THE EFFECT OF DELAYED KNOWLEDGE OF RESULTS ON THE PERFORMANCE OF A DART THROWING SKILL

by

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The purpose of this study was to investigate the effect of delayed knowledge of results on the performance of a dart throwing skill. The subjects were forty-five women students who were randomly selected from the freshman class at The University of North Carolina at Greensboro. The subjects who agreed to participate in the study were randomly assigned to one of three different groups. Each group contained fifteen subjects. Subjects threw darts over a screen at an unseen target. All three groups had an intertrial interval of 20 seconds. Group I received knowledge of results immediately after a response, then waited approximately 18 seconds before initiating the next response; Group II received knowledge of results 10 seconds after a response, then waited approximately 10 seconds before initiating the next response; Group III received knowledge of results 15 seconds after a response, then waited approximately 5 seconds before initiating the next response. All subjects practiced for four consecutive days. Each subject threw 50 darts per day for a total of 200 trials.

The one-way analysis of variance was used to determine if:

1. There were any differences among the three groups on the basis of total group scores.

2. There were any differences among the three groups on the basis of first day practice scores of each group.

3. There were any differences among the three groups on the basis of second day practice scores of each group.

4. There were any differences among the three groups on the basis of third day practice scores of each group.

5. There were any differences among the three groups on the basis of fourth day practice scores of each group.

The results indicated that there were no significant differences among the three groups on the basis of total group scores, the first day practice scores of each group, the second day practice scores of each group, and the third day practice scores of each group. The results did indicate that there was a significant difference among the three groups on the basis of the fourth day practice scores of each group. The Scheffé test of significant differences indicated that the difference was between Group I - Immediate Knowledge of Results and Group II - A 10-Second Delay of Knowledge of Results. Group I was superior to Group II. It was concluded that additional practice trials were necessary to determine if the difference was due to chance or to a definite superiority in the performances of subjects in Group I.

On the basis of the overall total scores of each group, it was concluded that delayed knowledge of results did not affect the performance of the dart throwing skill designed for this study.

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

Among the numerous elements that contribute to the area of human learning called motor skills learning, knowledge of results is considered one of the most important. Terminal information feedback, or knowledge of results (KR) is information supplied intrinsically and/or extrinsically to the performer after the completion of an act or skill. This information primarily supplies error information to the performer so that he can adjust his performance in an effort to improve on his next trial or so that he can attempt to repeat a successful performance. For example, the golfer might see his ball land far beyond the green and thus realize the need to use a shorter iron in facing a similar situation; or the pilot uses an instrument called an altimeter to supply him with information necessary to help him maintain a constant cruising altitude of several thousand feet.

Bilodeau and Bilodeau (1958) pointed out that in all studies of knowledge of results, there are three specific time intervals involved. These three intervals may be referred to as the pre-KR interval, the post-KR interval, and the intertrial interval. The pre-KR interval is the time that elapses between the initiation of a response and the presentation of knowledge of results; the post-KR interval is the time that elapses between the

presentation of knowledge of results and the initiation of the succeeding response; and the intertrial interval is the time that elapses between the initiation of one response and the initiation of the succeeding response. Many studies in the past have emphasized the importance of the immediacy of knowledge of results or the importance of a near zero lapse of time between initiation of a response and the presentation of knowledge of results. However, studies involving delays in knowledge of results or longer pre-KR intervals have failed to produce conclusive evidence that delays have detrimental effects upon learning rates and performances. A Greenspoon and Foreman (1956) study indicated that a delay of knowledge of results was inversely related to learning rate, while two years later Bilodeau and Bilodeau (1958) reported a study which had results showing no detrimental effects upon performance with delays in knowledge of results up to several days in duration.

The interest to undertake the present study was partially prompted by such ambiguities in the literature as cited above, and also by the desire to use a gross motor skill in the design of such a study because of a scarcity of gross motor skills used in past research of this nature. The author's interest was also attracted to the variety of experimental designs made possible by the manipulation of the three temporal intervals already discussed. Perhaps knowledge of results immediately before the succeeding response is better than or equals performances where knowledge of results immediately follows a response, if the intertrial interval is held constant. Perhaps equating the pre-KR and post-KR

intervals would produce a superior performance. The author hopes that the current study might contribute to a further understanding of the effect of delayed knowledge of results, and the temporal intervals involved in such a study, on the performance of a gross motor skill.

CHAPTER II

STATEMENT OF PROBLEM

The purpose of this study was to investigate the effect of delayed knowledge of results on the performance of a dart throwing skill. Forty-five subjects, randomly selected, were randomly assigned to each of three groups with fifteen in each group. Each group had the same intertrial interval of 20 seconds. Group I received knowledge of results approximately 2 seconds (immediate) after a response, then waited approximately 18 seconds before initiating the next response; Group II received knowledge of results approximately 10 seconds after a response and then waited approximately 10 seconds before initiating the next response; Group III received knowledge of results approximately 15 seconds after a response, then waited approximately 5 seconds before initiating the next response. Each subject practiced under the conditions assigned to her specific group for a period of four consecutive days which resulted in a total of 200 trials. Totals for each group were statistically compared by computation of a one-way analysis of variance.

DEFINITION OF TERMS

1. Knowledge of Results - (terminal information feedback) - information supplied intrinsically and/or extrinsically to the

testing days. An attempt was made to avoid time variances up to several hours from one day to another, however, this was not always possible.

3. The design of the experiment required subjects to throw darts over a screen at a target which they were not allowed to see until after the last day of testing was completed. In the case of two subjects, the target was inadvertantly observed prior to the commencement of the first testing session. The author does not believe that any direct advantage was gained by the two subjects involved, however, it was felt that the information should be noted for possible future reference.

CHAPTER III

REVIEW OF LITERATURE

Research in the area of terminal information feedback or knowledge of results is quite extensive. The literature cited in the review for this study was selected in an effort to provide a general background of the importance of knowledge of results to the learning and performance situations; to provide a summary of investigations of the temporal intervals associated with all studies of knowledge of results; and to provide an extensive review of research studies designed specifically to investigate the concept of delay of knowledge of results and its relative effects upon human learning and performance.

Knowledge of Results and Learning and Performance

The importance of knowledge of results in human learning and performance has been exemplified by numerous research studies in the field of experimental psychology and in the motor learning area of physical education. One of the earliest of these studies was conducted by Elwell and Grindley (1938). They investigated the effects of knowledge of results on the learning and performance of a motor skill involving a coordinated movement of the hands to position a beam of light on the bull's eye of a target. The design of the apparatus allowed for the provision of immediate knowledge of results with the light beam visible to the subject as he

performed, or no knowledge of results in which case the light beam was not visible to the subject as he performed. The results of the experiment showed that accuracy of performance failed to improve in the absence of knowledge of results; that accuracy of performance did improve when knowledge of results was provided; and that previously acquired skill in accuracy of performance deteriorated upon removal of knowledge of results (1938:53).

In 1948 Grindley, having teamed with MacPherson and Dees, examined the effects of knowledge of results on the learning and performance of a variety of simple motor skills. The motor skills involved were line drawing, lever pressing, timed lever pressing, and timed morse key pressing. The results of the experiments showed that the presence of knowledge of results improved performances in all of the tasks, and that removal of knowledge of results caused rapid deterioration in acquired accuracy of performance with the exception of the lever pressing experiment which resulted in a vacillation in performance when knowledge of results was removed during later trials (MacPherson, Dees, and Grindley, 1948).

Late in the 50's, a study by Bilodeau, Bilodeau, and Schumsky (1959) contributed additional evidence for the importance of knowledge of results to learning and performance. They employed 160 subjects in a manual lever displacing task to determine the effects of introducing and withdrawing knowledge of results during various phases of the practice period. Their findings indicated that without knowledge of results, subjects failed to improve in performance; that with knowledge of results, subjects progressively

improved in performance; and that upon removal of knowledge of results, subjects decreased in proficiency of performance. Further, they found that neither level of performance nor rate of learning was affected diversely by immediate or late introduction of knowledge of results during the practice period.

More recent investigations into the area of knowledge of results and its effects upon human learning and performance include a review of research by Bilodeau and Bilodeau (1966) and a book by John Annett (1969) which delves into the nature of feedback and its effects upon human behavior. The review by Bilodeau and Bilodeau (1966) emphasizes the importance of knowledge of results as the most important factor controlling skilled, human performance. They examined knowledge of results in terms of delay of presentation, frequency of presentation, transformations of, and as supplements to the standard. Annett (1969) provides insight into the types of knowledge of results (feedback) characteristic of most perceptual motor skills. He describes intrinsic knowledge of results as being inherent in the situation and as incapable of experimenter manipulation, while extrinsic knowledge of results are those elements of the situation which can be manipulated or controlled by the experimenter. In conclusion, Annett stated that,

> The performance of motor skills in particular involves intrinsic knowledge of results, and, whilst without extrinsic knowledge of results subjects may not learn to achieve some specified standard of performance, learning is often possible on the basis of this intrinsic knowledge of results. In many perceptual and verbal tasks knowledge of results has been used as the only means of providing a performance standard, that

> is specifying the nature of the task to be learnt, and to this extent knowledge of results is crucial to learning (Annett, 1969:168-169).

Bilodeau and Bilodeau (1966) seem to have expressed the inherent nature of the importance of knowledge of results to the learning and performance situations, as supported by research, in stating that,

> Studies of feedback or knowledge of results (KR) show it to be the strongest, most important variable controlling performance and learning. . . . there is no improvement without KR, progressive improvement with it, and deterioration after its withdrawal (1966:214).

Temporal Intervals

The temporal relationship of knowledge of results to a given response and the temporal relationship of one response to the next became topics of concern in research studies investigating the effects of immediate and delayed knowledge of results on learning and performance. As Bilodeau and Bilodeau (1958) pointed out in an investigation of these effects, all studies of knowledge of results or delayed knowledge of results involve three major temporal intervals. These intervals are (1) the interval between the completion of the response and the presentation of knowledge of results (KR delay); (2) the interval between the presentation of knowledge of results and the initiation of the next response (post-KR interval); and (3) the interval between one response and the next (intertrial interval), which is the sum of the KR delay and post-KR intervals. Figure 1, page 11, presents a schematic representation of these three intervals (1958:603).

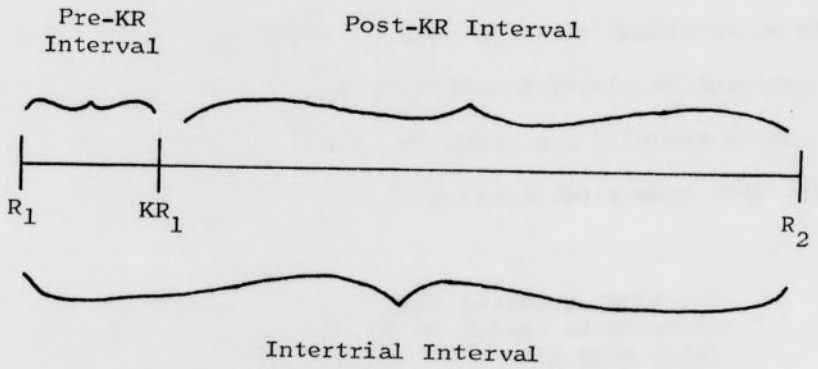


FIGURE 1

SCHEMATIC REPRESENTATION OF THE
THREE TEMPORAL INTERVALS

Closer examination of the temporal intervals reveals the variability that is possible in the design of a research study by the independent manipulation of the intervals. For example, to vary the KR delay, the post-KR interval must be varied in the opposite direction in order to maintain a constant intertrial interval, or the post-KR interval must be held constant in order to vary the intertrial interval (1958:603). The confusion that might arise in terms of which variable actually functions to produce significant differences in performance levels or learning curves can be easily understood. Bilodeau and Bilodeau seemed to pinpoint the ambiguity confronting researchers when they stated that,

> Almost universal is the view that learning varies inversely with the duration of KR delay; an uncommon view is not that learning varies directly with delay of KR, but that learning varies inversely with the value of post-KR delay. Whichever experimental delay period is favored for purposes of theorizing, a position on the effects of intertrial interval should also be taken (1958:603).

