

PATTERNING
IN THE
PERCEPTION OF TIME

A Thesis

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the Department of Psychology

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Master of Social Science

by

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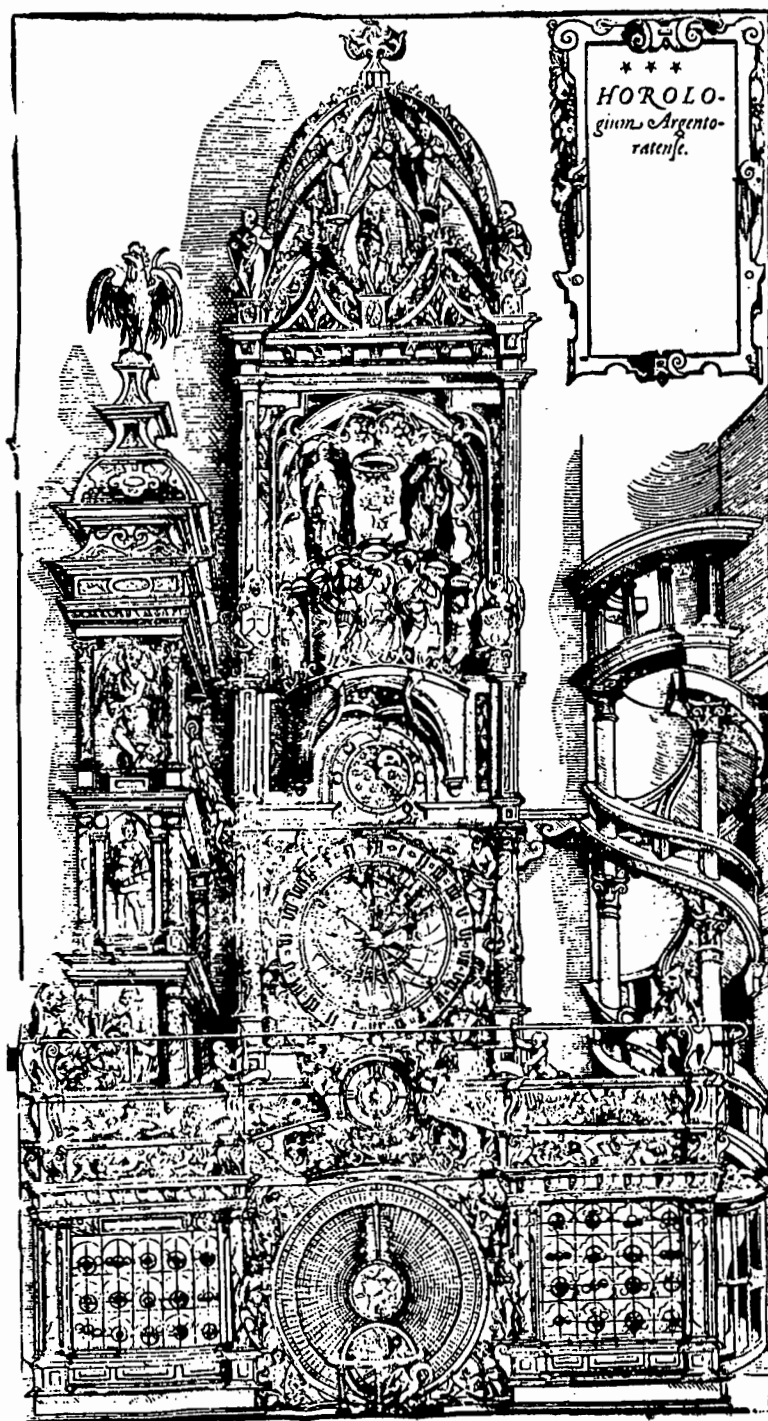
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All life, all life resolved itself into this:
tick-tack, tick-tack, tick-tack; then the
striking of the hour ...

D.H. Lawrence (1921)
from *Women in Love*



The Astronomical Clock of the Strasbourg Cathedral
built in 1574

From a contemporary woodcut drawn by Tobias Stimmer and printed
in Nikodemus Frischlin, *Operum Poeticarum* Strasbourg (1598).
Photograph courtesy of the Warburg Institute, University of London.

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PATTERNING IN THE PERCEPTION OF TIME

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University of Cape Town, 1983

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Oxtoby's novel study in 1971 coupled the perception of time to the patterning of stimuli. The present study is an open-ended investigation that further explores this area. It particularly addresses the question of whether or not the ratio of the lengths of successive intervals in a series, affects the accuracy of reproduction of that series.

48 normal human subject volunteers from the first year psychology population of the University of Cape Town each reproduced 16 four-interval series in two experiments with target intervals of either 1 000 milliseconds or 3 000 milliseconds. The "empty" intervals were delimited by 50 millisecond sound pulses. Each series consisted of a target interval and three "other intervals. In any given series the three "other" intervals were equal, and their durations relative to the standard were in one of the following ratios: 1:3, 3:1, 1:2, 2:1, 2:3, 3:2. Six groups of 8 subjects each were used. In the two experiments each group was assigned to one temporal ratio. Each group reproduced 8 series. In 4 of these series the subjects were required to reproduce the entire series as heard. In the other 4, the subject heard the entire series but

reproduced the target interval only. Each series was heard and reproduced three times before moving on to the next series. In both experiments the target interval was assigned to either the first, second, third or fourth position in the series, for both the entire reproduction and the reproduction of the target interval only. The subjects' error of reproduction was measured.

A 3-factor analysis of variance, split-plot design was employed. As this involved repeated measures, all scores were transformed in both experiments and when transformed did not violate the homogeneity assumption (F MAX statistic used). The power of both experiments was 0.8. The subjects were randomly assigned in each of the two experiments and the sequence of administration in terms of position of target interval and reproduction of the whole versus target interval was randomized for each subject. The order of presentation of each of the 16 series and the order of participation in the two experiments was also randomized for all subjects. Extraneous variables controlled for included external sounds (a sound attenuated laboratory was used), ambient temperature, diurnal variation within subjects, external timing cues and fatigue (experimental sessions did not exceed 20 minutes).

Subjects sat in an experimental chair and reproduced the series (heard as sound pulses produced by a signal generator via headphones) on a vertically mounted contact sensitive copper plate. A Micro-Nova computer by Data General Corporation recorded the responses in milli-

seconds and calculated percentage errors of reproduction.

For the 1 000 millisecond standard across the four interval positions, the relative ratio of 1:2 produced the greatest accuracy, and the ratios of 3:1, 2:3, 3:2 were least accurate. The reproduction of the entire series by the subject produced greater accuracy of reproduction than reproduction of the target-interval only.

For the 3 000 millisecond standard the relative ratios of 3:1, 2:3 and 3:2 across the four interval positions, yielded the least accurate reproduction, as was the case in the previous experiment. Contrary to the findings of the 1 000 millisecond experiment, the reproduction of the temporal target interval only, produced the greatest accuracy.

The author attempts to relate these findings to Oxtoby's theory of patterning in time perception (1971). Suggestions for further research are outlined.

Chapter 1

APPROACHES TO THE STUDY OF TIME PERCEPTION

The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities ... requires creative imagination and marks real advance in science.

Einstein and Infeld (1938)

Understanding Time

Since the Chinese constructed and operated astronomical clocks between the years A.D. 725 and 1370, a corpus of literature has accumulated on the measurement of time. What the nature of time is, however, has puzzled philosophers for even longer, the puzzlement going back to at least the time of the ancient Greeks. St. Augustine's view of the nature of time was,

It is in you, O my mind, that I measure time. I do not measure the things themselves whose passage produced the impress; it is the impress that I measure, when I measure time. Thus either that is what time is, or I am not measuring time at all.

St. Augustine (355)

Augustine's discussion pinpoints a fundamental difficulty in conceptualizing the nature of time; the intangible, abstract nature of the entity. It is this very aspect which doubtless has led some philosophers to the view that time is non-existent (de Spinoza, 1677), and is a mere illusion (McTaggart, 1934). Studying such viewpoints it is difficult

at times not to wonder whether we have made any progress at all since St. Augustine.

However, not all philosophers have retreated to the position that time is an illusion, - not a very comfortable philosophical position for a psychologist wishing to investigate its perception! Indeed much of the philosophical discussion on this point seems not really relevant. One important distinction has been made, however, which it does seem important to take account of: the distinction between the absolute and relational views of time. According to the absolute view, time and space form a framework within which the universe is set. They exist independently of the physical substance of the universe and would continue to exist even if the physical substance of the universe were to cease to exist. The implication of this philosophical position is that time can be directly perceived, independent of any physical substance or event. According to the relational view, space and time have existence only as relations between the events of the physical universe. If there were no physical universe, space and time would not exist.

What difference does the philosophical viewpoint as to the nature of time make to a psychological investigation of the perception of time?

To the extent that one holds the absolute view one's attention will be directed to the 'flow of time' during an interval, and one will perhaps think it meaningful to talk in terms of physiological receptors activated by time (Oxtoby, 1971). But to the extent that one holds a relational view,

one will see events as fundamental and judgements about time as abstractions from events. One's attention will then be directed to events, possibly those occurring during a time interval, but certainly and necessarily to those demarcating the interval (Oxtoby, 1971).

The existential-phenomenological perspective of psychology affirms the viewpoint of real time, and to some extent integrates the above two contrasting views.

Myself as it is lived by me is both in a time that is somehow independent of me and makes time what it is. I must reckon with time as something beyond myself and yet I do so by structuring time according to my own rhythms and tempos ... Nothing I experience occurs outside of time - time being both my temporalizing and the time of the world. I place all events in time and that is how I organize experience into a meaningful pattern.

Keen (1978)

It is evident, that this phenomenological perspective investigates time firstly, as it is lived and allows this 'living of time' to shape the organization of its investigation (Keen, 1978:46).

By contrast, within the experimental psychology tradition, a plan of organization is functionally applied to the study of time perception. The present study falls within this field and places its emphasis almost exclusively on the stimuli demarcating time intervals and the structuring of the temporal relationships between those stimuli.

Time Perception

In the light of interesting developments in the general explosion of scientific activity, particularly in areas

like information theory and experimental biology, and the way in which these have influenced experimental psychology, the recent marked upsurge in time perception studies can perhaps be understood. As many papers have been published in the last 20 years, as were published between 1860 and 1960 (Pöppel, 1972). The new interest in the problems of time perception is also reflected in the increase of monographical papers and books by: Bergius (1969); Cohen (1967); Creelman (1962); Fraisse (1964 and 1966); Goody (1969a); Heiss (1961); Lévy (1969); Orme (1969); Ornstein (1969); Michon (1967, 1970); Schaltenbrand (1963); Treisman (1963); Wallace and Rabin (1960); and Woodrow (1951). In attempting to summarize these contributions two basic concepts emerge; namely, the endogenous and the exogenous factors in time perception.

The endogenous basis of time perception has been discussed under the categories of cortical representation by Davis (1956); Dimond (1964); Hoff and Pötzl (1934); general physiological cues by Bell and Watts (1966); Hawkes et al., (1962); Schaefer and Gilliland (1938) and 'internal clocks' by Goody (1969b); Pöppel (1968a, 1969, 1970a); Treisman (1963). 'Internal clocks' have been identified with the alpha rhythm of the electroencephalogram by Anliker (1963); Cahoon (1967); Fraisse and Voillaume (1969); Holubář and Machek (1962); Legg (1968); Werboff (1962) and Wiener (1963).

The exogenous basis of time perception considers not

only the processing of information but also the processed information which creates a reference system. This concept is demonstrated in the adaptation-level theory (Helson, 1964). Pooling processes and anchor stimuli have been shown to affect time perception by Adamson (1967); Behar and Bevan (1961); Goldstone (1967); Goldstone et al. (1957); Nelson et al. (1963); Postman and Miller (1945); Sictl (1963); Zoltbrocki (1965). Schiffman (1976) points out that longer intervals of time (longer than minutes) are judged with greater reference to external events and require a cognitive explanation.

We shall consider some of the research into these factors in more detail below.

Influenced by the endogenous concept, attempts have been made to determine the way in which physiological factors influence time perception. In 1923 Piéron came to the conclusion that if speeds of organic processes were modified by variations in body temperature; decreased temperature would slow the internal clock (underestimation) and increased temperature would speed the internal clock up (overestimation). Experiments confirming this hypothesis were done by François (1927 and 1928) and Hoagland (1933). Pharmacological substances have also been shown to influence time perception. Caffeine and metamphetamine (Frankenhaeuser, 1959) speed up the clock while pentobarbital and nitrous oxide (Frankenhaeuser, 1959), (Steiberg, 1955) cause underestimation of time by slowing the internal clock. One of the most

striking effects on time perception are those caused by the administration of psychedelic drugs: marijuana, mescaline, psilocybin, LSD. They generally cause or produce a dramatic lengthening of perceived time (Fisher, 1967; Weil et al., 1968).

The effect of the hormone thyroxine is to increase the metabolic rate which in turn results in overestimation i.e. an increase of time in the internal clock (Sterzinger, 1935 and 1938).

Returning to the question of exogenous factors, research has been undertaken on environmental cues which influence time perception.

Attention

" ... every time we turn our attention to the course of time, it seems to grow longer." (Katz, 1906).

Stimulus Characteristics

Hirsch et al., (1956) pointed out that more intense stimulation is perceived as having a longer duration. It is possible that this may be a function of the degree of arousal induced. Falk and Bindra (1954) introduced shock as the arousal stimulus. A mild shock was administered to subjects via a pair of spring clamps over their fingers after which the subjects produced "filled" intervals of 15 second durations by pressing a telegraph key. The subjects overestimated the durations. Langer, Wapner and Werner (1961) showed that with increased danger, over-

estimation of time also increases (the increased arousal speeds up the internal clock). Smets (1969) exposed subjects to red and blue colour screens for 45 seconds each. The subjects verbally estimated the duration of exposure to each of the colours. The red colour stimulus produced overestimation. This overestimation may occur as a result of increased physiological arousal, which speeds up the internal clock (Cahoon, 1969).

Ambient Temperature

Lockhart (1967) investigated the relationship of ambient temperature to time estimation. He tested the hypotheses of Piéron (1923), François (1927 and 1928) and Hoagland (1933), that increased body temperature would speed up the internal clock, resulting in overestimation.

Lockhart's study used extreme ambient temperature conditions (5°C and 43°C) to induce a change in body temperature. Subjects judged the duration of 4, 9 and 13 minutes by using the methods of verbal estimation and production. Only the high ambient temperature condition (43°C) significantly raised rectal temperature. And in this condition the judgement of the duration of time was overestimated. This is consistent with the findings of Piéron, François and Hoagland. In the extremely low ambient temperature condition, body temperature was not affected and therefore the expected underestimation of time did not occur (slowing of the internal clock). In fact, Lockhart found that in this condition overestimation of time took

place (speeding up the internal clock) and attributes this to stress (physiological arousal).

Motivation

Jahoda (1941) found that when factory workers worked more actively and showed greater interest, their mental clock sped up and time passed more quickly (overestimation).

Methodology

During recent years attempts to impose order on the methodology of time perception have produced four basic methods (Clausen, 1950; Bindra and Waksberg, 1956; Fraisse, 1963). The methods are:

- a) Pure estimation. The experimenter presents a stimulus of a defined duration and the subject responds reporting how long (in conventional time units) the interval appeared to be.
- b) Comparison. The experimenter presents two stimuli in sequence, and the subject decides which one of the two is longer.
- c) Production. The experimenter asks the subject to produce an interval of a certain duration specified in conventional time units.
- d) Reproduction. The experimenter presents a stimulus and the subject reproduces it without necessarily being aware of its duration in conventional time units.

Pöppel (1972)

Stimuli may be presented visually, auditorily or tactually, either as brief pulses (which define the duration of "empty" intervals) or as periods of continuous stimulation ("filled" intervals).

The methods of estimation and production employ conventional time units acquired from the subjects' social

environment and involve short and long-term memory. In the methods of comparison and reproduction the subject is free from the necessity of using the acquired standard for time judgement and thus these methods are more useful for studies in which the main interest is the intrinsic temporal organization (Pöppel, 1972). These latter two methods involve short-term memory processes only (Treisman, 1963).

Studies Employing One or More of These Methods

Carlson and Feinberg (1968) employed the methods of estimation, production and reproduction in a study that investigated the time judgements of normal versus schizophrenic subjects. A low correlation was found between the methods of estimation and production.

Hornstein and Rotter (1969) concluded that the methods used in experimentation are of crucial importance, because they found significant differences between the methods of production and reproduction on the one hand and verbal estimation on the other. They hypothesized that in the methods of production and reproduction, the time was perceived as being shorter (overestimated) due to the subject's active participation in this method, whereas with the method of verbal estimation, time is perceived as being longer (underestimated) due to the fact that subjects more 'passively' observed time in this method.

Ochberg, Pollack and Meyer (1965) compared the method of reproduction with the method of estimation. The method of

reproduction produced more accurate time estimates as compared to the method of verbal estimation.

Warm, Morris and Kew (1963) found significant differences between the methods of production, reproduction and verbal estimation. In the method of verbal estimation subjects underestimated the passage of time.

Only low correlations have been found between the four methods, and there is no agreement that a single factor of time perception is being investigated by all four of these methods (Clausen, 1950; Du Preez, 1963; Kruup, 1961; Siegman, 1962).

A Model for the Perception of Time

The general background orientation to the present study is based on Oxtoby's theory of time perception (1971), which conforms to the relational view of the nature of time. As such it places its emphasis almost exclusively on the stimuli demarcating the time intervals - a still somewhat neglected aspect in the study of the perception of time. Treisman (1963), synthesizing the work of various other theorists, proposed a most useful model of an "internal clock" to represent the processes occurring in judgements about the duration of time intervals. The essential details of this model are presented in the following figure:

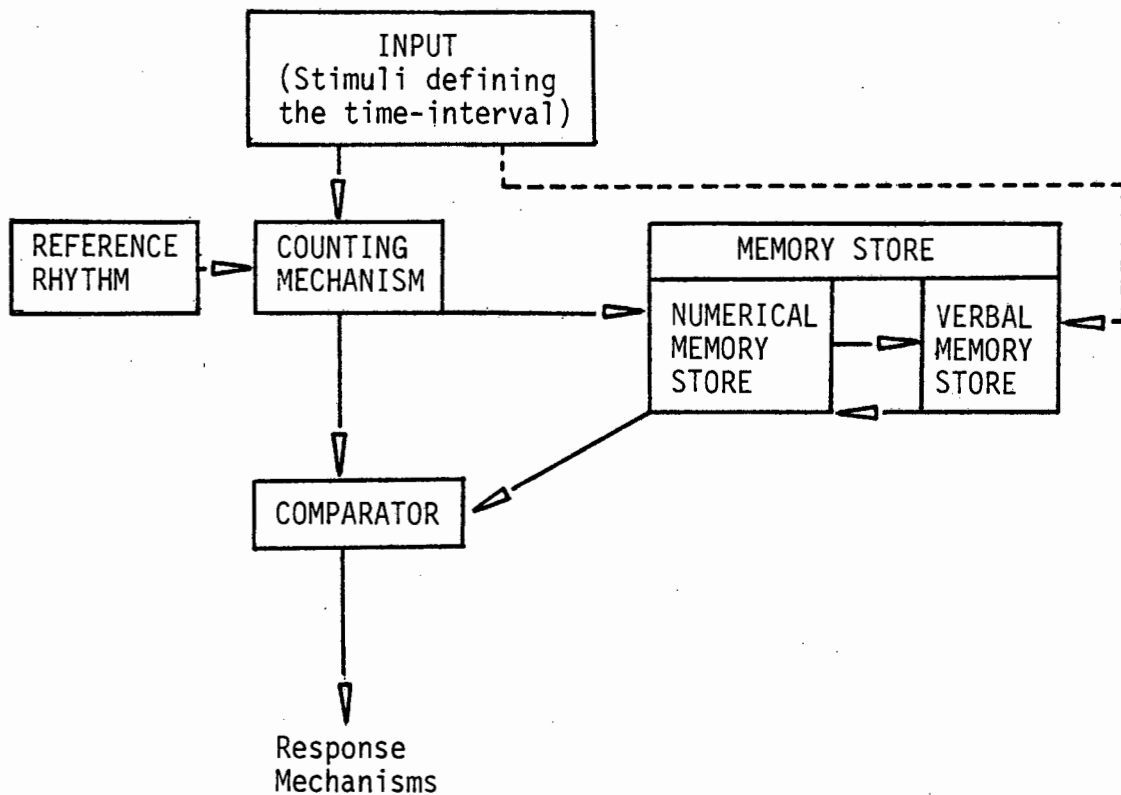


Figure 1
Model of the "Internal Clock"

The essential components of such a model comprise the following:

- a Reference Rhythm
- a Counting Mechanism
- a Memory Store
- a Comparator.

In the absence of any external mechanical aid (for example a watch), the durations of time intervals are assessed by counting the number of cycles of a reference rhythm which occur between the stimuli demarcating the time-interval.

The Reference Rhythm provides regular pulse sequences which are emitted at a constant rate.

The Counting Mechanism is set in operation by the stimulus marking the beginning of the time-interval under consideration. It continues to function until the arrival of the stimulus marking the end of that interval. It registers the number of cycles of the Reference Rhythm occurring during the time-interval and transfers this number to the Memory Store.

The Memory Store is divided into two parts: a Numerical Memory Store in which numbers transferred from the Counting Mechanism are recorded, and a Verbal Memory Store which contains such verbal labels as 'one second' etc., the locations of the Verbal Memory Store becoming linked with certain positions in the Numerical Memory Store by a learning process.

The Comparator is a decision unit which responds to indicate the equivalence of, or a discrepancy between, its two inputs (from the Counting Mechanism and the Memory Store).

The Present Study

In considering a method for the investigator's research the following facts have been considered.

Results obtained from the method of Verbal Estimation are heavily dependent on the magnitude of the subject's learned standard time-interval. The method of Production furthermore yields results which are affected both by the magnitude of the learned standard time-interval and by factors involved in the making of a motor response (Grant, 1967).

The method of Comparison would seem to be the 'purest'

measure of time "perception", whereas in the method of Reproduction a motor response component is involved.

The investigator has however elected to employ the method of Reproduction in his research. This method provides the greatest flexibility in dealing with series of time-intervals with more than two components.

The essential features of the method of Reproduction as related to Treisman's model of an 'internal clock' are outlined in Figure 2.

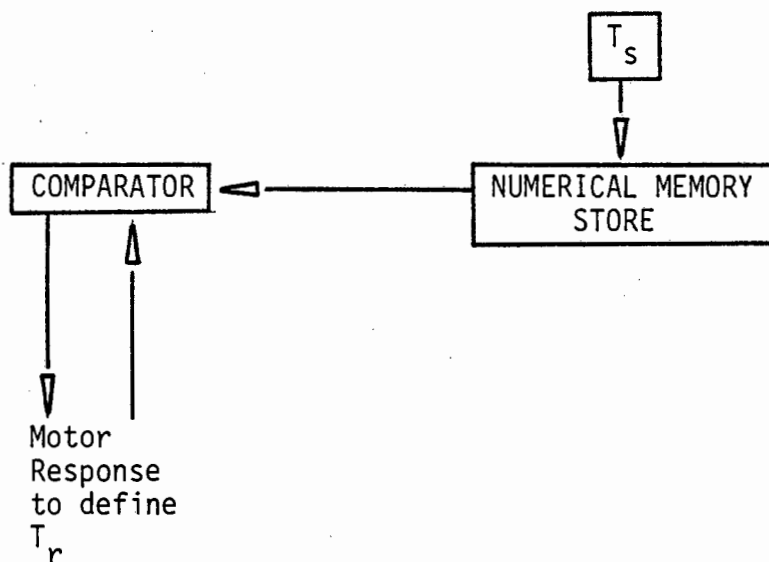


Figure 2

Diagrammatic Representation of the Processes Involved in Estimating the Duration of Temporal Intervals by the Method of Reproduction

In the method of Reproduction the duration of a time-interval is compared with that of one which almost immediately preceded it (T_s). In terms of the model, the Counting

Mechanism will have transferred a number corresponding to the duration of T_s into the Numerical Memory Store. At the commencement of the T_r , this number will already have been transferred from the Memory Store to the Comparator, into which the Counting Mechanism will be feeding a number corresponding to the duration of T_r which has elapsed so far. The subject is required to make a motor response to terminate T_r which he will do when there is equality between the number fed in by the Counting Mechanism for elapsed duration of T_r and the number transferred from the Numerical Memory Store in respect of the duration of T_s (Treisman, 1963).

