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EFFECT OF SELECTED PREPARATORY AND RESPONSE SIGNAL DURATIONS ON REACTION TIME IN A SIMPLE REACTION TIME TASK

by

William Dean Utter

A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
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Approved by

E. Doris McKinney
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APPROVAL PAGE

This dissertation 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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March 22, 1974
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UTTER, WILLIAM DEAN. Effect of Selected Preparatory and Response Signal Durations on Reaction Time in a Simple Reaction Time Task. (1974) Directed by: Dr. E. Doris McKinney. Pp. 67.

It was the purpose of this study to investigate the effect selected durations of PS and RS had on simple RT in a simple RT task. The hypotheses investigated were: (1) PS durations of one and four seconds would produce significantly different RT, (2) RS durations of 100 and 300 msec. would result in significantly different RT, (3) the interaction of PS and RS would significantly affect RT.

The subjects were 18 male undergraduate students with a mean age of 20 years, enrolled at the University of North Carolina at Greensboro. Subjects were selected at random from a listing of male students in the freshman, sophomore, and junior classes at the University.

Each subject was tested under four task conditions in which the PS and RS durations were varied. A total of 160 trials with 40 trials randomly arranged in each condition were completed by each subject. The Hunter Model 120 A Klockounter, a constructed control unit to record RT, a unit to control PS and RS durations, and a response key comprised the instrumentation.

An analysis of variance for a two-factor experimental design with repeated measures was used to compare the effects of the four task conditions. The significance level was set

at the .05 critical value. The Omega Square post hoc test, and the Newman-Keuls test were used to further analyze significant findings.

Hypothesis one, stating that the main effect for the PS would significantly affect RT was not supported. Hypothesis two, proposing that the main effect for the RS would significantly affect RT was supported. The short signal duration produced the fastest RT. Hypothesis three, stating that interaction between PS and RS would significantly affect RT, was also supported. The combination of a short PS and short RS produced the shortest RT.

Within the limitations of the study, it was concluded that RT is affected by various durations of RS; and that RT is affected by the interaction between PS and RS.

Dedicated to

My Wife Beverley and

Daughters, Becky, Jill, Pam, and Jennifer

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CHAPTER I

Introduction

Attention to reaction time (RT) has been a central concern in experimental psychology since the earliest RT study conducted by Helmholtz in 1850. In spite of the prodigious research generated by that attention, many questions still remain regarding the relationships in which the process of RT is involved.

A review of more than 160 studies spanning a period of 20 years, compiled by Teichner (1954), identifies research of the many internal and external variables affecting RT performance. Until recently, however, the most basic variable associated with simple RT, temporal uncertainty, has been largely overlooked. Temporal uncertainty appears to be the primary uncertainness that a subject encounters in a simple RT task. The subject is usually aware of the stimulus to be presented and the response to be made. He does not know when the stimulus is to be presented or the duration of the stimulus. Temporal uncertainty is primarily a result of imperfect time keeping ability on the part of the subject, and the clock-time variability of the stimulus.

The importance attached to the variable of temporal uncertainty and to the time keeping ability of a subject suggests that simple RT is a rather complex measure, consisting of a set of actions and reactions between receptor and effector processes. The importance of timing in the development of skill was related by Bartlett (1947) as follows:

> If we could understand the simple timing mechanisms which the human body and mind must obviously be able to use, and how they work, we should have got some way, at least, towards a measure of degree or level of skill [p. 34].

In an attempt to understand the complex timing mechanisms Bartlett writes about, most investigators turned to the classical RT study to measure the component of skill. However, investigators found that they were unable to obtain significant information to answer many questions they had related to skill development. Conflicting results continue to exist when individuals study the problem of RT in relationship to skill.

Disagreement in results of earlier studies, and the conclusions showing significant effects on RT by PS and RS in a recent study by Slater-Hammel, Cole, & Wells, (1973), established a need for further investigation of time-related variables involved in RT performance. The present investigation studied the time-related variables of preparatory signal (PS) and response signal (RS) durations as determinants of RT.

The additional study of the PS and RS variables may lead to a clearer understanding of their relationship, and the manner in which the signals aid in a possible reduction of temporal uncertainty. If it becomes possible to reduce temporal uncertainty, response latency may decrease, leading to a subsequent facilitation of human movements.

Statement of the Problem

The purpose of the present study was to investigate the effect of PS and RS durations upon simple RT, using male undergraduate students as subjects. An additional purpose was to study the interaction, if any, between selected durations of the PS and RS.

Hypotheses. The study tested the general hypothesis that a specific RT occurs as a function of task conditions for response initiation. Specific hypotheses tested were:

1. Selected PS durations of one and four seconds produce a significantly different RT.

2. Selected RS durations of 100 and 300 msec. produce significantly different reaction times.

3. The interaction between PS and RS durations will significantly effect RT.

Definitions of Terms

The following definitions were accepted for the purpose of this study:

Preparatory signal duration. The interval immediately after the preparatory light goes on and continuing until the response signal light appears.

Response signal duration. The duration of the stimulus presented to the subject immediately following the cessation of the PS.

A trial. One and only one stimulus presentation and one and only one response.

A response. The lifting of the subject's middle and index fingers of his preferred hand from the response key at the onset of the RS.

A block of trials. A series of 40 stimulus presentations and 40 responses.

Scope of the Study

The study involved one major problem, to ascertain the effect selected PS and RS durations had upon simple RT. The major problem was broken down into four task conditions which consisted of combining the various selected PS and RS durations. Durations for the PS were set at one and four seconds. The durations for the RS were set at 100 and 300 msec. The four task conditions were presented to subjects in a random series of 40 trials per series.

Eighteen male undergraduate students enrolled at the University of North Carolina, Greensboro, North Carolina, during the fall semester of 1973-74, served as subjects in the investigation. All subjects performed each of the four task conditions during a single session. Subjects ranged in age from 18 to 22 years, with a mean age of 20 years.

Certain assumptions were made for this investigation. One such assumption was the research strategy employed acknowledges that RT occurs in an open-loop system. That is, stimulus and response are viewed as discrete events. A second assumption proposed that attention, motivation, and fatigue are factors assumed to be constant across subjects and trial blocks. Finally, it was assumed that the "state" of the subjects was appropriate for participation in the study.

Significance of the Study

As long as inconsistencies exist in the data obtained from studies investigating time-related variables similar to those selected for the present study, continued replication and rearrangement are necessary to lend substance to existing theories related to simple RT. The additional knowledge resulting from each subsequent investigation adds further thinking material, and aids in the quest to either support or deny a particular theory.

Conflicting and incomplete data still exist as to optimal durations and mode of presentation for the PS and RS variables in a simple RT task. Questions also remain as to what effect the interaction between the PS and RS has on simple RT. The question concerning the interaction between PS and RS was most recently investigated by Slater-Hammel, et al., (1973) with results proving negative. However, the investigators suggested that with a more sensitive experiment, a significant effect may be found for the interaction of the two signals.

The present study attempted to add further information to existing theories regarding the variables of PS and RS as they affected simple RT, and to examine the interaction effect, if any, between PS and RS.

As a result of the current investigation, it is assumed that there will be further understanding of the PS and RS variables as determinants of simple RT. The additional knowledge may make it possible to reduce the temporal uncertainty associated with simple RT, with a resultant decrease in response latency.

CHAPTER II

Review of Literature

Researchers have dealt with the many variables associated with RT in a variety of tasks, and under a number of varying conditions. Pertinent to this study are historical reviews, and investigations involving the PS and RS as determinants of RT.

Extensive study of RT, and the factors affecting RT, was undertaken during the nineteenth century. Hermann von Helmholtz reported in 1850 that the speed of nerve impulse was relatively slow, however, not as slow as RT itself (Fitts & Posner, 1967). In one of his experiments Helmholtz stimulated a subject on the thigh and on the sole of the foot and measured the delay in the responses. On the basis of the calculated differences in RT, Helmholtz concluded that neural impulses travel at the rate of 50 to 100 meters per second (Fitts & Posner, 1967, p.94). The rate of 100 meters per second for the speed of nerve impulses was substantiated in later research. As the figure of 100 meters per second may indicate, most of the RT involves delays in the central processing rather than along the peripheral nerves.

Prior to the discoveries by Helmholtz, astronomers had become aware of the significance of RT. The recording of a star's transit was considered to be very important to the work of astronomers, and therefore related to the concept of RT. Maskelyne, (Bilodeau, 1969) while chief astronomer at the Greenwich Observatory in 1794, noted that a one-second discrepancy existed between his recordings and those of his assistant. The finding of errors in the measurements led to further investigation of differences in measurement obtained at other laboratories. Bessel (Bilodeau, 1969) determined that the differences in the measurements between astronomers was attributed to processes within the individual observers. He termed these discrepancies the "personal equation." Further observations by Bessel suggested that delays were shorter with the more intense stars, and that the delays increased where events were not expected, and when simultaneous auditory and visual events occurred.

With continued concern over the "personal equation" discrepancy proposed by Bessel, an astronomer by the name of Hirsch used the Hipp Chronoscope to measure what he termed the "physiological time" of the eye, ear, and sense of touch. Values for simple RT were obtained and have remained relatively standard to the present time (Woodworth & Schlosberg, 1954). Following the work of Maskelyne, Helmholtz, Bessel, and Hirsch, researchers such as Donders, Exner, Wundt, Cattell, Kulpe, Pieron, and Hipp, aided in pioneering work in the study of RT. Many other psychologists have made important contributions, and have found a variety of scientific and applied uses for the RT technique (Woodworth & Schlosberg, 1954, p.11).