In a study preceding the Bilodeau and Bilodeau (1958) study, MacPherson, Dees, and Grindley (1949) investigated the influence of the intertrial interval in relation to the effects of knowledge of results on learning and performance. Their investigation was conducted under conditions of knowledge of results (KR) and no knowledge of results (NKR). In general, they found that subjects receiving visual KR after performing simple movements exhibited greater accuracy with short intertrial intervals of about 1 to 2 seconds in duration (1949:174). Also, they

found that when KR was removed, performances deteriorated faster with short intertrial intervals (1949:174). The Bilodeau and Bilodeau (1958) study supported MacPherson, Dees, and Grindley (1949) by revealing similar deteriorations in performances as the intertrial interval was progressively lengthened. They suggested forgetting and, possibly, the need to warm up as factors related to the decisiveness of the intertrial interval variable (1958:611).

A study by Denny and other researchers subsequently supported the findings of Bilodeau and Bilodeau (1958). They concluded that the intertrial interval was apparently more crucial than KR delay in a line drawing task (Denny and others, 1960).

In 1963, Bourne and Bunderson conducted research partially aimed at determining the importance of the post-KR interval. Contrary to the findings of Bilodeau and Bilodeau (1958) that post-KR interval has a more critical influence on learning and performance than KR delay (1958:611), Bourne and Bunderson found that subjects performing concept identification tasks improved significantly as the post-KR interval increased rather than as it decreased or KR more closely preceded the next response (1963:3). They attributed their findings to a processing or rehearsing of KR by the subject prior to the next response. This processing or rehearsing of information takes place during the post-KR interval, and decreasing the interval would tend to interfere with the rehearsing of information, thus causing a deterioration in performance on succeeding trials (1963:4). Supporting the

findings of Bourne and Bunderson (1963) was a study conducted the following year by Weinberg, Guy, and Tupper (1964). They examined the post-KR interval using a task which involved pulling a yardstick a given distance from a sheath while blindfolded. Their conclusions revealed improved performances as post-KR interval increased from 1 to 20 seconds. They summarized their findings by stating that,

> As length of post-IF [information feedback] interval increases, so does opportunity for S to make use of information provided on any trial, thus facilitating overall performance (Weinberg, Guy, Tupper, 1964:99).

A recent publication by Edward A. Bilodeau (1969) updates terminology and presents current findings in regard to the temporal intervals associated with knowledge of results. He describes <u>locus</u> as referring to the position of information feedback (IF) in the trial cycle and as including three temporal intervals:

> delay - time from R_n to IF; post-IF - time from IF_n to R_{n+1}; and interresponse - the sum of delay and post-IF intervals, time from R_n to R_{n+1} (1969:275).

In his summary, Bilodeau states that,

> Locus includes more than delay of IF. Unfilled (and sometimes filled) delay from R to IF is ineffective. Accuracy does decline when the S must make his next R before he has IF for the last R as a cue to the required modification in behavior, and temporal lag in continuous-R tasks is damaging to performance. The wait from one IF to the next R is an effective variable in many tasks and the total time between adjacent R's affects the accuracy of simple motor R's (1969:282).

Annett (1969), also a leader in feedback research, recognizes the relevancies of the three temporal intervals already described, and he views any two of them as determinants of the

particular task to be performed (1969:130). He further recognizes the IF delay interval as the interval responsible for reinforcing effects (1969:130). In concluding remarks concerning temporal relationships, Annett states that,

> Whilst it is possible for the experimenter to do nothing which affects the subject in the interval between the R and KR, there is no way of controlling what goes on in the subject's head in that interval. If the interval is at all long, the subject will undoubtedly initiate some other activity. Effects can not be attributed purely to the lapse of time as such but only to whatever processes are going on during the interval. Another way of looking at the problem is to delay KR by a given number of trials. This can be done by giving the individual KR trial by trial, n trials late, or by giving the subject a summary of his performance over a given number of trials after the completion of that block of trials (1969:131).

The delay of knowledge of results or information feedback has been a topic of considerable research. Such investigations have included delay intervals of anywhere from a few seconds up to a period of several days and delay intervals which are empty or filled with some type of interpolated activity.

Delay of Knowledge of Results

One of the earliest studies conducted to investigate the effects of delaying knowledge of results was that of Lorge and Thorndike (1935). Their subjects were instructed to toss balls over their shoulders at an unseen target of concentric circles. Conditions of knowledge of results varied to include immediate knowledge of results, delays of 1, 2, 4, and 6 seconds, a one-trial delay, and no knowledge of results. The order of practice under each of the conditions was varied from one group to another

over a three day period of practice. The results of the study showed that a 6-second delay in providing knowledge of results was as beneficial to learning as immediate knowledge of results or a 0-second delay (1935:191). Lorge and Thorndike also found that delaying knowledge of results by one trial produced no improvements in learning progress (1935:193).

In 1951, Saltzman conducted an experiment aimed at investigating the effects of delay of reward on human verbal learning. The task involved was a verbal maze and reward was in the form of information provided the subject that a response was correct. Actually, two experiments were conducted within the design of Saltzman's study. The first concerned the effects of speed of presentation of material upon learning rate. The results indicated that a reduction in the presentation time from 18 seconds between items to 12 seconds between items did not significantly affect rate of learning (1951:431). The second experiment showed that learning rate was significantly slower when reward was effectively delayed as opposed to an improved learning rate when reward was presented immediately following a correct response (1951:439).

Greenspoon and Foreman (1956) investigated the effects of delaying knowledge of results in the learning of a line drawing task. They employed four experimental groups in addition to the control group which practiced under conditions of no knowledge of results. Group I received immediate knowledge of results with a post-KR interval of 30 seconds; Group II received knowledge of results 10 seconds following a response and had a post-KR interval

of 20 seconds; Group III received knowledge of results 20 seconds following a response and had a post-KR interval of 10 seconds; and Group IV received knowledge of results 30 seconds following a response and had a post-KR interval of 0 seconds, thus, knowledge of results immediately preceded the succeeding response. Results indicated that as the delay interval increased, learning rate decreased, and that a 30 second delay of knowledge of results was superior to no knowledge of results (1956:228). Thus, Greenspoon and Foreman's study suggested that delay of knowledge of results was inversely related to learning rate. Confirming their findings was a study produced a year later by Bourne (1957). Bourne found that delaying information feedback in a task requiring subjects to identify and classify geometric patterns resulted in a positively accelerated decrease in performance (1957:206).

A study previously cited, which produced results contrary to the findings of Greenspoon, Foreman, and Bourne, was that of Bilodeau and Bilodeau (1958). Their investigation was a composite of five individual experiments in which KR delay intervals ranged from a few seconds in duration to several days in duration. They found no significant differences in performances in delays up to 24 hours and 7 days (1958:611). However, Bilodeau and Bilodeau cited some important new findings concerning the temporal intervals related to knowledge of results. They found that performance of subjects varied inversely with intertrial interval as opposed to KR delay, and as noted before, they attributed this to the

factors of forgetting and warming up (1958:611). Also, they indicated that the post-KR interval was a more critical interval than KR delay with subjects performing less accurately as post-KR interval was increased (1958:607). The tasks utilized in their investigation were simple motor tasks and included knob turning, lever pulling, and stick displacing.

Two studies produced later the same year appeared to support the findings of Bilodeau and Bilodeau (1958) concerning the effect of KR delay on learning and performance. Archer and Namikas (1958) conducted an experiment using pursuit rotor performance as the function of delay. They provided continuous knowledge of results to the subjects as they performed following a specified delay interval. The delays employed were .0, .2, .4, .8, and 1.6 seconds. Total time on target was recorded for each subject, and the results indicated that the five groups were almost equal in initial trials and failed to differentiate from one another after 45 trials (1958:327). They concluded that the absence of any statistically significant difference between groups indicated the ineffectiveness of KR delay as a variable in the acquisition of skill in the rotary pursuit tracking task (Archer and Namikas, 1958:327). Noble and Alcock (1958) used six delays of serial reward (varying from 0 to 3 seconds) in human trial-and-error learning. They found no significant effect of delay upon learning regardless of the length of the task or the amount of practice provided (1958:411).

Investigating the effects of delay of auditory feedback on speech and key tapping, Chase and other researchers (1959) found that the intrinsic nature of human speech is severely affected by a delay in auditory feedback. A delay of 244 msec caused subjects to speak louder, to prolong verbal sounds, to increase pauses between sounds, and to repeat a sound four times instead of the required three times (1959:903). Similar results were obtained using a key tapping task with a delay of 244 msec (Chase and others, 1959). Later the same year, McGuigan (1959) reported a research study aimed at investigating the problems involved with the design of studies concerned with delay of knowledge of results. A basic design that he cited was one composed of two experimental groups: the first group would receive immediate knowledge of results and have a post-KR interval of 10 seconds, and the second group would receive knowledge of results 20 seconds after the response and have a post-KR interval of 10 seconds (1959:241). McGuigan pointed out that the design of this study was criticized on the basis that the intertrial interval was confused with the length of delay of knowledge of results. As the length of the KR delay interval varied so did the intertrial interval. To avoid this confusion, the addition of a control group was recommended. If the control group were to receive immediate knowledge of results like Group I received, and the post-KR interval was set at 30 seconds, then the control group and Group I would have identical intertrial intervals. Any superiority in the control group and Group I could be attributed to the length of delay

of KR since the intertrial interval could be considered irrelevant 1959:241). However, McGuigan pointed out that,

> . . . a finer analysis would indicate that the problem is not solved for still a third variable must be considered. This variable is length of time that KR precedes next R. The possible importance of this variable is pointed out by Brown when he suggests that providing KR just prior to a R might well be a superior condition to providing KR shortly after a R is made (1959:241).

In concluding, McGuigan stated that,

> Hence it is necessarily the case that either length of time KR precedes next response or intertrial interval will be confounded with delay of KR after a R. For this reason it is not possible to evaluate unambiguously the effect of KR after a R on performance (1959:243).

Thus, McGuigan described the confusion created by manipulation of the various temporal intervals of knowledge of results, and thereby emphasized the importance of control factors in the experimental design of research investigations.