It is of interest to note that prior to 1971, most if not all, previous investigations in time perception appear to have employed single temporal intervals only. Oxtoby (1971) initiated an investigation into the effect of patterning on the perception of time intervals presented in a continuous series of more than one temporal interval, employing Treisman's model of the internal clock. On the basis of this work he advanced a preliminary outline theory of time perception (see Appendix A). Aspects of this theory were confirmed by initial experimentation. The theory postulates the possibility that the patterning of temporal-intervals not only affects the perception of intervals, but that in fact the intervals are perceived in terms of the pattern.

This approach spans both the endogenous and exogenous concepts of time perception. It involves the endogenous in

that an 'internal clock' is hypothesized and exogenous in that it is proposed that the external stimuli demarcating the intervals of the time-series create reference rhythms in terms of which the durations of the intervals are assessed.

This investigator has undertaken an open-ended investigation that will further explore this field of patterning and its effect on the perception of time-intervals. It is addressed particularly to the question of whether or not the ratio of the lengths of successive intervals in a series affects the accuracy of reproduction of that series. Specifically the investigator is concerned with questions like "Does one reproduce a 1 second interval more accurately if it is preceded by a number of 500ms intervals than if it is preceded by a number of 333 or 667ms intervals? In a series of three 500ms intervals and one 1 000ms interval, is the accuracy of reproduction of the 1 000ms interval affected by the position of that interval in the series, e.g. preceded by one and followed by two 500ms intervals versus preceded by three and followed by no 500ms intervals, etc.?"

Chapter 2

DESIGN OF THE STUDY

It is a rare thing that a specific body of data tells us as clearly as we would wish how it itself should be analysed.

Tukey (1977)

A split-plot factorial design was used in this study for a number of reasons.

Firstly, three independent variables were simultaneously studied to determine their independent and interactive effects on the dependent variable.

Secondly, as differences among subjects often obscure treatment effects and as heterogeneity is the order of the day in behavioural research, the split-plot factorial design is particularly appropriate in that it partially isolates the effect of subject heterogeneity.

Although the F test for split-plot repeated designs does not include a term for sequence or carry over effects, Gaito (1961) has pointed out that if the investigator randomizes the presentation of treatment levels, the problem can be contained. This precaution was taken in the present study.

The type of design employed was what Kirk (1968) calls the SPF-p.qr design. This design has one between block treatment (A) and two within-block treatments, (B, C).

p samples of n subjects each from a population of subjects are randomly assigned to levels of the non-repeated treatment (A). The sequence of administration of the repeated treatment levels in combination with one level of the repeated treatment levels in combination with one level of the non-repeated treatment is randomized independently for each block.

Kirk (1968:245)

Concerning subject selection from the Psychology Department subject "pool" where the students receive academic credit for participating in research studies, Rosenthal and Rosnow (1975) have identified the motivation characteristics of such volunteer subjects and as randomized selection was not possible in this study, the next best solution to random selection, was to randomly assign subjects to treatment conditions. This controlled for systematic bias between the various groups of available subjects. The investigator has also reported the nature of subject selection and assignment in addition to the characteristics of the subjects to enable other investigators to assess the comparability of the results (Christensen, 1977:242-243). 48 subjects were used in each experiment which gives a power 0.8, a very acceptable figure (Kirk, 1968:109). The rationale for the calculation is given in Appendix B.

The basic control method used in this study was randomization. Randomization provides control for all sources of variation whether known or unknown (Christensen, 1977:124). Subjects were randomly assigned to a treatment level of factor A for each of the two experiments and the sequence of administration of BC treatment combinations was

also randomized for each subject. Subjects were randomly assigned to commence with experiment 1 or 2, and the order of presentation of the series for each subject was also randomized.

In addition to randomization, the present study controlled for a number of extraneous variables. In the light of the literature review the following sources of potential rival hypotheses were controlled for: noise levels, ambient laboratory temperature, fatigue of subjects, time of day of testing (diurnal variation), external timing aids.

Various possible transformations of the raw scores were tried out as recommended by Kirk (1968:66). Following Kirk's criteria the $\sqrt{X} + \sqrt{X+1}$ transformation was selected as most appropriate. The F MAX statistic for the transformed scores indicated that there was no violation of homogeneity. Though the raw scores in Experiment 2 did not violate the homogeneity assumption, the identical transformation was applied to all scores in this experiment, to make it comparable to experiment 1.

The major reasons for employing this transformation, was to achieve homogeneity of error variance and to achieve normality of treatment-level distributions (or within-cell distributions), Kirk (1968:63).

The investigator attempted to prepare clear, unambiguous, specific and uncomplicated instructions in writing, for this study (Sutcliffe, 1972). These are given

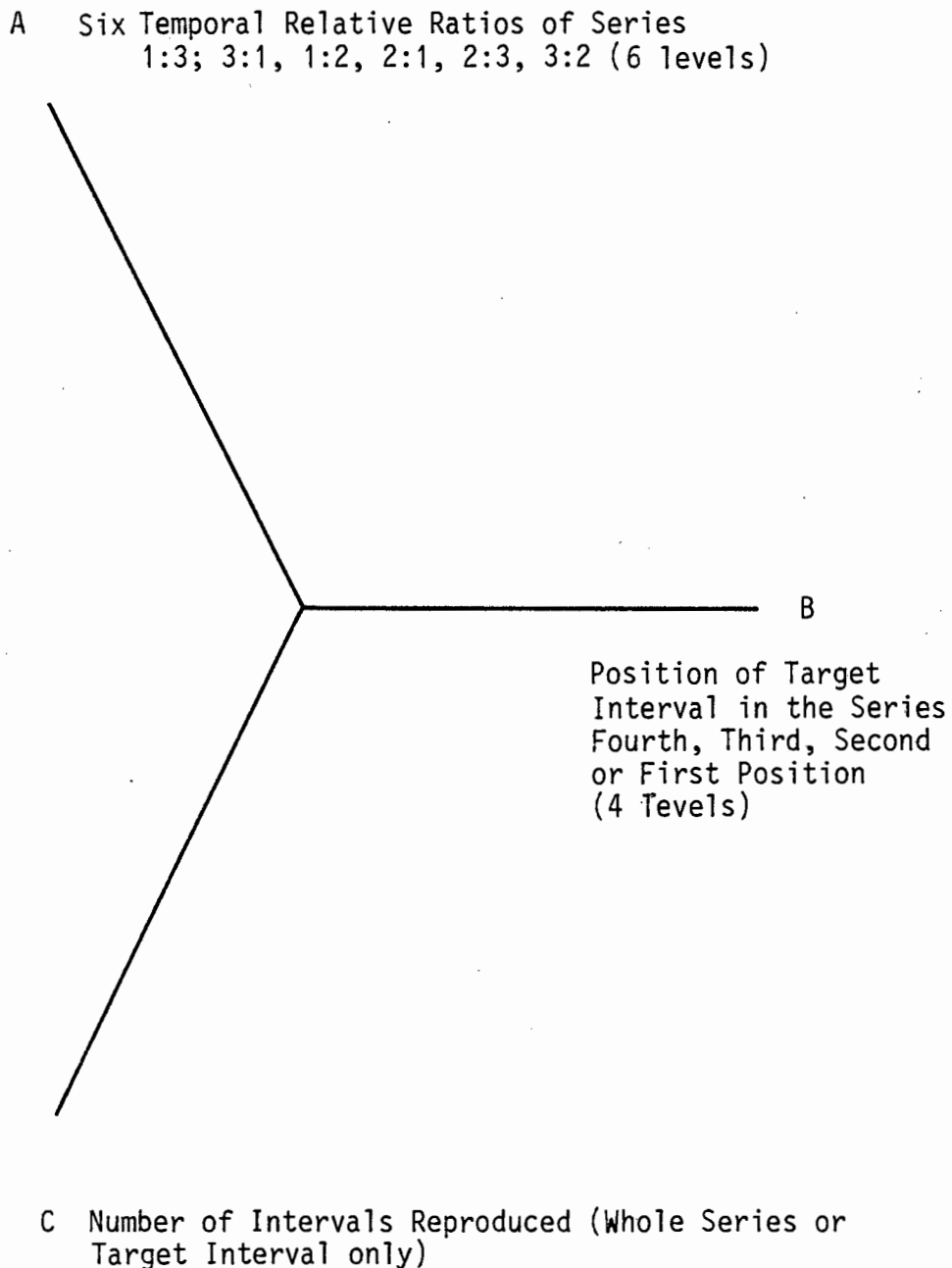
in Appendix C.

A post-experimental interview was conducted with all subjects. This interview enabled the investigator to obtain a subjective report from the subjects concerning the effectiveness of the independent variables (Christensen, 1977). 250).

A temporal standard of 1 000ms was selected for experiment 1 and a standard of 3 000ms was selected for experiment 2. With these standards and relative ratios already selected the total range of time intervals used, ranged from 333 to 9 000ms. This is in keeping with past studies which mostly employed brief time intervals in the range of 200ms to 10 000ms.

The Research Design : Experiments 1 and 2

Split-plot Factorial, non-repeated measures on Factor A.
Repeated measures on Factors B and C (Kirk, 1968:298-307).



Two experiments for each of 48 subjects with target intervals of 1 000ms and 3 000ms respectively.

Figure 3

Diagrammatic Representation of Research Design

Independent Variables

Factor A: Temporal Relative Ratios of Series

a_1	a_2	a_3	a_4	a_5	a_6
1:3	3:1	1:2	2:1	2:3	3:2

Factor B: Position of Target Interval in the Series of Four Temporal Intervals



Factor C: Number of Temporal Intervals Reproduced

Levels

c_1	c_2
■ ■ ■ ■	■ - - -
All Four Intervals	Target Interval Only

Dependent Variable

The subjects' absolute percentage error of reproduction of the target interval.

Method

Subjects. Forty eight subjects from the first year Psychology student population at the University of Cape Town, volunteered for the experiments.

Apparatus. (a) Experimentation was conducted in the Perception Laboratory of the Department of Psychology, University of Cape Town. (b) Standard laboratory furniture was used. Special equipment included a Micro-Nova computer from the Data General Corporation, a teleprinter, a Krohn-Hite signal generator, one pair of Sansui SS10 two-way mechanical headphones, an 'experimental' chair equipped with: two copper tapping plates, electrical circuitry linked to the computer, a wristband, a 9-volt battery and a digital indicator.

Procedure. (a) The subject was seated in the experimental chair and instructions were given to the subject in written form. After having read the instructions, the headphones were placed on the subject's head. (b) Right-handed subjects positioned their right hands over the right-hand copper plate. A wristband linked to the 9-volt battery was attached to the wrist of the subject's left hand. The opposite procedure was used for left-handed subjects. (c) Now the subject heard a number of sound 'pips' coming through the headphones. The digital read out indicated whether the whole series or target interval only should be reproduced and the position of the target in the series. When the 'pips' stopped, the subject tapped back what he/she had heard, on the copper plate. (d) For each subject, the investigator activated a given sequence on the computer terminal. Upon hearing the series of intervals, bounded by 50ms pulses with a frequency of 1 KHz per second, the subject reproduced the

series by tapping the plate. The 9-volt charge entered the subject via the wristband. Upon tapping the plate, the charge momentarily flowed to the computer and activated a switch closure. When the finger lifted off the plate, the switch again opened. The electronic clock in the computer measured the time in milliseconds between the taps. The computer calculated the percentage error between the given and the reproduced series. A teleprinter linked to the computer, printed out results.

Experimental Steps

Step 1

- (1) Instructions given to the subject. (See Appendix C)

Step 2

- (1) Each subject received 2 training trials for Exp. 1 & 2 respectively.
- (2) 1 trial for whole series reproduction.
- (3) 1 trial for reproduction of target interval only.
- (4) Each of above series Heard and Reproduced three times.

Step 3.

- (1) Each of 48 subjects completed a total of 8 series for Exp. 1 and 8 series for Exp. 2.
- (2) The 16 series were selected from the series table listing the 48 series (Table 1). A randomized order is obtained for the 16 series of each subject (Table 2 and Appendix D, Table A).
- (3) Subject received designated 16 series (Appendix D, Table A).
- (4) Subject tested for 20 minutes (Appendix D, Table A).

Step 4

- (1) Subject is debriefed.
- (2) Results printed on teleprinter.
- (3) Results labelled and filed.

Table 1
Series Table to be Used in Experimentation

Experiment 1: 1000ms							Relative Ratios
Series Numbers	Durations of Intervals in Milliseconds						
301	999	500	500	500	1000	0	
302	999	500	500	1000	500	0	1:2
303	999	500	1000	500	500	0	
304	999	1000	500	500	500	0	
305	999	2000	2000	2000	1000	0	
306	999	2000	2000	1000	2000	0	2:1
307	999	2000	1000	2000	2000	0	
308	999	1000	2000	2000	2000	0	
309	999	333	333	333	1000	0	
310	999	333	333	1000	333	0	1:3
311	999	333	1000	333	333	0	
312	999	1000	333	333	333	0	
313	999	3000	3000	3000	1000	0	
314	999	3000	3000	1000	3000	0	3:1
315	999	3000	1000	3000	3000	0	
316	999	1000	3000	3000	3000	0	
317	999	667	667	667	1000	0	
318	999	667	667	1000	667	0	2:3
319	999	667	1000	667	667	0	
320	999	1000	667	667	667	0	
321	999	1500	1500	1500	1000	0	
322	999	1500	1500	1000	1500	0	3:2
323	999	1500	1000	1500	1500	0	
324	999	1000	1500	1500	1500	0	

Table 1 (continued)

Experiment 2: 3000ms							
Series Numbers		Durations of Intervals in Milliseconds				Relative Ratios	
325	999	1500	1500	1500	3000	0	
326	999	1500	1500	3000	1500	0	1:2
327	999	1500	3000	1500	1500	0	
328	999	3000	1500	1500	1500	0	
329	999	6000	6000	6000	3000	0	
330	999	6000	6000	3000	6000	0	2:1
331	999	6000	3000	6000	6000	0	
332	999	3000	6000	6000	6000	0	
333	999	1000	1000	1000	3000	0	
334	999	1000	1000	3000	1000	0	1:3
335	999	1000	3000	1000	1000	0	
336	999	3000	1000	1000	1000	0	
337	999	9000	9000	9000	3000	0	
338	999	9000	9000	3000	9000	0	3:1
339	999	9000	3000	9000	9000	0	
340	999	3000	9000	9000	9000	0	
341	999	2000	2000	2000	3000	0	
342	999	2000	2000	3000	2000	0	2:3
343	999	2000	3000	2000	2000	0	
344	999	3000	2000	3000	3000	0	
345	999	4500	4500	4500	3000	0	
346	999	4500	4500	3000	4500	0	3:2
347	999	4500	3000	4500	4500	0	
348	999	3000	4500	4500	4500	0	

Table 2
Experiment Outline

1. All subjects take part in Experiments 1 and 2. (48 subjects)
2. Each subject reproduces eight whole series and eight single interval series.
(Total 16)
3. Each subject hears and reproduces each series three times.

		Experiment 1: 1000ms Ratio 3:1				Experiment 2: 3000ms Ratio 1:3				
	S 9.	313	314	315	316	333	334	336	335	
	S10.	313	314	316	315	336	333	334	335	
2a Whole	S11.	315	313	316	314	334	335	333	336	Whole
Series	S12.	316	313	314	315	336	334	335	333	Series
Repro-	S13.	314	313	315	316	335	336	334	333	Repro-
duced	S14.	313	315	316	314	336	335	333	334	duced
	S15.	315	314	313	316	335	334	333	336	
	S16.	313	315	316	314	335	333	334	336	
2b Single	S 9.	315	313	314	316	335	336	334	333	Single
Target	S10.	314	315	316	313	334	333	335	336	Target
Interval	S11.	316	313	315	314	335	334	333	336	Interval
Repro-	S12.	315	313	314	316	335	336	334	333	Repro-
duced	S13.	316	313	314	315	334	336	333	335	duced
only	S14.	316	315	314	313	335	336	333	334	only
(1st,2nd	S15.	315	316	314	313	335	334	333	336	(1st,2nd
3rd or 4th	S16.	314	315	316	313	333	335	336	334	3rd or 4th
positions)										positions)

Three Levels of Randomization

- (a) Subjects assigned randomly to reproduce whole temporal series or single target interval only.
- (b) Subjects assigned randomly to Experiment 1 first or Experiment 2, first.
- (c) Subjects assigned to randomized series sequence (a form of counterbalancing to overcome possible sequencing effects).

Similar randomized series for the other subject groups are given in Appendix D.

Chapter 3

EXPERIMENT 1: 1 000 MILLISECONDS

Indeed, continuity is required for the exercise of critical judgement, since beauty and the opposite do not arise in this or that isolated note or time or speech sound, but in the series, as they are a blend of the smallest elements in an actual composition.

Plutarch: (c A.D. 46-120)

Experiment 1 with a temporal standard of 1 000ms was conducted to determine the effects of three independent factors, namely: relative ratios, the position of the target interval and the reproduction of the whole series versus the target interval only, on the subjects' error of reproduction.

Table 3
 Identification of Factors and Levels
 Experiment 1

Factors and Levels	Intervals in Series in Milliseconds			
Factor A = Relative Ratios				
$A_1 = 1:3$	333	333	333	1000
$A_2 = 3:1$	3000	3000	3000	1000
$A_3 = 1:2$	500	500	500	1000
$A_4 = 2:1$	2000	2000	2000	1000
$A_5 = 2:3$	667	667	667	1000
$A_6 = 3:2$	1500	1500	1500	1000
Factor B = Position of Target Interval in the Series				
$B_1 = \text{Fourth Position}$	333	333	333	1000
$B_2 = \text{Third Position}$	333	333	1000	333
$B_3 = \text{Second Position}$	333	1000	333	333
$B_4 = \text{First Position}$	1000	333	333	333
Factor C = Reproduction of Whole Series or Target Interval Only				
$C_1 = \text{Whole Series}$	333	333	333	1000
$C_2 = \text{Target Interval Only}$	-	-	-	1000

Results

Table 4

Cell Means and Standard Deviations

	C ₁				C ₂				
	B ₁	B ₂	B ₃	B ₄	B ₁	B ₂	B ₃	B ₄	Mean
A ₁ \bar{X}	7.3196917	8.1810734	7.447751	6.9423434	9.5166758	12.04499	10.905418	8.5283147	8.8607823
A ₁ SD	1.4149313	1.0443864	1.5710635	1.9355566	2.6444707	1.4386755	3.7884909	3.3457462	
A ₂ \bar{X}	10.228404	11.430557	10.84244	10.663878	8.957678	10.790179	9.6841449	10.405929	10.375401
A ₂ SD	3.4661808	3.814426	3.6535661	3.0836694	2.8274532	3.7431957	2.7986304	2.139773	
A ₃ \bar{X}	6.4747109	6.6488276	6.6362728	5.2198542	6.8409507	6.143023	8.482306	7.182133	6.7035095
A ₃ SD	2.3417972	2.9388442	2.6993585	1.8522419	1.63046	1.4472722	3.621904	2.6160617	
A ₄ \bar{X}	9.6720707	9.7502216	8.9538513	10.461261	8.9274796	9.0257862	10.385725	10.548415	9.7156011
A ₄ SD	3.1959155	2.8323455	2.4055138	2.4026729	2.2258986	1.9332834	2.741305	2.3103906	
A ₅ \bar{X}	7.4110451	9.5624454	9.1576949	10.737664	9.3628385	9.8463529	10.692045	10.641502	9.6764481
A ₅ SD	1.9576488	1.7879702	2.8622847	1.8339732	3.1299476	2.7747297	3.067873	1.8818959	
A ₆ \bar{X}	10.954832	10.149028	10.080234	8.5212229	12.326457	10.712571	12.157411	12.082702	10.873057
A ₆ SD	1.8769837	2.0802113	3.325337	2.8727272	1.3529512	1.4468139	2.2012849	1.265482	
	8.6767923	9.2870251	8.8530403	8.7577036	9.3220128	9.7604835	10.384508	9.8981658	9.3674648

Table 5
Ratio (A_i) - Position (B_i) Means

	B_1	B_2	B_3	B_4	
A_1	8.4181837	10.113032	9.1765845	7.735329	8.860782
A_2	9.5930409	11.110368	10.263292	10.534903	10.375401
A_3	6.6578308	6.3959253	7.5592894	6.2009936	6.7035096
A_4	9.2997751	9.3880038	9.6697881	10.504838	9.7156011
A_5	8.3869418	9.7043991	9.9248699	10.689583	9.6764482
A_6	11.640644	10.430799	11.118822	10.301962	10.873057

Table 6
Position (B_i) - Whole and Single Reproduction (C_i)
Means

	C_1	C_2	
B_1	8.6767923	9.3220131	8.9994025
B_2	9.2870253	9.7604835	9.5237542
B_3	8.8530406	10.384508	9.6187742
B_4	8.7577038	9.8981658	9.3279345

Table 7
Ratio (A_i) - Whole and Single Reproduction (C_i)
Means

	A_1	A_2	A_3	A_4	A_5	A_6	
C_1	7.4727148	10.79132	6.2449163	9.7093511	9.2172123	9.9263291	8.89364
C_2	10.24885	9.9594826	7.1621032	9.7218513	10.135684	11.819785	9.841292

The Subjects'
Percentage
Error of
Reproduction

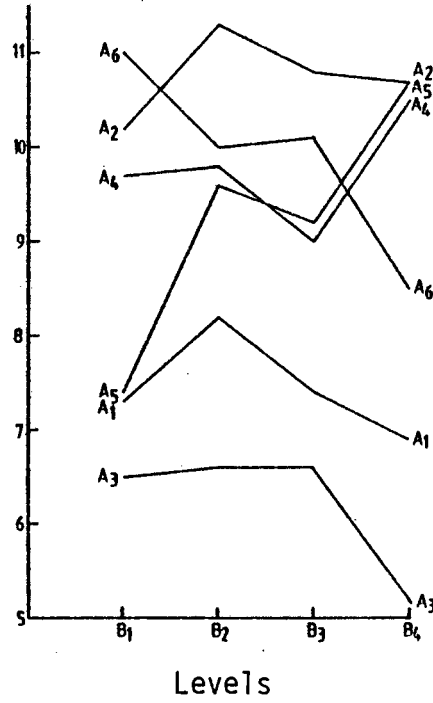


Figure 4

The Ratios (A_i) at the Positions (B_i)
for the Whole Series (C_1)

The Subjects'
Percentage
Error of
Reproduction

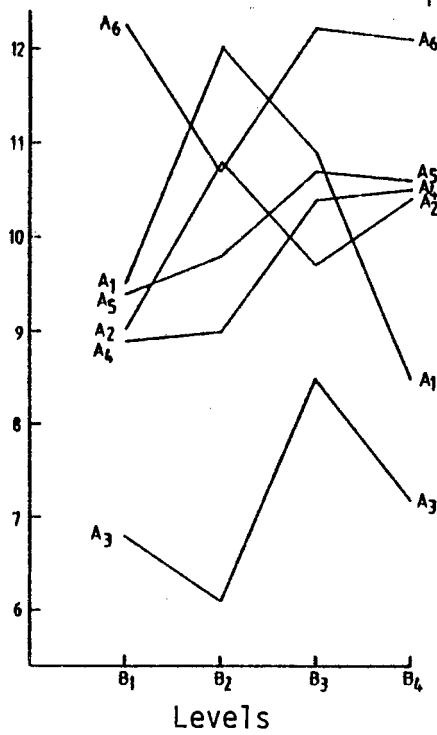


Figure 5

The Ratios (A_i) at the Positions (B_i)
for the Target Interval Only (C_2)

