AN INFORMATION PROCESSING MODEL OF TEMPORAL DURATION AND EXTRAVERSION

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ABSTRACT

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TEMPORAL DURATION AND EXTRAVERSION

By

Melvin Berg

This study presents a theory of temporal duration based on an information processing model. That is, estimation of duration is a function of the amount of information stored in memory during a given interval; the more data input in storage the more time is estimated to have passed. The other variables such as anxiety, motivation drugs, and task unity which the research literature indicates influences temporal duration do so indirectly by affecting the storage of information. This in turn determines the experience of duration.

An experiment was designed in which the amount of information processed would be an intervening variable controlled by the perceptual and cognitive set established in the subject by the instructions. Two virtually identical series of cartoons with 10 cartoons in each series

were constructed. These depict geometrical objects in motion. The cartoons varied in duration from .58 sec. to 3 sec. In the physical perception condition the subject was asked to view the cartoon as mere physical objects, to remember the content and make an estimate of the duration of the film by the method of reproduction. In the social perception condition the subject was asked to interpret the cartoon as people in social interaction, to remember the content and make a time estimate of the duration of the film by the method of reproduction. It was assumed that the cartoons in the social perception condition would be labeled and coded in such a manner that less information would be in storage. In the physical perception condition all of the discrete movements of the objects must be stored in memory; however, in the social perception condition the amount of information stored can be reduced by coding the input as social behavior. By storing a socially descriptive label such as a fight, a party, or rendezvous which seems to summarize the content of the cartoon all of the minor details can be derived. Thus the same amount of input in both conditions is stored but in the social perception condition less information need be processed.

Hypothesis I states that information perceived during an interval and interpreted as social behavior will result in shorter time estimates of that interval than a condition where stimilar stimuli are perceived as movements of physical objects.

Subjects high on the extraversion scale are more vigilant to the external environment and process more input therefrom than subjects scoring lower in extraversion. If extroverts process and store relatively more data input from the environment than introverts then their duration estimates of given intervals should be relatively longer. Thus Hypothesis II follows: extraversion correlates positively with the length of duration estimated.

Eighteen undergraduate subjects consisting of eleven females and seven males were run through the experiment.

The results show that there was not a significant difference in time estimates in the social and physical perception condition. Thus Hypothesis I was not confirmed. Nevertheless an interaction effect was found such that for intervals greater than 1.60 sec. estimates in the social perception condition are higher. This does lend support to the theory.

Hypothesis II received some support from the data for extraversion was found to have a high correlation in the physical perception condition but not in the social perception condition. Reasons for this are discussed.

The indifference interval for these data is around 1.25 sec. which suggests that the indifference interval is a function of the experimental conditions and not a constant.

Strong sex determined differences were found showing that estimates by females were significantly shorter than those by males.

Approved: ____________________

Date: ____________________

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By

Melvin Berg

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For my parents and Maxibean
and the Clear Mountain mysteries in you all:
the strength of heart, the sparkle of eyes,
these flames of vision. Your source of wonder.

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CHAPTER I

INTRODUCTION

This paper will develop and try to find evidence for the theory that temporal duration is a result of a cognitive process. This process makes use of that which is perceived and the manner in which this material is stored in memory as input. The ability to estimate duration, the "time sense," is not a mode of sensation analogous to vision or audition, for time itself is not perceived, but objects, events, and the transformations of the relationships between them. First, there are no receptors for "time stimuli." Secondly, there is no physical energy transmission such as occurs with light and sound which can be identified as the external source of stimulation. Rather, time is related to the amount of information stored in memory during a given interval.

The process of temporal estimation depends upon the information derived from the receptor organs mediating the other senses, primarily the eyes and the ears, and how this material is stored in memory. In the past, this has been formulated as the amount of "change" (Fraisse, 1963), or the amount of "mental content" (Sturt, 1923, 1925) stored during an interval that determines the estimation of duration.

Typically, man orients himself in time by observing some physical change which is presumed to occur at a constant rate. This is exemplified by counting the number of full moons that have occurred since a past event, the number of times the sun rose, or the number of revolutions of the hour hand around the face of a clock. In this sense, time is a quantification of change perceived in the environment by the observer.

By monitoring the amount of change that has occurred in the environment or the amount of time that has passed a person can maintain his orientation in the temporal course of expected events and be prepared for whatever will happen next; e.g. "in 10 minutes the concert will begin so I must coordinate my behavior in order to be in my seat within a 10-minute duration." Or another example might be that "in about one second the person I am speaking to will probably make a certain facial expression and at that time it will be necessary to focus my attention on certain facial features so as to confirm my expectation of his meaning and thus clarify the communication." The measurement of duration is made with the express purpose of adapting perceptual and motor acts to the exigencies of a changing environment. By quantifying these transformations, behavior can be made compatible with the changes predicted to occur within the environment and the most suitable course of action to be taken.