In an effort to reveal the possible source of the discrepancies in findings between the Greenspoon and Foreman (1956) study previously cited and the Bilodeau and Bilodeau (1958) study previously cited, Bilodeau and Ryan (1960) conducted a study designed to duplicate that of Greenspoon and Foreman (1956). Two groups in the study were identical to the groups employed by Greenspoon and Foreman. The intertrial interval was set at 30 seconds for both groups. One group received immediate knowledge of results and had a post-KR interval of 30 seconds; the second group received knowledge of results 20 seconds after a response and had a post-KR interval of 10 seconds. The results of these two groups indicated no significant difference between immediate

and delayed knowledge of results in the line drawing task (Bilodeau and Ryan, 1960:419). Denny (1960) and several other researchers also contributed support to the Bilodeau and Bilodeau (1958) study. They conducted another line drawing experiment using 0, 10, and 20-second delays of knowledge of results and a post-KR interval of 10 seconds. A control group was added and it had a 0-second delay of knowledge of results and a post-KR interval of 30 seconds. Thus, the design of the study produced two groups with the same intertrial interval, but different maximally on KR delay; and two groups with the same KR delay interval, but different maximally on intertrial interval. The results indicated that 0-second and 10-second delay groups performed significantly better than the 20-second delay group. Also, the control group performed significantly worse than the 0-second delay group (Denny and others, 1960:327). Thus, Denny and the other researchers agreed with Bilodeau and Bilodeau (1958) in that the intertrial interval which was confused with post-KR delay appeared to be the critical variable rather than KR delay (1960:327).

Another line drawing task was used in an experiment conducted by McGuigan, Crockett, and Bolton (1960). Their investigation was aimed at determining the effects of immediate knowledge of results and delayed knowledge of results on learning; the effects of variation in length of time by which knowledge of results precedes a response; and the effects of maintaining a constant intertrial interval and comparing a condition of knowledge of results that immediately follows a response to a condition of knowledge of

results that immediately precedes a response (1960:51). They employed four separate groups of subjects. Group I received knowledge of results immediately after a response then immediately drew the next line; Group II received knowledge of results 20 seconds after a response then immediately drew the next line; Group III received knowledge of results immediately after a response then waited 20 seconds before drawing the next line; and Group IV received knowledge of results 20 seconds after a response then waited 20 seconds before drawing the next line (1960:52). McGuigan and his associates found that there was no significant difference in the condition of knowledge of results given immediately preceding a response and the condition of knowledge of results given 20 seconds before a response (1960:53). They also found that there was no significant difference between the condition of knowledge of results given immediately after a response and the condition of knowledge of results given immediately before a response (1960:54).

An investigation into the effects of delaying reinforcement in learning and retaining unfamiliar and meaningless information was conducted in 1962 by Brackbill and several other researchers. Since previous investigation by Brackbill and others had shown that delay of reinforcement aided in retaining familiar, meaningful information, she decided to conduct a similar study using meaningless and unfamiliar information. Four groups of subjects were used in the design of the study with groups varying in delays of either 0 seconds delay or 10 seconds delay and retention tests

given either one day or eight days after learning the task. The task involved learning a series of eighteen two-choice discriminations ordered at random (1962:553). An intertrial interval of 20 seconds was standard for each group. Retention tests on the first or eighth day took place under conditions of 0 seconds delay of reinforcement for all groups (1962:553). Results indicated that a delay of reinforcement during learning improved the retention of unfamiliar, nonsense material as well as familiar, meaningful material (Brackbill and others, 1962:554).

A previously cited study by Bourne and Bunderson (1963) showed delay of knowledge of results to be an ineffective variable in a concept identification task (1963:3). However, they found that as the length of the post-KR interval increased, performance improved in tasks of greater complexity (1963:3). As noted previously, their findings were at variance with those of Bilodeau and Bilodeau (1958). In conclusion, Bourne and Bunderson suggested the possibility of a certain length of post-KR interval which would allow the subject to apply the information received and thereby possibly enhance his performance on the succeeding trial (1963:4).

Lavery (1964) investigated the effects of a one-trial delay of knowledge of results on the learning and retention of a tossing skill. He compared a one-trial delay group with a group that received immediate knowledge of results after each trial. Subjects threw magnetized pellets over their shoulders at a target of concentric circles. In the first three training sessions,

subjects were given knowledge of results in the form of a score only, and in the last three training sessions, they were given knowledge of results in the form of a score and clock position of each toss (1964:438). During the testing sessions, no knowledge of results was given. Lavery found that acquisition was slightly slower for subjects under a one-trial delay condition, but that retention for them was better as knowledge of results became more specific, and they performed in retention as if knowledge of results was actually being provided (1964:442).

Dyal (1964) reported another study investigating the effects of delaying knowledge of results in a line drawing task. The design of his study involved three groups of subjects. One group received immediate knowledge of results and had a post-KR interval of 30 seconds. A second group received knowledge of results 30 seconds after a response and had a post-KR interval of 0 seconds. Thus, these first two groups had identical inter-trial intervals, but differed maximally on KR delay intervals. A third group received no knowledge of results (1964:433). Dyal's findings supported those of Greenspoon and Foreman (1956) in that delay of knowledge of results interfered with the learning of a line drawing task (1964:434). However, as Bilodeau and Ryan (1960) pointed out, the subject needs time to attend to the information provided before the next response (1960:417), and the design of Dyal's study did not provide such time prior to the next response for subjects in the group with a 30-second KR delay interval.

A year later, Dyal teamed with Wilson and Berry and investigated the effects of delaying knowledge of results on the acquisition and extinction of a line drawing task. The design of their study replicated that of Greenspoon and Foreman (1956), except that they used the 20-second delay interval used by Bilodeau and Ryan (1960). All subjects were required to draw eighty-five lines. For responses 1 through 10, no knowledge of results was given to any of the subjects; for responses 11 through 35, half of the subjects were given immediate knowledge of results and half were given knowledge of results following a delay of 20 seconds; and for responses 36 through 85, knowledge of results was eliminated (1965:159). Results indicated no significant difference between subjects prior to the introduction of knowledge of results (response 1 through 10). The Duncan Multiple Range Test was employed to determine if there were any significant differences between the immediate and delayed groups when knowledge of results was introduced in responses 11 through 35. The Multiple Range Test indicated that the immediate group made significantly more correct responses than the delay group (1965:159). However, although these findings support the Greenspoon and Foreman (1956) study and oppose the Bilodeau and Ryan (1960) study, Dyal and his associates found that while the immediate group did elicit significantly more correct responses than the delay group, there was no significant difference in performance between the two groups at the end of the acquisition trials (26 through 35) (1965:159).

The studies cited concerning delay of knowledge of results reflect the ambiguities in results from varying research designs. The tasks employed in these studies vary from simple line drawing tasks to the performance of gross motor skills such as ball tossing at a target. Variation in research design and variation in chosen task, as well as various types and specificity of knowledge of results, may be suggested as possible elements contributing to such diversities in results.

Kinesthesis

A brief overview of research in the area of kinesthesis is presented. The importance of kinesthesis in motor skills performance can not be overlooked, however, the emphasis in this study is placed upon terminal information feedback (knowledge of results) and the effects of delaying its presentation. Kinesthesis is an intrinsic form of feedback that must be considered in all studies where subjects must rely upon such cues because of certain limitations placed upon external sources of information (i.e., subject blindfolded; subject throwing at an unseen target). Numerous factors contribute to kinesthetic functioning and it seems that this functioning is specific to the skill or activity involved.

In 1941, Phillips examined the relationship between kinesthesis, as measured by ten specific tests of kinesthesis, and performance during the early stages of the acquisition of two perceptuo-motor skills. The two motor skills simulated the putt and the drive in golf. Phillips found that there is no

"general kinesthetic sensitivity and control," but rather kinesthesis is specific to the stimulus patterns involved in the tests (Phillips 1941:584). Another finding showed correlation coefficients to be larger between the kinesthetic test scores and the putting than between the kinesthetic test scores and the driving. The influences of chronological age, morphology, intelligence, and grip strength were statistically ruled out in his computations (1941:584). Phillips also found that the more nearly a kinesthetic test resembled the movement patterns similar to putting, the greater was the tendency for subjects who performed high on that test to exhibit a better performance in the putting (1941:584). The latter finding was not completely true in the case of driving. Finally, Phillips found evidence that a battery of four of the ten kinesthetic tests could be used to predict the extremes in skill levels in putting and driving.

Wiebe (1954) conducted a study aimed at investigating tests of kinesthesis. He examined twenty-one tests of kinesthesis and compared the results of separate administrations to athletes and non-athletes. In general, his findings agreed with those of Phillips (1941) in that the low intercorrelations between the test items indicated that there was no general kinesthetic sensitivity and control, but rather that numerous specific elements were involved (1945:227). Wiebe concluded that three of the test items could be combined to provide a measure of kinesthesis comparable to an administration of all the items.

Later the same year, Phillips and Summers (1954) investigated the relationship between kinesthetic perception and motor skills learning. They tested 115 college women on twelve positional measures of kinesthesis, then classified them as either fast or slow learners on the basis of their individual improvement exhibited during twenty-four bowling classes. Mean scores for the kinesthetic tests were compared for the fast and slow learners (1954:456). Results indicated that on the basis of significant differences found to exist between the mean scores of the fast and slow learners on two separate kinesthetic tests and on several combinations of the tests, a relationship was established between motor learning and positional measures of kinesthesis (1954:468). Phillips and Summers concluded that kinesthetic sensitivity was more important in the early stages of learning a motor skill than in later stages on the basis of the evaluations made in their particular investigation (1954:456).

In 1962, Witte attempted to find out if a relationship might exist between kinesthetic perception and a selected motor skill for elementary age school children. He used four arm positioning tasks as the measures of kinesthesis to compare with two ball rolling tasks as the motor skills. Contrary to the findings of Phillips and Summers (1954), Witte found no significant relationship between positional measures of kinesthesis and ball rolling accuracy. He also found no significant difference between boys and girls in ability to accurately repeat positional type measures of kinesthesis. Witte did find that boys were

significantly better than girls in their ability to accurately maneuver large and small balls according to the tasks designed for the purposes of his study (1962:476). Witte's study contributes to the concept that kinesthetic sensitivity and control is specific to the activity involved and can not be generalized.

While there are discrepancies as to the value of tests of kinesthesis, most of the literature on kinesthetic feedback has confirmed its importance to the field of motor learning and development. Singer (1968) summarizes the primary findings in kinesthetic research as pertains to motor learning in stating that,

> In a general sense, kinesthesis is believed to underlie many discriminating functions of the body required for successful motor skill performance: locomotion, perception of pressure changes, balance and body equilibrium, and overall body coordination. Its presence is thought to contribute to an individual's ability to learn as well as perform motor skills. However, this presence must not be thought of as a general factor but rather specific to the skill which requires certain movements of the body (Singer, 1968:76).

The importance of knowledge of results in the learning and performance of motor skills has been confirmed by numerous studies in the field of experimental psychology and by the motor learning area of physical education. All studies investigating knowledge of results involve three important temporal intervals. These three intervals have been described as (1) the KR delay (pre-KR) interval or the interval between the completion of a response and the presentation of knowledge of results; (2) the post-KR interval or the interval between the presentation of knowledge of results and the initiation of the next response; and (3) the intertrial interval

or the interval between one response and the next. Ambiguities in the literature have indicated that there is no conclusive evidence that delays in knowledge of results (increase in pre-KR interval) are detrimental to learning and performance. Much of the confusion in such studies arises from the question as to which of the three temporal intervals most significantly influences the outcome, if the results can truly be attributed to one.