The Subjects' Percentage Error of Reproduction

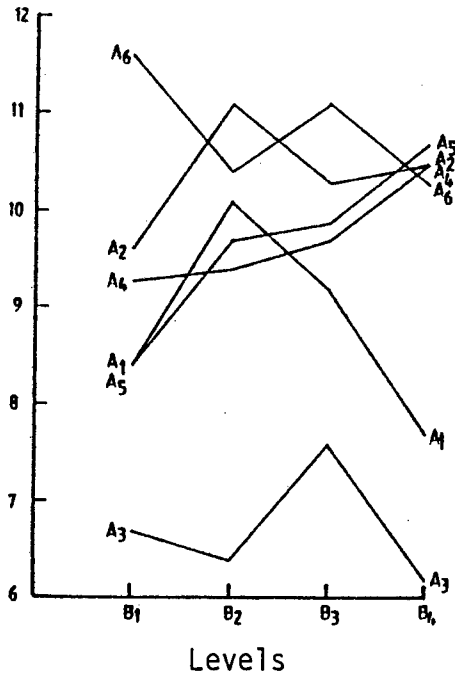


Figure 6

The Ratios (A_i) at the Positions (B_i)

The Subjects' Percentage Error of Reproduction

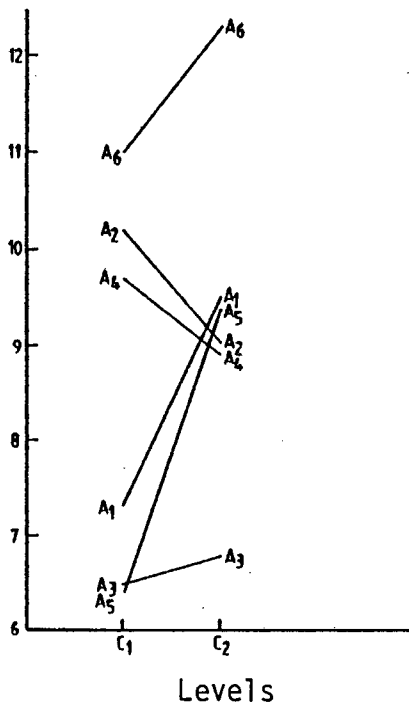


Figure 7

The Ratios (A_i) at the Whole and Single Reproduction (C_i) for the Fourth Position (B₁)

The Subjects'
Percentage
Error of
Reproduction

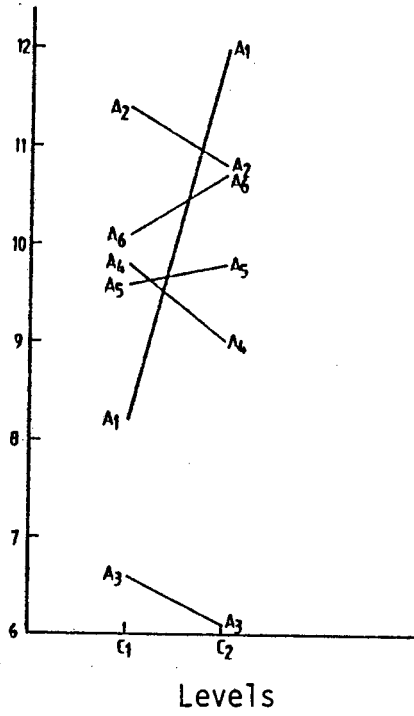


Figure 8

The Ratios (A_i) at the Whole and Single Reproduction (C_i)
for the Third Position (B_2)

The Subjects'
Percentage
Error of
Reproduction

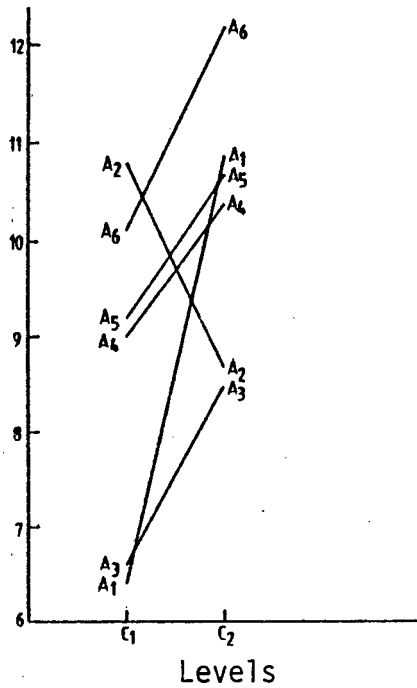


Figure 9

The Ratios (A_i) at the Whole and Single Reproduction (C_i)
for the Second Position (B_3)

The Subjects'
Percentage
Error of
Reproduction

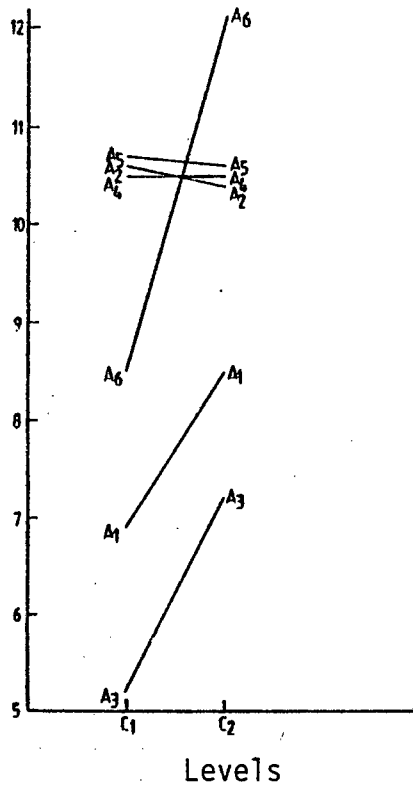


Figure 10

The Ratios (A_i) at the Whole and Single Reproduction (C_i)
for the First Position (B_4)

The Subjects'
Percentage
Error of
Reproduction

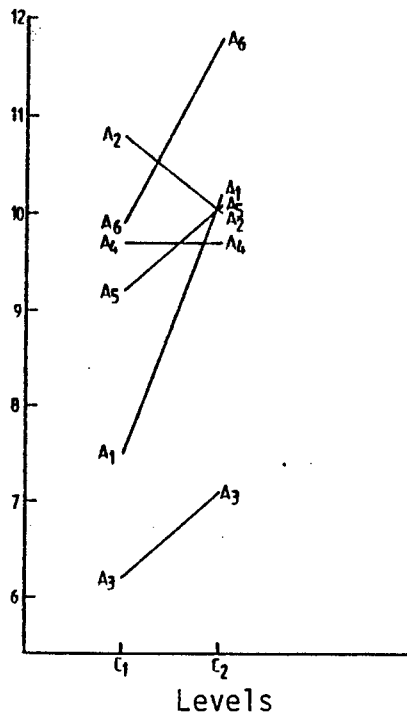


Figure 11

The Ratios (A_i) at the Whole and Single Reproduction (C_i)

The Subjects' Percentage Error of Reproduction

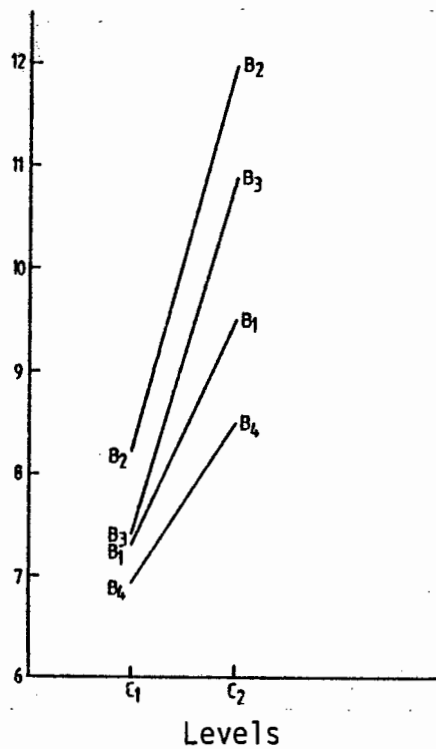


Figure 12

The Position (B_i) at the Whole and Single Reproduction (C_i) for the Ratio 1:3 (A₁)

The Subjects' Percentage Error of Reproduction

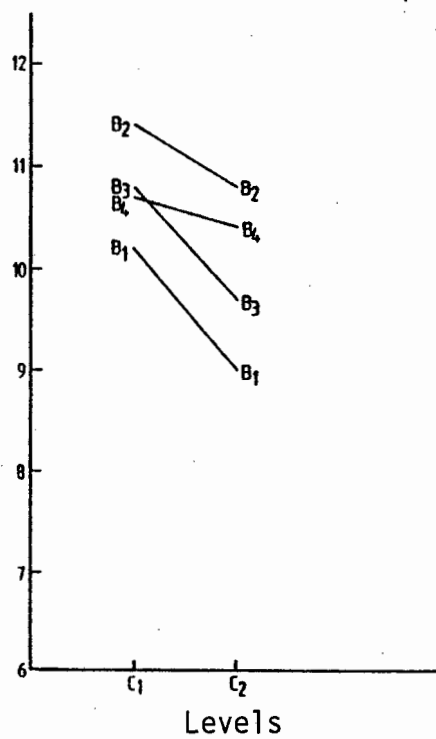
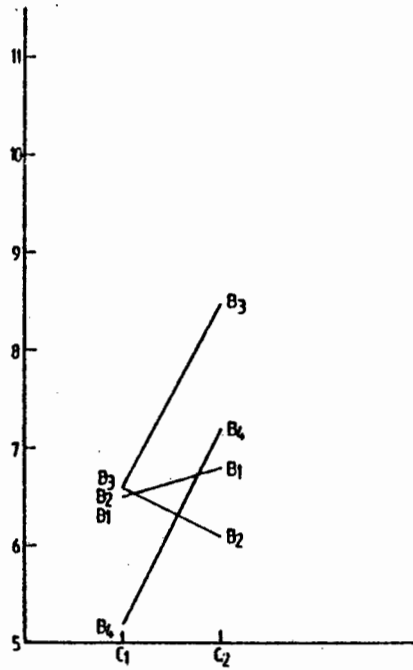


Figure 13

The Positions (B_i) at the Whole and Single Reproduction (C_i) for the Ratio 3:1 (A₂)

The Subjects'
Percentage
Error of
Reproduction

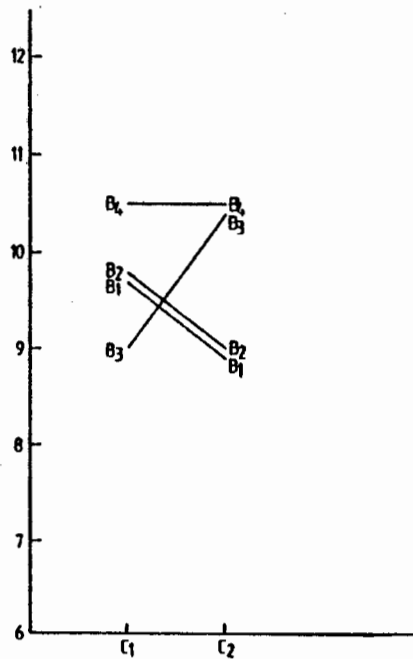


Levels

Figure 14

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 1:2 (A_3)

The Subjects'
Percentage
Error of
Reproduction



Levels

Figure 15

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 2:1 (A_4)

The Subjects'
Percentage
Error of
Reproduction

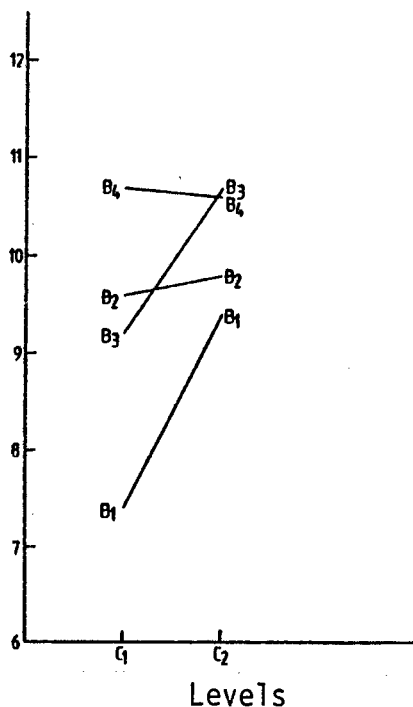


Figure 16

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 2:3 (A_5)

The Subjects'
Percentage
Error of
Reproduction

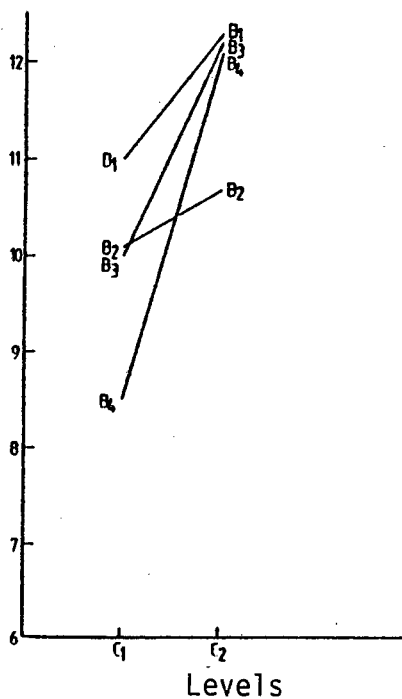


Figure 17

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 3:2 (A_6)

The Subjects'
Percentage
Error of
Reproduction

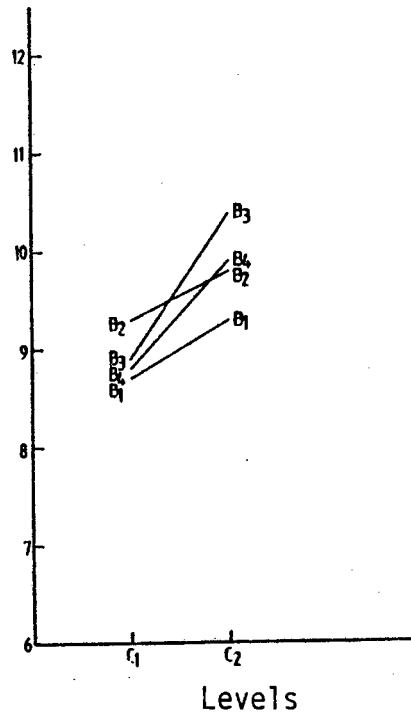


Figure 18

The Positions (B_i) at the Whole and Single Reproduction (C_i)

Table 8
Anova Summary Table

Source	SS	DF	MS	F Ratio
<u>Between Subj</u>				
A	694.58594	5	138.91719	6.8307391**
Subj. W.G.	854.15674	42	20.337065	
<u>Within Subj</u>				
B	21.569824	3	7.1899414	1.6572446
AB	142.11865	15	9.4745767	2.1491772*
BX SWG	546.6499	124	4.4084669	
C	86.216309	1	86.216309	10.541013
AC	132.48877	5	26.497754	3.239679*
CX SWG	343.52344	42	8.1791294	
BC	16.661133	3	5.5537109	1.5144756
ABC	60.220215	15	4.014681	1.077386
BX SWG	462.05273	124	3.7262316	
Check on Homogeneity of Error Terms				
F max (Subj.W.G.)	= 8.5629565	DF = 6,7		
F max (BX SWG)	= 3.3305407	DF = 6,21		
F max (CX SWG)	= 2.4401848	DF = 6,7		
F max (BC SWG)	= 2.7823642	DF = 6,21		

* Significant at the 0.05 level

** Significant at the 0.01 level

Table 9
Simple Main Effects

Source	SS	DF	MS	F Ratio
A at B ₁	217.83514	5	43.567029	5.225033**
A at B ₂	216.34766	5	43.269531	5.1893539**
A at B ₃	115.18188	5	23.036377	2.7627735*
A at B ₄	287.34192	5	57.468384	6.8922351**
Error	742.09398	89	8.3381346	
A at C ₁	463.12109	5	92.624218	6.4962538**
A at C ₂	363.9541	5	72.79082	5.1052268**
Error	1012.3249	71	14.258097	
B at A ₁	50.086487	3	16.695496	3.8482261*
B at A ₂	19.044556	3	6.3481852	1.4632241
B at A ₃	17.305267	3	5.7684224	1.3295918
B at A ₄	14.483765	3	4.8279215	1.1128111
B at A ₅	44.028442	3	14.676147	3.3827767*
B at A ₆	18.741699	3	6.247233	1.4399552
Error	546.6499	126	4.3384913	
C at A ₁	123.31091	1	123.31091	15.076288**
C at A ₂	11.071411	1	11.071411	1.3536173
C at A ₃	13.459778	1	13.459778	1.6456248
C at A ₄	0.00262451	1	0.00262451	0.00032088
C at A ₅	13.497681	1	13.497681	1.6502589
C at A ₆	57.363098	1	57.363098	7.0133501*
Error	343.52343	42	8.1791294	

* Significant at the 0.05 level

** Significant at the 0.01 level

Table 10
Significant Simple Main Effects on which
Tukey's HSD was Non-significant

A	at	C_1	B	at	A_1
A	at	C_2	B	at	A_5
A	at	B_3			

The following simple main effects were significant, but because there are only two levels of the factor, there is obviously no need to perform the Tukey's HSD Test.

For C at A_1 , compare $\bar{X}_{C_1A_1}$ and $\bar{X}_{C_2A_1}$

For C at A_6 , compare $\bar{X}_{C_1A_6}$ and $\bar{X}_{C_2A_6}$

Table 11: C at A_1

$\bar{X}_{C_1A_1}$	$\bar{X}_{C_2A_1}$
7.4727148	10.24885

Table 12: C at A_6

$\bar{X}_{C_1A_6}$	$\bar{X}_{C_2A_6}$
9.9263291	11.819785

TUKEY'S HSD SUMMARY TABLES

Table 13

Ratios at Fourth Position
A at B₁

	A ₁ B ₁	A ₂ B ₁	A ₃ B ₁	A ₄ B ₁	A ₅ B ₁	A ₆ B ₁
A ₁ B ₁		1.1507889	1.72429	0.86353096	0.03060187	3.1564442
A ₂ B ₁			2.8750868	0.28726585	1.1813987	2.0056474
A ₃ B ₁				2.5878209	1.6936881	4.8807341**
A ₄ B ₁					0.89413282	2.2929133
A ₅ B ₁						3.1870461
A ₆ B ₁						

Table 14

Ratios at Third Position
A at B₂

	A ₁ B ₂	A ₂ B ₂	A ₃ B ₂	A ₄ B ₂	A ₅ B ₂	A ₆ B ₂
A ₁ B ₂		0.97690438	3.6409572	0.71017506	0.40026153	0.31125718
A ₂ B ₂			4.6178616*	1.6870794	1.3771659	0.6656472
A ₃ B ₂				2.9307821	3.2406957	3.9522144
A ₄ B ₂					0.30991353	1.0214322
A ₅ B ₂						0.715187
A ₆ B ₂						

Table 15

Ratios at Second Position
A at B₄

	A ₁ B ₄	A ₂ B ₄	A ₃ B ₄	A ₄ B ₄	A ₅ B ₄	A ₆ B ₄
A ₁ B ₄		2.7422214	1.5029026	2.7127723	2.8937325	2.5140525
A ₂ B ₄			4.245124	0.02944814	0.15151109	0.22816895
A ₃ B ₄				4.2156749	4.3966351*	4.0169551
A ₄ B ₄					0.18096023	0.19871931
A ₅ B ₄						0.37968003
A ₆ B ₄						

* Significant at the 0.05 level

** Significant at the 0.01 level

Interpretation

ABC Interaction

The F Statistic for the ABC interaction is non-significant. There was therefore no significant interaction between the relative ratios (A), position of the target interval (B) and the reproduction of the whole series versus the target interval only (C).

Two-Factor Interaction Effects

AB interaction (see Figure 6) and AC interaction (see Figure 11) are significant at the 0.05 level, whereas the BC interaction (see Figure 18) is non-significant.

Simple Main Effects for AB Interaction

A at B₁ (see Figure 7)

The relative of ratio 1:2 produced the smallest error of reproduction and 3:2 produced the largest error, in the fourth position of the series.

B ₁ = 4th Position (smallest error)				B ₁ = 4th Position (largest error)			
Target				Target			
500	500	500	1000	1500	1500	1500	1000

A at B₂ (see Figure 8)

The ratio 1:2 produced the smallest error of reproduction and 3:1 produced the largest error with the target interval in the third position of the series.

(smallest error)				(largest error)			
Target				Target			
500	500	1000	500	3000	3000	1000	3000

A at B₃ (see Figure 9)

The F statistic for A at B₃ is significant. However Tukey's HSD test revealed non-significance on mean differences. Although the difference does not attain statistical significance on the Tukey's HSD test, we find the greatest difference between the ratio of 1:2 (most accurately reproduced) and 3:2 (least accurately reproduced) for the target in the second position.

	(smallest error)			
	Target			
A ₃ = 1:2	500	1000	500	500

	(largest error)			
	Target			
A ₆ = 3:2	1500	1000	1500	1500

A at B₄ (see Figure 10)

In the first position, the ratio 1:2 produced the smallest error of reproduction and the ratio 2:3 produced the largest error of reproduction.

	(smallest error)			
	Target			
A ₃ = 1:2	1000	500	500	500

	(largest error)			
	Target			
$A_5 = 2:3$	1000	667	667	667

B at A_1 (see Figure 12)

The F statistic for B at A_1 is significant. However, Tukey's HSD test revealed non-significance on all mean differences. Although the difference does not attain statistical significance on the Tukey's HSD test, we find the greatest difference between the first position (most accurately reproduced) and the third position (least accurately reproduced) for the 1:3 ratio.

	Ratio = 1:3			
	(smallest error)			
$B_4 = 1st\ Posn$	1000	333	333	333

	Ratio = 1:3			
	(largest error)			
$B_2 = 3rd\ Posn$	333	333	1000	333

B at A_5 (see Figure 16)

As is the case for B at A_1 , B at A_5 is significant on the F Statistic but non-significance was found on the Tukey's HSD test. Although the difference does not attain statistical significance on the Tukey's HSD test, we find the greatest difference between the fourth position (most accurately reproduced) and the first position (least accurately reproduced) for the 2:3 ratio.

Ratio = 2:3
(smallest error)

$B_1 = 4\text{th Posn}$ 667 667 667 1000

Ratio = 2:3
(largest error)

$B_4 = 1\text{st Posn}$ 1000 667 667 667

For B at A_2 , A_3 , A_4 , and A_6 (see Figures 13, 14, 15 and 17 respectively) no significant difference was found. The position of the target interval at these ratios does not make a difference.

Simple Main Effects for AC Interaction

A at C_1 and C_2 (see Figure 11)

The F statistic for both A at C_1 and C_2 is significant. However Tukey's HSD test revealed non-significance on all mean differences. Clearly however, the greatest difference is between the ratio 1:2 (most accurate reproduction) and 3:1 (least accurate reproduction) when reproducing the whole series.

C_1 Reproducing the Whole Series
(largest error) Target

$A_2 = 3:1$ 3000 3000 3000 1000

Irrespective of Position

(smallest error) Target

$A_3 = 1:2$ 500 500 500 1000

Irrespective of Position

And when reproducing the target interval only, the greatest

difference lies between the ratio 1:2 (most accurate reproduction) and 3:2 (least accurate reproduction).