The Preparatory Signal and Reaction Time

Preparation for reaction is clearly an essential part of the response latency process. Without some preparation the reaction may not occur at all. However, the more exact the preparation, the more punctual the reaction to a stimulus.

The use of preparatory signals has proven to yield a faster RT than the elimination of such a signal. Most investigators consequently use a ready signal, varying the duration and the method of presentation.

According to Teichner (1954) the factor of readiness seems to depend on the length of time between the ready signal and the stimulus to which a response is to be made. He refers to this time span as the "foreperiod of reaction."

An early study by Breitwieser (1911) investigated the relations of the PS and reaction, and for extended and more complex purposes, these relationships continue to be under analysis in more recent studies (Botwinick & Brinley, 1962; Drazin, 1961; Hermelin & Venables, 1964; Karlin, 1959; Klemmer, 1956; and Slater-Hammel, et al., 1973). Breitwieser (1911) found definite individual differences in the length of the optimum PS, and reported a range of optimum preparatory signals between one and four seconds. Woodrow (1914), in studying the relationship between simple RT and the PS, extended the range of preparatory signals to 24.0 seconds, well beyond the range investigated by Breitwieser. Using an auditory stimulus, Woodrow (1914) found that when the PS remained constant, the optimal PS was approximately two seconds. When the PS was varied irregularly there was no clear optimum, and the reaction was slow throughout, about as slow as the longest PS in the regular series. Although the study by Woodrow (1914) is the one most frequently quoted in regard to the effect of the PS on RT, the significance of his results have been questioned since the data collected were obtained from only three subjects. However, it should be noted that the use of a small population was more the trend than the exception in early studies.

Woodworth and Schlosberg (1954), after reviewing a number of RT studies investigating the PS duration as it affects RT, support the findings of Woodrow (1914) showing the two-second PS to be the optimum duration. Monro (1951) also confirmed that a PS of two seconds duration was the most efficient interval between the PS and the RS. Monro (1951) added that too short a PS does not allow the subject time to get properly set to react. A PS too long in duration inhibits reaction, and the subject's readiness to react diminishes.

A study by Telford (1931) examined a PS of 0.5 seconds, along with durations of 1.0, 2.0, and 4.0 seconds. Reaction time at durations of 1.0 or 2.0 seconds were significantly shorter than the 0.5 or 4.0 second durations. The 1.0 second interval gave the shortest latency of all the preparatory signals presented. The PS durations were presented to the subjects in an irregular series. Telford (1931) actually used no warning signals, but his procedure could have been interpreted in PS terms by treating each stimulus as a PS for the next RS.

In an experiment concerned with reaction times to regularly recurring visual stimuli (Aiken & Lichtenstein, 1964), the investigators established that when the effects of practice are essentially nullified, the optimum PS is less than two seconds, and probably closer to one second. Results also demonstrated that practice was more effective in reducing RT with a short PS than with signals of longer duration. The establishment of an optimum PS of less than two seconds in duration has found support from a number of later investigations (Oxendine, 1968; Sage, 1971; Robb, 1972; and Drouin, 1973).

A number of studies have investigated the ability of a subject to maintain a peak level of readiness during a given duration of the PS. One of the earliest studies (Mowrer, 1940) used what was termed a "catch" PS technique to determine how readiness developed during a PS of 12.0 seconds. Mowrer (1940) presented a RS for the greater majority of trials 12.0 seconds after the initiation of the PS. Inserted occasionally throughout the trials were PS durations longer and shorter than the established 12.0-second interval. The group readiness curve obtained showed that readiness reached a peak at the modal PS of 12.0 seconds. Over a range of longer durations, 15.0 to 24.0 seconds, RT increased slightly. Later studies by Karlin (1959, 1966) produced varying results compared to the data obtained by Mowrer. Using a less direct technique than Mowrer (1940), Karlin (1959) established readiness curves of a sort for average PS intervals of 0.5, 1.0, 2.0, and 3.5 seconds. The last three durations could be considered consistent with the findings of Mowrer (1940). However, peak readiness at the 0.5-second interval could not be maintained. Results suggest that a subject may not maintain a peak readiness much beyond the expected duration of PS when it is of relatively short duration. For the study by Karlin (1959), a relatively short duration was below the 1.0-second interval. The 1966 study by Karlin attempted to investigate further the problem concerning peak readiness at short durations below 1.0 second. Using an auditory PS and RS, simple RT as a function of PS duration was determined for six PS distributions characterized as leptokurtic, bimodal, or rectangular. The readiness curves obtained with shorter preparatory signals suggested a ballistic type of preparation which follows a preset course of development independent of current information. In the study by Mowrer (1940), it appeared that with a longer modal PS of 12.0 seconds, subjects had more time to monitor information, thereby enabling them to reach the peak of readiness at the PS interval of 12.0 seconds.

Rothstein (1973) conducted an experiment to test the effect on temporal expectancy of the position of a selected PS within a range. She defined temporal expectancy as increasing readiness to respond to events that occur over time. The increased readiness was observed by measuring RT, the hypothesis being that as readiness increases, RT decreases. Using three overlapping, consecutive ranges with a common PS of 2.5 seconds, results demonstrated that under the conditions of the experiment, temporal expectancy increased as the upper limit of each range was approached. It seems apparent that the occurrence of the fastest RT constantly at the upper limit of each range was due to the development of a particular set to respond to a short PS duration. The subjects were therefore able to use the additional information from each preceding PS to develop peak readiness at the upper limit of each range.

An experimental study by Drazin (1961) also established a range effect between RT and the PS. Using only three subjects, Drazin investigated the effects of foreperiod, foreperiod variability and probability, and probability of stimulus occurrence, on visual simple RT. In the first part of the study the mean foreperiod was held constant throughout the test at 1.5 seconds for both the range of the foreperiod and the probability of stimulus presentation. For the second part of the experiment the range of the foreperiod was held constant at a 1.0-second duration, and the probability of stimulus occurrence at 1.0 second with the minimum foreperiod held at five different levels. Fourteen conditions were presented to subjects, with the minimum foreperiod, range of foreperiods and probability of stimulus occurrence randomized. In all conditions where the range of foreperiods exceeded a duration of 0.5 seconds, RT tended to decrease initially as a negatively accelerated function of the length of the foreperiod. Drazin (1961) also observed that RT varies with foreperiods preceding and following the preceding reaction. The marked effects were found following reactions preceded by a short foreperiod.

Investigating the factor of time uncertainty in simple visual RT, Klemmer (1956) tested six subjects in two series of studies on simple response latency. In the first series, the subjects received a warning click occurring at 1.0-second intervals, and randomized preparatory signals with a mean PS change between tests. The second series contained no warning click, and no variability of time of stimulus occurrence during each run. However, the PS was changed between tests. The results established that visual RT increases with PS variability and also with a mean PS above some small optimum value less than 1.0 second. The finding by Klemmer (1956) was not in agreement with information in a review by Teichner (1954) which suggested that an optimum PS lies somewhere within a range of 1.5 to 8.0 seconds. The 1956 study by Klemmer indicated that the optimum PS in a test with randomly ordered preparatory signals is dependent upon the range of variation of the PS. Still, as the writer mentioned, the most striking finding in the test with variable preparatory signals was that the important determinant of RT was not the immediate PS, but rather the distribution of preparatory signals within which it was embedded.

Hermelin and Venables (1964) conducted an experiment in which the interval between a warning signal and the PS was varied irregularly. Six normal subjects, six non-Mongol imbeciles, and six Mongol imbeciles participated in the study. Some RT responses were presented when the alpha rhythm was still blocked by the PS, while for others the alpha rhythm had returned. Reaction time did not differ significantly under either condition. However, results did illustrate that RT for sub-normals did increase as the PS duration was lengthened. The investigators attributed the change in RT as the PS duration increased to the inability of the subnormal group to maintain a sustained motor set. Additional investigators (Huston, Shakow, & Riggs, 1964; Hermelin, 1964) have shown a relationship of RT to the PS in mentally deficient subjects, even when the PS was varied irregularly. The writers also attempted to obtain information on the relationship between EEG activation and RT as a result of using mentally deficient subjects in their studies. No significant results were found at the time of the 1964 studies.

A number of studies have produced interesting data on the relationship of the PS to various established components of RT. Botwinick and Thompson (1966) fractionated RT into premotor and motor components based upon the difference between EMG and finger-lift responses. Premotor time was that period from the presentation of the stimulus to the appearance of increased muscle firing. The motor component was the period of time from the change in action potential to the finger-lift response. Four preparatory intervals of 0.5, 3.0, 6.0, and 15.0 seconds were used to measure simple auditory RT in both a regular and irregular series. Results demonstrated that RT was related to premotor time and showed comparable variations as a function of PS and the type of series. Motor time was found to be independent of the PS and type of series, and not related to RT. It was concluded that set, as inferred from the relations between RT and PS, and type of series, is a premotoric process. The conclusions of the study by Botwinick and Thompson (1966) are comparable to data collected in an earlier investigation by Hohle (1965). Hohle performed a mathematical analysis of two assumed components of RT, one distributed normally, and the other distributed exponentially. Results established that the normally distributed component of RT was in functional relation to the PS, but not with the latter component. Hohle (1965) concluded that variation in RT was due to variation in the normally distributed component. Botwinick and Thompson (1966) inferred that their premotor component and the normally distributed component found by Hohle (1965) are closely related. Other studies (Weiss, 1965; and Botwinick & Brinley, 1962) also concluded that variation in set due to the PS was a premotoric process. The PS optimum was seen to be between 2.0 and 3.0 seconds from a range of 1.0 to 4.0 seconds. The preparatory signals in these investigations were irregularly presented to the subjects.