Although the main purpose of this study was to investigate the effect of delayed knowledge of results on the performance of a gross motor skill, the role of kinesthesis should not be overlooked. Kinesthesis plays an important role in the performance of any type of motor skill and, therefore, must be considered a variable in all research of this nature.

CHAPTER IV

PROCEDURE

The purpose of this study was to investigate the effect of delay of knowledge of results on the performance of a dart throwing skill. The delay intervals were (1) immediate knowledge of results, (2) 10-second delay of knowledge of results, and (3) 15-second delay of knowledge of results. All three groups had an intertrial interval of 20 seconds.

TESTING APPARATUS

The apparatus for the actual testing phase of the experiment was designed in such a way that visual terminal information feedback was controlled by the experimenter. The equipment included a screen, the target, and a light panel connected to a switchboard. Other equipment included fifty lightweight darts, two dart holders, a cassette tape recorder, four cassette tapes, and score sheets.

The Screen

Terminal information feedback or knowledge of results was to be controlled by the experimenter; therefore, a screen was made to prevent the subject from viewing any portion of the target during the entire testing procedure. The screen consisted of a wooden frame 4 feet wide and 6 feet long. The frame was covered with two layers of unbleached muslin which adequately prevented the subject

from seeing through to the target on the opposite side. The frame was mounted between two wooden stands which stood 5 feet tall. Each stand had a long open groove cut through its center. These grooves provided a passage for two screws and wing nuts on each stand thereby making the screen adjustable up and down in order to accommodate height differences among the subjects (Figure 2, page 33). Half inch markings down the front edges of the two stands and frame assured accurate adjustment of both sides of the screen. The screen and stands stood approximately 6 inches from the front edge of the target. A quadrangular shaped table was set between the screen and the restraining line from which the subject was to throw the darts.

The Target

The target was placed on the side of the screen opposite that of the subject. The face of the target was parallel to the floor and elevated approximately 2 feet above the floor. A large wooden frame 66 inches by 65 inches provided the base for the target. Two sides of the frame rested on a 19-inch ledge protruding 12 inches from the walls of the testing room. The free corner of the frame was supported by two 18-inch stools which were padded with foam rubber to level the target surface and to protect the finished surfaces of the stools.

The construction of the frame provided slots for inserting wooden panels to separate the surface of the target into nine individual sections. The wooden panels were 5 inches wide and 46 inches long. The length of the panels ran from the left side

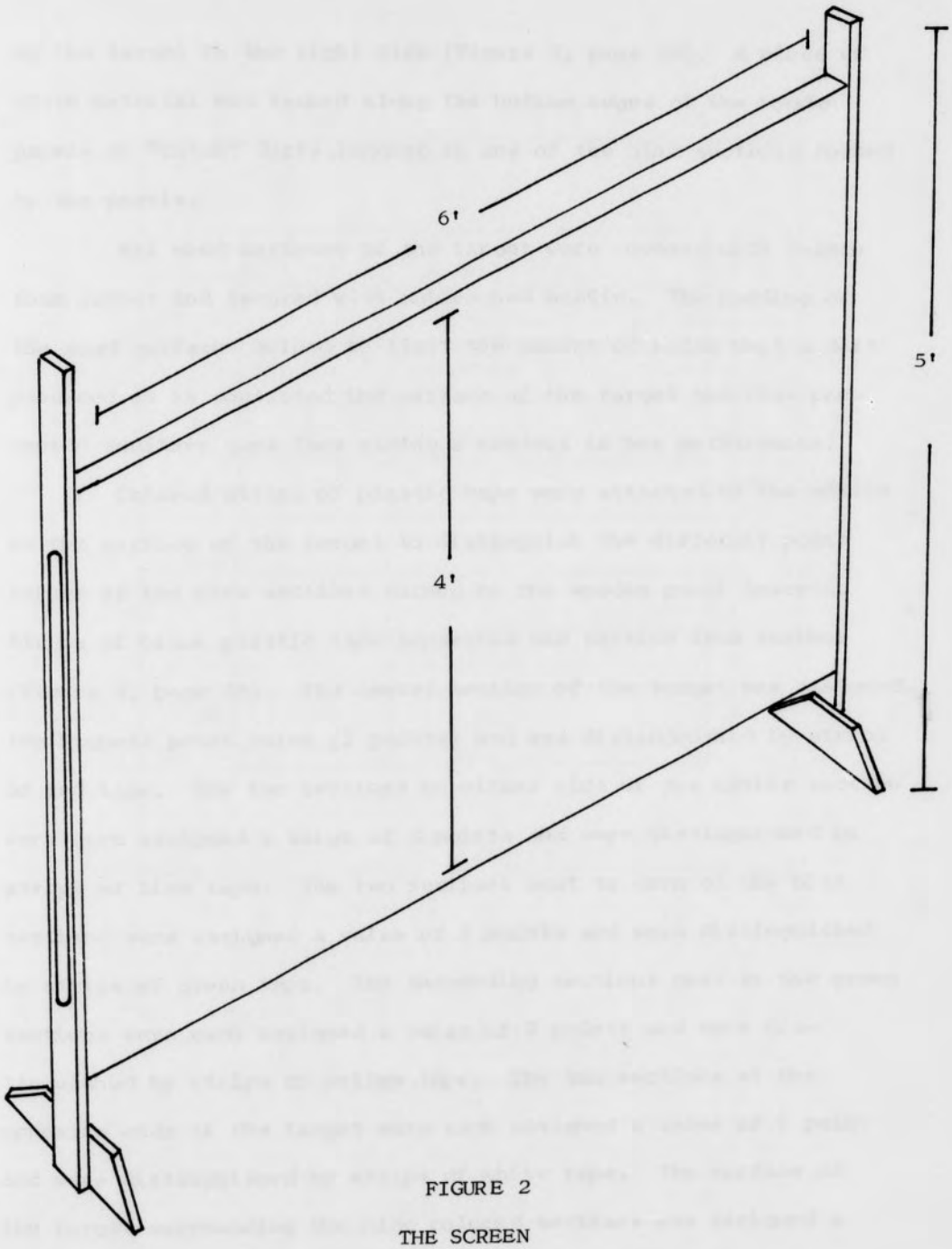


FIGURE 2

THE SCREEN

of the target to the right side (Figure 3, page 35). A piece of cloth material was tacked along the bottom edges of the wooden panels to "catch" darts landing in any of the nine sections formed by the panels.

All wood surfaces of the target were covered with 1-inch foam rubber and secured with unbleached muslin. The padding of the wood surfaces helped to limit the amount of noise that a dart produced as it contacted the surface of the target and thus prevented auditory cues from aiding a subject in her performance.

Colored strips of plastic tape were attached to the muslin on the surface of the target to distinguish the different point values of the nine sections formed by the wooden panel inserts. Strips of black plastic tape separated one section from another (Figure 4, page 36). The center section of the target was assigned the highest point value (5 points) and was distinguished by strips of red tape. The two sections on either side of the center section were each assigned a value of 4 points and were distinguished by strips of blue tape. The two sections next to each of the blue sections were assigned a value of 3 points and were distinguished by strips of green tape. The succeeding sections next to the green sections were each assigned a value of 2 points and were distinguished by strips of yellow tape. The two sections at the opposite ends of the target were each assigned a value of 1 point and were distinguished by strips of white tape. The surface of the target surrounding the nine colored sections was assigned a point value of 0 or no score. (See Figure 3, page 35.)

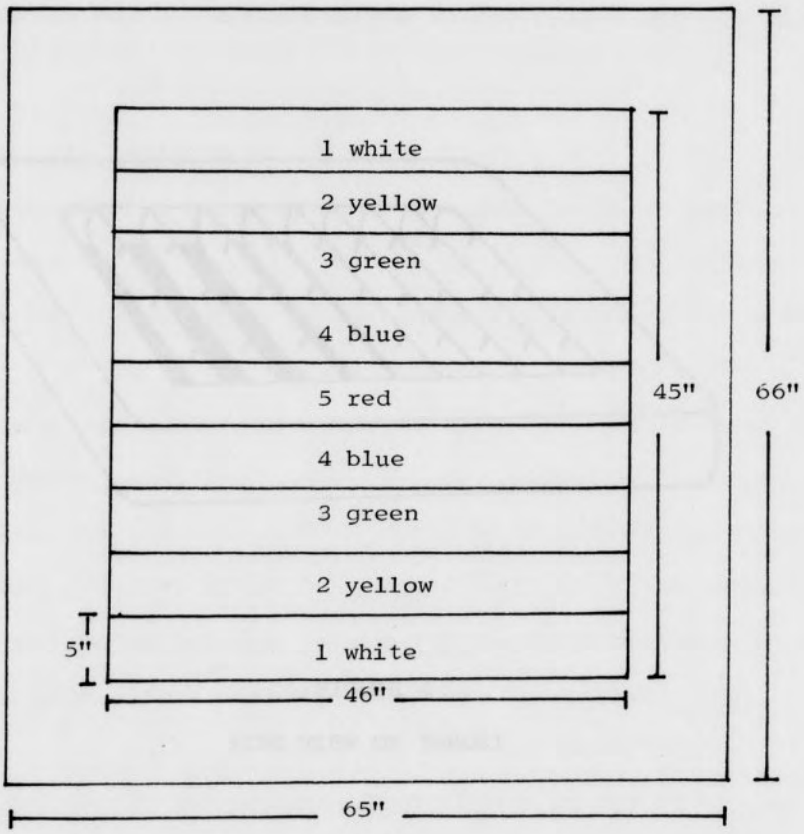


FIGURE 3

OVERVIEW OF TARGET FACE

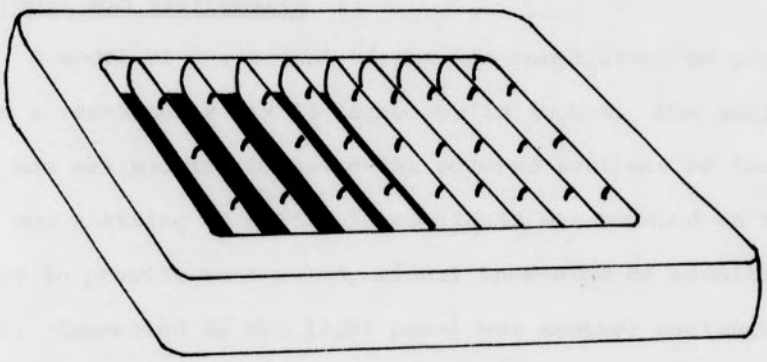


FIGURE 4

SIDE VIEW OF TARGET

A piece of net material was stretched from the back of the screen to the front edge of the target to help prevent darts that rebounded off the surface of the target from landing on the floor.