C_2 Reproducing Target Interval Only

$A_3 = 1:2$ (500 - - - 1000 (smallest error)

Irrespective of Position

$A_6 = 3:2$ (1500) - - - 1000 (largest error)

Irrespective of Position

C at A_1 and A_6 (see Figure 11)

When subjects reproduced a series with both the ratios 1:3 and 3:2, their error of reproduction was most accurate when reproducing the whole series and least accurate when reproducing the target interval only.

	Ratio = 1:3				
				Target	
$C_1 = \text{Whole}$	333	333	333	1000	
					smallest error
	Ratio = 3:2				
				Target	
$C_1 = \text{Whole}$	1500	1500	1500	1000	
	Ratio = 1:3				
				Target	
$C_2 = \text{Target only}$	(333)	-	-	-	1000
					largest error
	Ratio = 3:2				
				Target	
$C_2 = \text{Target only}$	(1500)	-	-	-	1000
	Irrespective of Position				

For C at A_2 , A_3 , A_4 , and A_5 , (see Figure 11) no significant difference was found. It made no difference for the ratios 3:1, 1:2, 2:1 and 2:3, whether the whole series or target interval only was reproduced.

Summary

Table 16

The Relative Ratios at the
Target Interval Positions

	Smallest Error				Largest Error				
1:2	500	500	500	1000	1500	1500	1500	1000	3:2
1:2	500	500	1000	500	3000	3000	1000	3000	3:1
1:2	1000	500	500	500	1000	667	667	667	2:3

Table 17

Reproduction of the Whole Series
versus
Target Interval Only for the
Relative Ratios

	Smallest Error				Largest Error				
1:3	333	333	333	1000	(333) -	-	-	1000	1:3
3:2	1500	1500	1500	1000	(1500) -	-	-	1000	3:2
	C_1 = Whole Series				C_2 = Target Interval Only				
	Irrespective of Position				Irrespective of Position				

Most striking in these results is the fact that for the target interval in the first, third and fourth place, the simple ratio 1:2 is most accurately reproduced and the higher order ratios 2:3, 3:1, and 3:2 least accurately reproduced. This finding is clearly demonstrated in Figure 6.

Chapter 4

EXPERIMENT 2 : 3 000 MILLISECONDS

(For the primitive mind the concept of cycles) is the repetition of a fixed point in space, ... which constitutes a temporal event. It is ... the completion of the given cycle which is regarded as significant ...

Hinks (1939)

Experiment 2 with a temporal standard of 3 000 milliseconds was conducted to determine the effects of three independent factors, namely, relative ratios, the position of the target interval in the series and the reproduction of the whole series versus the target interval only, on the subjects' error of reproduction.

Table 18
 Identification of Factors and Levels
 Experiment 2

Factors and Levels	Intervals in Series in Milliseconds			
A = Relative Ratios				
A ₁ = 1:3	1000	1000	1000	3000
A ₂ = 3:1	9000	9000	9000	3000
A ₃ = 1:2	1500	1500	1500	3000
A ₄ = 2:1	6000	6000	6000	3000
A ₅ = 2:3	2000	2000	2000	3000
A ₆ = 3:2	4500	4500	4500	3000
B = Position of Target Interval in the Series				
B ₁ = Fourth Position	1000	1000	1000	3000
B ₂ = Third Position	1000	1000	3000	1000
B ₃ = Second Position	1000	3000	1000	1000
B ₄ = First Position	3000	1000	1000	1000
C = Reproduction of Whole Series or Target Interval Only				
C ₁ = Whole Series	1000	1000	1000	3000
C ₂ = Target Interval Only	-	-	-	3000

Results

Table 19

Cell Means and Standard Deviations

		C ₁				C ₂				
		B ₁	B ₂	B ₃	B ₄	B ₁	B ₂	B ₃	B ₄	Mean
A ₁	\bar{X}	11.069231	11.223189	10.159438	12.267424	7.5398716	8.5540544	10.467627	8.8669243	10.018469
	SD	3.3142674	2.6362115	4.3578001	4.0000752	3.6442882	3.5143489	3.9517073	2.7592487	
A ₂	\bar{X}	11.029726	10.546995	9.3259857	8.9964913	12.414736	10.601008	10.207865	10.734612	10.482177
	SD	2.3870073	2.6404056	1.7931	1.3309577	1.7460226	3.432058	2.992818	3.6650609	
A ₃	\bar{X}	9.2704833	9.0417482	10.187711	11.294224	9.6037685	8.5082711	9.9810016	11.527589	9.9269743
	SD	2.1500952	2.2759659	1.9999128	3.7534074	1.8378641	2.5053908	2.9213381	1.7259197	
A ₄	\bar{X}	11.350157	8.7158124	9.8446521	8.9100496	9.6917179	9.3551345	9.3944148	11.154023	9.8019947
	SD	2.6651562	2.1697939	2.1701583	2.2542669	3.3304986	0.77077025	1.936719	1.8296277	
A ₅	\bar{X}	10.646785	11.079176	11.570382	11.951866	9.8606561	9.3142239	9.5332887	12.153185	10.763695
	SD	2.4342871	1.9102624	2.1561807	2.3771747	2.4968368	3.0200423	2.9957421	1.6363405	
A ₆	\bar{X}	10.402563	10.201856	9.5425146	10.858289	9.356007	10.474773	10.294698	13.345852	10.559569
	SD	1.8443682	2.0315649	2.8237163	1.5263936	3.7719479	3.0647132	3.5945804	3.094769	
		10.628157	10.134796	10.105113	10.713057	9.7444591	9.4679105	9.9798155	11.29703	10.258813

Table 20
Ratio (A_i) - Position (B_i) Means

	B_1	B_2	B_3	B_4	
A_1	9.3045512	9.8886217	10.313532	10.567174	10.018469
A_2	11.722231	10.574002	9.7669253	9.8655516	10.482177
A_3	9.4371258	8.7750096	10.084356	11.410906	9.9268494
A_4	10.520937	9.0354735	9.6195334	10.032036	9.8019949
A_5	10.253721	10.1967	10.551835	12.052526	10.763695
A_6	9.879285	10.338315	9.9186063	12.10207	10.559569

Table 21
Position (B_i) - Whole or Single Reproduction (C_i)
Means

	C_1	C_2	
B_1	10.628157	9.7444593	10.186308
B_2	10.134796	9.4679108	9.8013532
B_3	10.105114	9.9798157	10.042464
B_4	10.713057	11.297031	11.005044

Table 22
Ratio (A_i) - Whole or Single Reproduction (C_i)
Means

	A_1	A_2	A_3	A_4	A_5	A_6	
C_1	11.17982	9.9747994	9.9485415	9.7051677	11.312052	10.251306	10.39528
C_2	8.8571193	10.989555	9.9051574	9.8988224	10.215338	10.867832	10.122303

The Subjects'
Percentage
Error of
Reproduction

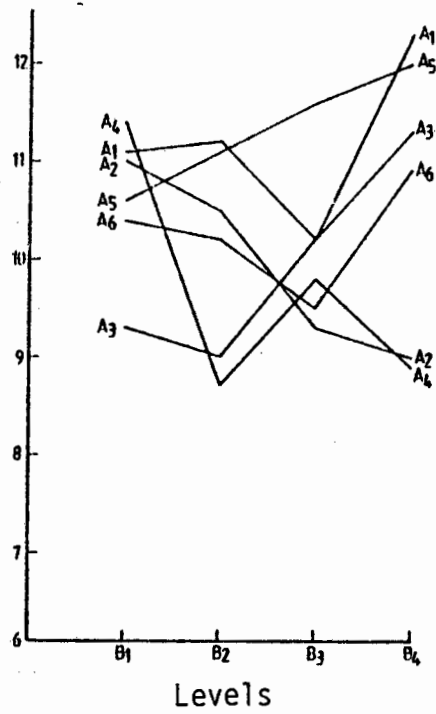


Figure 19

The Ratios (A_i) at the Positions (B_i)
for the Whole Series (C_1)

The Subjects'
Percentage
Error of
Reproduction

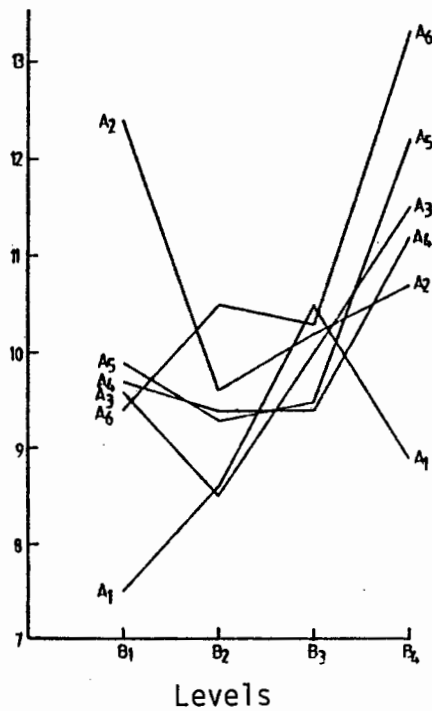


Figure 20

The Ratios (A_i) at the Positions (B_i)
for the Target Interval Only (C_2)

The Subjects'
Percentage
Error of
Reproduction

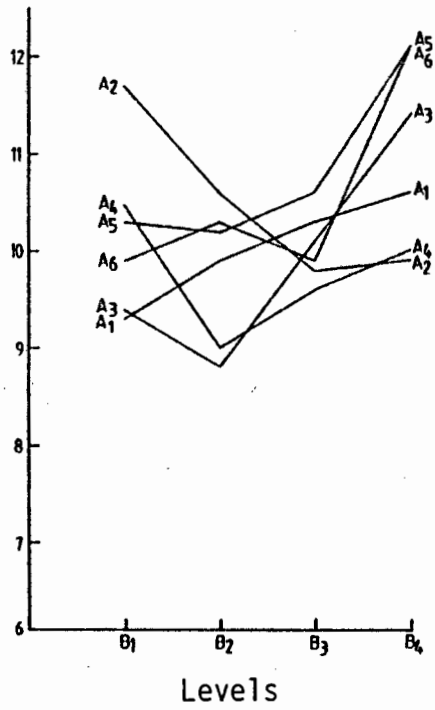


Figure 21

The Ratios (A_i) at the Positions (B_i)

The Subjects'
Percentage
Error of
Reproduction

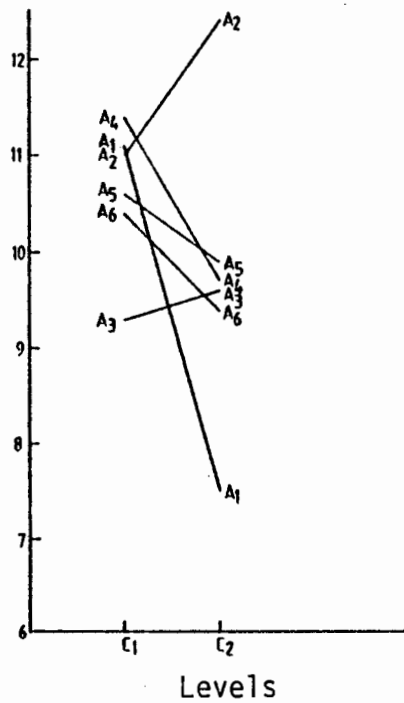


Figure 22

The Ratios (A_i) at the Whole and Single Reproduction (C_i)
for the Fourth Position (B_i)

The Subjects' Percentage Error of Reproduction

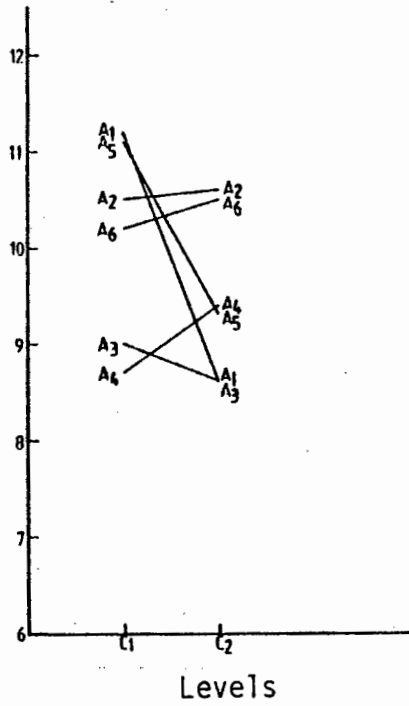


Figure 23

The Ratios (A_i) at the Whole and Single Reproduction (C_i) for the Third Position (B_2)

The Subjects' Percentage Error of Reproduction

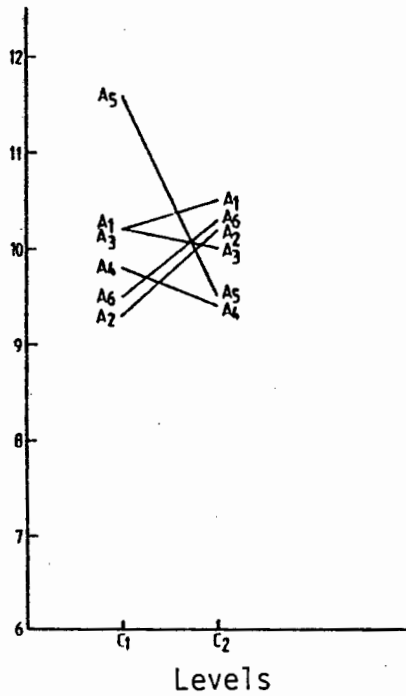


Figure 24

The Ratios (A_i) at the Whole and Single Reproduction (C_i) for the Second Position (B_3)

The Subjects'
Percentage
Error of
Reproduction

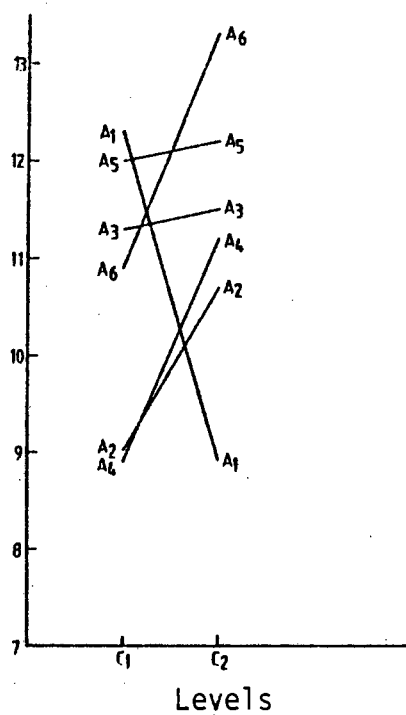


Figure 25

The Ratios (A_i) at the Whole and Single Reproduction (C_i)
for the First Position (B_4)

The Subjects'
Percentage
Error of
Reproduction

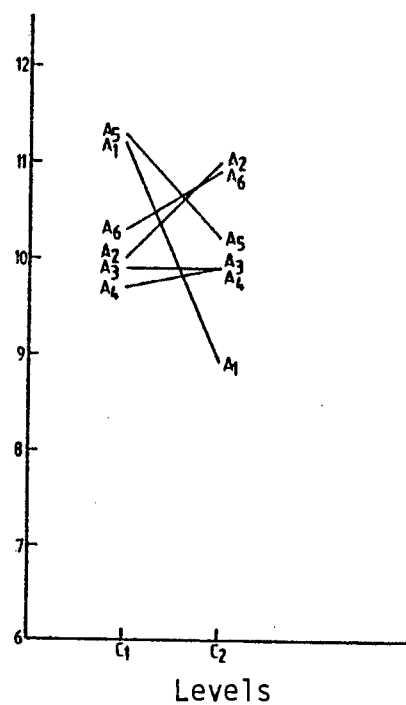


Figure 26

The Ratios (A_i) at the Whole and Single Reproduction (C_i)

The Subjects'
Percentage
Error of
Reproduction

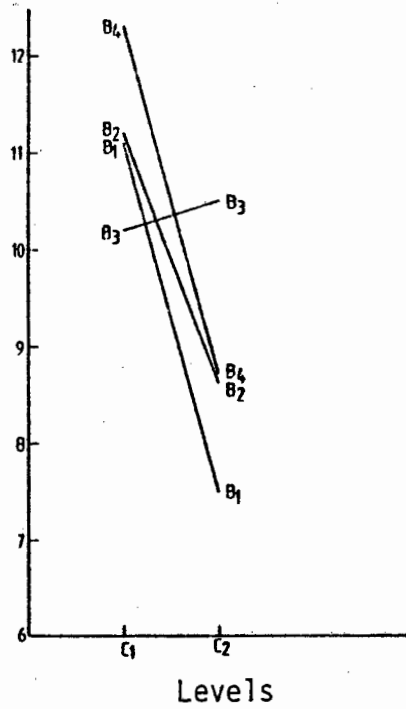


Figure 27

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 1:3 (A_1)

The Subjects'
Percentage
Error of
Reproduction

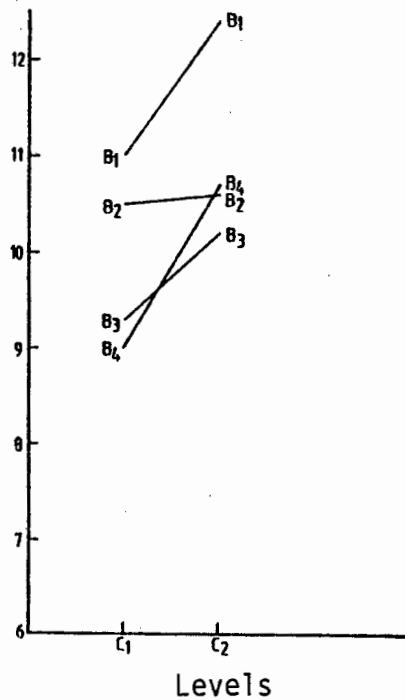


Figure 28

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 3:1 (A_2)

The Subjects'
Percentage
Error of
Reproduction

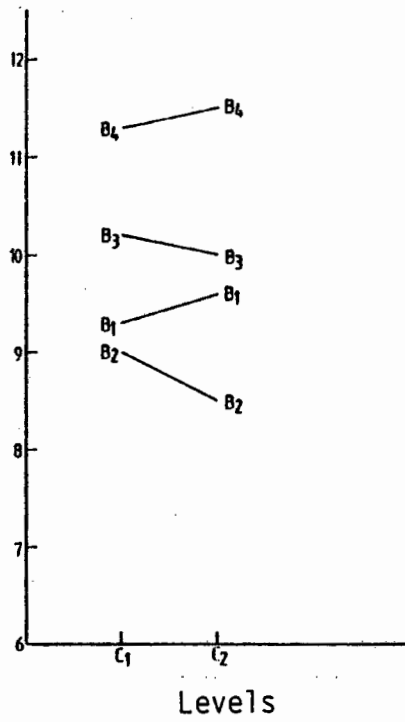


Figure 29

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 1:2 (A_3)

The Subjects'
Percentage
Error of
Reproduction

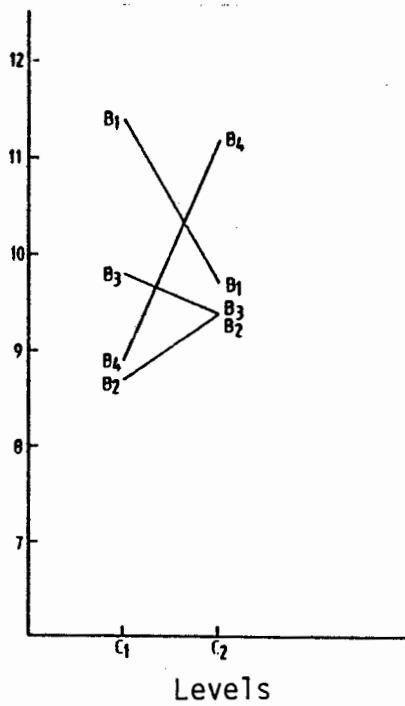


Figure 30

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 2:1 (A_4)

The Subjects'
Percentage
Error of
Reproduction

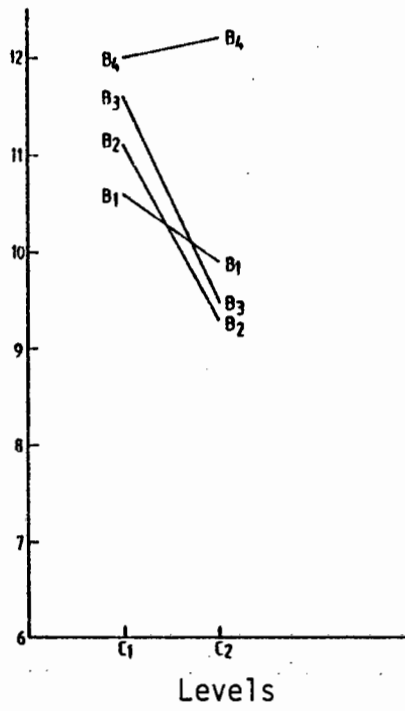


Figure 31

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 2:3 (A_5)

The Subjects'
Percentage
Error of
Reproduction

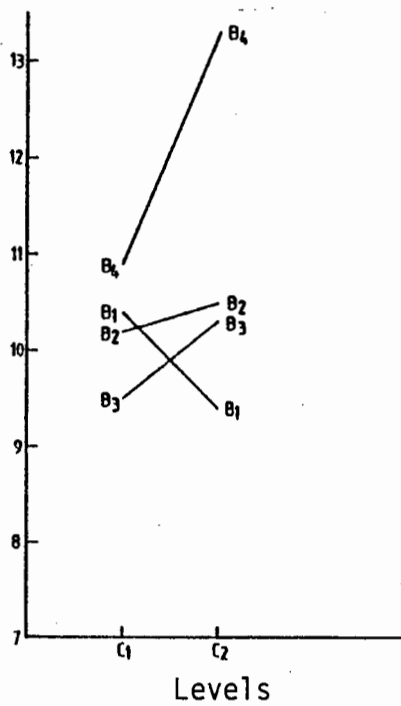


Figure 32

The Positions (B_i) at the Whole and Single Reproduction (C_i)
for the Ratio 3:2 (A_6)

The Subjects'
Percentage
Error of
Reproduction

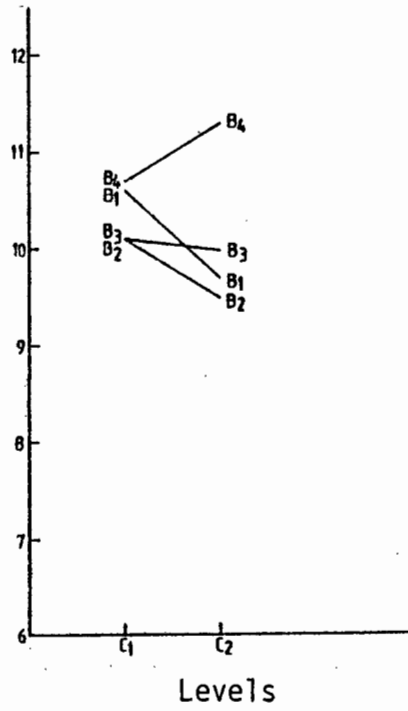


Figure 33

The Positions (B_i) at the Whole and Single Reproduction (C_i)

Table 23
Anova Summary Table

Source	SS	DF	MS	F Ratio
<u>Between Subj</u>				
A	49.408691	5	9.8817382	0.35036514
Subj. W.G.	1184.5728	42	28.204113	
<u>Within Subj</u>				
B	78.553223	3	26.184407	7.4173408
AB	144.27002	15	9.6180012	2.7245219**
BX SWG	444.80029	126	3.5301611	
C	7.1567383	1	7.1567383	0.79536267
AC	121.59473	5	24.318945	2.7026811*
CX SWG	377.91943	42	8.9980817	
BC	30.82189	3	10.273763	2.6349952
ABC	87.208984	15	5.8139322	1.4911463
BX SWG	491.27002	126	3.8989684	

Check on Homogeneity of Error Terms

F max (Subj. W.G.)	=	6.2931803	DF =	6,7
F max (BX SWG)	=	2.4821601	DF =	6,21
F max (CX SWG)	=	5.0187448	DF =	6,7
F max (BCX SWG)	=	2.1869046	DF =	6,21

* Significant at the 0.05 level

** Significant at the 0.01 level

Table 24
Simple Main Effects

Source	SS	DF	MS	F Ratio
A at B ₁	62.538208	5	12.507642	1.2896272
A at B ₂	43.027344	5	8.6054688	0.8872753
A at B ₃	9.6777344	5	1.9355469	0.19956871
A at B ₄	78.437622	5	15.687524	1.6174958
Error	717.70003	74	9.698649	
A at C ₁	74.54126	5	14.908252	0.80147164
A at C ₂	96.462402	5	19.29248	1.0371689
Error	1227.6724	66	18.601097	
B at A ₁	14.63501	3	4.8783365	1.381902
B at A ₂	39.007935	3	13.002645	3.6833007*
B at A ₃	60.700928	3	20.233643	5.7316484**
B at A ₄	19.050598	3	6.3501993	1.7988412
B at A ₅	36.600647	3	12.200216	3.455994*
B at A ₆	52.830322	3	17.610107	4.9884713**
Error	444.8003	126	3.5301611	
C at A ₁	86.319153	1	86.319153	9.5930617**
C at A ₂	16.475891	1	16.475891	1.8310448
C at A ₃	0.03027344	1	0.03027344	0.00336443
C at A ₄	0.60021973	1	0.60021973	0.0667053
C at A ₅	19.244629	1	19.244629	2.138748
C at A ₆	6.0818481	1	6.0818481	0.67590497
Error	377.91943	42	8.9980817	

* Significant at the 0.05 level

** Significant at the 0.01 level

Table 25
Significant Simple Main Effects on which
Tukey's HSD was Non-significant

B	at	A_2
B	at	A_5
B	at	A_6

Tukey's HSD Summary Tables

Table 26: B at A_3

	B_1A_3	B_2A_3	B_3A_3	B_4A_3
B_1A_3		0.99674009	0.97433089	2.9713
B_2A_3			1.971071	3.9680401*
B_3A_3				1.9969692
B_4A_3				

* Significant at the 0.05 level

The following simple main effect was significant, but because there are only two levels of the Factor, there is obviously no need to perform the Tukey's HSD Test.