The possibility that the PS functions as more than a mere cuing signal for a response was investigated by Geblewiczowa (1963) and by Behar and Adams (1966). The study by Geblewiczowa studied the relationship between RT and the number of warning signals in a series of measurements. She investigated the effect of single PS, paired PS, and the interval between paired PS on RT. The findings from the study show that RT to paired warning signals separated by a short interval was significantly shorter than RT to paired warning signals separated by a longer interval, and to a single PS. The duration of the paired PS producing the fastest RT was 1.0 second. The durations were varied between 1.0 and 2.5 seconds. The duration of the interval between paired signals producing the fastest RT was 0.5 second out of a range extending from 0.5 to 2.5 seconds.

Behar and Adams (1966) obtained data from two experiments derived from a conditioning model of the RT task. The investigators examined the conditioned stimulus-like properties of the RT ready signal. In the first study, the intensity of the PS varied over a range of 60 db., with three different preparatory signals of 1.0, 3.0, and 8.0 seconds. Using a within subjects design, reaction times decreased significantly with an increase in the intensity of the PS. A decrease in RT was proportionate at each of the three durations.

Testing a second property of the PS as a conditioning stimulus, Behar and Adams (1966) varied the duration of the PS. In a trace condition, an auditory PS came on for 100 msec., followed by a variable interstimulus interval, and a visual RS appearing for 30 msec. In the delayed condition, the auditory PS continued through the interstimulus interval and was terminated at the same time with a 300 msec. visual RS. Comparing the two conditions, results demonstrated that the delayed ready signal yielded significantly shorter reaction times than for the trace condition at all PS durations. Taken together, results indicated that the PS in RT tasks serves as more than a mere cuing function.

A more recent study by Slater-Hammel, et al., (1973) supports the Behar and Adams (1966) conclusion that the PS acts as more than a cuing function in RT tasks. The researchers investigated the effect of the PS and RS upon RT. The following signal-response relationships were studied: (a) signals terminated before the subject responded (trace), (b) signals terminated by the subject's response (response terminated), and (c) signals terminated after the subject responded (delayed). Durations for the PS and RS in the trace condition were 100 msec. The response terminated condition had a PS duration equal to the interstimulus interval of 2000 msec. plus RT, and a RS duration equal to RT. For delayed signals, the duration of the PS was 6000 msec., with a duration of 100 msec. for the RS. Three durations for each signal provided for a 3 x 3 factorial arrangement of nine duration combinations. The significant main effect of the PS suggested that the PS did function as more than a cuing signal. Results of the study also agreed with the Behar and Adams study (1966) where the trace PS of 100 msec. resulted in the longest RT. In the study by Behar and Adams (1966), the delayed PS condition produced the shortest RT, while in the present investigation by Slater-Hammel, et al., (1973) the response terminated condition resulted in the fastest RT. The delay PS condition in the investigation proved to be neither significantly longer than the response terminated condition, or shorter than the trace condition.

It is obvious that a number of factors tend to influence what investigators refer to as optimum PS. No single value for the optimum PS appears acceptable mainly due to the varying conditions that are effective.

The Response Signal and Reaction Time

Teichner (1954, p.134) pointed out that it is difficult to see why the duration of the RS should influence the

RT to the onset of a suprathreshold stimulus, unless some type of summation of intensity hypothesis could be advanced. Still, though limited in number, there are studies in the literature that lend credence to the suggestion that RS durations do have an effect upon RT.

The variable of stimulus duration as a determinant of RT was recognized as early as 1907 in an investigation by Froeberg (1907). He varied visual stimuli by equal geometric intervals of 3.0, 6.0, 12.0, 24.0, and 48.0 seconds. On the basis of his results within the range mentioned, it was concluded that the longest durations produced the shortest reaction times, the function of the geometric intervals being linear.

Another study by Wells (1913) varied the duration of both visual and auditory stimuli. In examining the effect of stimulus duration in the visual stimulus condition, Wells used a constant intensity stimulus of five durations ranging from 10 to 1000 msec. Reaction time to the onset and the cessation of the RS was recorded. The results, different from those obtained by Froeberg, suggested that there does exist an optimal duration for the RS, and that the optimum varies from individual to individual. Whatever the optimum was for any one individual, deviation from the optimal level resulted in longer reaction times. Wells (1913) also observed that reaction times to the longer RS durations tended to be slower than to the shorter durations. This particular result was in disagreement with the relationship between RT and the RS durations found by Froeberg (1907).

Two related studies that provided additional information concerning the effect of stimulus duration on RT were conducted by Raab, Fehrer, and Hershenson (1961), and Fehrer and Raab (1962). The 1961 study investigated the relation between RT and the brightness of light flashes as contingent upon their duration. Using visual RS durations between 10 and 500 msec., it was demonstrated that RT depended upon stimulus characteristics rather than the phenomenal appearance of the RS. The investigation by Fehrer and Raab (1962) was set up to determine if the phenomenal masking of the first stimulus is associated with a decrease in the capacity of the stimulus to elicit a simple overt response. More specifically, the investigators attempted to determine whether RT was correlated with the brightness of a light subjected to various degrees of metacontrast masking. The stimulus pattern was presented 2.9, 3.2, or 3.5 seconds after the onset of a one-second warning tone. Three preparatory signals were switch selected and presented in a random order. The counter recording RT was stopped when the subject depressed a normally closed telegraph key. Using the stimulus durations of 5 and 50 msec., results established a mean RT to the 50 msec. RS at 165.4 msec., and a mean RT of 167.0 for the 5 msec. RS. The results obtained were in agreement with those found by Raab, Fehrer, and Hershenson (1961) where RT was independent of stimulus duration in a visual RT task.

A more recent experiment (Drouin, 1973) studied performance of 12 subjects in a visual RT task under anticipatory and classical RT conditions. A sub-problem of the investigation was to ascertain the interaction between stimulus duration and RT. Drouin presented each subject with stimulus durations of 154, 204, and 254 msec. A constant PS was used in the anticipatory task condition, while varying PS durations were used in the classical condition. Stimulus durations were presented to the subjects in a random series for both task conditions. A significant difference in performance favoring the stimulus duration of 154 msec. was established. The faster RT at the 154 msec. duration was observed in both of the conditions. Results of the study are not in agreement with the data from the Raab, et al., (1961), and Fehrer and Raab (1962) studies, where no relationship between RT and stimulus duration was found.

The effects of stimulus duration on RT in an auditory RT task tend to produce conflicting results similar to the findings in visual RT tasks. In the earlier study by Wells (1913), auditory stimuli of 7, 36, 51, 76, and 108 msec. were presented to two subjects in the form of an electric buzzer. The results indicated that auditory stimulus durations used in the study had no marked effect on RT.

Chernikoff and Brogden (1949) gave 40 trials of an auditory stimulus to 20 subjects, where the stimulus was terminated by the pressing of a telegraph key. This condition was compared with a second condition in which subjects received an equal number of trials to a tone of a fixed duration of 2000 msec. Half of the group being tested received the fixed duration stimulus followed by the response terminated series. The other half of the group was presented the stimulus in a reverse order. The response terminated condition was found to yield a significantly lower RT over the fixed duration condition. The effect of the response terminated signal on RT was attributed primarily to the knowledge of results provided the subject in that condition. Also noted by the researchers was the fact that the fixed duration of 2000 msec., and the response terminated durations were but two points on a continuum of possible RS durations, and that RT could be a function of a RS duration approximating a subject's RT.

In a control procedure conducted within the framework of the above study, Chernikoff and Brogden (1949) observed no reliable differences in RT to the response terminated or fixed duration stimuli when presented in a random series. The result suggested that for either condition to produce a shorter RT, trials should be presented in a regular series occurring as a stable condition.

A series of three follow-up studies were conducted by Chernikoff, Gregg, and Brogden (1950), and Gregg and Brogden (1949, 1949) to study further the effect of response terminated and fixed response signals upon RT. Chernikoff, Gregg, and Brogden (1950) measured RT for six groups of subjects to the response terminated stimulus condition and to a fixed RS condition using durations of 100, 200, 400, 800, 1400, and 2000 msec. Results of the experiment demonstrated that response termination of the auditory stimulus produced a more rapid RT than did a stimulus of fixed duration paired with it, when the fixed duration RS was set at 400, 800, 1400, or 2000 msec. However, there was no evidence of facilitation of RT produced by the response terminated condition when the duration of the fixed stimulus was 100 or 200 msec. It was suggested that the magnitude of the difference in RT for the two conditions increased as the duration of the fixed stimulus was increased.

The two experiments by Gregg and Brogden (1949, 1949) produced the following conclusions: (a) RT to the fixed duration stimulus, and the magnitude of the differences between RT to fixed duration and response terminated stimuli, increased as the duration of the fixed duration increased; (b) there was no evidence of change in the RT to the response terminated stimulus condition as a function of the duration of the fixed stimulus condition; and (c) for fixed durations of 100, 200, 400, 800, 1600, and 2400 msec., RT increased as the duration of the fixed RS increased. The relationship between the increase in RT and the increase in RS duration was found to be linear when scale values of 1, 2, 3, 4, 5, and 5.5 were used to represent a geometric progression of the durations.