Light Panel and Switchboard

A model of the actual target was constructed of plywood to form a rectangular box 15 inches by 18 inches. One surface of the box was painted to match the colored sections of the actual target and a string of multicolored lights was mounted on the sections to provide controlled, visual knowledge of results to the subject. Connected to the light panel was another rectangular, plywood box. The box measured 12 inches by 15 inches, and one surface was painted to match the colored sections of the actual target. Push button switches were mounted on each of the nine colored sections. Each section controlled the corresponding colored light on the light panel, and the experimenter could control the lighting and extinguishing of each of the lights by pressing the appropriate button. Figure 5, page 38, shows the arrangement of the light panel and switchboard. The wiring connecting the two boxes was long enough to allow for the placement of the light panel on the table in front of the screen and for the placement of the switchboard on a table set along the right side of the target out of the view of the subject (Figure 6, page 39).

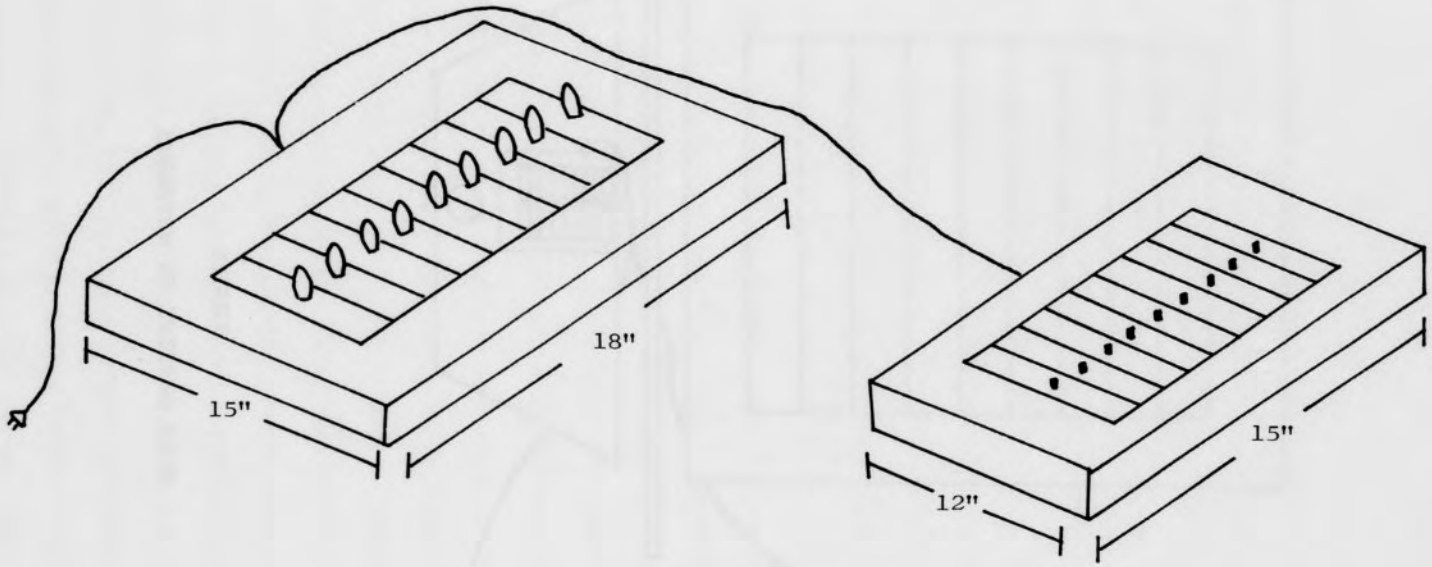


FIGURE 5

LIGHT PANEL AND SWITCHBOARD

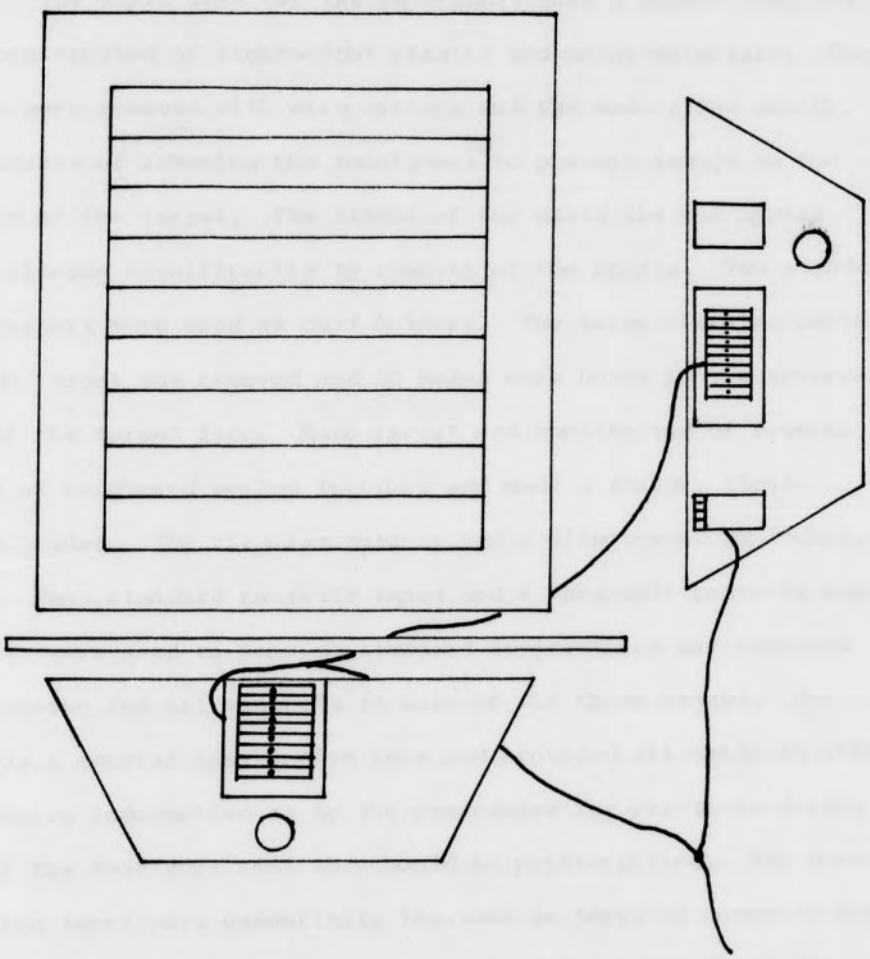


FIGURE 6

OVERVIEW OF TESTING ROOM

Other Equipment

The darts used for the experiment were 3 inches long and were constructed of lightweight plastic and metal materials. The points were removed with wire cutters and the ends filed smooth. The purpose of removing the points was to prevent damage to the surface of the target. The flight of the darts did not appear to be altered significantly by removal of the points. Two standard wall targets were used as dart holders. The large circular center of each target was removed and 50 holes were bored in the reverse side of the target face. Each target was constructed of several layers of cardboard sealed together and made a sturdy, lightweight holder. The circular holders had a diameter of 8¼ inches.

Four standard cassette tapes and a Panasonic cassette tape recorder were used to provide standard instructions and commands for throwing for all subjects in each of the three groups. One tape was a general instruction tape and provided all subjects with preliminary information as to the procedures for practices during each of the four days that they would be participating. The three remaining tapes were essentially the same in terms of commands for throwing, taped according to the set intertrial interval of 20 seconds. The main difference in the three tapes was in the cues added for purposes of indicating to the experimenter the appropriate time to depress the light switch corresponding to the placement of the dart on the target. The cues were in the form of a light tapping noise made with the point of a pencil against a cardboard surface. Such cues were only present in the tapes for the immediate

and 10-second delay groups. The general commands for throwing provided adequate cuing in the tape for the 15-second delay group.

A black tape line approximately 18 inches long and 1 inch thick was centered on the wall above the target. The line was approximately 2 feet above the surface of the target and provided a standard for adjusting the screen level for each subject. The procedure for adjusting the screen will be explained in a later portion of this chapter.

PILOT STUDY

Procedure

A pilot study was conducted approximately two weeks prior to the actual testing of the subjects participating in the experiment. The main purposes of the pilot study were to determine if selected testing techniques were feasible and to determine if the actual testing equipment would withstand prolonged usage. The subjects selected for the pilot study were six graduate students enrolled at The University of North Carolina at Greensboro. All six subjects volunteered to participate for a total of four consecutive days. They were randomly assigned to one of the three experimental groups so that each group was composed of two subjects. There was a standard intertrial interval of 30 seconds for all groups. Group I received immediate knowledge of results, Group II received knowledge of results 20 seconds after a response, and Group III received knowledge of results 25 seconds after a response.

An effort was made to treat all subjects in the same manner. The first day of testing was the longest session, because an instruction tape was played in addition to the tape of commands for throwing. The instruction tape was brief and general. The information was aimed at familiarizing the subject with the equipment and the purposes of each piece of equipment within the subject's view.

After the instruction tape was played, the experimenter answered any questions that the subject had concerning the procedures for throwing the 50 darts. When the subject was ready to perform, the experimenter and an assistant proceeded to adjust the screen for the subject. The procedure for adjusting the screen was to have the subject stand erect behind the restraining line. The screen was lowered to a point at which the subject saw the black line. It was then slowly raised to the nearest half inch mark at which the subject could no longer see any portion of the line. The wing nuts were tightened to secure the screen in place, and the experimenter recorded the mark for future reference.

After the screen was adjusted, the experimenter and assistant moved to their positions at the table along the right side of the target. The appropriate group command tape was played. The experimenter worked the light switchboard as the assistant retrieved and recorded the score for each dart.

On the three succeeding days, only the appropriate group command tape was played for each subject. Prior to each subject's

arrival, the screen was pre-adjusted according to the half inch mark recorded during the initial testing session.

Results

The purposes of the pilot study were to determine if selected testing techniques were feasible, and to determine if the testing apparatus was sound enough for prolonged usage. Only one change was found to be necessary in terms of the testing apparatus, and that was to replace the painted masking tape with pre-colored plastic tape for indicating the different sections of the target surface. The plastic tape was found to adhere better to the muslin target surface and, because of the pre-coloring, paint did not chip off of the tape when contacted by a dart.

As a result of the pilot study, several changes were made in terms of testing techniques and procedures. A significant change was made in the length of the intertrial interval. Thirty seconds between trials was found to be an almost unbearable length of time for throwing darts. All subjects in the pilot study suggested a shorter interval between trials. A decision was made to change the intertrial interval from 30 seconds to 20 seconds. Consequently, the delay intervals were changed from 20 seconds and 25 seconds to 10 seconds and 15 seconds respectively. All three group command tapes were changed relative to a 20-second intertrial interval.

A change was made in the procedure of the initial testing session with respect to the screen adjustment. Rather than waiting until after the instruction tape had been played, it was decided to adjust the screen prior to the playing of the instruction tape. By adjusting the screen before playing the instruction tape, the subject could commence to throw the darts as soon as all of her questions had been answered and while the instructions were still fresh in her mind.

The position of the experimenter in relation to the subject during the testing sessions was also changed. During the pilot study, the experimenter was seated at a table along the right side of the target. From this position, the subject could see the experimenter and the experimenter could see the subject. It was decided that having the experimenter sitting in view of the subjects during their performance might be an inhibiting factor; therefore, the experimenter was moved to a position behind the screen and out of view of the subject. Since the new position made it convenient for the experimenter to retrieve darts, the need for an assistant to score and retrieve was eliminated. The experimenter retained assistants to adjust the screen level on the initial day of testing for each new group of subjects. After the initial session, the experimenter was able to adjust the screen level on her own prior to the arrival of each subject.