For C at A_1 , compare $\bar{X}_{C_1A_1}$ and $\bar{X}_{C_2A_1}$

Table 27: C at A_1

	$\bar{X}_{C_1A_1}$	$\bar{X}_{C_2A_1}$
	11.17982	8.8571193

Interpretation

ABC Interaction

The F Statistic for ABC interaction is non-significant. There was therefore no significant interaction between the relative ratios (A), position of the target interval (B) and the reproduction of the whole series versus the target interval only (C).

Two-Factor Interaction Effects

On examining the two-factor interaction effects it is found that AB interaction (see Figure 21) is significant at the 0.01 level and AC interaction (see Figure 26) is significant at the 0.05 level. BC interaction (see Figure 33) is non-significant.

Simple Main Effects for AB Interaction

B at A_2 (see Figure 28)

The F Statistic for B at A_2 is significant. However Tukey's HSD test revealed non-significance. Although the difference does not attain statistical significance on the Tukey's HSD test, we find the greatest difference between second position (most accurately reproduced) and the fourth position (least accurately reproduced) for the 1:3 ratio.

	Ratio = 3:1 (smallest error)			
$B_3 = 2\text{nd Posn}$	9000	3000	9000	9000

	Ratio = 3:1 (largest error)			
$B_1 = 4\text{th Posn}$	9000	9000	9000	3000

B at A_3 (see Figure 29)

The third position produced the smallest error and the first position produced the largest error of reproduction, for the ratio 1:2.

	Ratio = 1:2 (smallest error)			
$B_2 = 3\text{rd Posn}$	1500	1500	3000	1500

	Ratio = 1:2 (largest error)			
$B_4 = 1\text{st Posn}$	3000	2000	2000	2000

B at A_6 (see Figure 32)

Though the F Statistic for B at A_6 was significant, the Tukey's HSD test revealed non-significance on all mean differences. Clearly however, the greatest difference lies between the fourth position (most accurate reproduction) and the first position (least accurate reproduction) for the 3:2 ratio.

		Ratio = 3:2		
		(smallest error)		
$B_1 = 4\text{th Posn}$	4500	4500	4500	3000
		Ratio = 3:2		
		(largest error)		
$B_4 = 1\text{st Posn}$	3000	4500	4500	4500

For B at A_1 and A_4 (see Figures 27 and 30), no significant difference was found. The position of the target interval at these ratios does not make a difference.

Simple Main Effects for AC Interaction

A at C_1 and C_2 (see Figure 26)

No significant difference was found between the levels of A at C_1 and C_2 . When the whole series or the target interval only were reproduced, there was no difference between the ratios 1:3, 3:1, 1:2, 2:1, 2:3 and 3:2.

C at A_1 (see Figure 26)

When subjects reproduced a series with the ratio 1:3, their reproduction was most accurate when reproducing the target interval only and least accurate when reproducing the whole series. It is interesting to note that in the report of the subjective time experience in the post experimental interview, subjects indicated that they experienced greater difficulty when reproducing the entire series, versus the target interval only.

Ratio 1:3
(smallest error)

	Target
$C_2 =$ Target only (1000) - - -	3000
Irrespective of Position	

Ratio = 1:3
(largest error)

	Target
$C_1 =$ Whole 1000 1000 1000	3000
Irrespective of Position	

For C at A_2 , A_3 , A_4 , A_5 and A_6 (see Figure 26) no significant difference was found. It made no difference for the ratios 3:1, 1:2, 2:1, 2:3, and 3:2 whether the whole series or target interval only was reproduced.

Summary

Table 28

The Target Interval Positions
for the Relative Ratios

	1st Posn	2nd Posn	3rd Posn	4th Posn
Ratio = 1:2	1500	1500	3000	1500
	3000	1500	1500	1500
	↓ largest error		▲ smallest error	

Table 29
The Relative Ratios for the Reproduction
of the Whole Series versus the
Target Interval Only

Largest Error					Smallest Error					
Whole Series					Target Interval Only					
1:3	1000	1000	1000	3000	(1000)	-	-	-	3000	1:3
Irrespective of Position					Irrespective of Position					

Most striking in the results of this experiment is the fact that reproduction of the target interval only was most accurate for the ratio 1:3, and the reproduction of the whole series was the least accurate. This is opposite to the finding in Experiment 1: 1 000ms. This finding is clearly demonstrated in Figure 26.

Chapter 5

CONCLUSIONS

The greatest value of a picture is when it forces us to notice what we never expected to see.

Tukey (1977)

Whilst acknowledging that nature is complex, it is difficult nevertheless not to feel a stab of disappointment when the results of research projects do not reveal an unambiguously clear picture. It would be satisfying to be able to specify precisely the effects of the factors under study in these experiments and to make completely valid generalizations about the effect of patterning on the reproduction of a series of 4 time intervals. Such a clear-cut picture however has not emerged, and in shedding some light on the research question, more new questions have been raised.

What are the main conclusions to be drawn from this study? Perhaps the most important finding lies in the discrepancies in the results of the two experiments: - the results obtained with a target interval of 1 000ms are not the same as those with a 3 000ms target interval. Whether this difference would disappear on further more extensive investigation is a question that can only be answered by further research. In the absence at present of such further research, the findings must be taken at face value. Three

major findings can be identified.

1. Comparing Tables 7 and 22 it is seen that the overall accuracy of reproduction of the 1 000ms target is greater (by about 9%) than that of the 3 000ms target. Unfortunately the already complex design of these experiments did not permit a statistical comparison of these findings. This preliminary observation suggests however that the next step in the research should be an examination of the effects of the length of the target interval as a manipulated independent variable.

2. Again comparing Tables 7 and 22 it is seen that the effects of reproducing the whole series versus the target interval only are exactly reversed in the two experiments. For the 1 000ms target greatest accuracy is achieved with the reproduction of the whole series; for the 3 000ms target the accuracy is greatest with the reproduction of the target interval only. This raises an extremely interesting question which has not appeared before in the literature comparing the different methods of time perception. Is there a continuum here in which the same pattern of results would be found for all target intervals above and below a certain value? If so, the similarity between this situation and that of the indifference interval is striking. Only further research can establish whether or not this is indeed the case.

3. Most strikingly, as already laid out in detail in the previous two chapters, the effects of the different

ratios are not the same for the two target intervals. Inspection of the graphs (Figures 4, 5, 19 and 20) gives a vivid impression of the way in which the effects of the relative ratios are more clear-cut and substantial with the 1 000ms than with the 3 000ms target interval. Figures 19 and 20 show a predominant concentration of points and Figures 4 and 5 show a much wider spread and differentiation of lines, the highly significant greater accuracy with the ratio 1:2, already referred to, being only one aspect (albeit the most striking) of this picture.

Each of the above findings needs to be replicated and extended using more ratios, different length series and a wider range of target intervals, but an immediate implication would seem to be in respect of the generality of Oxtoby's theory of time perception (1971). Perhaps only relatively "short" time intervals are capable of generating the brain rhythms referred to in that theory, and that only in that case does this exogenous factor exert such a powerfully determining effect. Where longer time intervals are involved perhaps the internal clock has to rely only on endogenous rhythms, and so the effects of patterning of stimuli are reduced.

Although the interpretation is tenuous, some support for this idea might be found in the data reflected graphically in Figure 4. For the target interval in the third (B_2) and fourth place (B_1), it is very clear that greatest accuracy is achieved for A_1 , A_3 and A_5 , i.e. for the series

in which the "other" intervals were all shorter than the target. This is a little less true for the target interval in second place (B_3), and a little less again for the target in first place (B_4). Significantly it is only the "complex" ratio of 2:3 (A_5) and the "simple" ratio of 2:1 (A_4) which mark the pattern in the first (B_4) and second positions (B_3). This would suggest perhaps that greater accuracy is achieved where the "other" intervals are shorter than the target. This idea was examined more rigorously by doing a set of Scheffé comparisons as tabled below.

Table 30

Comparison of Series in which "Other" Intervals are
Shorter than the Target (A_1 , A_3 and A_5) with
those in which they are Longer than
the Target (A_2 , A_4 and A_6)

Experiment 1

Ratios Compared	at	Scheffé F
$A_1 A_3 A_5$ versus $A_2 A_4 A_6$	B_1	1.5869319
$A_1 A_3 A_5$ versus $A_2 A_4 A_6$	B_2	0.70594523
$A_1 A_3 A_5$ versus $A_2 A_4 A_6$	B_3	0.61209064
$A_1 A_3 A_5$ versus $A_2 A_4 A_6$	B_4	1.4317046
$A_1 A_3$ versus $A_2 A_4 A_6$	B_1	1.5927086
$A_1 A_3$ versus $A_2 A_4 A_6$	B_2	0.96542214
$A_1 A_3$ versus $A_2 A_4 A_6$	B_3	0.89846835
$A_1 A_3$ versus $A_2 A_4 A_6$	B_4	2.7664184*
A_3 versus $A_2 A_4 A_6$	B_1	1.7699164
A_3 versus $A_2 A_4 A_6$	B_2	2.188099
A_3 versus $A_2 A_4 A_6$	B_3	1.1130047
A_3 versus $A_2 A_4 A_6$	B_4	2.5756054*

* Significant at the 0.05 level (F crit = 2.27)

Again these results are somewhat disappointing, although the failure to find statistical significance may be due to small sample size and large variability. Because it is uncorroborated by statistical evidence the finding is no more than suggestive but would seem to merit further research. The facts are that the ratio of 1:2 yielded the greatest accuracy of reproduction for all the positions of

the target interval in the series in Experiment 1: the ratio 1:3 yielded the next greatest accuracy and with 2:3 the results were less clear-but. Experiment 2 yielded no such clear-cut results. The fact that the greater accuracy is achieved with the shorter target interval, and that for this shorter target interval greater accuracy is achieved with "other" intervals less than the 1 000ms target as compared with those cases in which they were longer than the 1 000ms target, suggests a simple conclusion: "the shorter the target interval in a series and the shorter the other intervals surrounding it, the greater the accuracy of reproduction of the target interval". The fact however that the greatest accuracy in Experiment 1 was not obtained with the shorter "other" intervals (333ms) but with the simplest ratio (1:2) and the fact that (again in Experiment 1) in most cases greatest accuracy was obtained where the "other" intervals are shorter than the target, suggests that such a simple conclusion is probably faulty. There seems to be three factors here: absolute length of the intervals involved, the question of whether the "other" intervals are longer or shorter than the target, and the relative complexity of the ratios of the target to the "other" intervals. Elucidating the relationships between these factors is going to require much further research, and whilst confirmation of Oxtoby's theory (1971) seems if anything further off than before, it is at least showing its value in opening relevant questions in regard to how time is perceived.

Suggestions for Further Research

1. In addition to the aspects already mentioned it would also be interesting to explore how "empty", embedded ratio intervals, relate to the alpha brain wave. Electroencephalograms could be recorded as subjects simultaneously reproduce various temporal series. The investigator could examine whether differential judgement errors result when the external stimuli demarcating the "empty" intervals, are or are not in phase with the alpha wave.

2. Further research could profitably explore the aspects of physiological functioning, intelligence and their relationships to multi-interval patterned series.

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APPENDIX A

Hypothesis 1: The duration of a time-interval is estimated by counting the number of cycles of a reference rhythm.

Hypothesis 2: The alpha or other endogenous rhythm provides such a constant internal reference rhythm.

Hypothesis 3: (a) When incoming stimuli (S_1, S_2) are separated by a time-interval, T_i (the duration of T_i lying between certain critical maximum and minimum values), they set up a reference rhythm (R_r) with frequency $\frac{1}{T_i + \delta T_i}$ and variance $\sigma_{T_i}^2$, which supersedes the endogenous rhythm as a standard in terms of which the durations of time-intervals between subsequent stimuli are judged. σ_{T_i} may be positive negative or equal to zero, and is a measure of the precision with which the internal rhythm mirrors the occurrence of the external events S_1 and S_2 .

(b) By appropriate instructions, as given in the method of reproduction, the reference rhythm R_r may be converted into a rhythmic "tendency to response" (A_i) with frequency $\frac{1}{T_i + (\delta T_i + \theta_1)}$ and variance $\sigma_{T_i}^2$, the difference between $\sigma_{T_i}^2$ and $\sigma_{T_i}^2$ being determined by the magnitude of θ_1 . θ_1 reflects an increase in δT_i as a result of the involvement of a larger neuronal network. (As in the case of δT_i , $\theta_1 \geq 0$).

Hypothesis 4: (a) The greater the number of stimuli which follow each other at equal intervals, the more firmly will R_r be established and the more accurately will the duration of subsequent intervals be perceived. Occurrences of S_i ($i > 2$) after S_2 with the same interval T_i between the S_i "reinforce" R_r , reducing $\sigma_{T_i}^2$ (the variance in the time intervals $T_i + \delta T_i$ of R_r) thus making R_r a more stable standard in terms of which the subsequent intervals are perceived.

(b) A time-interval $T_s = T_i$, following a series of $n S_i$ ($n > 2$) in which all T_i 's are equal, will be reproduced as the time-interval $T_R = T_i + (\delta T_i + \theta_1 + \theta_2)$. The reproduction of this interval involves merely the conversion of two of the "tendencies to response", A_i , into overt motor responses, θ_2 representing the possible distortion of the perceived interval by the motor response mechanism. θ_2 may be positive or negative but almost certainly does not equal 0, and is at least partially a function of the length of T_i .

(c) The reproduction of a series of m equal intervals $T_s = T_i$ involves the conversion of $(m + 1)$ A_i 's into overt motor responses. For a given $T_s = T_i$, $\left| \left[T_i + (\delta T_i + \theta_1 + \theta_2) \right] - T_s \right|$ (the absolute error of reproduction) will approach a minimum as m increases up to a certain point (reflecting the reinforcement of R_r), but as m increases beyond this point $\left| \left[T_i + (\delta T_i + \theta_1 + \theta_2) \right] - T_s \right|$ will again increase (reflecting the effect of reactive inhibition).

Hypothesis 5: The reproduction of an interval $T_m = nT_i$ after a series of intervals T_i has established R_r (with the time-interval between the $A_i = T_i + \delta T_i$) requires the inhibition of $(n - 1)$ of the A_i . The inhibition of the A_i will exercise a disrupting effect on the reproduced interval T_m , the extent of such disruption being a function of

- (a) n ,
- (b) the duration of T_m and
- (c) certain physiological characteristics of the subject, related to the rate of build-up and dissipation of inhibition.

Hypothesis 6: The perception of an interval $T_I = nT_i + \Delta T_i$ ($\Delta T_i < T_i$) after a series of intervals T_i has established R_r with frequency $\frac{1}{T_i + \delta T_i}$, involves the counting of n of the intervals T_i plus the estimate of ΔT_i . ΔT_i is probably estimated in terms of the number of cycles of the endogenous rhythm, or possibly by fractionation of T_i . The reproduction of T_I then involves the inhibition of $(n - 1)$ of the A_i and the displacement of the last A_i by a "correction interval", the length of the correction interval being determined by S's estimate of ΔT_i .

APPENDIX B

Calculation for the Power of Experiments 1 and 2(Kirk, 1968:110)

The calculation of the power of an F Test in analysis of variance provides a basis for deciding on the number of subjects that should be included in an experiment.

If an accurate estimate of σ_{ξ} is not available from previous research or from a pilot study, a procedure that does not require a knowledge of σ_{ξ} can be used.

An experimenter can determine the size of n necessary to achieve a given power if the largest difference among means is equal to $C\sigma_{\xi}$, where C is any number greater than zero.

If an experimenter computes the sample size necessary to achieve a given power for treatment effects, he can be certain that any other combination of effects for which the maximum is $C\sigma_{\xi}$ will yield a power greater than specified. The formula for computing n when the size of treatment effects is expressed in units of σ_{ξ} can be written as follows: $\sqrt{n} \sqrt{C^2/2k}$

Experiments 1 and 2, each contain twelve treatment levels and the investigator is interested in detecting differences among means such that the largest difference is equal to $1\sigma_{\xi}$. If C , α , $1-\beta$, and V_1 are specified as 1, .05, .80, and 11, respectively, the value of n can be estimated by

trial and error from the formula.

This procedure for computing n does not require a priori information concerning the size of σ_{ξ} . $C = 1$,
 $k = 12$, $n = 48$.

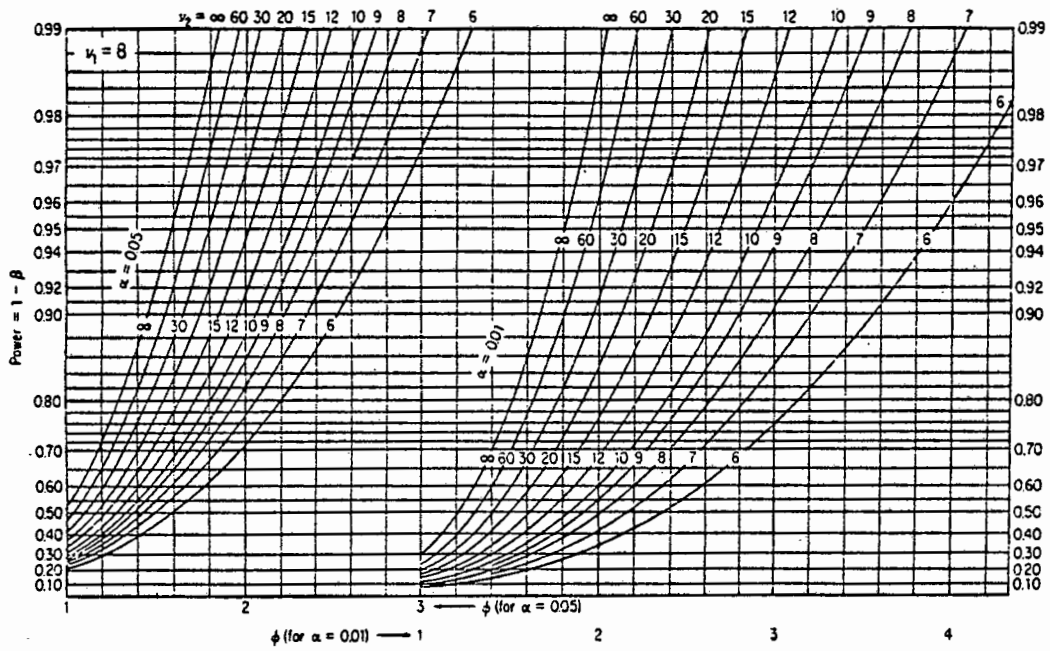


Figure A

Critical values to determine
the power of the F test

APPENDIX C

Experimental Instructions

This is a time perception experiment that will test your objective judgement in estimating various intervals of time.

To begin with you will be given six very short training trials to acquaint you with the experiment.

Firstly, this is the experimental chair in which you will be seated. Would you like to seat yourself? Remove your watch and place it out of sight. Fit the wrist strap firmly onto your left arm if you are right handed (and onto your right arm if you are left handed).

The set of headphones will be fitted over your ears. You will hear sound pulses coming through them. On your right just below the seat you will notice a copper plate. You will be required to tap this plate a number of times (if you are left handed you will use the left plate).

Tap the plate with the finger you prefer and make sure you do not tap with your nails. The number of taps you will tap out on the plate will be an accurate reproduction of the sound pulses (clicks) you hear through the headphones.

You will be asked to reproduce all (\emptyset convention) or one of the time intervals only (1, 2, 3 or 4) at a time. The digit dial on the wall in front of you, will indicate

which of these you will tap out:

e.g. 1 = 1st and 2nd pips (1st interval)

3 = 3rd and 4th pips (3rd interval)

Secondly, let us consider the training trials now.

You are going to hear four empty time intervals bounded by 50ms sound pips. In other words a succession of 5 sound pips with four empty time intervals between them. After hearing these four intervals or 5 sound pips, you tap out what you have heard as accurately as possible on the copper tapping plate. Any questions? Now put the headphones on and await the series. When you have heard the series reproduce it by tapping the copper plate. You will hear the series and tap it out, hear it again and tap it out and hear it once more and tap it out.

Series no. 299: 999 300 300 300 900

Right, that is the end of the first three training trials. Now for the next three trials you will again hear a series of four intervals or 5 sound pips, but this time you will only reproduce the first interval or first two sound pips you hear. Any questions? Now put the headphones on and await the series. When you have heard the series reproduce the first interval or the first two pips by tapping the copper plate. You will hear the series and tap out the 1st interval. This will happen two more times.

Series no. 300: 999 900 300 300 300

This order is followed when you as the subject reproduce SINGLE series first and the WHOLE series afterwards

(you will be given the print out).

Thirdly, paragraphs 1 and 2 are reversed under the second point, where the subject begins reproducing the whole series first and the single series afterwards.

Fourthly, we are now ready to begin Experiments 1 and 2. You will be hearing and reproducing 16 series within the next 15 to 20 minutes. Each series will be reproduced three times.

Are you ready?

Stand by ...

Begin ...

