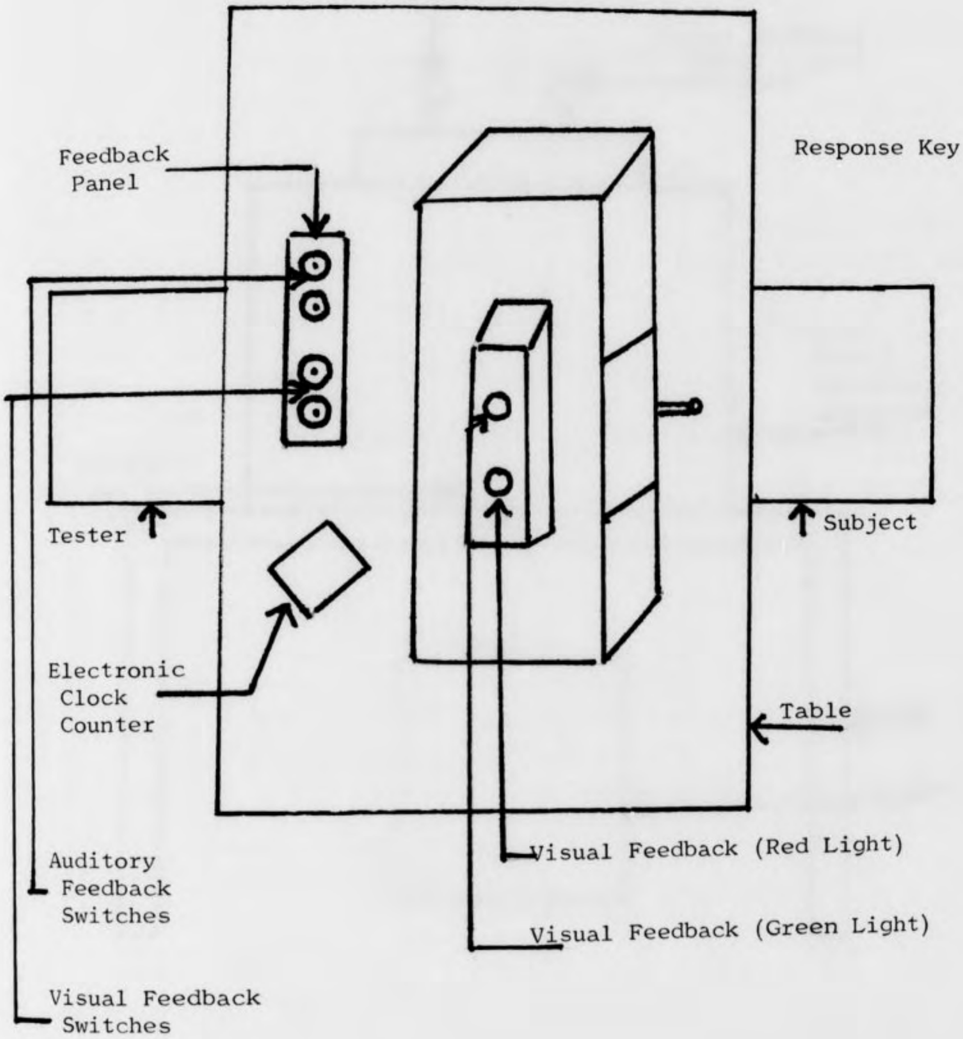

FIGURE 2

Top View of Apparatus

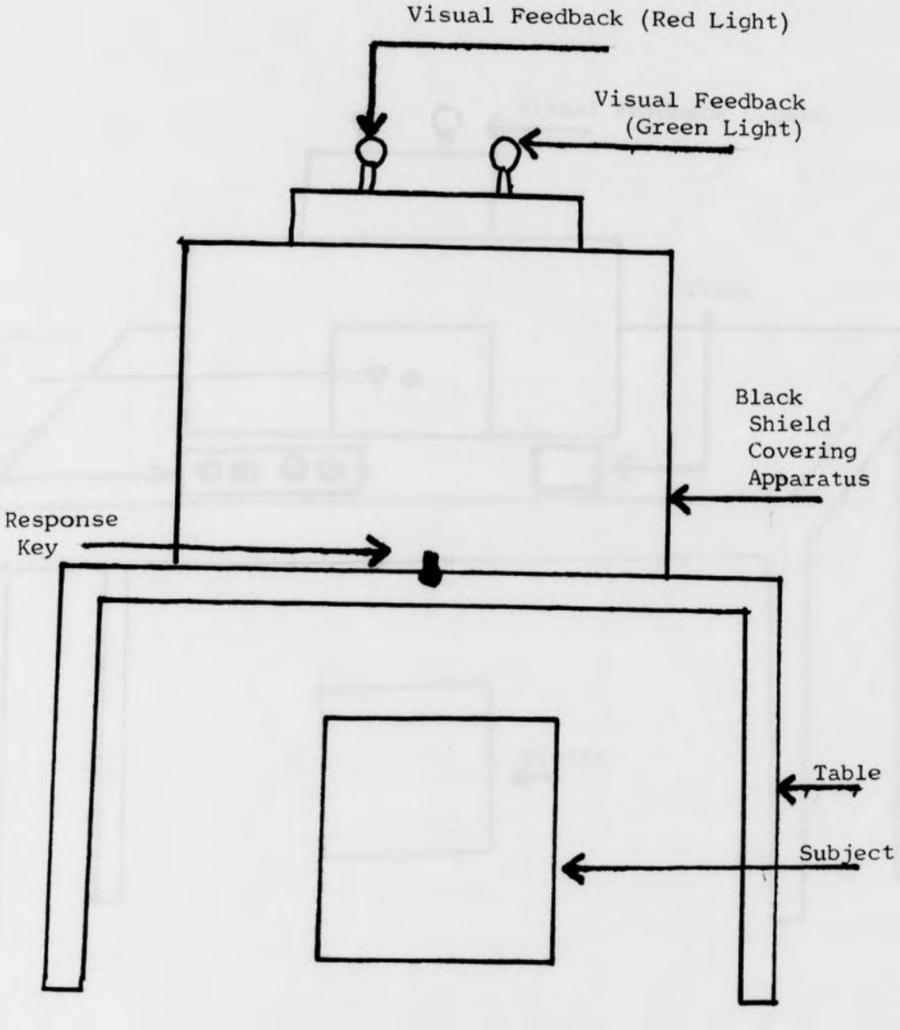

FIGURE 3

Subject's View of Apparatus

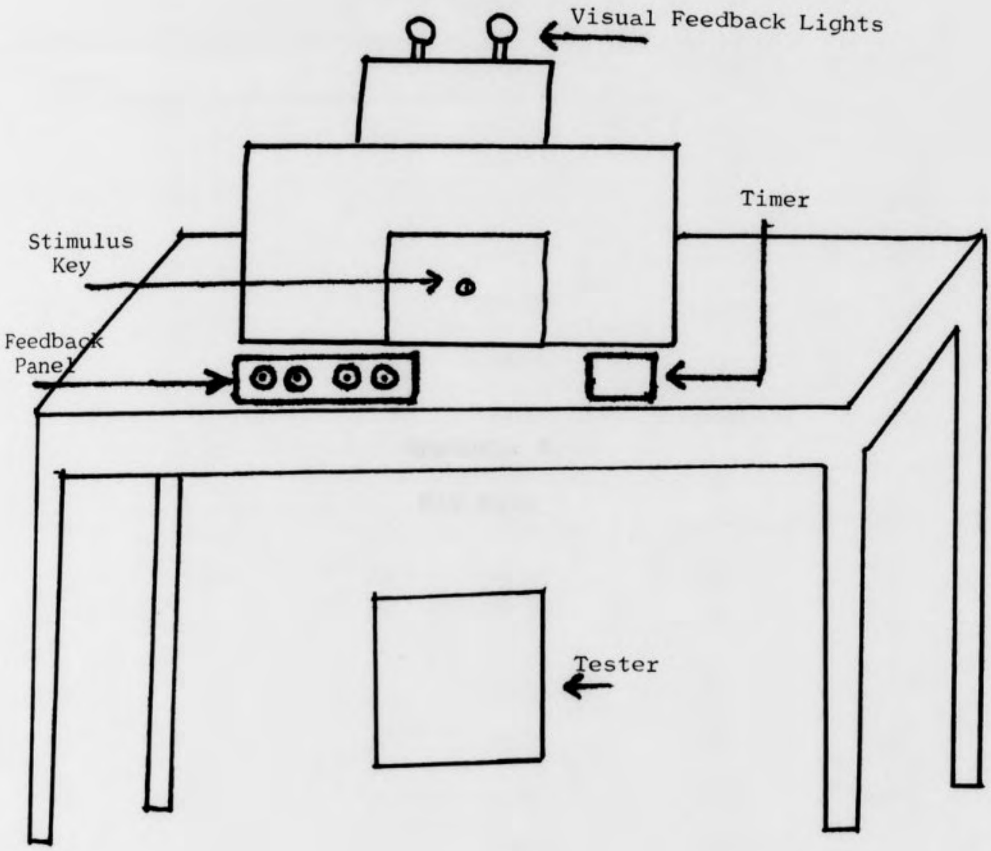

FIGURE 4

Tester's View of Apparatus

Appendix B

Raw Data

TABLE 3

Difference Scores Between Mean of Trials 1 - 5 and Mean of 46 - 50 for All Subjects According to Groups

Subject	Auditory	Visual	Control
1	.087	.046	.042
2	.055	.092	.058
3	.051	.021	.076
4	.002	.040	.051
5	.009	.068	.074
6	.015	.032	.018
7	.039	.012	.045
8	.014	.056	.043
9	.030	.057	.023
10	.079	.022	.034
11	.025	.012	.042
12	.006	.009	.027
13	.035	.070	.030
14	.008	.000	.019
15	.026	.003	.108

TABLE 4

Raw Data
Mean Scores of Auditory Group Per 5 Trials

Subject	Trials 1-5	Trials 6-10	Trials 11-15	Trials 16-20	Trials 21-25