Since the purposes of the pilot study did not include an attempt to actually solve the problem under investigation, no

statistical comparisons were made of the data collected from subjects participating in the pilot study.

TESTING PROCEDURE

The Subjects

The forty-five subjects for this experiment were selected from a random sampling of on-campus freshman women at The University of North Carolina at Greensboro. An initial letter was sent to all potential subjects (see Appendix A, page 73). The letter informed each individual that she had been randomly selected to participate in a research experiment, and that she would soon be contacted by telephone to determine her willingness to participate. Telephone calls were made on the Tuesday and Wednesday of the week prior to each new testing week in an effort to obtain a certain number (usually 8 to 10) of subjects. On Friday of the same week, a follow-up letter was sent to each individual who had agreed to participate during the next week. Enclosed with the letter was a copy of the subject's hours of participation and directions to the testing room in Coleman gymnasium. A second call was made on Sunday to remind subjects of their hours of participation for the week and to make sure that they each understood how to get to the testing room. A master schedule was made of the hours of participation of all subjects for each testing week.

Organization of Groups

Subjects were randomly assigned to each of three different groups. Group I received immediate knowledge of results after a

response, then waited approximately 18 seconds before making the next response; Group II received knowledge of results 10 seconds after a response, then waited approximately 10 seconds before making the next response; and Group III received knowledge of results 15 seconds after a response, then waited approximately 5 seconds before making the next response. Each group was composed of 15 subjects. Eight to ten subjects could be accommodated each testing week and a two week period was required to collect the data for each group. Each subject practiced for four consecutive days of one week, either Monday through Thursday or Tuesday through Friday, whichever was preferred. All subjects in all three groups threw 50 darts per day for a total of 200 trials. All subjects in each group listened to the same general instruction tape prior to beginning their first session of 50 trials. During the first session, a screen level was recorded for each subject. An effort was made to have the screen adjusted prior to each subject's arrival on the three succeeding testing days. In all three groups, each testing session for each subject took approximately 25 minutes to complete.

The Practice Sessions

Immediate knowledge of results. Subjects in Group I received immediate knowledge of results. However, it should be noted that the immediacy of knowledge of results was relative to the rate or speed of release of each subject. The command tape would say "next dart, ready, go." Approximately 2 seconds after

the word "go," a clicking noise in the command tape signalled the experimenter to press the appropriate button on the switchboard. Variations in speed of release would, therefore, affect the rate at which the subject received knowledge of results. The differences, however, appeared to be slight. The author believes that the insertion of cues into the command tape provided a more accurate standard for providing as near immediate knowledge of results as was possible, and was certainly more consistent than reliance upon the author's reaction time in providing immediate knowledge of results.

The command "next dart, ready, go" was begun 5 seconds before each trial. "Next dart" began 15 seconds after a response and more or less alerted the subject to prepare for her next throw. The light providing the subject with knowledge of results of her response was turned on when a clicking noise in the tape was heard 2 seconds after the word "go." Five seconds after the first clicking noise, a second clicking noise signalled the experimenter to turn off the light. After turning off the light, the experimenter retrieved the dart and recorded the score for that trial. The subject waited approximately 18 seconds after receiving knowledge of results before throwing her next dart. The same procedure was followed for each subject on all four days of testing.

A 10-second delay of knowledge of results. Subjects in Group II received knowledge of results 10 seconds after a response. They had to wait 10 seconds after a response before receiving knowledge of results and, likewise, they had to wait another 10

seconds after receiving knowledge of results before throwing the next dart. The command tape would say "next dart, ready, go" 15 seconds after a response. Ten seconds after the word "go," a clicking noise in the command tape signalled the experimenter to turn on the appropriate light. Five seconds later, the command "next dart, etc.," signalled the experimenter to turn off the light. The experimenter retrieved the dart and recorded the score for a particular trial in the interim between "go" and the clicking noise signalling the turning on of the appropriate light. The same procedure was followed for each subject on all four days of testing.

A 15-second delay of knowledge of results. Subjects in Group III received knowledge of results 15 seconds after a response. They had to wait 15 seconds after a response before receiving knowledge of results, and then they had to wait another 5 seconds before throwing the next dart. When the command tape said "next dart," the experimenter turned on the appropriate light. The light remained on until after the subject had released her next dart on the word "go." In actuality, the light should have been turned off on the word "go," however, the author felt that the noise of the light switch might have distracted the subject while in the act of throwing. The experimenter retrieved the dart and recorded the score in the interim between "go" and "next dart." The same procedure was followed for each subject on all four days of testing.

The author wishes to note that on the fourth (final) day of practice, all subjects in each of the three groups were verbally

administered an informal questionnaire. The questionnaire contained questions which the author had intended for personal use in terms of evaluating testing techniques and procedures used in this study. Contents of the questionnaire will be discussed in Chapter VII - Critique.

TREATMENT OF DATA

A one-way analysis of variance was computed to determine if any significant differences existed among the overall performances (200 trials per subject) of the three groups. In addition, a one-way analysis of variance was computed for each of the four testing days (50 trials per subject) to determine if any significant differences existed among the performances of the three groups on a day to day basis. The .05 level of confidence was set as the criterion for determining whether or not any differences were significant.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA

The purpose of this experiment was to investigate the effect of delayed knowledge of results on the performance of a dart throwing skill. Forty-five freshman women students were randomly assigned to each of three experimental groups. Each group was composed of fifteen subjects. All three of the groups had an intertrial interval of 20 seconds. Subjects in Group I received knowledge of results immediately after a response, then waited approximately 18 seconds before initiating the next response. Subjects in Group II received knowledge of results 10 seconds after a response, then waited approximately 10 seconds before initiating the next response. Subjects in Group III received knowledge of results 15 seconds after a response, then waited approximately 5 seconds before initiating the next response. In all three groups, subjects practiced dart throwing for four consecutive days. Each subject threw 50 darts per day for a total of 200 practice trials under the experimental conditions of her group.

Group Data

On the basis of the data collected from each of the three groups, five 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 five hypotheses were as follows:

1. There were no significant differences among the three groups on the basis of total practice scores (200 trials per subject) of each group.
2. There were no significant differences among the three groups on the basis of first day practice scores (50 trials per subject) of each group.
3. There were no significant differences among the three groups on the basis of second day practice scores (50 trials per subject) of each group.
4. There were no significant differences among the three groups on the basis of third day practice scores (50 trials per subject) of each group.
5. There were no significant differences among the three groups on the basis of fourth day practice scores (50 trials per subject) of each group.

To determine whether or not the above hypotheses were tenable, in each case a one-way analysis of variance was computed. Tables I through IV, pages 52 through 55, show the results of the first four computations. No significant differences were found to exist among the three groups on the basis of total group scores, first day practice scores, second day practice scores, and third day practice scores. Hypotheses 1 through 4 were found tenable. In terms of fourth day practice scores, however, a significant difference among the three groups was found to exist. The fifth hypothesis was, therefore, rejected. Table V, page 56, shows the results. The Scheffé test of significant differences was used to

TABLE I

ANALYSIS OF VARIANCE AMONG TOTAL SCORES OF ALL GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F
Between	2723.3333	2	1361.666	1.1863
Within	48204.6667	42	1147.7301	
Total	50928.0000	44		

TABLE II

ANALYSIS OF VARIANCE AMONG FIRST DAY SCORES OF ALL GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F
Between	414.7111	2	207.3555	.6009
Within	14492.5334	42	345.0603	
Total	14907.2445	44		

TABLE III

ANALYSIS OF VARIANCE AMONG SECOND DAY SCORES OF ALL GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F
Between	296.5778	2	148.2889	1.6353
Within	3808.4000	42	90.6761	
Total	4104.9778	44		

TABLE IV

ANALYSIS OF VARIANCE AMONG THIRD DAY SCORES OF ALL GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F
Between	45.7333	2	22.8666	.2318
Within	4142.2667	42	98.6253	
Total	4188.0000	44		

TABLE V

ANALYSIS OF VARIANCE BETWEEN FOURTH DAY SCORES OF ALL GROUPS

Source of Variance	Sum of Squares	df	Mean Squares	F
Between	433.9111	2	216.9555	4.0082*
Within	2273.3334	42	54.1269	
Total	2707.2445	44		

*Significant at the .05 level of confidence.

determine the origin of the difference. Table VI, page 58, shows that the difference was between Group I - Immediate Knowledge of Results and Group II - A 10-Second Delay of Knowledge of Results.

Interpretation of Data

The one-way analysis of variance showed that no significant differences existed among the three groups on the basis of total group scores, first day practice scores of each group, second day practice scores of each group, and third day practice scores of each group. These findings tended to support the findings of Bilodeau and Bilodeau (1958) that delayed knowledge of results was not detrimental to performance. However, the results also indicated that Group I was superior to Group II on the basis of fourth day practice scores of each group. Perhaps further practice trials (additional 50-100 trials per subject) would have provided insight as to whether the difference was due to chance or a definite superiority in the performances of subjects in Group I. On the basis of the overall total scores of each group, it would seem that delay of knowledge of results did not affect the performance of the dart throwing skill used in the design of this study.

Possibly, the intertrial interval had a great influence on the results of this study, even though it was held constant in all three groups. MacPherson, Dees, and Grindley (1949) investigated the influence of the intertrial interval in relation to the effects of knowledge of results on learning and performance. They found

TABLE VI

DIFFERENCE BETWEEN MEANS OF FOURTH DAY SCORES OF ALL GROUPS AND CALCULATED SCHEFFÉ VALUES

Groups	Means	Difference		Scheffé
I	217.2			
vs.		6.8667	>	6.8242*
II	210.3333			
I	217.2			
vs.		.6000	<	6.8242
III	216.6			
II	210.3333			
vs.		6.2667	<	6.8242
III	216.6			

*Significant at the .05 level of confidence.

that subjects that received visual knowledge of results after performing simple movements exhibited greater accuracy with short intertrial intervals of about 1 to 2 seconds in duration (1959:174). The Bilodeau and Bilodeau (1958) study supported MacPherson, Dees, and Grindley (1949) by revealing similar deteriorations in performances as the intertrial interval was progressively lengthened. They suggested forgetting and/or the need to warm up as factors possibly related to the decisiveness of the intertrial interval variable (1958:611). Denny and other researchers also supported these findings. They concluded that the intertrial interval was apparently more critical than delay of KR in a line drawing task (Denny and others, 1960). The intertrial interval for the current study was 20 seconds for all three groups. Possibly 20 seconds between darts was long enough to produce such deteriorations in performances, that no differences emerged among the three groups. The existing difference (Group I was superior to Group II on the basis of fourth day practice scores of each group), it would seem, therefore, occurred by chance.

In conclusion, on the basis of the overall total scores of each group, delayed knowledge of results did not affect the performance of the dart throwing skill designed for this study.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the effect of delayed knowledge of results on the performance of a dart throwing skill. The forty-five women subjects were randomly selected from the freshman class at The University of North Carolina at Greensboro. Each group was composed of fifteen subjects. All three groups had the same intertrial interval of 20 seconds. Subjects in Group I received knowledge of results immediately after a response, then waited approximately 18 seconds before initiating the next response; subjects in Group II received knowledge of results 10 seconds after a response, then waited approximately 10 seconds before initiating the next response; and subjects in Group III received knowledge of results 15 seconds after a response, then waited approximately 5 seconds before initiating the next response. Each subject threw 50 darts per day for four consecutive days. A total of 200 trials were thus recorded for each subject in each group.