APPENDIX D

Table A
Numbered Randomized Series for Subjects 1-8

S 1:	312(120)*	309(150)*	311(130)*	310(140)*	309	310	311	312
S 1:	339	340	338	337	338(140)	339(130)	340(120)	337(150)
S 2:	312(120)	311(130)	309(150)	310(140)	309	310	312	311
S 2:	337(150)	339(130)	340(120)	338(140)	337	338	339	340
S 3:	311(130)	312(120)	309(150)	310(140)	339	338	340	337
S 3:	339(130)	338(140)	337(150)	340(120)	310	311	309	312
S 4:	338	340	337	339	338(140)	340(120)	337(150)	339(130)
S 4:	309(150)	310(140)	312(120)	311(130)	309	311	312	310
S 5:	338(140)	337(150)	339(130)	340(120)	310	311	312	309
S 5:	337	339	340	338	311(130)	309(150)	310(140)	312(120)
S 6:	310	309	312	311	337(150)	338(140)	340(120)	339(130)
S 6:	337	340	338	339	310(140)	311(130)	312(120)	309(150)
S 7:	339(130)	338(140)	340(120)	337(150)	309	310	312	311
S 7:	312(120)	311(130)	309(150)	310(140)	340	338	339	337
S 8:	312	310	309	311	311(130)	312(120)	309(150)	310(140)
S 8:	337	338	339	340	337(150)	339(130)	340(120)	338(140)

Numbered Randomized Series for Subjects 9-16

S 9:	313	314	315	316	333	334	336	335
S 9:	335(130)	336(120)	334(140)	333(150)	315(130)	313(150)	314(140)	316(120)
S10:	314(140)	315(130)	316(120)	313(150)	313	314	316	315
S10:	336	333	334	335	334(140)	333(150)	335(130)	336(120)
S11:	334	335	333	336	316(120)	313(150)	315(130)	314(140)
S11:	315	313	316	314	335(130)	334(140)	333(150)	336(120)
S12:	336	334	335	333	316	313	314	315
S12:	335(130)	336(120)	334(140)	333(150)	315(130)	313(150)	314(140)	316(120)
S13:	335	336	334	333	334(140)	336(120)	333(150)	335(130)
S13:	314	313	315	316	316(120)	313(150)	314(140)	315(130)
S14:	336	335	333	334	313	315	316	314
S14:	316(120)	315(130)	314(140)	313(150)	335(130)	336(120)	333(150)	334(140)
S15:	335	334	333	336	315(130)	316(120)	314(140)	313(150)
S15:	335(130)	334(140)	333(150)	336(120)	315	314	313	316
S16:	335	333	334	336	333(150)	335(130)	336(120)	334(140)
S16:	313	315	316	314	314(140)	315(130)	316(120)	313(150)

Table A (continued)
Numbered Randomized Series for Subjects 17-24

S17:	303	304	302	301	301(150)	302(140)	303(130)	304(120)
S17:	329(150)	330(140)	331(130)	332(120)	331	329	330	332
S18:	303(130)	302(140)	301(150)	304(120)	331(130)	330(140)	329(150)	332(120)
S18:	303	304	302	301	330	332	329	331
S19:	331(130)	332(120)	330(140)	329(150)	303(130)	304(120)	302(140)	301(150)
S19:	330	329	331	332	302	304	303	301
S20:	302	303	301	304	301(150)	304(120)	302(140)	303(130)
S20:	330(140)	329(150)	332(120)	331(130)	329	330	331	332
S21:	304(120)	303(130)	302(140)	301(150)	331	332	330	329
S21:	302	303	301	304	329(150)	332(120)	330(140)	331(130)
S22:	302	304	301	303	303(130)	301(150)	302(140)	304(120)
S22:	331	332	330	329	331(130)	329(150)	330(140)	332(120)
S23:	302	301	303	304	331	329	330	332
S23:	303(130)	304(120)	302(140)	301(150)	332(120)	329(150)	330(140)	331(130)
S24:	332(120)	331(130)	330(140)	329(150)	302(140)	304(120)	301(150)	303(130)
S24:	301	302	304	303	331	330	332	329

Numbered Randomized Series for Subjects 25-32

S25:	327(130)	325(150)	326(140)	328(120)	308	305	306	307
S25:	306(140)	307(130)	308(120)	305(150)	328	327	326	325
S26:	328	325	327	326	308(120)	307(130)	306(140)	305(150)
S26:	306	305	308	307	328(120)	325(150)	326(140)	327(130)
S27:	306(140)	305(150)	308(120)	307(130)	306	307	305	308
S27:	328(120)	327(130)	326(140)	325(150)	327	325	326	328
S28:	305	307	308	306	327(130)	328(120)	326(140)	325(150)
S28:	325	328	327	326	307(130)	306(140)	308(120)	305(150)
S29:	308	307	306	305	328	327	325	326
S29:	326(140)	328(120)	325(150)	327(130)	308(120)	307(130)	305(150)	306(140)
S30:	326	327	328	325	306	307	308	305
S30:	325(150)	327(130)	326(140)	328(120)	305(150)	306(140)	308(120)	307(130)
S31:	308(120)	306(140)	307(130)	305(150)	325(150)	328(120)	327(130)	326(140)
S31:	325	326	327	328	308	305	307	306
S32:	327	326	328	325	307	308	306	305
S32:	308(120)	306(140)	307(130)	305(150)	327(130)	328(120)	325(150)	326(140)

Table A (continued)
Numbered Randomized Series for Subjects 33-40

S33:	319(130)	318(140)	320(120)	317(150)	346	348	345	347
S33:	348(120)	346(140)	345(150)	347(130)	317	320	319	318
S34:	347(130)	348(120)	345(150)	346(140)	318(140)	317(150)	320(120)	319(130)
S34:	348	346	345	347	319	320	317	318
S35:	319(130)	317(150)	318(140)	320(120)	317	318	320	319
S35:	348	347	346	345	346(140)	347(130)	348(120)	345(150)
S36:	318(140)	320(120)	317(150)	319(130)	346(140)	345(150)	348(120)	347(130)
S36:	317	320	318	319	347	346	348	345
S37:	345	347	346	348	319(130)	317(150)	318(140)	320(120)
S37:	345(150)	348(120)	346(140)	347(130)	318	317	320	319
S38:	345	347	346	348	319(130)	317(150)	318(140)	320(120)
S38:	345(150)	348(120)	346(140)	347(130)	318	317	320	319
S39:	347(130)	348(120)	345(150)	346(140)	345	346	347	348
S39:	320(120)	319(130)	317(150)	318(140)	317	318	320	319
S40:	320	319	317	318	348	345	347	346
S40:	319(130)	318(140)	317(150)	320(120)	347(130)	346(140)	345(150)	348(120)

Numbered Randomized Series for Subjects 41-48

S41:	343(130)	344(120)	342(140)	341(150)	344	341	343	342
S41:	323(130)	324(120)	322(140)	321(150)	324	321	322	323
S42:	342(140)	343(130)	344(120)	341(150)	344	343	341	342
S42:	323	321	322	324	323(130)	324(120)	322(140)	321(150)
S43:	324	321	323	322	344(120)	341(150)	343(130)	342(140)
S43:	322(140)	324(120)	323(130)	321(150)	343	344	341	342
S44:	324	322	323	321	344(120)	342(140)	343(130)	341(150)
S44:	322(140)	323(130)	321(150)	324(120)	341	342	344	343
S45:	343	341	342	344	344(120)	343(130)	341(150)	342(140)
S45:	322(140)	323(130)	321(150)	324(120)	324	323	321	322
S46:	343(130)	341(150)	342(140)	344(120)	322(140)	324(120)	321(150)	323(130)
S46:	323	321	322	324	342	343	344	341
S47:	322(140)	321(150)	323(130)	324(120)	344	343	341	342
S47:	324	321	322	323	341(150)	342(140)	344(120)	343(130)
S48:	321(150)	322(140)	324(120)	323(130)	342(140)	341(150)	343(130)	344(120)
S48:	343	344	341	342	324	323	322	321

Table A (continued)

- *(120) = Target Interval in first position in series
- (130) = Target Interval in second position in series
- (140) = Target Interval in third position in series
- (150) = Target Interval in fourth position in series

APPENDIX E

Table B
Raw Data Matrix
Experiment 1

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
1	07.40	12.80	06.70	09.0	01	1	1	1	309
2	06.60	10.60	13.20	10.1	02	1	1	1	309
3	18.30	46.00	01.70	22.0	07	1	1	1	309
4	05.30	19.40	23.50	16.1	08	1	1	1	309
5	16.20	24.80	21.40	20.8	06	1	1	1	309
6	15.10	02.40	13.70	10.4	03	1	1	1	309
7	11.80	09.00	07.30	09.4	04	1	1	1	309
8	01.90	22.10	02.60	08.9	05	1	1	1	309
9	12.20	11.10	25.90	16.4	01	1	1	1	309
10	50.20	02.50	03.50	18.7	02	1	1	1	309
11	33.50	41.70	59.60	44.9	07	1	1	1	309
12	20.10	74.10	24.20	39.5	08	1	1	1	309
13	09.20	03.40	09.10	07.2	06	1	1	1	309
14	40.50	24.30	09.30	24.7	03	1	1	1	309
15	57.20	03.30	14.70	25.1	04	1	1	1	309
16	07.00	08.70	23.10	12.9	05	1	1	1	309
17	07.90	16.40	08.20	10.8	01	1	1	1	310
18	06.20	07.70	36.50	16.8	02	1	1	1	310
19	19.50	06.20	13.90	11.9	07	1	1	1	310
20	17.30	16.50	03.60	12.5	08	1	1	1	310
21	20.80	18.70	17.70	19.1	06	1	1	1	310
22	09.40	27.30	26.60	21.1	03	1	1	1	310
23	12.90	24.60	26.00	21.2	04	1	1	1	310
24	21.50	18.00	15.60	18.4	05	1	1	1	310
25	07.60	18.10	60.40	28.7	01	1	1	1	310
26	12.90	72.10	21.20	35.4	02	1	1	1	310
27	42.40	40.70	52.60	45.2	07	1	1	1	310
28	51.60	50.70	52.10	51.5	08	1	1	1	310
29	34.60	17.50	22.90	25.0	06	1	1	1	310
30	66.40	28.30	11.10	35.3	03	1	1	1	310
31	12.00	59.30	39.50	38.9	04	1	1	1	310
32	25.10	11.30	52.90	29.8	05	1	1	1	310
33	00.30	14.90	10.40	08.5	01	1	1	1	311
34	07.60	02.10	03.60	04.4	02	1	1	1	311
35	01.80	12.20	35.30	16.4	07	1	1	1	311
36	14.70	18.40	01.10	11.4	08	1	1	1	311
37	11.40	12.80	22.10	15.4	06	1	1	1	311
38	06.70	20.70	23.10	16.8	03	1	1	1	311
39	11.20	25.90	20.90	19.3	04	1	1	1	311
40	24.50	15.90	16.80	19.1	05	1	1	1	311
41	05.20	04.90	04.80	05.0	01	1	1	1	311
42	27.90	32.50	18.00	26.5	02	1	1	1	311
43	48.30	46.30	17.10	37.2	07	1	1	1	311
44	00.60	09.60	41.40	17.2	08	1	1	1	311
45	14.00	12.40	18.50	15.0	06	1	1	1	311
46	69.80	56.90	47.80	59.2	03	1	1	1	311
47	43.50	37.20	40.00	40.2	04	1	1	1	311
48	61.60	66.10	51.30	59.7	05	1	1	1	311
49	24.50	06.10	00.50	10.4	01	1	4	1	312
50	07.50	05.70	16.30	09.8	02	1	4	1	312
51	35.70	00.90	08.80	15.1	07	1	4	1	312
52	33.90	21.30	28.10	27.8	08	1	4	1	312
53	23.60	08.50	13.50	14.1	06	1	4	1	312
54	08.30	08.00	05.10	07.1	03	1	4	1	312
55	09.10	01.60	22.80	11.2	04	1	4	1	312
56	03.80	03.20	03.40	03.5	05	1	4	1	312
57	25.10	12.00	19.20	19.8	01	1	4	1	312
58	01.70	31.50	31.90	21.7	02	1	4	1	312
59	00.00	05.70	03.50	03.1	07	1	4	1	312
60	24.00	59.10	40.10	41.1	08	1	4	1	312
61	02.20	15.70	08.60	08.8	05	1	4	2	312

Table B (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
62	31.60	20.60	14.90	22.4	03	1	4	N	0312
63	61.20	16.80	37.70	38.6	04	1	4	N	0312
64	00.40	11.90	04.40	05.6	05	1	4	N	0312
65	23.60	18.80	05.70	16.0	09	1	1	1	0313
66	05.10	00.50	03.00	02.9	13	1	1	1	0313
67	40.50	29.90	13.40	27.9	14	1	1	1	0313
68	49.40	49.10	48.30	48.9	15	1	1	1	0313
69	46.90	28.50	21.00	32.1	16	1	1	1	0313
70	21.70	27.20	28.30	25.7	12	1	1	1	0313
71	60.90	48.00	49.40	52.8	10	1	1	1	0313
72	18.30	26.80	15.00	20.0	11	1	1	1	0313
73	13.80	06.80	35.00	18.5	09	1	1	1	0313
74	18.40	07.70	12.30	12.8	13	1	1	1	0313
75	01.20	15.30	23.10	13.2	14	1	1	1	0313
76	19.50	07.60	19.80	15.6	15	1	1	1	0313
77	02.10	01.70	36.40	13.4	16	1	1	1	0313
78	27.10	29.40	29.20	28.6	12	1	1	1	0313
79	52.20	56.30	63.90	57.5	10	1	1	1	0313
80	10.70	09.70	12.20	10.9	11	1	1	1	0313
81	00.60	16.40	16.90	11.3	09	1	1	1	0314
82	11.20	07.50	04.10	07.6	13	1	1	1	0314
83	69.20	66.10	64.40	66.6	14	1	1	1	0314
84	50.00	07.90	28.80	28.9	15	1	1	1	0314
85	60.60	47.00	40.40	49.3	16	1	1	1	0314
86	41.40	30.10	32.10	34.9	12	1	1	1	0314
87	63.10	55.00	55.70	57.9	10	1	1	1	0314
88	22.60	41.90	15.50	26.7	11	1	1	1	0314
89	24.00	13.80	18.20	18.7	09	1	1	1	0314
90	07.70	09.50	06.70	08.0	13	1	1	1	0314
91	25.00	65.00	02.90	31.0	14	1	1	1	0314
92	48.10	47.10	61.30	52.2	15	1	1	1	0314
93	43.90	32.30	13.50	29.9	16	1	1	1	0314
94	30.70	26.80	27.10	28.2	12	1	1	1	0314
95	76.30	67.30	76.80	73.9	10	1	1	1	0314
96	11.60	12.20	11.90	11.9	11	1	1	1	0314
97	21.50	15.80	19.80	19.0	09	1	1	1	0315
98	15.10	04.00	06.40	08.5	13	1	1	1	0315
99	74.40	72.50	75.40	74.1	14	1	1	1	0315
100	32.10	16.90	04.70	17.9	15	1	1	1	0315
101	18.50	18.70	75.90	37.7	16	1	1	1	0315
102	39.70	45.00	31.80	38.8	12	1	1	1	0315
103	39.10	38.70	52.00	43.3	10	1	1	1	0315
104	18.30	11.30	16.10	15.2	11	1	1	1	0315
105	13.40	20.00	13.70	15.7	09	1	1	1	0315
106	13.70	03.40	03.90	07.0	13	1	1	1	0315
107	03.00	34.30	62.30	33.2	14	1	1	1	0315
108	45.70	12.00	14.00	33.9	15	1	1	1	0315
109	28.20	66.00	04.10	32.8	16	1	1	1	0315
110	36.90	28.10	26.40	30.5	12	1	1	1	0315
111	11.80	62.90	59.00	44.6	10	1	1	1	0315
112	12.80	07.90	08.20	09.6	11	1	1	1	0315
113	52.20	10.90	24.00	29.0	09	4	4	1	0316
114	05.30	06.30	15.80	09.1	13	4	4	1	0316
115	42.60	73.00	45.70	53.8	14	4	4	1	0316
116	18.90	22.10	07.30	16.1	15	4	4	1	0316
117	33.30	55.60	57.00	49.0	16	4	4	1	0316
118	32.40	29.40	30.00	30.6	12	4	4	1	0316
119	27.70	41.40	45.10	38.1	10	4	4	1	0316
120	06.80	07.60	28.80	14.4	11	4	4	1	0316
121	16.80	21.00	45.70	27.8	09	4	4	1	0316
122	09.90	17.10	11.30	12.8	13	4	4	1	0316
123	27.30	45.50	03.80	25.5	14	4	4	1	0316

Table B (continued)

Line	Trials			Mean	Subj	Cell			Series		
	1	2	3			A	B	C			
124	09	70	16	40	56	20	27	4	15	3	16
125	25	90	35	10	15	90	25	6	16	3	16
126	41	70	23	80	38	90	34	8	12	3	16
127	54	20	48	40	48	80	50	5	10	3	16
128	16	50	18	40	13	80	16	2	11	3	16
129	20	20	05	90	01	00	12	7	17	3	01
130	11	10	14	30	06	10	10	5	18	3	01
131	26	90	19	60	57	40	34	6	22	3	01
132	10	40	06	40	05	60	07	5	23	3	01
133	09	30	07	30	01	90	06	8	19	3	01
134	08	50	06	30	02	20	05	7	20	3	01
135	09	50	00	20	11	50	07	1	21	3	01
136	04	00	02	90	06	90	04	6	24	3	01
137	20	50	02	90	38	80	20	7	17	3	01
138	08	10	17	30	07	00	10	8	18	3	01
139	06	20	19	80	09	40	11	8	22	3	01
140	14	60	07	00	11	60	11	1	23	3	01
141	07	90	01	00	03	80	04	2	19	3	01
142	13	80	06	50	12	90	11	1	20	3	01
143	07	90	03	30	06	90	06	0	21	3	01
144	20	10	12	10	23	70	18	6	24	3	01
145	25	30	15	30	18	70	19	8	17	3	02
146	04	60	09	40	04	20	06	1	18	3	02
147	48	00	31	80	37	50	39	1	22	3	02
148	02	10	06	30	10	90	06	5	23	3	02
149	13	30	05	00	08	00	08	8	19	3	02
150	02	80	01	00	01	60	01	8	20	3	02
151	05	40	20	90	07	10	11	1	21	3	02
152	01	10	04	90	13	20	06	4	24	3	02
153	08	40	00	60	05	60	04	9	17	3	02
154	06	70	10	40	11	20	09	4	18	3	02
155	05	90	01	30	08	00	05	1	22	3	02
156	21	00	03	50	03	60	09	4	23	3	02
157	00	60	05	60	08	10	04	8	19	3	02
158	01	00	11	10	17	80	10	0	20	3	02
159	01	50	00	60	51	70	17	9	21	3	02
160	10	40	28	20	02	40	13	7	24	3	02
161	25	10	35	50	31	00	30	5	17	3	03
162	04	80	01	50	36	30	14	2	18	3	03
163	15	90	15	00	19	10	16	7	22	3	03
164	03	60	02	60	07	00	04	4	23	3	03
165	03	70	03	60	03	80	05	4	19	3	03
166	02	10	04	90	03	10	03	4	20	3	03
167	18	20	20	20	17	90	18	8	21	3	03
168	05	50	02	30	02	80	03	5	24	3	03
169	46	00	40	40	18	60	35	0	17	3	03
170	68	40	51	20	51	80	57	1	18	3	03
171	03	60	20	00	11	70	12	4	22	3	03
172	40	10	11	40	11	50	21	0	23	3	03
173	27	40	04	10	11	70	14	4	19	3	03
174	15	50	17	70	07	20	13	5	20	3	03
175	02	80	03	50	04	90	03	7	21	3	03
176	07	00	06	20	04	10	05	8	24	3	03
177	23	20	09	20	03	00	11	9	17	3	04
178	03	20	02	00	01	10	02	1	18	3	04
179	13	30	15	00	17	50	15	3	22	3	04
180	01	10	07	70	01	80	03	5	23	3	04
181	01	00	00	80	09	70	03	8	19	3	04
182	07	40	08	20	06	50	07	4	20	3	04
183	05	20	12	10	14	50	10	6	21	3	04
184	04	10	01	00	00	80	02	0	24	3	04
185	05	00	00	20	03	40	02	9	17	3	04

Table B (continued)

Line	Trials			Mean	Subj	Cell			Series				
	1	2	3			A	B	C					
185	09	30	07	00	02	60	06	3	18	3	4	N	304
187	08	40	03	20	03	80	05	1	22	3	4	N	304
188	07	00	09	40	09	50	08	6	20	3	4	N	304
189	25	90	36	10	23	60	08	5	19	3	4	N	304
190	15	70	16	50	14	90	15	6	20	3	4	N	304
191	26	00	21	90	17	80	20	1	21	3	4	N	304
192	02	10	32	70	32	00	22	3	24	3	4	N	304
193	09	90	60	00	61	10	53	0	25	4	1	1	305
194	17	90	12	30	05	20	11	9	26	4	1	1	305
195	03	90	23	30	54	00	40	4	27	4	1	1	305
196	34	80	20	90	17	30	24	3	31	4	1	1	305
197	04	90	46	10	29	10	36	7	28	4	1	1	305
198	13	80	14	50	03	70	10	7	32	4	1	1	305
199	14	30	06	10	19	80	13	4	30	4	1	1	305
200	11	30	19	60	00	10	10	3	29	4	1	1	305
201	16	90	01	00	20	60	12	8	25	4	1	1	305
202	15	00	17	30	07	80	13	4	26	4	1	1	305
203	24	90	18	40	51	20	31	5	27	4	1	1	305
204	47	80	11	50	41	20	33	5	31	4	1	1	305
205	08	90	07	50	11	30	09	2	28	4	1	1	305
206	17	70	05	20	09	80	10	9	22	4	1	1	305
207	23	00	48	20	16	20	29	1	30	4	1	1	305
208	04	20	24	10	12	90	23	7	29	4	1	1	305
209	54	90	43	70	06	10	34	9	25	4	1	1	306
210	10	80	19	40	17	40	15	9	26	4	1	1	306
211	03	00	29	00	28	10	20	0	27	4	1	1	306
212	47	30	55	10	12	20	38	2	31	4	1	1	306
213	01	60	53	90	18	10	31	2	28	4	1	1	306
214	01	50	00	90	10	20	07	2	28	4	1	1	306
215	35	10	00	00	40	00	42	4	30	4	1	1	306
216	06	50	00	10	02	50	10	4	29	4	1	1	306
217	29	30	02	90	33	90	22	0	25	4	1	1	306
218	29	10	03	50	20	80	27	8	26	4	1	1	306
219	62	90	08	90	20	40	30	5	27	4	1	1	306
220	50	70	02	70	22	40	25	3	31	4	1	1	306
221	40	30	16	10	04	30	20	2	28	4	1	1	306
222	26	60	08	30	07	80	14	2	30	4	1	1	306
223	07	40	08	20	02	00	05	9	20	4	1	1	306
224	21	90	12	00	24	90	19	6	29	4	1	1	306
225	05	90	50	60	09	40	22	0	25	4	1	1	307
226	04	50	05	40	20	00	10	0	26	4	3	1	307
227	16	10	18	40	29	10	21	2	27	4	1	1	307
228	03	30	19	50	28	40	26	7	31	4	3	1	307
229	03	60	51	50	52	50	42	5	28	4	1	1	307
230	10	80	12	80	45	00	22	9	32	4	3	1	307
231	01	20	08	80	10	60	06	9	30	4	3	1	307
232	30	70	09	80	02	30	14	6	29	4	3	1	307
233	18	40	11	60	40	90	23	6	25	4	3	1	307
234	12	80	00	60	18	00	10	5	26	4	3	1	307
235	44	90	46	40	41	80	44	4	27	4	3	1	307
236	51	80	56	40	39	60	49	3	31	4	3	1	307
237	50	80	36	30	26	20	37	8	28	4	3	1	307
238	08	70	14	10	16	00	12	9	22	4	3	1	307
239	37	50	31	10	10	90	26	5	30	4	3	1	307
240	22	60	03	20	33	90	19	9	29	4	3	1	307
241	62	60	10	50	40	40	37	8	25	4	4	1	308
242	11	80	19	90	09	80	12	5	28	4	4	1	308
243	47	50	32	10	28	50	35	0	27	4	4	1	308
244	32	90	55	50	20	90	36	4	31	4	4	1	308
245	17	40	50	80	47	60	38	4	28	4	4	1	308
246	09	50	07	80	22	00	13	2	32	4	4	1	308
247	49	40	44	50	09	80	34	6	30	4	4	1	308