1	.272	.188	.184	.200	.207
2	.252	.211	.209	.207	.217
3	.255	.241	.235	.259	.260
4	.191	.190	.181	.193	.210
5	.310	.320	.330	.339	.338
6	.197	.180	.185	.181	.185
7	.197	.187	.179	.211	.165
8	.260	.271	.255	.251	.241
9	.196	.187	.182	.185	.179
10	.201	.194	.197	.200	.188
11	.164	.191	.201	.188	.204
12	.172	.363	.314	.218	.326
13	.241	.238	.323	.276	.251
14	.165	.147	.150	.151	.146
15	.186	.193	.155	.178	.186
	X = .224	X = .220	X = .219	X = .216	X = .220

Subject	Trials 26-30	Trials 31-35	Trials 36-40	Trials 41-45	Trials 46-50
1	.218	.334	.170	.189	.185
2	.224	.198	.212	.298	.197
3	.243	.194	.207	.194	.204
4	.221	.218	.212	.210	.189
5	.277	.270	.277	.280	.301
6	.193	.170	.187	.185	.182
7	.148	.151	.144	.164	.158
8	.266	.355	.269	.260	.246
9	.194	.164	.157	.179	.166
10	.151	.182	.163	.138	.122
11	.189	.203	.190	.193	.189
12	.332	.283	.287	.264	.278
13	.261	.266	.234	.243	.276
14	.166	.158	.180	.165	.173
15	.214	.196	.200	.327	.160
	X = .216	X = .223	X = .204	X = .219	X = .202

TABLE 5

Raw Data
Mean Scores of Visual Group Per 5 Trials

Subject	Trials 1-5	Trials 6-10	Trials 11-15	Trials 16-20	Trials 21-25
1	.237	.418	.272	.257	.554
2	.277	.252	.206	.212	.221
3	.219	.196	.203	.179	.186
4	.225	.195	.216	.209	.192
5	.345	.369	.370	.343	.304
6	.205	.213	.198	.186	.196
7	.220	.213	.210	.202	.207
8	.262	.256	.259	.247	.247
9	.264	.240	.211	.317	.236
10	.234	.205	.210	.170	.203
11	.194	.209	.196	.188	.186
12	.164	.253	.175	.182	.187
13	.249	.252	.235	.253	.290
14	.188	.170	.169	.236	.173
15	.194	.202	.236	.236	.216
	X = .232	X = .243	X = .225	X = .224	X = .245