The one-way analysis of variance was used to determine if:

1. There were any differences among the three groups on the basis of overall total group scores (200 trials per subject).

2. There were any differences among the three groups on the basis of the total first day practice scores of each group (50 trials per subject).
3. There were any differences among the three groups on the basis of the total second day practice scores of each group (50 trials per subject).
4. There were any differences among the three groups on the basis of total third day practice scores of each group (50 trials per subject).
5. There were any differences among the three groups on the basis of total fourth day practice scores of each group (50 trials per subjects).

No significant differences were found to exist among the three groups on the basis of overall total group scores, total first day practice scores, total second day practice scores, or total third day practice scores. A significant difference was found to exist among the three groups on the basis of total fourth day practice scores. The Scheffé test of significant differences was used to determine the origin of the difference. The significant difference was between Group I - Immediate Knowledge of Results and Group II - A 10-Second Delay of Knowledge of Results. It was decided that possibly an additional 50-100 trials per subject would have revealed whether this difference was due to chance or a definite superiority in the performances of subjects in Group I.

On the basis of total group scores, it was concluded that delayed knowledge of results did not affect the performance of the dart throwing skill used in the design of this study.

CHAPTER VII

CRITIQUE

In evaluating this study, the author has considered the information obtained from the informal questionnaire, the experimental design of the study, and the testing apparatus. Suggestions and recommendations are presented for consideration in terms of future research of this nature.

Questionnaire

As stated in Chapter IV - Procedure, the questionnaire was not originally intended to be an actual part of the procedure. The author designed the questions for a personal evaluation of the experimental design and apparatus. It was decided *ipso post facto* that the questionnaire would be valuable in justifying some of the suggestions and recommendations offered. The author wishes to note that not all questions were used with all subjects. Some questions were only applicable to subjects in specific groups. Also, some questions were introduced as the experiment progressed, and, therefore, not all subjects responded to some of the questions designed for all three groups. The author also wishes to note that the questions, which are listed in Appendix D, page 87, were not all asked necessarily as they were written. Some questions were not detailed enough for the subjects and, therefore, the author had to elaborate further when asking them.

Three of the questions were concerned with noises or possible distractions that might have affected the subjects as they performed. The command tapes for Groups I and II had clicking or light tapping noises in them to cue the experimenter to turn the panel lights on or off. All subjects in Groups I and II said that the noises did not distract them in any way. They became accustomed to these cues after hearing them during the first few trials. The buttons mounted on the switchboard also made a clicking noise when pressed on or off. However, none of the subjects in any of the three groups indicated that the clicking noise distracted them in any way during their performances. All subjects were asked if they were significantly distracted by noise outside of the testing room. Since the testing room was a small drying room located inside the girls' locker room, many noises such as students entering between classes, running showers, electric hair dryers, etc., could be heard. All but two subjects said that they were not distracted by the noises outside the room. Many said that they were so involved with the experiment that they were not even aware of outside disturbances. Two of the subjects indicated that they were aware of noises outside the room, but were not sure if the noises distracted them to the point of interfering with daily performances.

Two of the questions concerned, more or less, the length of the intertrial interval. One of the questions was later omitted because the author considered it irrelevant. After further

consideration, however, it was decided to include the question for evaluative purposes. Subjects were asked if they became bored during the daily sessions of 50 darts. The majority of the subjects said no, and that they usually attempted to concentrate on the lights and where their darts had landed. It would seem that as a subject became bored, she would initiate some other activity or concentrate on something unrelated to the experiment. The other question was an effort to determine how the subjects felt about the length of the intertrial interval. They were asked if they felt that the interval between darts was too long or uncomfortably long. Twenty-five of the twenty-nine subjects that were asked this question answered in the affirmative. Many of them said they had the urge to throw ahead of the command.

All subjects were asked if they felt motivated or rewarded when the red light (five points) came on after they had thrown a dart. All but one said yes. One subject also indicated that she found the blue lights (four points) rewarding. Most of the subjects (31) were asked if they felt that the time of day might have affected their performances in some way. They were asked if they felt that they might have performed better in the morning than the afternoon, vice-versa, or if they felt that the time of day made no difference. The majority felt that the time of day made no difference in their performances. Four subjects felt that they could not really say one way or the other. Several felt that the time of day probably did affect their performances. Many said

that they were tired in the afternoons and felt that their performance might have suffered as a result. Others said that they were "sleepy" in the mornings and that this might have affected their performances.

Another question concerned the implications of the role of kinesthesis in the performance of the dart throwing skill used in the study. Subjects were asked if they could determine, prior to the presentation of knowledge of results, whether they had overshot or undershot the middle (red - five points) section of the target. All but four subjects said yes, that they could definitely tell when they had missed the middle section. Many subjects said that they could tell approximately where the darts were landing by watching the flight or trajectory of the dart. Others stated that they could tell approximately where darts were landing by the feel of the force with which they threw them. Some subjects stated they were aware of the force and the trajectory of each throw.

Evaluation and Recommendations

Experimental design. On the basis of the questionnaire and the motor skill used in this study, the author would suggest a decrease in the length of the intertrial interval. Possibly 10 or 15 seconds between trials would be more conducive for throwing darts. If the intertrial interval was set at 10 seconds, for example, delays of 4 seconds and 8 seconds could be the delays

used for Groups II and III respectively. With a shorter inter-trial interval, the need for rest intervals would have to be considered.

Testing apparatus. The author would strongly suggest the elimination of voice commands for the purpose of indicating to the subjects when to throw each dart. The author found it very difficult to record all fifty command sequences consistently and without alteration in force of voice command or loudness of commands. The use of a tone signal or light signal would provide for a more consistent standard to cue subjects to throw on each trial.

Another recommendation would be in terms of the design of the target. A substitute for the foam rubber padding is recommended to prevent the great amount of rebound that often propelled darts completely off the target surface and onto the floor. Possibly binding the target with a less resilient fabric than foam rubber would eliminate the problem of too much rebound. Some type of cotton stuffing or padding might serve this purpose and still prevent the production of an auditory cue. Also, in terms of the target, the author would recommend the addition of self-supporting legs so that external objects (wall, ledge, stools, etc.,) would not be required to raise the target the desired distance above the floor.

The final recommendation is in terms of the light panel and switchboard apparatus. The author would suggest the use of silent light switches for the purpose of eliminating the noise

of the switches as a distraction. Also, an additional switch and corresponding light might be added to provide information concerning darts that land in areas of the target which were designated as no score. While few darts landed on the no score areas of the target in the current study, an appropriate light on the target would have added consistency in providing knowledge of results (the subject was told if a dart failed to score on a given trial).

REFERENCES

REFERENCES

Annett, John. Feedback and Human Behaviour. Baltimore, Maryland: Penquin Books, 1969.

Archer, E. James, and Gediminas A. Namikas. "Pursuit Rotor Performance as a Function of Delay of Information Feedback," Journal of Experimental Psychology, 56:325-327, October, 1958.

Bilodeau, E. A. Principles of Skill Acquisition. New York: Academic Press, 1969.

Bilodeau, Edward A., and Ina McD. Bilodeau. "Motor-Skills Learning: Feedback," Background Readings for Physical Education, ed. Ann Paterson and Edmond C. Hallberg (New York: Holt, Rinehart and Winston, Inc., 1966), pp. 213-229.

Bilodeau, Edward A., and Ina McD. Bilodeau. "Variation of Temporal Intervals Among Critical Events in Five Studies of Knowledge of Results," Journal of Experimental Psychology, 55:603-611, June, 1958.

Bilodeau, Edward A., Ina McD. Bilodeau, and Donald A. Schumsky. "Some Effects of Introducing and Withdrawing Knowledge of Results Early and Late in Practice," Journal of Experimental Psychology, 58:142-144, August, 1959.

Bilodeau, Edward A., and Francis J. Ryan. "A Test for Interaction of Delay of Knowledge of Results and Two Types of Interpolated Activity," Journal of Experimental Psychology, 59:414-419, June, 1960.

Bourne, Lyle E., Jr. "Effects of Delay of Information Feedback and Task Complexity on the Identification of Concepts," Journal of Experimental Psychology, 54:201-207, September, 1957.

Bourne, Lyle E., and C. Victor Bunderson. "Effects of Delay of Informative Feedback and Length of Postfeedback Interval on Concept Identification," Journal of Experimental Psychology, 65:1-5, January, 1963.

Brackbill, Yvonne, et al. "Delay of Reinforcement and the Retention of Unfamiliar, Meaningless Material," Psychological Reports, 11:553-554, October, 1962.

Chase, Richard Allen, and others. "Comparison of the Effects of Delayed Auditory Feedback on Speech and Key Tapping," Science, 129:903-904.

Denny, M. R., and others. "Supplementary Report: Delay of Knowledge of Results, Knowledge of Task, and Intertrial Interval," Journal of Experimental Psychology, 60:327, November, 1960.

Dyal, James A. "Effects of Delay of Knowledge of Results in a Linedrawing Task," Perceptual and Motor Skills, 19:433-434, October, 1964.

Dyal, James A., Wayne J. Wilson, and Kenneth K. Berry. "Acquisition and Extinction of a Simple Motor Skill as a Function of Delay of Knowledge of Results," Quarterly Journal of Experimental Psychology, 17:158-162, May, 1965.

Elwell, J. L., and G. C. Grindley. "The Effect of Knowledge of Results on Learning and Performance," British Journal of Psychology, 29:39-53, July, 1938.

Greenspoon, Joel, and Sally Foreman. "Effect of Delay of Knowledge of Results on Learning a Motor Task," Journal of Experimental Psychology, 51:226-228, March, 1956.

Lavery, J. J. "The Effect of One-trial Delay in Knowledge of Results on the Acquisition and Retention of a Tossing Skill," American Journal of Psychology, 77:437-443, September, 1964.

Lorge, Irving, and Edward L. Thorndike. "The Influence of Delay in the After Effect of a Connection," Journal of Experimental Psychology, 18:186-194, April, 1935.

MacPherson, S. J., Valerie Dees, and G. C. Grindley. "The Effect of Knowledge of Results on Learning and Performance II. Some Characteristics of Very Simple Skills," Quarterly Journal of Experimental Psychology, 1:68-78, October, 1948.

MacPherson, S. J., Valerie Dees, and G. C. Grindley. "The Effect of Knowledge of Results on Learning and Performance III. The Influence of the Time Interval Between Trials," Quarterly Journal of Experimental Psychology, 1:167-174, October, 1949.

McGuigan, F. J. "Delay of Knowledge of Results: A Problem in Design," Psychological Reports, 5:241-243, June, 1959.

McGuigan, F. J., Frances Crockett, and Carolyn Bolton. "The Effect of Knowledge of Results Before and After a Response," The Journal of General Psychology, 63:51-55, July, 1960.

Noble, Clyde E., and Wayne T. Alcock. "Human Delayed-Reward Learning with Different Lengths of Task," Journal of Experimental Psychology, 56:407-412, November, 1958.