Table B (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
248	16.10	16.10	16.10	16.1	29	4	4	1	308
249	07.50	34.50	39.10	27.0	25	4	4	4	308
250	00.20	18.80	17.00	12.0	26	4	4	4	308
251	71.60	36.20	36.90	48.2	27	4	4	4	308
252	77.50	08.20	42.40	42.7	31	4	4	4	308
253	36.00	52.00	07.30	31.9	32	4	4	4	308
254	35.80	17.90	11.50	18.4	32	4	4	4	308
255	24.60	19.20	14.10	19.3	33	4	4	4	308
256	25.80	30.90	28.60	28.4	34	4	4	4	308
257	67.90	09.30	02.40	25.2	34	5	5	5	317
258	10.40	27.40	02.60	13.5	34	1	1	1	317
259	01.50	09.90	06.10	03.8	37	1	1	1	317
260	17.60	26.10	18.60	20.4	38	1	1	1	317
261	06.50	06.50	07.60	06.9	39	1	1	1	317
262	19.90	21.90	09.00	16.9	40	1	1	1	317
263	04.50	12.30	14.80	10.5	35	1	1	1	317
264	09.70	09.30	27.10	15.4	36	1	1	1	317
265	03.70	11.80	04.80	06.8	33	1	1	2	317
266	31.00	07.30	14.60	17.7	34	1	1	1	317
267	21.00	38.00	30.10	29.7	37	1	1	1	317
268	22.60	07.70	04.20	11.5	38	1	1	1	317
269	07.30	08.00	16.30	10.9	39	1	1	2	317
270	68.00	63.60	33.70	55.1	40	1	1	1	317
271	35.30	35.50	27.90	33.2	35	1	1	1	317
272	16.90	29.30	25.80	24.0	36	1	1	2	317
273	25.60	19.40	20.30	21.8	33	1	1	1	318
274	13.00	19.20	31.40	21.2	34	1	1	1	318
275	34.60	26.30	37.20	32.7	37	1	1	1	318
276	12.20	06.80	31.80	16.9	38	1	1	1	318
277	23.50	19.70	29.20	24.1	39	1	1	1	318
278	18.70	48.00	18.10	28.3	40	1	1	1	318
279	27.20	38.60	27.20	31.0	35	1	1	1	318
280	06.20	01.50	17.80	08.5	36	1	1	1	318
281	03.90	18.70	10.30	11.0	33	1	1	1	318
282	51.70	51.00	04.30	35.7	34	1	1	1	318
283	18.80	01.40	36.10	18.8	37	1	1	1	318
284	18.00	05.40	10.20	11.2	38	1	1	1	318
285	28.90	14.80	00.60	14.8	39	1	1	1	318
286	65.10	27.90	03.80	32.4	40	1	1	1	318
287	47.30	17.20	16.30	26.9	33	1	1	1	318
288	46.10	52.60	58.50	52.7	36	1	1	1	318
289	00.90	03.90	06.50	03.8	33	1	1	1	319
290	29.00	38.60	38.50	35.4	34	1	1	1	319
291	07.30	06.00	10.60	08.0	37	1	1	1	319
292	01.70	36.90	17.30	18.6	38	1	1	1	319
293	39.30	20.80	28.30	29.5	39	1	1	1	319
294	17.80	34.40	36.20	29.9	40	1	1	1	319
295	39.70	30.70	30.70	33.7	35	1	1	1	319
296	15.00	27.90	16.00	19.6	36	1	1	1	319
297	13.00	04.10	11.20	09.4	33	1	1	1	319
298	43.00	00.60	26.90	23.5	34	1	1	1	319
299	25.00	38.70	20.00	31.2	37	1	1	1	319
300	31.00	11.20	24.20	22.1	38	1	1	1	319
301	27.10	79.40	23.60	43.4	39	1	1	1	319
302	54.60	74.50	68.00	65.7	40	1	1	1	319
303	25.40	22.10	40.60	29.4	35	1	1	1	319
304	07.20	38.80	13.20	16.4	36	1	1	1	319
305	44.10	38.20	31.00	37.8	33	4	4	1	320
306	01.00	35.90	07.10	14.7	34	4	4	1	320
307	37.70	31.00	28.30	32.3	37	4	4	1	320
308	24.00	47.20	30.00	33.7	38	4	4	1	320
309	22.20	38.90	22.20	27.8	39	4	4	1	320

Table B (continued)

Line	Trials			Mean	Subj	Cell			Series					
	1	2	3			A	B	C						
0310	41.	80	35.	30	31.	10	36.	1	40	5	4	1	3	0
0311	24.	70	35.	30	44.	00	34.	7	35	5	5	1	3	0
0312	14.	10	10.	00	22.	20	15.	4	36	5	4	1	3	0
0313	06.	90	14.	20	35.	50	18.	9	33	5	4	1	3	0
0314	37.	30	54.	30	40.	80	44.	1	34	5	4	1	3	0
0315	12.	80	10.	50	32.	60	18.	6	37	5	4	1	3	0
0316	06.	40	53.	80	42.	60	34.	3	38	5	4	1	3	0
0317	07.	60	13.	90	30.	80	17.	4	39	5	4	1	3	0
0318	51.	90	46.	50	03.	10	33.	8	40	5	4	1	3	0
0319	18.	10	17.	90	36.	80	24.	3	35	5	4	1	3	0
0320	26.	50	61.	10	24.	20	37.	3	36	5	4	1	3	0
0321	04.	20	56.	80	48.	20	36.	4	41	5	4	1	3	0
0322	44.	40	07.	10	03.	50	18.	3	42	5	4	1	3	0
0323	19.	10	13.	30	37.	70	23.	4	43	5	4	1	3	0
0324	31.	10	22.	90	28.	40	27.	5	44	5	4	1	3	0
0325	59.	50	00.	60	39.	90	33.	0	47	5	4	1	3	0
0326	51.	30	35.	70	11.	20	32.	7	48	5	4	1	3	0
0327	49.	00	46.	70	58.	20	51.	3	45	5	4	1	3	0
0328	18.	10	10.	10	30.	80	19.	6	46	5	4	1	3	0
0329	12.	70	60.	40	39.	60	37.	6	41	5	6	1	3	1
0330	39.	30	42.	10	18.	20	33.	2	42	6	6	1	3	1
0331	50.	40	41.	00	46.	90	46.	1	43	6	6	1	3	1
0332	29.	00	26.	50	31.	30	28.	9	44	6	6	1	3	1
0333	42.	10	48.	60	43.	50	44.	7	47	6	6	1	3	1
0334	73.	80	67.	40	13.	10	51.	4	48	6	6	1	3	1
0335	32.	10	37.	90	21.	20	30.	4	45	6	6	1	3	1
0336	42.	90	23.	70	25.	70	30.	8	46	6	6	1	3	1
0337	05.	70	10.	00	42.	00	19.	2	41	6	6	1	3	2
0338	38.	60	15.	00	30.	70	28.	1	42	6	6	1	3	2
0339	31.	20	04.	20	07.	60	14.	3	43	6	6	1	3	2
0340	07.	50	15.	30	18.	30	13.	7	44	6	6	1	3	2
0341	31.	10	56.	10	44.	90	44.	0	47	6	6	1	3	2
0342	22.	20	11.	10	40.	20	24.	5	48	6	6	1	3	2
0343	45.	30	45.	50	22.	80	37.	9	45	6	6	1	3	2
0344	27.	80	25.	20	30.	60	27.	9	46	6	6	1	3	2
0345	22.	20	37.	90	35.	60	38.	6	41	6	6	1	3	2
0346	41.	70	35.	30	20.	10	32.	4	42	6	6	1	3	2
0347	20.	30	51.	30	33.	80	35.	1	43	6	6	1	3	2
0348	14.	40	14.	70	25.	20	18.	1	44	6	6	1	3	2
0349	56.	20	22.	40	08.	20	28.	9	47	6	6	1	3	2
0350	30.	00	01.	30	53.	70	28.	3	48	6	6	1	3	2
0351	23.	90	05.	30	23.	50	17.	6	45	6	6	1	3	2
0352	23.	20	29.	40	39.	10	30.	2	46	6	6	1	3	2
0353	49.	70	50.	90	51.	00	50.	5	41	6	6	1	3	2
0354	02.	60	00.	90	18.	90	07.	5	42	6	6	1	3	2
0355	24.	90	18.	40	09.	70	17.	7	43	6	6	1	3	2
0356	08.	00	12.	40	14.	10	11.	5	44	6	6	1	3	2
0357	47.	10	19.	00	39.	90	35.	3	47	6	6	1	3	2
0358	54.	20	52.	80	53.	50	54.	2	48	6	6	1	3	2
0359	12.	40	32.	20	36.	10	23.	6	45	6	6	1	3	2
0360	13.	30	26.	40	15.	30	18.	3	46	6	6	1	3	2
0361	48.	40	38.	10	66.	80	57.	8	41	6	6	1	3	2
0362	29.	70	01.	90	27.	70	19.	8	42	6	6	1	3	2
0363	24.	50	51.	60	42.	40	39.	5	43	6	6	1	3	2
0364	30.	60	49.	00	56.	80	45.	5	44	6	6	1	3	2
0365	29.	60	17.	70	32.	40	23.	2	47	6	6	1	3	2
0366	42.	20	49.	60	52.	70	50.	2	48	6	6	1	3	2
0367	18.	90	33.	30	33.	50	33.	6	45	6	6	1	3	2
0368	41.	30	35.	20	29.	30	25.	5	46	6	6	1	3	2
0369	35.	50	05.	80	29.	80	29.	4	41	6	6	1	3	2
0370	14.	30	12.	80	09.	00	10.	7	42	6	6	1	3	2
0371	03.	30	01.	90	19.	00	08.	1	43	6	6	1	3	2

Table B (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
372	46.60	03.80	05.50	18.6	44	6	4	1	324
373	52.30	50.40	50.50	51.1	47	6	4	1	324
374	13.90	10.20	24.80	16.3	42	6	4	1	324
375	04.40	00.20	22.60	09.1	45	6	4	1	324
376	01.70	19.90	15.70	12.4	46	6	4	1	324
377	66.60	42.90	03.90	37.8	41	6	4	2	324
378	32.40	29.30	27.90	29.5	42	6	4	2	324
379	22.10	35.00	23.60	30.2	43	6	4	2	324
380	27.80	38.70	43.50	36.7	44	6	4	2	324
381	17.50	59.60	53.30	43.5	47	6	4	2	324
382	32.70	01.50	42.70	25.6	48	6	4	2	324
383	45.80	52.50	47.60	48.6	45	6	4	2	324
384	21.80	42.70	52.10	39.9	46	6	4	2	324

Table C
 Transformed Data Matrix
 Experiment 1: Target Interval 1000ms
 Raw Scores transformed by
 transformation $\sqrt{x} + \sqrt{x+1}$

		C ₁				C ₂			
		B ₁	B ₂	B ₃	B ₄	B ₁	B ₂	B ₃	B ₄
A ₁		6.2	6.7	6.0	6.6	8.2	10.8	4.7	9.0
		6.5	8.3	4.4	6.4	8.8	12.0	10.4	9.4
		9.5	7.0	8.2	7.9	13.5	13.5	12.3	3.8
		8.1	7.2	6.9	10.6	12.6	14.4	8.4	12.9
		9.2	8.9	8.0	7.6	5.5	10.1	7.9	6.1
		6.6	9.3	8.3	5.5	10.0	12.0	15.3	9.6
		6.3	9.3	8.9	6.8	10.1	12.6	12.8	12.5
		6.1	8.7	8.9	4.0	7.3	11.0	15.5	4.9
		8.1	6.9	8.8	10.9	8.7	8.8	8.0	10.6
		3.7	5.7	6.0	6.2	7.3	5.8	5.5	7.3
A ₂		10.7	16.4	17.3	14.7	7.5	11.2	11.6	10.2
		14.1	10.8	8.6	8.1	8.0	14.5	9.9	10.6
		11.4	14.1	12.4	14.1	7.5	11.0	11.5	10.2
		10.2	11.8	12.5	11.2	10.8	10.7	11.1	11.9
		14.6	15.3	13.2	12.4	15.2	17.2	13.4	14.3
		9.1	10.4	7.9	7.7	6.8	7.0	6.4	8.2
		7.3	9.0	11.1	7.0	9.2	4.6	11.9	3.7
A ₃		6.6	5.1	7.7	3.2	6.7	6.3	15.2	5.2
		11.8	12.6	8.3	7.9	7.0	4.7	7.2	4.7
		5.7	5.3	4.4	4.0	6.8	6.3	9.3	6.0
		5.4	6.1	4.9	4.1	4.3	4.6	7.7	10.8
		5.0	3.0	3.9	5.6	6.8	6.5	7.5	8.0
		5.5	6.8	8.8	6.7	5.1	8.6	4.1	9.5
		4.5	5.3	4.0	3.1	8.7	7.5	5.0	9.5

Table C (continued)

	C ₁				C ₂			
	B ₁	B ₂	B ₃	B ₄	B ₁	B ₂	B ₃	B ₄
A ₄	14.7	11.9	9.5	12.4	7.3	9.5	9.8	10.5
	7.0	8.1	6.5	7.2	7.5	10.6	6.6	7.1
	12.8	9.1	9.3	12.1	11.3	11.1	13.4	14.0
	10.0	12.4	10.4	12.1	11.7	10.2	14.1	13.1
	12.2	11.3	13.1	12.5	6.2	9.1	12.4	11.4
	6.7	5.5	9.7	7.4	6.8	7.7	7.3	8.7
	7.5	13.1	5.4	11.8	10.9	5.1	10.4	8.9
	6.6	6.6	7.7	8.1	9.8	9.0	9.0	10.8
	10.1	9.4	4.1	12.4	5.4	6.8	6.3	8.8
	7.5	9.3	12.0	7.8	8.5	12.0	9.8	13.4
A ₅	4.1	11.5	5.8	11.5	11.0	8.8	11.3	8.7
	9.1	8.3	8.7	11.7	6.9	6.8	9.5	11.8
	5.4	9.9	11.0	10.6	6.6	7.8	13.3	8.5
	8.3	10.7	11.0	12.1	14.9	11.5	16.3	11.7
	6.6	11.2	11.7	11.9	11.6	10.5	10.9	10.0
	8.0	6.0	9.0	8.0	9.9	14.6	8.2	12.3
	12.1	8.9	14.3	10.9	12.3	12.5	15.3	12.4
	8.7	10.7	5.7	6.7	11.6	11.5	9.0	11.0
	9.8	7.7	8.5	5.9	13.7	11.9	12.6	11.1
	10.6	7.5	6.9	8.7	10.8	8.6	13.6	12.2
A ₆	11.6	13.3	12.0	14.4	13.4	10.8	9.7	13.3
	11.5	10.0	12.8	8.2	14.4	10.7	14.2	10.2
	14.4	12.4	9.8	6.2	11.1	8.5	12.8	14.0
	9.0	10.7	8.7	7.2	11.2	11.1	12.0	12.6

APPENDIX F

Table D
Raw Data Matrix
Experiment 2

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
1	26.30	45.40	05.30	25.7	09	1	1	1	333
2	15.20	09.50	20.10	15.0	13	1	1	1	333
3	62.00	46.90	69.50	59.4	14	1	1	1	333
4	16.70	24.80	28.90	23.5	15	1	1	1	333
5	26.60	55.40	36.90	39.6	16	1	1	1	333
6	37.70	38.50	19.30	31.8	12	1	1	1	333
7	60.50	54.40	55.60	56.8	10	1	1	1	333
8	09.90	10.70	04.70	08.5	11	1	1	1	333
9	22.80	08.00	06.70	12.5	09	1	1	2	333
10	06.10	15.30	04.60	08.7	13	1	1	2	333
11	55.10	34.50	60.50	50.4	14	1	1	2	333
12	23.40	24.00	00.80	17.7	15	1	1	2	333
13	05.60	05.80	01.50	04.3	16	1	1	2	333
14	00.60	12.90	03.10	05.5	12	1	1	2	333
15	40.90	28.90	22.60	30.8	10	1	1	2	333
16	04.80	02.00	02.40	03.1	11	1	1	2	333
17	30.30	16.00	02.00	16.1	09	1	1	1	334
18	17.20	20.90	20.70	19.6	13	1	2	2	334
19	40.50	47.30	42.80	43.5	14	1	2	1	334
20	35.30	18.90	31.00	28.4	15	1	2	1	334
21	10.30	26.10	44.80	27.1	16	1	2	1	334
22	46.20	53.20	44.90	48.1	12	1	1	1	334
23	58.00	60.20	55.70	57.9	10	1	1	1	334
24	40.90	11.20	05.90	19.4	11	1	2	1	334
25	08.60	01.20	15.20	08.3	09	1	2	2	334
26	28.30	11.90	06.70	15.6	13	1	2	2	334
27	49.60	55.40	54.30	53.1	14	1	2	2	334
28	08.70	17.10	42.30	22.7	15	1	2	2	334
29	24.50	17.50	18.20	20.1	16	1	2	2	334
30	06.50	07.60	00.80	05.0	12	1	2	2	334
31	40.30	37.60	24.90	34.3	10	1	2	2	334
32	11.60	00.60	02.40	04.9	11	1	2	2	334
33	07.10	45.20	46.00	32.8	09	1	3	1	335
34	11.50	09.50	04.30	08.4	13	1	3	1	335
35	41.20	54.20	56.00	50.5	14	1	3	1	335
36	01.90	06.50	03.20	03.9	15	1	3	1	335
37	41.70	25.60	49.90	39.1	16	1	3	1	335
38	41.60	47.50	33.20	40.8	12	1	3	1	335
39	52.70	55.00	55.30	54.3	10	1	3	1	335
40	5.80	7.90	4.00	5.9	11	1	3	1	335
41	72.50	67.30	31.90	57.2	09	1	3	2	335
42	02.70	17.20	31.70	17.2	13	1	3	2	335
43	64.70	60.30	64.20	63.0	14	1	3	2	335
44	26.30	13.50	40.60	26.8	15	1	3	2	335
45	07.90	24.40	65.90	32.7	16	1	3	2	335
46	00.60	06.80	07.40	04.9	12	1	3	2	335
47	37.80	37.70	18.20	31.2	10	1	3	2	335
48	35.40	00.50	02.60	09.5	11	1	3	2	335
49	17.20	00.60	44.90	20.9	09	1	4	1	336
50	54.20	30.80	39.90	41.6	13	1	4	1	336
51	61.30	64.50	64.40	63.4	14	1	4	1	336
52	40.00	08.00	49.50	32.5	15	1	4	1	336
53	16.70	47.40	03.10	22.4	16	1	4	1	336
54	72.30	76.60	61.10	70.0	12	1	4	1	336
55	74.40	65.40	60.10	66.6	10	1	4	1	336
56	10.20	08.80	03.80	07.6	11	1	4	1	336
57	21.70	14.10	03.40	13.1	09	1	4	2	336
58	06.40	08.50	32.20	13.7	13	1	4	2	336
59	53.20	39.60	52.70	49.2	14	1	4	2	336
60	04.00	18.10	26.40	16.2	15	1	4	2	336
61	47.30	09.20	09.20	21.6	16	1	4	2	336

Table D (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
62	03.90	13.70	16.00	11.2	12	1	4	2	336
63	26.00	32.20	39.30	32.5	10	1	4	2	336
64	16.20	05.00	00.00	07.1	11	1	1	2	336
65	51.50	11.80	27.30	30.2	02	1	4	1	337
66	27.90	19.10	18.80	21.9	01	1	1	1	337
67	29.80	06.30	21.80	19.3	07	1	1	1	337
68	15.60	33.90	60.40	36.7	08	1	1	1	337
69	54.40	31.10	44.30	43.2	06	1	1	1	337
70	43.10	54.30	43.30	46.9	03	1	1	1	337
71	00.10	10.30	24.40	11.6	04	1	1	1	337
72	36.30	42.70	39.40	39.5	05	1	1	1	337
73	37.90	26.70	46.90	40.5	02	1	1	1	337
74	53.70	28.90	33.30	38.6	01	1	1	2	337
75	60.50	53.30	75.50	63.1	07	1	1	2	337
76	75.00	22.10	37.20	44.8	08	1	1	2	337
77	30.40	11.60	64.90	35.7	06	1	1	2	337
78	27.10	29.60	26.50	27.7	03	1	1	2	337
79	38.70	34.30	18.60	30.5	04	1	1	2	337
80	62.00	12.90	11.20	28.7	05	1	1	2	337
81	29.80	66.60	34.20	43.5	01	1	1	2	338
82	06.40	10.20	19.50	12.0	02	1	1	1	338
83	13.50	14.30	70.70	32.9	07	1	1	1	338
84	16.50	13.90	53.30	27.9	08	1	1	1	338
85	25.90	02.60	25.10	17.8	06	1	1	1	338
86	43.60	73.60	44.20	53.8	03	1	1	1	338
87	07.60	34.70	03.50	15.3	04	1	1	1	338
88	32.00	21.70	28.70	27.5	05	1	1	1	338
89	26.60	06.10	43.50	25.4	02	1	1	1	338
90	48.70	41.70	45.80	45.4	01	1	1	1	338
91	77.60	44.00	43.10	54.9	07	1	1	1	338
92	18.80	06.00	06.80	10.5	08	1	1	1	338
93	11.90	21.20	58.40	30.5	06	1	1	1	338
94	25.20	60.60	66.30	50.7	03	1	1	1	338
95	22.10	12.00	06.10	13.4	04	1	1	1	338
96	04.20	09.80	17.80	10.6	05	1	1	1	338
97	35.90	19.20	24.80	26.7	01	1	1	1	339
98	08.60	27.00	15.40	17.0	02	1	1	1	339
99	31.50	56.80	11.20	33.1	07	1	1	1	339
100	15.30	60.40	07.90	27.9	08	1	1	1	339
101	06.50	20.40	12.20	13.0	06	1	1	1	339
102	48.70	06.30	36.30	30.4	03	1	1	1	339
103	25.40	06.30	10.40	14.0	04	1	1	1	339
104	03.60	08.10	29.00	13.5	05	1	1	1	339
105	64.80	11.80	42.50	39.7	02	1	1	1	339
106	42.40	47.60	49.10	46.4	01	1	1	1	339
107	17.20	51.60	50.30	39.7	07	1	1	1	339
108	18.90	22.70	00.90	14.2	08	1	1	1	339
109	30.40	23.60	67.10	40.4	06	1	1	1	339
110	17.30	00.20	13.90	10.5	03	1	1	1	339
111	25.40	09.60	13.80	16.3	04	1	1	1	339
112	18.10	12.30	08.30	12.9	05	1	1	1	339
113	42.40	03.10	29.30	24.9	01	4	1	1	340
114	00.20	09.80	27.70	12.6	02	4	1	1	340
115	25.00	12.50	15.40	17.7	07	4	1	1	340
116	01.20	21.50	46.00	22.9	08	4	1	1	340
117	14.60	45.10	15.80	25.1	06	4	1	1	340
118	16.00	14.10	54.60	28.2	03	4	1	1	340
119	26.70	01.30	10.90	13.0	04	4	1	1	340
120	01.10	20.20	28.60	16.6	05	4	1	1	340
121	35.60	59.60	42.60	46.0	02	4	1	2	340
122	39.40	33.50	43.00	38.7	01	4	1	2	340
123	31.20	41.60	61.60	44.8	07	4	1	2	340