Subject	Trials 26-30	Trials 31-35	Trials 36-40	Trials 41-45	Trials 46-50
1	.223	.207	.195	.186	.191
2	.221	.199	.196	.164	.185
3	.195	.181	.172	.230	.198
4	.227	.225	.192	.198	.185
5	.349	.307	.237	.278	.277
6	.174	.187	.170	.167	.173
7	.215	.184	.219	.190	.208
8	.216	.184	.222	.218	.206
9	.218	.262	.207	.212	.207
10	.213	.180	.200	.226	.212
11	.218	.196	.214	.209	.182
12	.188	.174	.186	.186	.173
13	.262	.274	.270	.275	.319
14	.208	.168	.194	.173	.188
15	.232	.197	.197	.196	.197
	X = .224	X = .208	X = .209	X = .210	X = .207

TABLE 6

Raw Data
Mean Scores of Control Group Per 5 Trials

Sub-ject	Trials 1-5	Trials 6-10	Trials 11-15	Trials 16-20	Trials 21-25
1	.233	.237	.247	.233	.253
2	.241	.255	.206	.240	.232
3	.269	.251	.235	.212	.225
4	.230	.204	.227	.217	.242
5	.264	.278	.211	.190	.179
6	.232	.192	.183	.200	.129
7	.226	.234	.296	.240	.226
8	.234	.221	.245	.229	.237
9	.247	.235	.209	.206	.144
10	.227	.213	.312	.226	.264
11	.234	.221	.245	.230	.237
12	.184	.239	.200	.172	.183
13	.182	.231	.175	.195	.155
14	.231	.183	.171	.207	.136
15	.219	.219	.281	.262	.318
	X = .228	X = .226	X = .230	X = .215	X = .216

	Trials 26-30	Trials 31-35	Trials 36-40	Trials 41-45	Trials 46-50
1	.283	.196	.209	.237	.191
2	.306	.191	.193	.212	.183
3	.289	.180	.276	.228	.193
4	.212	.193	.286	.234	.179
5	.209	.208	.180	.415	.190
6	.300	.254	.258	.195	.250
7	.230	.175	.237	.233	.181
8	.288	.217	.193	.260	.191
9	.273	.233	.222	.231	.224
10	.214	.174	.205	.250	.193
11	.287	.217	.193	.260	.192
12	.355	.189	.306	.162	.157
13	.300	.212	.260	.209	.212
14	.277	.210	.241	.245	.250
15	.164	.130	.153	.210	.120
	X = .266	X = .199	X = .223	X = .242	X = .193

Appendix C

Instructions

Score Sheet

Instructions

You will be involved in an experiment to test your reaction time. The object of the experiment is to determine if selected experimental conditions will significantly change simple reaction time. The objective of the subject is to respond, for the duration of the experiment, as quickly as possible to the buzzer stimulus.

Please seat yourself in the chair, facing the testing apparatus. Place your dominant hand on the edge of the chair rest and place your forefinger on the apparatus directly in front of the response key. You will hear a verbal cue from the tester, "Ready?', then a buzzer. When you hear the buzzer, depress the key with your forefinger as quickly as possible.

Following the response, you will receive information feedback concerning the speed of your response from the panel in front of you. You will have 10 practice trials, during which the feedback will alternate from a sound to a light throughout the 10 practice trials.

A red light will signify a slow response.

A green light will signify a fast response.

A buzzer sound will signify a slow response.

A tone sound will signify a fast response.

Following the practice period you will designate to the tester which type of feedback you choose to receive for the duration of the experiment.

There will be a 10 second rest period between each trial.

Are there any questions?

Thank you.

Score Sheet

NAME: ______________________ AGE: __________

PRACTICE: A1 __________ V6 __________

V2 __________ A7 __________

A3 __________ V8 __________

V4 __________ A9 __________

A5 __________ V10 __________

PREFERENCE: __________

1 ______	16 ______	26 ______	41 ______
2 ______	17 ______	27 ______	42 ______
3 ______	18 ______	28 ______	43 ______
4 ______	19 ______	29 ______	44 ______
5 ______	20 ______	30 ______	45 ______
6 ______	21 ______	31 ______	46 ______
7 ______	22 ______	32 ______	47 ______
8 ______	23 ______	33 ______	48 ______
9 ______	24 ______	34 ______	49 ______
10 ______	25 ______	35 ______	50 ______
11 ______		36 ______	
12 ______		37 ______	
13 ______		38 ______	
14 ______		39 ______	
15 ______		40 ______	