Four major theoretical orientations have been developed in order to deal with the problem of duration: the perceptual moment hypothesis, the alpha wave theory, the biological clock theory, and the information storage model.

Stroud (1956) and White (1963) suggested that perceptual input received over a duration of 100 msec. is integrated into a single "quantum of datum." Each of these constitutes a "perceptual moment" and defines what is commonly called the "present." As quanta of perceptual moments are channeled through a neural counting device, time is judged to be passing and duration can be estimated by the number of perceptual moments which have been counted. However the perceptual moment theory fails to account for accuracy of judgments which are not integral multiples of the basic unit period of 100 msec. (Michon, 1967); that is, periods of 130, 575, or 910 msec. would be indescriminable from intervals of 100, 500, or 900 msec., respectively, if the basic unit is 100 msec. Michon (1967) indicates that this is just not so. Secondly, this theory suggests that duration is free from the influence of the organization of the perceived content and the motivational set of the observer. Evidence cited by Fraisse (1963), however, shows that content of the stimuli and motivational variables are crucial in their influence upon temporal estimation.

Another theory, initiated by Wiener (1948), holds that the alpha rhythm of the EEG is a manifestation of the pulse of a biological clock. Since the phase length of the alpha wave is about equal to the 100 msec. of the perceptual moment, the alpha wave could be a physiological manifestation of the beats of the neural time clock as the perceptual moments register on it. The problem with this hypothesis is that the alpha rhythm is absent from the EEG for the greater part of the day when time estimates are being made (Michon, 1967). Additionally the empirical evidence suggests that there is no correlation between estimates of duration and the frequency of the EEG

(Murphee, 1954; Wright and Kennard, 1957; Legg, 1967), further suggesting that temporal estimation has no direct connection with brain wave activity.

The third line of research posits that physiological organ functioning provides a time clock by which duration is estimated. Boring (1917) found that accurate time estimates could be made by subjects awakened at various times during sleep by their analysis of cues from their digestive and excretory systems. These cues can be used at a high level of accuracy as shown by MacLeod and Roff (1938) whose subjects were isolated for 48 to 86 hours and produced time estimates of the entire period accurate to within minutes. The circadian rhythm of organ functioning can serve as a gross expectancy table guiding the estimate of long periods; however, it provides no cues for the estimate of short time intervals ranging in minutes.

It is feasible that intervals too fine to be discriminated by the circadian organ rhythms could possibly be estimated by the monitoring of neural signals emitted by the function of certain organs. These would provide a pulse, the counting of which would provide beats to be counted for estimating duration. This is similar to the alpha wave theory, for they both rely on the counting of some neural beat. However Schaeffer and Gilliland (1938) did not find any relationship between duration estimates, pulse rate, or breathing rate.

Another physiological approach sought to find the biological clock within the metabolic processes. Francois (1927) showed that tapping rate increases when body temperature is artificially increased. Pieron (1923) speculated that the sense of duration depends upon the speed of the metabolic processes. Hoagland (1966) reports that time estimates vary directly with body temperature as does also the speed of counting. Heart rate, respiration, and alpha rhythm frequency, Hoagland found, were also correlates of body temperature. Hoagland suggests that the sense of time is determined by the speed of metabolic reactions in certain brain cells which serve as an internal time keeper. The more chemical change occurring within these cells the more time is estimated to have elapsed.

This metabolic velocity hypothesis was given support by Cahoon (1966) whose subjects produced temporal underestimations at high altitudes. Correspondingly alpha frequency was reduced as Hoagland would have predicted.

The assumption is that anoxia caused a depression of the metabolism in the "time clock cells."

The relevance of the speed of the metabolic processes as an influence upon time estimation was given support by Thor and Crawford (1964). They detected in their subjects who were isolated for 15 days a consistent overestimation of duration in the afternoon hours and a consistent underestimation during the morning hours when the metabolic rate is typically lower.

In line with this approach is the research showing that any drug which accelerates vital processes lengthens the experience of duration (Fernberger, 1932; Bromberg, 1934; Kleber, Lhamon, Goldstone, 1963; Fischer, 1967). Analogously those chemicals which decelerate functioning lead to underestimates of duration (Goldstone, Boardman, and Lhamon, 1958; Kirkham, Goldstone, Lhamon, Boardman, and Goldfarb, 1962). These correlations between physiological condition and temporal experience and behavior are consistent and appear to be theoretically valid. Nevertheless the location of a specific organ of chronometric function has not been designated much less the mode of its operation.