Table D (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
1284	50.00	10.60	17.20	25.7	08	0	4	0	0340
1285	23.00	13.00	08.60	16.5	06	0	4	0	0340
1286	49.10	59.80	64.00	57.6	03	0	4	0	0340
1287	02.00	06.30	03.70	04.0	04	0	4	0	0340
1288	08.40	21.70	19.90	16.7	05	0	4	0	0340
1289	42.10	45.10	44.40	43.9	25	0	1	1	0325
1300	25.00	20.20	08.60	17.9	26	0	1	1	0325
1311	42.20	28.60	25.50	32.1	27	0	1	1	0325
1322	11.60	20.70	06.40	12.9	31	0	1	1	0325
1333	46.90	05.80	01.70	18.1	28	0	1	1	0325
134	15.90	21.40	04.60	13.9	22	0	1	1	0325
1355	19.60	25.10	26.90	23.9	30	0	1	1	0325
136	18.00	17.70	04.10	13.3	29	0	1	1	0325
137	37.00	28.10	10.40	25.8	25	0	1	1	0325
138	14.40	02.20	18.90	11.8	26	0	1	1	0325
139	28.80	33.60	26.60	29.7	27	0	1	1	0325
140	26.40	39.70	34.90	33.6	31	0	1	1	0325
141	25.00	07.10	29.50	20.5	28	0	1	1	0325
142	23.90	11.90	00.30	12.0	22	0	1	1	0325
143	35.40	17.70	44.10	32.4	30	0	1	1	0325
144	25.20	22.30	14.20	20.6	29	0	1	1	0325
145	39.20	37.50	44.30	40.4	25	0	1	1	0326
146	02.50	06.40	17.10	08.6	26	0	1	1	0326
147	24.50	18.80	02.30	15.2	27	0	1	1	0326
148	23.70	28.50	16.00	22.7	31	0	1	1	0326
149	14.90	07.70	25.90	16.2	28	0	1	1	0326
150	11.60	23.70	03.10	14.5	32	0	1	1	0326
151	26.00	42.90	35.30	35.0	30	0	1	1	0326
152	33.60	10.80	03.60	16.0	29	0	1	1	0326
153	17.50	33.90	33.50	28.3	25	0	1	1	0326
154	17.10	06.00	03.70	08.9	26	0	1	1	0326
155	37.30	46.20	42.10	41.9	27	0	1	1	0326
156	07.50	13.50	02.60	07.0	31	0	1	1	0326
157	07.30	31.40	16.70	18.4	28	0	1	1	0326
158	17.70	11.60	01.60	10.3	22	0	1	1	0326
159	18.10	28.70	19.30	22.1	30	0	1	1	0326
160	05.30	19.50	21.20	14.0	29	0	1	1	0326
161	40.30	31.50	52.80	41.5	25	0	1	1	0326
162	13.10	08.50	12.50	11.3	26	0	1	1	0327
163	03.40	24.20	46.40	24.7	27	0	1	1	0327
164	55.30	29.20	08.70	31.1	31	0	1	1	0327
165	31.60	09.80	08.20	16.5	28	0	1	1	0327
166	43.90	34.40	26.50	34.9	32	0	1	1	0327
167	28.30	27.70	32.90	29.6	30	0	1	1	0327
168	16.80	23.60	22.60	21.0	29	0	1	1	0327
169	70.20	58.00	41.80	56.7	25	0	1	1	0327
170	09.00	11.50	12.10	10.1	26	0	1	1	0327
171	38.10	36.80	60.80	49.2	27	0	1	1	0327
172	20.80	31.10	23.80	25.2	31	0	1	1	0327
173	37.30	18.60	09.60	21.9	28	0	1	1	0327
174	07.90	14.80	17.20	13.3	32	0	1	1	0327
175	30.00	10.70	10.00	16.9	30	0	1	1	0327
176	16.70	33.90	09.80	20.1	29	0	1	1	0327
177	67.90	67.10	37.80	57.6	25	0	4	4	0328
178	59.40	48.90	30.90	46.4	26	0	4	4	0328
179	45.40	40.50	34.00	39.9	27	0	4	4	0328
180	07.60	03.10	02.50	04.4	31	0	4	4	0328
181	34.90	33.30	63.70	50.6	28	0	4	4	0328
182	49.40	39.60	15.60	34.6	22	0	4	4	0328
183	42.50	21.20	27.20	30.0	30	0	4	4	0328
184	19.90	07.30	07.90	11.7	29	0	4	4	0328
185	42.90	38.90	47.50	39.8	25	0	4	4	0328

Table D (continued)

Line	Trials			Mean	Subj	Cell			Series				
	1	2	3			A	B	C					
186	46.	40	21.	30	33.	90	26	3	4	4	4	2	3
187	29.	90	27.	20	44.	30	27	3	4	4	4	2	3
188	38.	80	25.	20	38.	80	31	3	4	4	4	2	3
189	04.	20	53.	20	42.	10	28	3	4	4	4	2	3
190	29.	20	06.	40	74.	40	22	3	4	4	4	2	3
191	31.	20	73.	30	22.	00	30	3	4	4	4	2	3
192	17.	50	06.	60	15.	90	25	3	4	4	4	2	3
193	48.	40	18.	20	33.	10	17	3	4	4	4	2	3
194	34.	60	32.	00	28.	10	18	3	4	4	4	2	3
195	53.	20	17.	40	45.	30	22	3	4	4	4	2	3
196	68.	00	69.	60	74.	40	23	3	4	4	4	2	3
197	22.	10	12.	70	20.	30	19	3	4	4	4	2	3
198	39.	10	23.	80	36.	20	20	3	4	4	4	2	3
199	22.	00	24.	90	13.	50	21	3	4	4	4	2	3
200	26.	00	23.	80	10.	00	24	3	4	4	4	2	3
201	25.	50	76.	80	33.	50	17	3	4	4	4	2	3
202	18.	50	21.	60	12.	00	18	3	4	4	4	2	3
203	38.	70	53.	30	30.	00	22	3	4	4	4	2	3
204	18.	50	07.	30	11.	80	23	3	4	4	4	2	3
205	01.	50	13.	70	14.	50	19	3	4	4	4	2	3
206	27.	40	39.	60	70.	90	20	3	4	4	4	2	3
207	01.	90	05.	20	12.	80	21	3	4	4	4	2	3
208	41.	40	11.	30	22.	00	24	3	4	4	4	2	3
209	27.	70	36.	40	00.	70	17	3	4	4	4	2	3
210	03.	90	21.	90	23.	50	18	3	4	4	4	2	3
211	11.	80	12.	80	07.	90	22	3	4	4	4	2	3
212	08.	50	10.	90	07.	80	23	3	4	4	4	2	3
213	22.	40	01.	80	25.	40	19	3	4	4	4	2	3
214	30.	30	14.	10	23.	60	20	3	4	4	4	2	3
215	00.	90	34.	10	12.	50	21	3	4	4	4	2	3
216	46.	90	62.	80	20.	30	24	3	4	4	4	2	3
217	24.	60	29.	10	31.	60	17	3	4	4	4	2	3
218	14.	20	27.	10	09.	30	18	3	4	4	4	2	3
219	38.	90	16.	20	09.	50	22	3	4	4	4	2	3
220	20.	20	23.	00	07.	30	23	3	4	4	4	2	3
221	19.	00	25.	40	20.	80	19	3	4	4	4	2	3
222	00.	00	02.	40	61.	10	20	3	4	4	4	2	3
223	08.	90	37.	20	19.	00	21	3	4	4	4	2	3
224	45.	60	06.	00	20.	40	24	3	4	4	4	2	3
225	51.	90	07.	60	26.	40	17	3	4	4	4	2	3
226	28.	40	20.	80	10.	60	18	3	4	4	4	2	3
227	25.	30	24.	20	74.	90	22	3	4	4	4	2	3
228	18.	80	05.	00	30.	10	23	3	4	4	4	2	3
229	10.	50	09.	70	07.	40	19	3	4	4	4	2	3
230	19.	90	21.	30	31.	00	20	3	4	4	4	2	3
231	65.	70	26.	60	20.	20	21	3	4	4	4	2	3
232	18.	30	09.	40	30.	20	24	3	4	4	4	2	3
233	26.	70	34.	00	26.	90	17	3	4	4	4	2	3
234	33.	50	18.	70	10.	00	18	3	4	4	4	2	3
235	34.	10	14.	50	24.	00	22	3	4	4	4	2	3
236	32.	10	27.	40	17.	10	23	3	4	4	4	2	3
237	16.	80	04.	60	06.	30	19	3	4	4	4	2	3
238	31.	20	29.	00	42.	90	20	3	4	4	4	2	3
239	10.	70	21.	30	04.	90	21	3	4	4	4	2	3
240	24.	10	23.	60	13.	50	24	3	4	4	4	2	3
241	29.	60	33.	90	14.	90	17	3	4	4	4	2	3
242	55.	00	10.	50	00.	00	18	3	4	4	4	2	3
243	04.	90	29.	90	00.	80	22	3	4	4	4	2	3
244	13.	40	02.	10	19.	40	22	3	4	4	4	2	3
245	12.	40	04.	80	16.	00	19	3	4	4	4	2	3
246	10.	90	29.	10	03.	80	20	3	4	4	4	2	3
247	52.	80	08.	70	70.	80	21	3	4	4	4	2	3

Table D (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
0040	36.40	23.70	14.30	21.4	24	4	4	1	332
0041	33.90	54.90	34.40	41.1	17	4	4	2	332
0042	53.10	21.30	45.10	39.8	18	4	4	3	332
0043	24.70	12.70	37.40	24.9	22	4	4	4	332
0044	21.70	27.60	25.60	25.0	20	4	4	5	332
0045	26.40	02.90	33.50	21.0	19	4	4	6	332
0046	33.50	47.90	35.20	38.9	20	4	4	7	332
0047	17.60	22.00	14.00	17.9	21	4	4	8	332
0048	54.20	24.50	47.80	42.1	24	4	4	9	332
0049	39.90	34.40	31.90	35.4	41	5	5	1	341
0050	40.00	33.30	28.60	34.0	42	5	5	2	341
0051	12.90	02.80	07.70	07.8	43	5	5	3	341
0052	48.90	30.40	39.50	39.6	44	5	5	4	341
0053	35.60	52.10	43.70	43.8	47	5	5	5	341
0054	56.50	18.70	02.90	26.0	48	5	5	6	341
0055	16.90	34.50	31.10	27.5	45	5	5	7	341
0056	24.00	16.00	17.03	19.0	46	5	5	8	341
0057	34.40	19.70	45.90	33.2	41	5	5	9	341
0058	29.03	30.80	27.60	29.1	42	5	5	1	341
0059	33.20	35.70	40.50	38.2	43	5	5	2	341
0060	22.40	20.70	00.80	14.6	44	5	5	3	341
0061	18.20	02.80	27.20	16.1	47	5	5	4	341
0062	20.90	22.40	18.20	20.4	48	5	5	5	341
0063	08.80	11.10	04.80	08.3	45	5	5	6	341
0064	48.73	37.80	37.97	41.5	46	5	5	7	341
0065	45.80	44.80	36.00	42.2	41	5	5	8	342
0066	47.10	33.70	46.00	42.2	42	5	5	9	342
0067	11.00	22.00	14.20	15.4	43	5	5	1	342
0068	37.00	52.10	37.20	42.1	44	5	5	2	342
0069	33.30	29.00	25.70	29.3	47	5	5	3	342
0070	12.30	32.80	16.50	20.5	48	5	5	4	342
0071	45.00	17.70	28.10	30.6	45	5	5	5	342
0072	33.60	20.90	21.30	25.3	46	5	5	6	342
0073	25.00	16.60	06.50	16.0	41	5	5	7	342
0074	48.20	56.20	48.90	51.3	42	5	5	8	342
0075	04.80	21.90	07.00	11.2	43	5	5	9	342
0076	38.90	33.10	33.40	35.1	44	5	5	1	342
0077	17.80	13.60	14.90	15.4	47	5	5	2	342
0078	12.90	21.50	02.60	12.3	48	5	5	3	342
0079	11.70	08.20	06.70	08.9	45	5	5	4	342
0080	40.20	34.63	30.97	35.3	46	5	5	5	342
0081	32.50	55.40	52.20	46.7	41	5	5	6	343
0082	45.90	37.20	47.20	43.4	42	5	5	7	343
0083	34.80	09.20	10.60	18.2	43	5	5	8	343
0084	47.70	30.70	34.60	37.7	44	5	5	9	343
0085	15.70	12.20	25.00	17.6	47	5	5	1	343
0086	46.90	72.70	25.60	48.4	48	5	5	2	343
0087	26.70	41.40	19.00	29.0	45	5	5	3	343
0088	36.30	22.70	33.60	30.9	46	5	5	4	343
0089	79.80	40.40	36.00	52.1	41	5	5	5	343
0090	39.90	10.30	11.50	20.6	42	5	5	6	343
0091	35.10	05.60	00.80	14.5	43	5	5	7	343
0092	26.00	31.90	27.00	28.3	44	5	5	8	343
0093	16.10	12.10	03.90	10.7	47	5	5	9	343
0094	09.40	03.60	27.70	13.6	48	5	5	1	343
0095	21.80	03.10	07.60	10.8	45	5	5	2	343
0096	51.00	44.00	33.77	42.9	46	5	5	3	343
0097	28.30	28.40	49.80	35.5	41	5	5	4	344
0098	53.10	31.00	59.00	47.7	42	5	5	5	344
0099	03.30	12.20	16.80	10.8	43	5	5	6	344
0100	37.80	27.70	40.90	35.5	44	5	5	7	344
0101	56.60	56.50	47.30	53.4	47	5	4	1	344

Table D (continued)

Line	Trials			Mean	Subj	Cell			Series				
	1	2	3			A	B	C					
310	30.	70	39.	70	52.	40	40.	9	48	5	4	1	344
311	41.	50	27.	70	29.	40	32.	9	45	5	4	1	344
312	47.	60	25.	67	27.	57	34.	9	46	5	4	1	344
313	33.	90	50.	20	47.	40	43.	8	41	5	4	1	344
314	34.	10	49.	40	46.	70	43.	4	42	5	4	1	344
315	51.	10	35.	90	17.	60	34.	9	43	5	4	1	344
316	59.	10	41.	40	47.	60	49.	4	44	5	4	1	344
317	59.	10	41.	80	11.	00	37.	3	47	5	4	1	344
318	32.	20	08.	80	70.	40	37.	1	48	5	4	1	344
319	21.	00	08.	10	26.	90	18.	7	45	5	4	1	344
320	43.	00	26.	07	23.	40	31.	5	46	5	4	1	344
321	24.	20	21.	70	46.	10	30.	7	30	6	6	1	345
322	42.	00	39.	30	32.	00	37.	8	34	6	6	1	345
323	43.	60	18.	50	29.	40	30.	5	37	6	6	1	345
324	20.	40	08.	70	09.	60	12.	9	38	6	6	1	345
325	14.	50	41.	00	09.	00	21.	5	39	6	6	1	345
326	62.	80	08.	10	28.	90	33.	3	40	6	6	1	345
327	19.	80	44.	30	40.	80	35.	0	35	6	6	1	345
328	19.	30	29.	23	02.	50	16.	7	36	6	6	1	345
329	08.	00	06.	66	14.	70	09.	8	33	6	6	1	345
330	14.	70	03.	80	04.	00	07.	5	34	6	6	1	345
331	75.	10	66.	30	49.	50	63.	6	37	6	6	1	345
332	10.	40	06.	00	14.	30	10.	2	38	6	6	1	345
333	34.	50	03.	10	16.	30	18.	0	39	6	6	1	345
334	59.	00	62.	20	31.	70	49.	6	40	6	6	1	345
335	17.	70	22.	40	08.	50	16.	2	35	6	6	1	345
336	25.	00	12.	80	35.	50	21.	1	36	6	6	1	345
337	06.	40	46.	40	09.	00	20.	6	36	6	6	1	346
338	02.	40	27.	80	56.	30	28.	9	34	6	6	1	346
339	39.	50	38.	50	15.	00	31.	0	37	6	6	1	346
340	25.	60	04.	40	24.	30	18.	1	38	6	6	1	346
341	28.	40	12.	60	25.	60	22.	2	39	6	6	1	346
342	69.	40	47.	10	11.	90	42.	8	40	6	6	1	346
343	26.	00	39.	30	43.	90	36.	4	35	6	6	1	346
344	07.	90	20.	80	05.	40	11.	4	36	6	6	1	346
345	06.	40	09.	50	31.	40	15.	8	33	6	6	1	346
346	14.	50	38.	40	26.	80	26.	6	34	6	6	1	346
347	71.	60	75.	30	71.	80	72.	9	37	6	6	1	346
348	24.	90	17.	20	09.	40	17.	2	38	6	6	1	346
349	45.	40	00.	50	33.	60	26.	5	39	6	6	1	346
350	49.	10	16.	20	50.	10	37.	1	40	6	6	1	346
351	01.	70	49.	00	11.	10	20.	6	35	6	6	1	346
352	34.	10	01.	80	09.	60	15.	2	36	6	6	1	346
353	17.	10	24.	30	34.	10	25.	2	33	6	6	1	347
354	00.	60	10.	40	22.	00	11.	0	34	6	6	1	347
355	20.	60	02.	00	55.	30	26.	0	37	6	6	1	347
356	07.	40	09.	40	11.	20	09.	3	38	6	6	1	347
357	43.	90	29.	40	27.	20	33.	5	39	6	6	1	347
358	64.	50	54.	20	39.	80	52.	8	40	6	6	1	347
359	24.	90	05.	00	37.	60	22.	5	35	6	6	1	347
360	06.	10	00.	70	28.	60	11.	8	36	6	6	1	347
361	07.	70	14.	60	02.	40	08.	2	33	6	6	1	347
362	31.	30	71.	70	11.	50	38.	2	34	6	6	1	347
363	65.	30	67.	50	66.	90	66.	6	37	6	6	1	347
364	13.	70	18.	60	10.	60	14.	3	38	6	6	1	347
365	02.	60	20.	80	03.	70	09.	0	39	6	6	1	347
366	09.	60	53.	30	35.	70	32.	9	40	6	6	1	347
367	37.	60	42.	40	41.	40	37.	1	35	6	6	1	347
368	32.	10	24.	10	16.	60	24.	3	36	6	6	1	347
369	30.	20	03.	60	31.	70	21.	8	33	6	6	1	348
370	12.	90	24.	50	34.	90	24.	1	34	6	6	1	348
371	34.	70	32.	20	61.	40	42.	8	37	6	6	1	348

Table D (continued)

Line	Trials			Mean	Subj	Cell			Series
	1	2	3			A	B	C	
372	18.40	26.00	13.70	19.4	38	6	4	1	348
373	30.40	13.50	30.00	24.6	39	6	4	1	348
374	42.30	23.10	51.60	39.0	40	6	4	1	348
375	37.40	26.20	26.80	33.5	35	6	4	1	348
376	22.70	14.10	55.20	30.7	36	6	4	1	348
377	48.30	56.80	61.10	54.4	33	6	4	2	348
378	79.90	43.80	35.60	53.1	34	6	4	2	348
379	53.00	44.70	64.40	54.0	37	6	4	2	348
380	09.70	14.80	01.20	08.2	38	6	4	2	348
381	57.00	38.20	45.80	47.0	39	6	4	2	348
382	63.10	47.00	63.20	57.8	40	6	4	2	348
383	46.10	41.20	37.10	41.5	35	6	4	2	348
384	50.80	65.30	43.00	53.0	36	6	4	2	348

Table E
 Transformed Data Matrix
 Experiment 2: Target Interval 3000ms
 Raw Scores transformed by
 transformation $\sqrt{x} + \sqrt{x+1}$

		C ₁				C ₂			
		B ₁	B ₂	B ₃	B ₄	B ₁	B ₂	B ₃	B ₄
A ₁		10.2	8.1	11.5	9.3	7.2	5.9	15.2	7.4
		7.5	9.0	6.0	13.0	6.1	8.0	8.4	8.0
		15.5	13.3	14.3	16.0	14.3	14.6	15.9	14.1
		9.8	10.8	4.2	11.5	8.5	9.6	10.4	8.2
		12.7	10.5	12.6	9.6	4.4	9.1	11.5	9.4
		11.4	13.9	12.9	16.8	4.9	4.7	4.6	6.8
		15.1	16.3	14.8	16.4	11.2	11.8	11.3	11.5
		6.0	8.9	5.1	5.7	3.8	4.6	6.3	5.5
		11.1	13.3	10.4	10.1	12.8	10.2	12.7	13.6
		9.5	7.1	8.4	7.2	12.5	13.5	13.7	12.5
A ₂		8.9	11.6	11.6	8.5	15.9	14.9	12.7	13.5
		12.2	10.7	10.7	9.7	13.5	6.6	7.7	10.2
		13.2	8.6	7.3	10.1	12.0	11.1	12.8	8.2
		13.8	14.7	11.1	10.7	10.6	14.3	6.6	15.2
		7.0	7.9	7.6	7.3	11.1	7.5	8.2	4.2
		12.6	10.6	7.5	8.3	10.8	6.7	7.3	8.3
		13.3	12.8	13.0	15.2	10.3	12.7	15.1	12.7
		8.6	6.0	6.9	13.7	7.0	6.1	6.8	11.7
		11.4	7.9	10.0	12.7	11.0	13.0	13.5	11.7
		7.3	9.6	11.2	4.4	11.7	5.8	10.1	11.8
A ₃		8.6	8.2	8.2	14.3	9.2	8.7	9.5	11.6
		7.6	7.7	11.9	11.9	7.1	6.6	7.4	12.2
		9.9	11.9	11.0	11.1	11.5	9.5	8.3	13.1
		7.4	8.1	9.3	7.0	9.2	7.6	9.1	7.5

Table E (continued)

	C ₁				C ₂			
	B ₁	B ₂	B ₃	B ₄	B ₁	B ₂	B ₃	B ₄
A ₄	11.6	9.4	10.8	10.3	13.5	10.7	11.5	12.9
	11.3	8.2	9.0	9.7	8.5	8.3	9.2	12.7
	12.6	6.7	13.0	7.0	12.8	9.4	9.9	10.1
	16.9	6.2	8.6	7.0	7.2	8.3	10.2	10.1
	8.7	8.2	6.2	6.8	6.4	9.4	6.2	9.3
	11.6	9.6	9.9	7.8	13.6	9.3	11.8	12.6
	9.1	8.1	12.3	13.4	5.3	9.4	7.2	8.6
	9.0	13.2	8.9	9.4	10.1	9.9	9.1	13.1
	12.0	13.1	13.7	12.0	11.6	8.1	14.5	13.3
	11.7	13.1	13.3	13.9	10.9	14.4	9.2	13.3
A ₅	5.8	8.0	8.6	6.7	12.4	6.8	7.7	11.9
	12.7	13.1	12.4	12.0	7.8	11.9	10.7	14.1
	13.3	10.9	8.5	14.7	8.1	8.0	6.7	12.3
	10.3	9.2	14.0	12.9	9.1	7.2	7.5	12.3
	10.6	11.2	10.9	11.6	5.9	6.1	6.7	8.8
	8.8	10.2	11.2	11.9	13.0	12.0	13.2	11.3
	11.2	9.2	10.1	9.4	6.4	8.1	5.9	14.8
	12.4	10.8	6.8	9.9	5.7	10.4	12.4	14.6
	11.1	11.2	10.3	13.2	16.0	17.1	16.4	14.8
	7.3	8.6	6.3	8.9	6.5	8.4	7.7	5.9
A ₆	9.4	9.5	11.7	10.0	8.6	10.4	6.2	13.8
	11.6	13.2	14.8	12.6	14.2	12.3	11.6	15.3
	11.9	12.1	9.6	11.7	8.2	9.2	12.3	13.0
	8.3	6.9	7.0	11.2	9.3	7.9	10.0	14.6

APPENDIX G

Table E

3-Way Anova Interpretation Procedure

Kirk (1968)