Slater-Hammel, et al., (1973) investigated the effect of PS and RS durations upon RT. Three different conditions were presented to the subjects. The conditions were trace, response terminated, and delayed presentation of the PS and RS. The duration for the RS in the trace condition was 100 msec. In the response terminated condition the RS was equal to RT, and for the delayed treatment, the RS duration was 400 msec. The main effect of the RS was found to be significant, and consistent with the findings of Chernikoff and Brogden (1949), where the response terminated RS resulted in a shorter RT than for the trace RS condition.

An additional question that Slater-Hammel, et al., (1973) attempted to answer was whether there was an interaction between durations of the PS and RS, with an ensuing effect on RT. Results of the study proved negative for any interaction effect on RT. Still, the writers pointed out that the RT mean for response termination of both the PS and RS was from 7 to 33 msec. shorter than the means obtained for the other two conditions. As a result of the means obtained for their study, the researchers suggested that a more sensitive experiment would result in establishing an interaction between the PS and RS that would have a significant effect on RT.

The current study was conducted to investigate and expand upon present information related to the variables of PS and RS as determinants of RT. The investigation examined durations of the PS and RS at or near what are considered average for an individual. The project also examined the interaction between the PS and RS and the resultant effect, if any, upon RT.

CHAPTER III

Procedures

The major problems of this study were to determine the effect of selected PS and RS durations on simple RT, and to examine the interaction effect of PS and RS on RT.

A preliminary study was conducted to: (a) refine the instrumentation, (b) develop effective instructions, (c) illuminate unforeseen procedural difficulties, (d) determine the number of trials and how they should be presented, (e) select appropriate PS and RS durations, (f) allow practice time for the experimenter to develop data collecting skills, (g) conduct a preliminary testing of the stated hypotheses leading to more precise hypotheses in the main study, and (h) develop further insight into the feasibility of the problem.

Four volunteer male subjects ranging in age from 19 to 21 took part in the preliminary study. The instructions and directions were given, and the subjects were asked to respond to their clarity and adequacy. Each subject completed the four task conditions, to be included in the main study, in four blocks of trials with 40 responses per block. Durations of one and three seconds for the PS, and 100 and 300 msec. for the RS were tried first. The durations of the PS were later changed to one and four seconds. Observation for fatigue and change in reaction times with the different PS and RS durations were made.

As a result of the preliminary study, the following modifications were made: (a) clarification of instructions, (b) redesign of the trial blocks from 25 trials per block to 40 trials per block, and (c) changing the durations of the PS from one and three seconds to one and four seconds. The data obtained favored maintaining the original durations of 100 and 300 msec. for the RS for the final study. The preliminary results also showed that the original hypotheses should not be changed for the main study. Based on the observations made from the pilot study, the experimenter concluded that further investigation of the PS and RS as determinants of RT could be satisfactorily carried out.

On the basis of the information obtained from the preliminary investigation, the final structure and development for the main study are presented in the text that follows.

Source of Data

The subjects for the main study were 18 male undergraduate students enrolled at the University of North Carolina at Greensboro, North Carolina, during the fall semester of 1973-74. Mean age of the subjects was 20 years, with a range in age from 18 to 22 years. All subjects were right-handed.

Subjects were selected randomly for the final study from a list of male students enrolled as freshmen, sophomores, and juniors at the University. The list of names was taken from the 1973-74 student directory. All men listed under the three classes received a number from one to nine. Selection was made from the beginning of the alphabetical list of A, toward the end of A. For letter B, and each succeeding letter, the order was reversed. The table of random numbers was used to select a total of 30 subjects. Eighteen students were designated for the main study, with the additional 12 students serving as alternates.

The 30 subjects received an introductory letter (see Appendix A) requesting their presence at a meeting to review the experiment to be undertaken. During the introductory meeting, a second meeting was scheduled for the individuals consenting to take part in the final study. The format for the second meeting centered around familiarizing the subjects with the testing apparatus and the experimental procedures.

A letter of appreciation for their participation in the experiment was sent to all subjects at the conclusion of the study (see Appendix A).

Equipment

The equipment used for the collection of data for the present study consisted of two basic units; the experimental control unit, and the subject response unit. The equipment was located in the Rosenthal Research Laboratory at the University of North Carolina, Greensboro, where all testing was conducted.

Experimental control unit. The experimental control unit consisted of one recording device for RT in msec., and a separate unit for controlling PS and RS durations. The separate control unit also contained a button that was depressed to signal the subject that a new trial may be started.

The recording device used to record the RT of the subject was the Hunter Model 120 A klockounter. The recording device is capable of measuring either the time a circuit is open or closed, or count the pulses to speeds of 2000 counts per second. A range switch gives time revolutions of 0.001, 0.01, or 0.1 seconds, with four decades of timing capacity in the form of glow transfer tubes. The timer also has convenient terminal connections to double throw relays. A second identical instrument was used to calibrate the RS durations.

The special control unit (see Figure 1) was a small steel box 4½ x 5 inches, containing the required control unit circuits for accuracy in timing (see Figure 2). To enable the experimenter to calibrate the RS durations, a control knob (A) could be adjusted to a specific duration when the response key was depressed and held down. The second timer was used to record the exact duration of the RS. A second control knob (B) was used to set the desired duration for the PS. A cue light (C) was also a part of the special unit and was synchronized

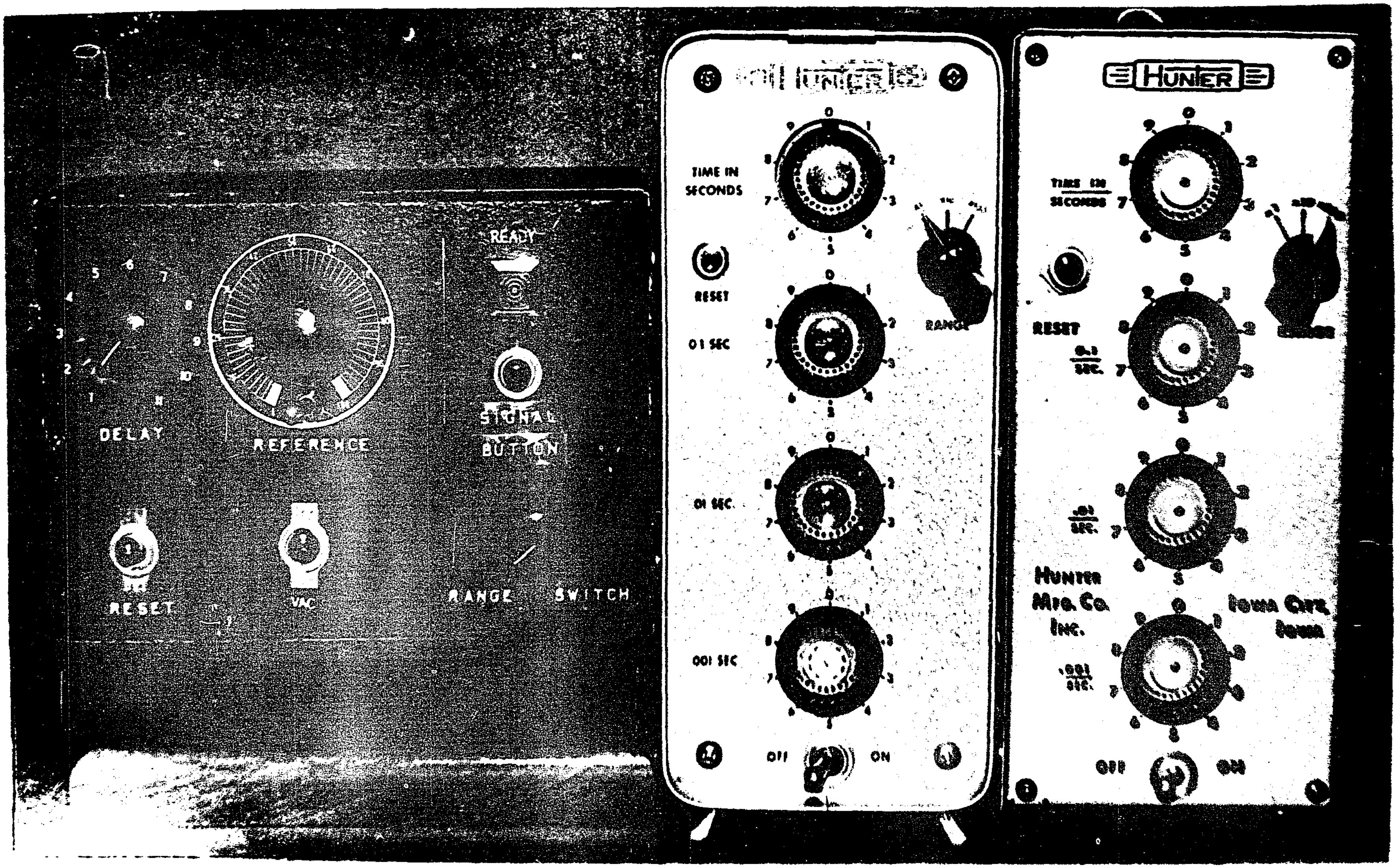

Fig. 1. The experimental control unit.