Phillips, B. E. "Relationship Between Certain Phases of Kinesthesis and Performance During the Early Stages of Acquiring Two Perceptuo-Motor Skills," Research Quarterly, 12:51-86, October, 1941.

Phillips, Marjorie, and D. Summers. "Relation of Kinesthetic Perception to Motor Learning," Research Quarterly, 25:456-469, December, 1954.

Saltzman, Irving J. "Delay of Reward and Human Verbal Learning," Journal of Experimental Psychology, 41:437-439, June, 1951.

Singer, Robert N. Motor Learning and Human Performance. New York: The Macmillan Company, 1968.

Weinberg, Dorothe R., Donald E. Guy, and Ronald W. Tupper. "Variation of Postfeedback Interval in Simple Motor Learning," Journal of Experimental Psychology, 67:98-99, January, 1964.

Wiebe, Vernon R. "A Study of Tests of Kinesthesis," Research Quarterly, 25:222-230, May, 1954.

Witte, F. "Relation of Kinesthetic Perception to a Selected Motor Skill for Elementary School Children," Research Quarterly, 33:476-484, October, 1962.

APPENDIXES

APPENDIX A

Correspondence

, 1972

Dear Miss ,

You have been randomly selected to participate in a research experiment to be conducted in the School of Health, Physical Education, and Recreation at The University of North Carolina at Greensboro. This experiment will involve a dart throwing skill and will require approximately thirty minutes of your time per day for a period of four consecutive days of a week (Monday through Thursday or Tuesday through Friday). The times and days that you participate will be arranged at your convenience according to your schedule for Spring semester 1972.

I think that you will find this experiment to be interesting and your participation will be greatly appreciated. I shall be contacting you by telephone in the near future to determine your willingness to participate and to answer any questions that you may have concerning your participation in this experiment.

Thank you very much.

Sincerely yours,

Elaine M. Bailey
Graduate Student
School of Health, Physical
Education, and Recreation

, 1972

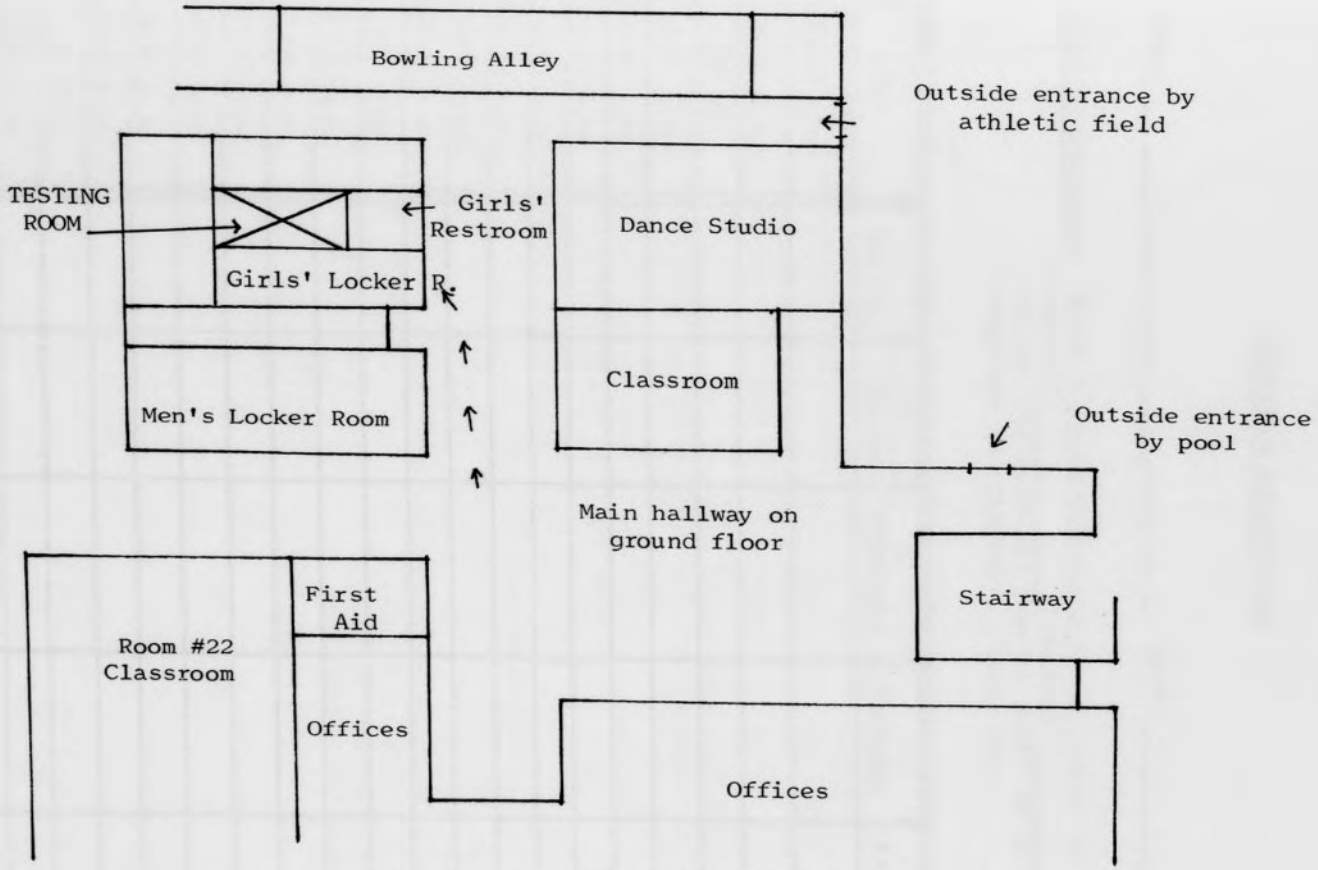
Dear Miss ,

I enjoyed talking to you on the phone, and I am very pleased that you will be participating in my research experiment. I have enclosed a map with directions to the testing room which is located in the girls' locker room at Coleman Gymnasium. I have also enclosed a schedule of your hours of participation. If you have any questions concerning either the map or your schedule, please contact me or leave a message at the following number: 274-4472.

I am looking forward to seeing you on _____. Thank you very much.

Sincerely yours,

Elaine M. Bailey
Graduate Student
School of Health, Physical Education, and Recreation



GROUND FLOOR of COLEMAN GYMNASIUM

SCHEDULE INFORMATION

Name: _____ Week: _____

Testing Schedule: Below is your participation schedule for the week of _____ through _____. Please try to be on time to avoid delays or overlaps in schedules. Thank you.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8:00 a.m.					
8:30 a.m.					
9:00 a.m.					
9:30 a.m.					
10:00 a.m.					
10:30 a.m.					
11:00 a.m.					
11:30 a.m.					
12:00 noon					
12:30 p.m.					
1:00 p.m.					
1:30 p.m.					
2:00 p.m.					
2:30 p.m.					
3:00 p.m.					
3:30 p.m.					
4:00 p.m.					
4:30 p.m.					
5:00 p.m.					
5:30 p.m.					

, 1972

Dear Miss ,

Thank you very much for your assistance with the research experiment I have been conducting in the School of Health, Physical Education, and Recreation. I sincerely appreciate the time and effort you devoted in helping me to obtain the information necessary to complete my research.

My sincerest and best wishes for a successful future at the University of North Carolina at Greensboro.

Again, thank you very much.

Sincerely yours,

Elaine M. Bailey
Graduate Student
School of Health, Physical
Education and Recreation

APPENDIX B

Tape Recorded Instructions

TAPE RECORDED GENERAL
INSTRUCTIONS FOR ALL GROUPS

This experiment involves a dart throwing skill and you will be required to throw a total of 200 darts within a period of four days. You will throw 50 darts today and 50 darts per day for the next three consecutive days.

As you can see, there is a screen set up between you and the target at which you will be throwing. The experimenter will adjust the screen according to your height before you begin.

The target on the other side of the screen is lying face up and is elevated approximately two feet from the floor. The small target in front of you is a miniature of the actual target and shows you the point values assigned to each section of the target. Any dart landing on the area surrounding the colored sections of the target will be scored a 0. You will be asked to rethrow any dart failing to clear the screen or any dart contacting wall or floor surfaces around the target. Each dart will be scored according to its initial contact with the surface of the target.

The cassette tape recorder will be used to provide prerecorded commands for each trial. The tape will say "next dart, ready, go" and you will throw your next dart. At some time in the interval between throws, the miniature target will be lighted to show you the score for your last throw. You are asked to

concentrate on this information and try to improve on your next throw. Attempt to score as high as possible with each dart.

At this time, you may ask any questions you have concerning the instructions or the testing apparatus.

After the instruction tape was played, the command tape was played. The command tape was essentially the same for all three groups, except for the cues inserted for the experimenter. The tape contained the following commands: "Prepare to throw your first dart, ready, go . . . next dart, ready, go . . . next dart, ready, go . . . etc., . . . last dart, ready, go."

APPENDIX C

Raw Scores

RAW SCORES

Group I

Subjects	1st Day	2nd Day	3rd Day	4th Day	Total
1	212	213	213	219	857
2	212	215	227	219	873
3	207	213	215	208	843
4	144	220	222	222	808
5	209	218	223	222	872
6	193	219	222	218	852
7	203	199	199	214	815
8	211	219	211	218	859
9	211	217	217	223	868
10	213	218	217	209	857
11	192	198	206	209	805
12	189	226	210	225	850
13	231	215	227	217	890
14	202	215	217	228	862
15	183	207	197	207	794
Totals	3012	3212	3223	3258	12705

RAW SCORES

GROUP II

Subjects	1st Day	2nd Day	3rd Day	4th Day	Total
1	194	207	206	207	814
2	191	208	214	206	819
3	217	219	207	205	848
4	165	210	210	222	807
5	212	199	214	207	832
6	208	206	212	206	832
7	216	216	227	223	882
8	146	188	210	208	752
9	203	219	215	205	842
10	213	229	226	214	882
11	219	213	233	210	875
12	165	185	187	200	737
13	197	210	217	211	835
14	221	209	219	216	865
15	211	203	209	215	838
Totals	2978	3121	3206	3155	12460

RAW SCORES

Group III

Subjects	1st Day	2nd Day	3rd Day	4th Day	Total
1	181	197	203	224	805
2	201	221	204	208	834
3	219	211	225	223	878
4	201	213	197	204	815
5	206	221	225	224	876
6	211	203	207	216	837
7	212	205	217	224	858
8	189	216	213	213	831
9	208	219	211	215	853
10	216	228	224	225	893
11	224	220	214	224	882
12	205	201	194	215	815
13	204	204	215	203	826
14	212	221	223	228	884
15	198	208	214	203	823
Totals	3087	3188	3186	3249	12710

APPENDIX D

Questionnaire

QUESTIONNAIRE

1. Did the clicks on the tape distract you?

2. Did the noise of the button being pressed to turn on the light distract you?

3. Did the noise outside the testing room distract you?

4. Did you get bored during the course of each session of 50 darts?

5. Did you feel that the interval between darts was too long?

6. Could you tell when you had overshot or undershot the red section of the target?

7. Did you find the red light to be motivating or rewarding?

8. Do you think that the time of day affected you in any way?

APPENDIX E

Photography of Apparatus