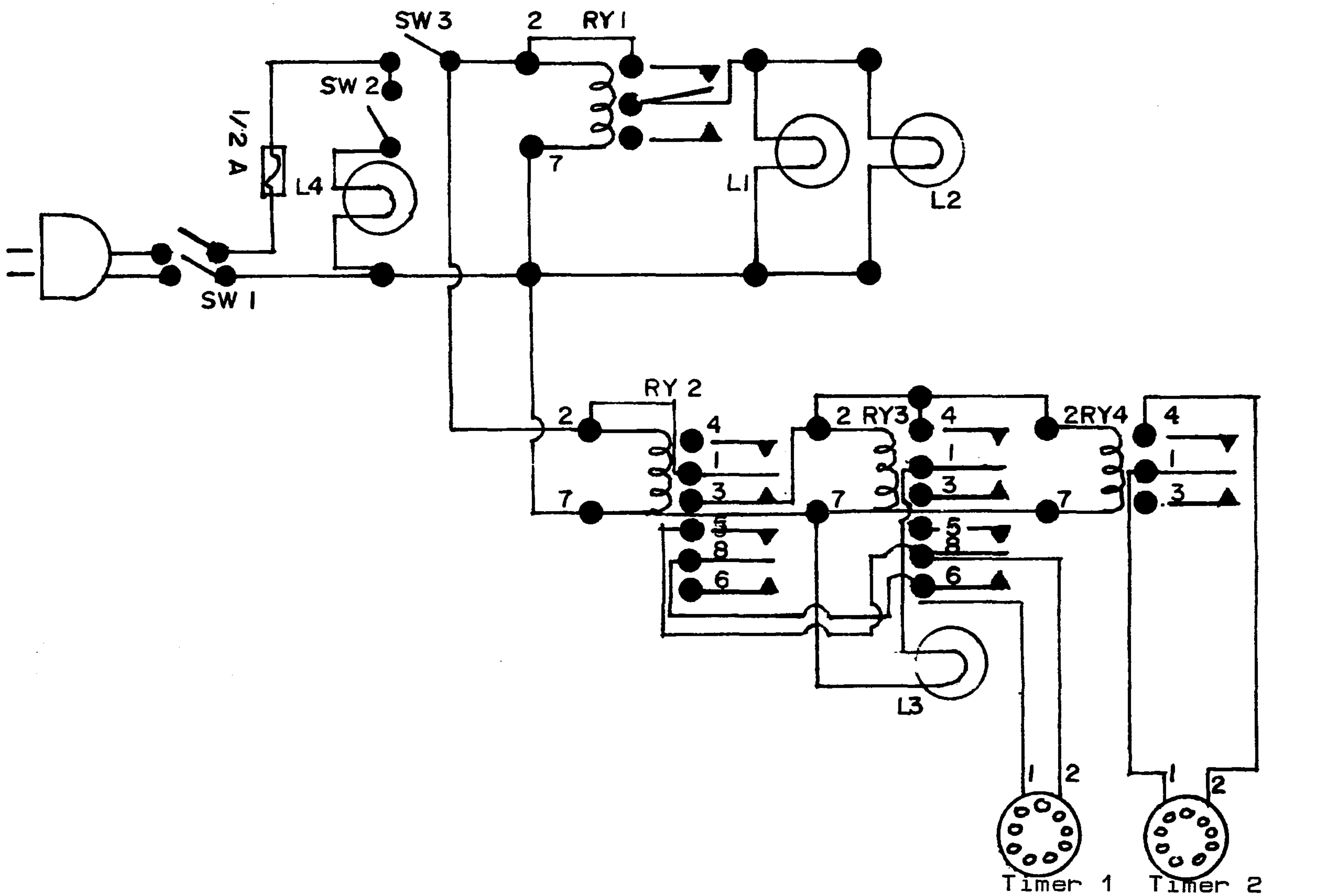

Fig. 2. Control Unit Circuits

with the preparatory light on the subject response box. A signal button (D) on the special unit was used to signal the subject when the experimenter was ready for him to initiate a new trial. When the button was depressed by the experimenter, a red signal light would light up on the subject response box.

Subject unit. The subject unit was a steel response box (see Figure 3), and a response key (see Figure 3), which were plugged into the special control unit and to timer number one. The subject response box, 10½ x 8 inches in size, included: a yellow preparatory light at the top, visible through an opening one inch in diameter, a white response light in the center, with a two inch diameter opening, and the red signal light with a vision area one inch in diameter, located at the base of the box. The use of the white response light was in accord with a suggestion by Woodworth (1954, p.431) that, under any given illumination, no surface can be brighter than the best available white. The response key was a standard telegraph key with a response surface one inch in diameter.

Experimental Conditions

Each subject was tested under the four task conditions developed for the main study. Individual conditions consisted of 40 trials, representing a total of 160 trials for the combined treatments. The 160 trials were randomly set

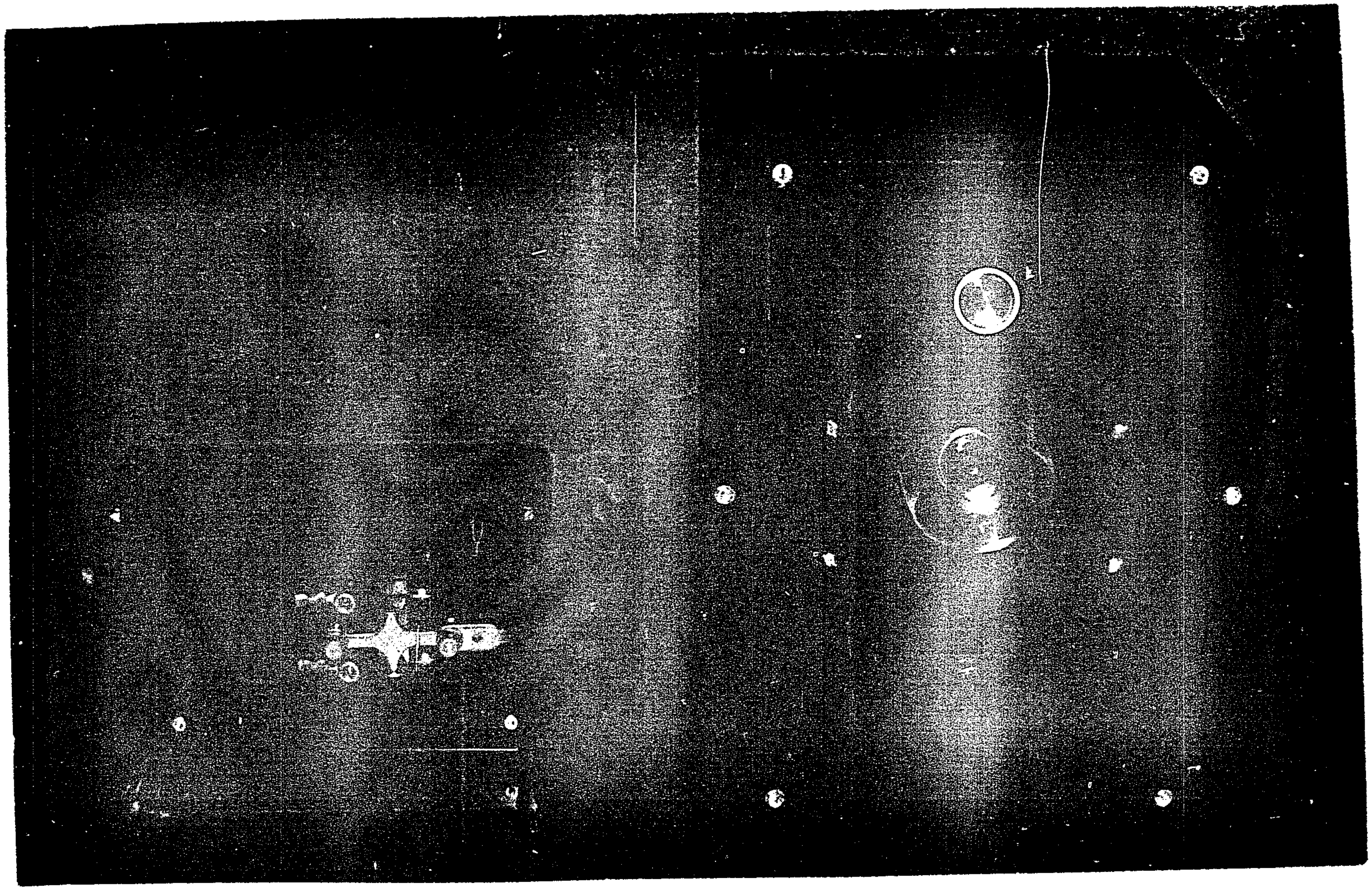

Fig. 3. The subject unit.

up to be presented to each subject in blocks of 40 trials (see Appendix B). The trials were randomized in five groups of eight trials so that each task condition was represented equally throughout a block, with no condition following itself at any time. A two-minute rest interval was provided each subject between blocks of trials. The testing session for each subject was conducted during a single day, and at least one hour from any meal so that they were considered reasonably alert. Two days were required to test all 18 subjects. Testing time for each subject lasted approximately 40 to 45 minutes.

For all conditions, the subject was isolated in a small windowless room 6' x 6' x 7', to aid in minimizing distractions. Subjects were seated on a standard desk chair, before a table, upon which was located the subject response unit (see Figure 4). The response box was placed approximately 32 to 36 inches in front of the subject's eyes, with the placement of the response key done at the convenience of the subject. This was established to allow the subject to assume a comfortable position while executing his responses. The experimenter and the experimental control unit were positioned directly outside of the experimental room facing the subject (see Figure 4). No visual contact was possible between the subject and the experimenter during the testing.

Upon entering the experimental room, each subject was asked to assume a comfortable position at the end of the table. The following instructions were then given to the subject:

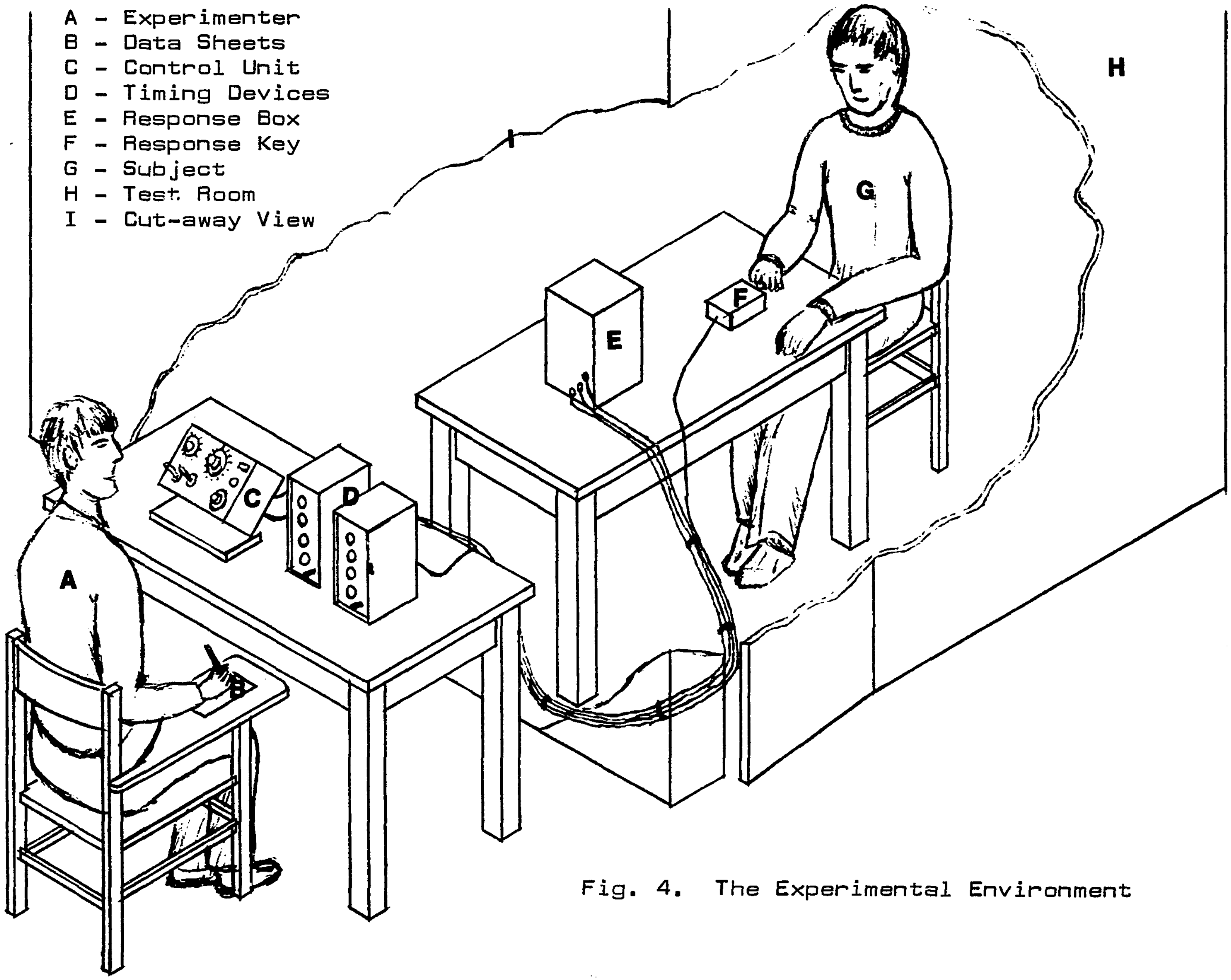

Fig. 4. The Experimental Environment

"This is an experiment to see how fast you can respond in a simple RT task. The task is performed by depressing the response key in front of you to initiate a trial, and then releasing the key as fast as you can to a white stimulus light. The stimulus light will appear in the center of the box in front of you.

"You will now place the response key in a position that is comfortable for you, while facing the response box. The response key is to be depressed using the index and middle fingers of your preferred hand.

"The apparatus is set up so that you will receive a red signal at the base of the response box prior to the start of each and every trial. Upon depressing the response key to initiate a trial, a yellow PS will light up at the top of the box. The PS light will last for varying periods of time, followed by the presentation of the white stimulus light. When the RS appears you are to release the response key as quickly as possible by moving your fingers off the key. The release of the key completes one trial. Your RT for that trial will then be recorded on the designated recording sheet (see Appendix B) by the experimenter. You are to relax between trials, and follow the same procedure for each and every trial.

"Four blocks of trials with 40 trials in each block will be presented to you during the experiment. A two-minute rest interval will be provided between each block of trials, at which time you may leave the experimental room.

"We will now go through the entire procedure using 10 practice trials. Remember, it is important that you wait for the red signal to appear before initiating a trial, and to respond as quickly as possible to the white response light.

"At the conclusion of the practice trials you will be asked if you have any questions prior to proceeding with the first block of 40 trials. If there are no questions, we will proceed with the experiment."

Task conditions. The four task conditions developed for the present study were as follows: (a) a long PS of four seconds, followed by a long RS of 300 msec., (b) a long PS of four seconds, followed by a short RS of 100 msec., (c) a short PS of one second, followed by a long RS of 300 msec., and (d) a short PS of one second, followed by a short RS of 100 msec.

Two of the conditions presented a constant PS with the RS varied, while the other two treatments varied the PS and held the RS constant.

Treatment of Data

To compare the effects of the four task conditions, an analysis of variance for a two-factor experimental design with repeated measures was used. The design is based upon the General Linear Hypothesis, which makes it possible to attribute specific causes of variation to the various factors being manipulated. Within the context of the present study, each subject's score is hypothesized to result from the additive effects of: (a) true score, (b) effect of PS, (c) effect of RS, (d) effect of PS and RS interaction, and (e) error. Hence, each effect may be tested separately by dividing by the appropriate error term.

The experimental design with repeated measures provides for a sensitive separation of the within subject error into within subject and between subject treatments. It was therefore possible to obtain a powerful F ratio by using the repeated measures design (Winer, 1962).

All statistical comparisons were evaluated at the .05 level of confidence. The Omega Square post hoc test was used to test the strength of association between independent and dependent variables when significant F values were established. The Newman-Keuls test was administered to determine where simple main effects of interaction were significantly different.

The BMD 08V statistical program provided the necessary computational model. The program was used to obtain computerized calculations. All computations were carried out through the Triangle University Computer Center.

CHAPTER IV

Analysis, Interpretation and Discussion

The major purpose of this study was to determine the effect that selected durations of PS and RS had on simple RT. Concurrent with the study of the main effects of PS and RS on RT was inquiry into the interaction effect of the two signals on RT. Subjects for the study were 18 male undergraduate students enrolled at the University of North Carolina at Greensboro, North Carolina. There were four task conditions, consisting of 40 randomly arranged trials per condition. Each condition was presented to all 18 subjects involved in the experiment.

Analysis of Data

An analysis of variance for a two-factor experimental design with repeated measures (Winer, 1962) was used to test the following hypotheses: (a) a PS duration of one second produces a RT significantly different than a PS duration of four seconds, (b) a RS duration of 100 msec. produces a significantly different RT than a RS duration of 300 msec., (c) the interaction between PS and RS durations will significantly affect RT.

The Omega Square post hoc test was used to test the strength of association between variables when a significant

F value was established. The Newman-Keuls test was administered to determine where simple main effects were significantly different when the F value for interaction between PS and RS proved significant.

The average range, means, and standard deviation scores for RT in each of the four conditions are presented in Table 1. The experimental condition average means ranged from a time of 0.164 msec. to 0.180 msec. By inspection, it can be observed that the fourth task condition appeared to result in the fastest RT. The raw data from which the averages were obtained are displayed in Appendix B, Table 4.

When the data for the effect of PS on RT were submitted to a test for main effects, the F value obtained was 0.34 (see Table 2). A value of this magnitude was not significant at the .05 level of confidence. Hypothesis one, which stated that PS would affect RT to a statistically significant degree, was not supported. No further analysis was conducted for the main effect of the PS.

Data for the effect of RS on RT were also submitted to a test for main effects. The F value obtained was 51.42 (see Table 2). The F value was significant at the .05 level, and supported Hypothesis two, which proposed that RS would significantly affect RT. Figure 5 presents a graph of the significance of the effect of the RS. With the dependent variable (RT) placed on the vertical axis, and the independent variable (RS) plotted on the horizontal axis, the graph demonstrates

Table 1

Average RT Ranges, Means, and Standard Deviations

For the Four Conditions

Task Conditions	Range in msec.	Mean in msec.	SD in msec.
Long PS, long RS	0.051	0.179	0.015
Long PS, short RS	0.060	0.169	0.017
Short PS, long RS	0.061	0.180	0.017
Short PS, short RS	0.073	0.164	0.016

Table 2

Analysis of Variance of RT

As Affected by PS and RS

Source	df	MS	F
PS	1	.00004835	0.34
RS	1	.00292611	51.42*
PS(S)	17	.00014413	
RS(S)	17	.00005691	
PS x RS	1	.00019667	4.91*
PS x RS(S)	17	.00004007	

* $p < .05$

Note: PS = preparatory signal
RS = responsr signal

PS x RS = interaction of PS and RS

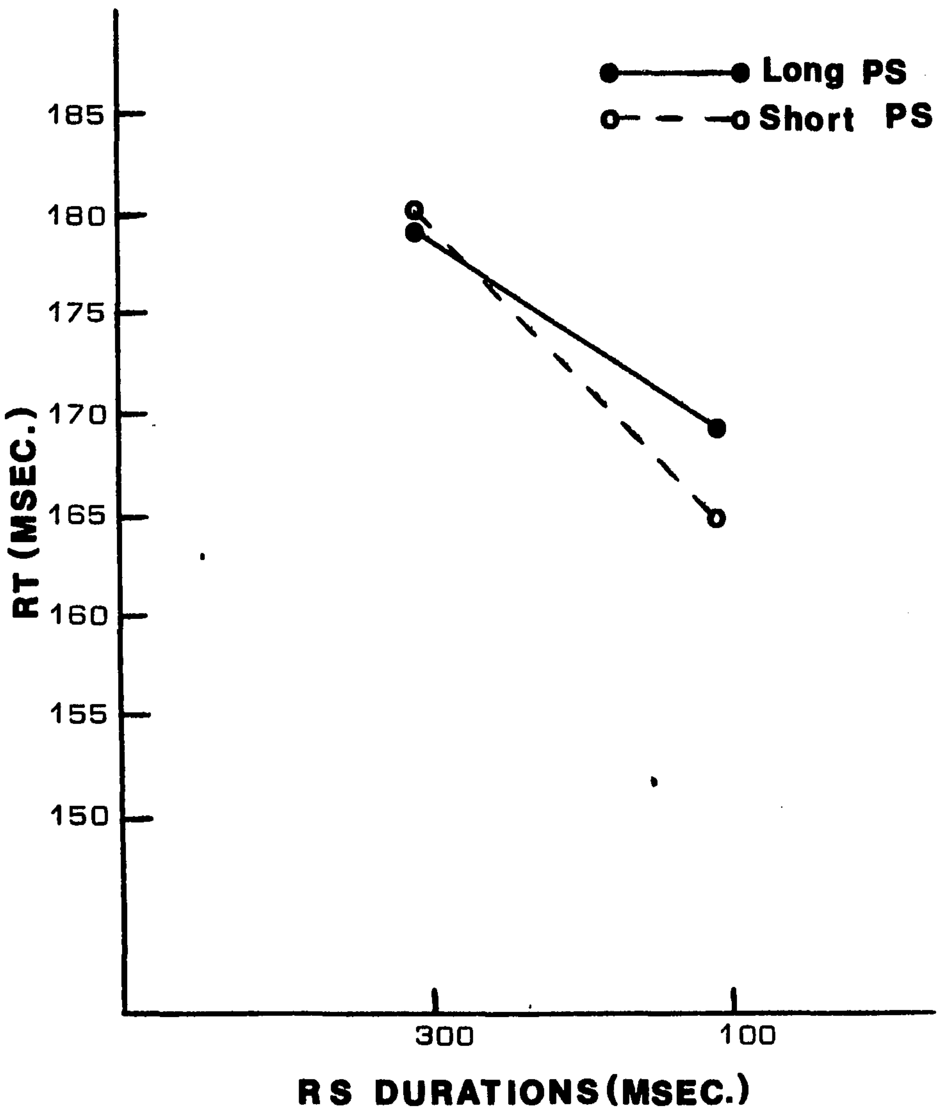

Fig. 5. Graphic Illustration of Effects on RT of the Response Signal, and of the Interaction of the PS and RS.

that the short RS of 100 msec. produced the fastest RT. To test the strength of association between the RS and RT, the Omega Square post hoc test (Hays, 1963) was used. The results indicated that the RS accounted for 13% of the total variance of the RT scores.

Hypothesis three, which stated that the interaction between PS and RS would significantly affect RT, was supported. The obtained *F* value of 4.91 was significant at the .05 level of confidence (see Table 2). The interaction showing that RT was faster when the PS was combined with the short RS is presented in Figure 5. The fastest RT occurred when the short PS of one second was combined with the short RS of 100 msec. The Omega Square test demonstrated that the interaction of the PS and RS accounted for 1% of the total variance of the RT scores.

The effects of the RS and of the interaction between the PS and RS, when combined, accounted for 14% of the total variance of the RT scores in the experiment. Results of the Omega Square test also showed that when the nuisance factor of between subjects variance was removed, the combined effects accounted for 42% of the experimental variance of the RT scores.

To determine where simple main effects were significantly different, when a significant *F* value for interaction was found, the Newman-Keuls test was administered. The results, presented in Table 3, illustrate where significant differences existed when compared to critical values for .01 and .05. Significant differences existed at the .01 level when the following combinations of signal durations were compared: (a) long PS, long RS and long PS, short RS, (b) long PS, long RS and short PS, short RS, (c) long PS, short RS and short PS, long RS, (d) short PS, long RS and short PS, short RS. Significance at the .05 level was established when the combinations of long PS, short RS and short PS, short RS were compared. No other combinations yielded significant differences.

Interpretation and Discussion

The results of the study indicated that the selected durations of one and four seconds employed for the PS did not significantly affect response latency on a simple RT task. As demonstrated by the non-significant *F* value for the PS, the main effect for the PS did not support the theory that it acts as more than a general cuing signal for reaction (Geblewiczowa, 1963; Behar & Adams, 1966; Slater-Hammel, et al., 1973). Possibly presenting the PS in an irregular pattern attenuated the effect the PS had on RT (Klemmer, 1956). However, related literature states that the optimum PS in a task with randomly ordered signals is dependent upon the range of variation of the PS, and not whether the specific durations are presented irregularly. Further study

Table 3

Newman-Keuls Test:

Differences Between Simple Main Effects

Of the Four Task Conditions

Task Conditions	Diff.	Critical Values .05	.01
Long PS, long RS & long PS, short RS	.010**		.0070
Long PS, long RS & short PS, long RS	.001	.0045	
Long PS, long RS & short PS, short RS	.013**		.0076
Long PS, short RS & short PS, long RS	.011**		.0070
Long PS, short RS & short PS, short RS	.005*	.0045	
Short PS, long RS & short PS, short RS	.016**		.0076

* $P < .05$
** $P < .01$

concentrating on the order of PS presentation more than particular values of the signal, might lead to a significant main effect for the PS.

Data obtained for the RS durations showed that the durations of 100 and 300 msec. were significantly different in their effect on RT. The significant main effect found for the RS is consistent with results obtained by Chernikoff and Brogden (1949), and Slater-Hammel, et al. (1973). The data showing that the shorter RS produced the faster RT is in agreement with the findings of a recent study by Drouin (1973) in which he compared RS durations of 0.154, 0.204, and 0.254 msec. The 100 msec. duration employed in the present study was shorter than average RT. It might be assumed that additional factors such as anticipation, optimal alertness, and motivation to excel aided RT performance in the present study. Another possible explanation for the difference in RT for the durations presented in this study may be that the subjects were reacting to changes inherent in the two durations. In the shorter duration, the subject was confronted with two changes, the onset of the RS and the cessation of the signal. In the longer duration the subject experienced only the onset of the RS, as his RT usually terminated the signal before it reached the full duration. Possibly RT was facilitated by the additional "off effect" suggested as inherent in the shorter duration. Support for this suggestion comes from an investigation by Raab, et al. (1961)

demonstrating that RT depended upon stimulus characteristics rather than the phenomenal appearance of the RS. Studies, recording the electrical potential in the optic nerve, have concluded that the retinal "off effect" is stronger than the "on effect." Still another possible explanation for the delayed reaction to the RS could have been that period between the presentation of PS and appearance of the RS. If this period did affect the RT, then its time would add to the delay already suggested between the durations of the short and long RS. Thus, although a difference was shown between RT to the two signals employed in this study, duration of the signal appears to be a critical variable in RT performance.

The interaction between the PS and RS was also found to be significant. Slater-Hammel, et al. (1973) contend that an interaction effect does exist between the two signals, although the results of their study fell short of establishing a significant interaction. Their contention was supported by the interaction significant at the .05 level of confidence found in the present study. The Slater-Hammel, et al. (1973) study suggested that a more sensitive study might result in a significant interaction. While the present study had its limitations, the durations employed may have provided conditions more sensitive to the establishing of an interaction between the PS and RS. One might make the conjecture that subjects were able to distinguish temporal cues which enabled them to differentiate between the time lapse after the PS and the presentation of the RS, as a result of the significant interaction. Previously it was shown that no differences existed between the durations employed in this study. However, the main effect for the RS was significant; the short RS produced the fastest RT. The shortest RT of the four conditions in the study was obtained for the combination of a short PS and a short RS. The significant finding of interaction between the PS and RS, especially for the short PS, short RS combination, may have been due to the subject learning the timing pattern between the PS and appearance of the RS. The slower reaction for the combination of a long PS and short RS may have been due to the subject being unable to maintain his peak readiness throughout the four-second duration of the PS.

Previous investigations have drawn varying conclusions related to the PS and RS as determinants of RT. The results of the present study have demonstrated that PS and RS may well be critical determinants of RT.

CHAPTER V

Summary, Conclusions, and Recommendations

Summary

The determination of the effects of selected durations of PS and RS on RT in a simple RT task formed the major problem of this study.

A preliminary study was conducted to refine instrumentation, experimental conditions, and design. Modifications made on the basis of the preliminary study findings included: (a) clarifying instructions, (b) re-designing trial blocks, and (c) changing the durations of the PS from one and three seconds to one and four seconds. Selected durations of 100 and 300 msec. for the RS were not changed. Results of the preliminary study demonstrated that, except for the change in the durations for the PS, original hypotheses should be maintained for the main study.

The main study involved 18 male undergraduate students with a mean age of 20 years, enrolled at the University of North Carolina at Greensboro. Subjects were selected randomly from a list of male students enrolled as freshmen, sophomores, and juniors at the university.

Each subject was tested under four task conditions in which the PS and RS durations were varied. The equipment used for the collection of data consisted of two basic units, the experimental control unit and the subject response unit. The experimental control unit consisted of a separate control unit for controlling PS and RS durations, and a klockounter to record RT. The subject response unit included a response box and a response key. A total of 160 trials with 40 trials randomly arranged in each condition were completed by each subject. All trials for a given subject were completed in one session on one day. The total time consumed in the one session was 45 minutes. Two days were necessary to complete the testing of all 18 subjects.

To compare the effects of the four task conditions, an analysis of variance for a two-factor experimental design with repeated measures was used. All statistical comparisons were evaluated at the .05 level of confidence. The BMD 08V statistical program provided the necessary computational model.

The Omega Square post hoc test was used to test the strength of association between the independent and dependent variables when significant $\underline{F}$ values were established. The Newman-Keuls test was applied to determine where simple main effects were significantly different when a significant $\underline{F}$ value for interaction was found.

Mean scores for the four task conditions were calculated for all 18 subjects involved in the study. Based on an obtained $\underline{F}$ value of 0.34 for the PS, the main effect for the PS was found not to be significant.

The *F* value of 51.42 obtained for the RS demonstrated that the main effect for the RS was significant. Although the data obtained for the RS did not specifically indicate which of the two durations employed had a more significant effect on RT, it appeared that RT was faster with the short duration.

The interaction between the PS and RS was also found to be significant with an *F* value of 4.91. The fastest RT occurred when the one second PS was combined with the 100 msec. RS.

The Omega Square post hoc test demonstrated that the combined effects of the RS and the interaction between the PS and RS accounted for 14% of the total variance of the RT scores in the experiment. The results of the Omega Square test also demonstrated that with the nuisance factor of between subject variation removed, the combined effects accounted for 42% of the experimental variance for the RT scores.

Differences for the simple main effects were found significant at the .01 level when the following combinations of signals were compared: (a) long PS, long RS and long PS, short RS, (b) long PS, long RS and short PS, short RS, (c) long PS, short RS and short PS, long RS, (d) short PS, long RS and short PS, short RS. Significance at the .05 level was established when a comparison was made between the combinations of long PS, short RS and short PS, short RS. No other combinations yielded significant differences.

Conclusions

Within the parameters of this study and the results obtained from the data collected and analyzed, the following conclusions are justified:

1. Significantly different RT are not produced when PS within the range of one to four seconds are presented in an irregular pattern.

2. A short RS duration of 100 msec. produces a significantly different RT than an RS duration of 300 msec.

3. The interaction of the PS and RS of the time intervals employed in this study does have an effect on RT. A short PS combined with a short RS appears to produce the fastest RT.

Findings of the present study could be applied in those situations in which it is important to reduce temporal uncertainty so that response latency is shortened. The advantage of reducing response latency would be the facilitation of a number of human movements.

As suggested in the chapter on analysis, studies have drawn varying conclusions about the PS and RS as determinants of RT. The results of the present study have demonstrated that PS and RS may well act as important determinants of RT.

Recommendations for Further Study

On the basis of the results of this study, the following recommendations for further investigation are made:

1. Conduct a similar study increasing the range of the PS, and employing more durations for both the PS and RS.

2. Modify the present study using both regular and irregular patterning for the PS, and compare the effects on RT.

3. Undertake another study to compare populations of males and females within the parameters of the present study.

4. Examine response signals of varying intensities and colors and their effect on a simple RT task.

5. Investigate the effects of the PS and RS when embedded in a complex field.

6. Examine the effect of increasing the population employed and/or the period over which the subjects are tested.

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APPENDIX A

Greensboro, November 5, 1973

Mr. Jeffrey Shoaf
Hinshaw Dormitory
Box 297
UNC-Greensboro
Greensboro, N.C.

Dear Jeff:

I am currently a doctoral candidate in the School of Physical Education at the University of North Carolina, Greensboro, N.C. As a portion of the dissertation required for the Ed. D. degree, I am presently in the process of conducting an experimental study on simple visual reaction time.

This correspondence is to inform you that your name has been randomly selected from the male population at the UNC-Greensboro to participate in the investigation. The experiment will be conducted in the Research Laboratory of Rosenthal Gymnasium on the UNC-G campus. Your participation in the experiment would require approximately 45 minutes of your time for one day. The primary purpose of the experiment will be to collect quantitative data on visual reaction time. Needless to say, your assistance and cooperation would enhance the satisfactory completion of this study.

A preliminary meeting is scheduled for Monday, November 19, 1973, at 4:30 p.m. in the Rosenthal Research Laboratory. At this time, a complete review of your role as a participant in the study and the experimental procedure to be followed will be explained. The preliminary meeting will also provide you with an opportunity to ask questions related to the study, and to acquaint yourself with other prospective participants.

I thank you in advance for your consideration and ensuing cooperation in assisting in the successful completion of the intended study.

Sincerely,

William D. Utter
School of HPER
UNC-Greensboro

Office Telephone: 379-5386
Home Telephone: 375-3601

Greensboro, January 14, 1974

Mr. George McKay
Phillips Dormitory
Room 423, Box 5423
UNC-Greensboro
Greensboro, N. C.

Dear George:

My purpose for this correspondence is to express my sincere appreciation for your assistance in making my recent experimental study a successful undertaking.

Your attention to detailed instructions given to you as a participant, and your promptness in arriving for the testing were instrumental in the ease with which the experiment was conducted.

As mentioned in our earlier discussion, you will be receiving the results of the testing portion of the study, in addition to a copy of the dissertation abstract.

Again, a final thank you.

Sincerely,

William D. Utter
School of HPER
UNC-Greensboro

APPENDIX B

RECORDING SHEET

NAME ______________________ DATE __________ TIME ______

PREFERRED HAND ______________ AGE __________

TN = Trial Number TC = Task Condition RT = Reaction Time

TN	TC	RT	TN	TC	RT	TN	TC	RT	TN	TC	RT
1	3		1	4		1	2		1	2	
2	4		2	2		2	3		2	4	
3	1		3	3		3	2		3	1	
4	2		4	2		4	4		4	3	
5	4		5	4		5	1		5	1	
6	2		6	1		6	4		6	4	
7	3		7	3		7	3		7	2	
8	1		8	1		8	1		8	3	
9	3		9	2		9	4		9	4	
10	4		10	3		10	2		10	2	
11	1		11	4		11	3		11	3	
12	2		12	1		12	1		12	1	
13	1		13	4		13	2		13	4	
14	4		14	2		14	4		14	3	
15	2		15	3		15	3		15	2	
16	3		16	1		16	1		16	1	
17	4		17	4		17	4		17	4	
18	1		18	2		18	1		18	3	
19	3		19	3		19	3		19	1	
20	2		20	4		20	2		20	3	
21	4		21	1		21	3		21	2	
22	2		22	2		22	4		22	4	
23	3		23	3		23	2		23	1	
24	1		24	1		24	1		24	2	
25	2		25	2		25	2		25	3	
26	3		26	1		26	3		26	2	
27	4		27	4		27	1		27	3	
28	3		28	2		28	3		28	4	
29	1		29	1		29	4		29	2	
30	4		30	3		30	2		30	1	
31	2		31	4		31	1		31	4	
32	1		32	3		32	4		32	1	
33	4		33	1		33	2		33	3	
34	2		34	3		34	1		34	2	
35	4		35	4		35	4		35	1	
36	1		36	2		36	1		36	3	
37	2		37	1		37	2		37	4	
38	3		38	4		38	3		38	2	
39	1		39	3		39	4		39	1	
40	3		40	2		40	3		40	4	

Random Ordering of Four Conditions

Block 1 40 Trials	Block 2 40 Trials	Block 3 40 Trials	Block 4 40 Trials
4	3	2	2
2	4	4	3
3	1	1	2
2	2	3	4
4	4	1	1
1	2	4	4
3	3	2	3
1	1	3	1
2	3	4	4
3	4	2	2
4	1	3	3
1	2	1	1
4	1	4	2
2	4	3	4
3	2	2	3
1	3	1	1
4	4	4	4
2	1	3	1
3	3	1	3
4	2	3	2
1	4	2	3
2	2	4	4
3	3	1	2
1	1	2	1
2	2	3	2
1	3	2	3
4	4	3	1
2	3	4	3
1	1	2	4
3	4	1	2
4	2	4	1
3	1	1	4
1	4	3	2
3	2	2	1
4	4	1	4
2	1	3	1
1	2	4	2
4	3	2	3
3	1	1	4
2	3	4	3

Legend: 1 = long PS; long RS
2 - long PS; short RS
3 = short PS; long RS
4 = short PS; short RS

Table 4

RAW DATA OF RT

MEAN SCORES FOR TASK CONDITIONS

Subjects	Task Conditions 1	2	3	4
1	.170	.165	.178	.165
2	.184	.177	.173	.161
3	.187	.175	.196	.183
4	.199	.202	.208	.211
5	.168	.156	.173	.157
6	.167	.159	.160	.151
7	.190	.186	.184	.172
8	.149	.142	.150	.142
9	.170	.155	.194	.171
10	.177	.173	.176	.159
11	.196	.202	.197	.176
12	.150	.143	.151	.138
13	.185	.173	.181	.161
14	.194	.169	.176	.164
15	.174	.163	.211	.156
16	.186	.167	.192	.170
17	.170	.150	.170	.158
18	.200	.182	.169	.154

Note: Condition 1 = Long PS with long RS in msec.
Condition 2 = Long PS with short RS in msec.
Condition 3 = Short PS with long RS in msec.
Condition 4 = Short PS with short RS in msec.