The Present Approach

A more economical approach which takes into account all of the evidence for a biological pacemaker is the information processing model. Changes in physiological functioning have a direct effect upon cognitive operations and information processing. The information processing model accounts for the influence of physical factors such as drugs and metabolic activity as well as stimulus conditions and motivational state, because the common denominator in all of these variables is the rate of information processing.

In the present thesis information is not defined in the technical manner as used in communication theory. Rather it is defined in its common usage sense as knowledge concerning a particular circumstance and the manner in which this is stored in memory as opposed to the technical sense as a measure of choice reduction or uncertainty (Shannon and Weaver, 1949; Miller, 1953, 1956; Berlyne, 1960). In most of the studies to be cited in this thesis information storage enters as an intervening variable, and not as a process which has been controlled and quantified.

In order to clarify the concept of information processing and information storage as used in the present thesis Ornstein's (1968) metaphor of storage space and his computer model will be discussed. Memories can be thought of in terms of input to a computer. Here we can measure "the size of the array or the number of spaces or number of words necessary to store the input information" (Ornstein, 1968). The more numerous the elements in the input or the more varied are the elements of the input, the larger the storage space this information must subtend in the memory banks. An input composed of varied items such as 830542 requires more storage space than a homogeneous input like 000000 although the ultimate number of elements is equal as is the amount of information. With the storage of information during a given interval either increasing the number of stored events or the complexity of the input increases the size of the storage space.

In the example cited above the number of basic elements in 000000 and 830542 is equal but the former can be stored as 6X0. This recoding consolidates the information into a more economical form which subtends less storage space. So the usage of a summarizing label reduces the size of the storage space. With other things equal the more compact the memory load, the smaller the storage space and this implies relatively shorter duration. The experience of duration is then a function of the size of the space used to store the information processed during a given interval.

A Review of Research on Time Estimation

It is expected that as the number of events processed increases, storage space used for the memory of those events increases. Thus one procedure used in temporal estimation research is to vary the number of events during an objective time interval. Matsuda (1966) varied the amount of input by presenting buzzer tones of equal length at various frequencies for intervals of 4 and 10 seconds. The intervals of higher input frequency were judged to be significantly longer. With a similar experimental design Ornstein (1968) used intervals of 9 minutes in length. Ornstein (1968) found that the interval with the greater frequency of stimuli was judged to be significantly longer. For a period of 1.5 min. Miller, Frauchiger and Kiker (1967) had their subjects view photic stimulation varying from 30 to 150 cpm. Verbal estimates of the length of the interval indicated that subjective duration is a function of the amount of perceptual input and, presumably, the amount of information in storage.

These experiments reduced the stimulus conditions to a very simple level of stimulation, i.e. tones and light flashes. Ornstein (1968) employed stimulus material more typical of that encountered in everyday situations. In Ornstein's (1968) experiment subjects viewed line drawings of abstract figures for 30 seconds after which they gave estimates of the duration during which they viewed the drawing. The number of interior angles served as a measure of stimulus complexity. Subjective duration varied directly with the degree of stimulus complexity. The effects of varying auditory stimulus complexity were shown to bear the same relationship to duration estimates when melody complexity was manipulated (Yeager, 1969).

A reduction of external input should have the effect of reducing the relative size of the storage space. The small size of the storage space should lead to temporal underestimations. The research on sensory deprivation indicates that periods of 1.5 hours (Banks and

Cappon, 1962), 18 hours (Sato and Ohyama, 1965), 48 hours (Ueno, Ohyama, Oyamala, and Kato, 1966), and 54 hours (Vernon and McGill, 1963) are all underestimated. However only the Banks and Cappon (1962) study employed a control group which estimated the duration under normal conditions.

The dependence of duration upon memory is made evident by the data describing the "time order error effect" (Woodworth and Schlosberg, 1954; Falk and Bindra, 1954; Treisman, 1963). The "time order error effect" is the progressive shortening of estimates of interval length when subjects attempt to produce intervals of the same length consecutively after having been exposed to an example of that interval. Ornstein (1968) explains that this phenomenon illustrates the dependence of duration estimates upon the amount of information remaining in storage. As the example interval fades from memory, the input registered during that interval fades from memory. The storage space associated with that interval becomes smaller and smaller as time passes. Thus the intervals produced by the subject which are attempts at reproducing the example interval grow shorter and shorter in length as the memory fades and the storage space becomes smaller.

As information processed during an interval fades from memory and the storage space shrinks, the duration of that interval seems to be shorter. In order to control the amount of storage decay, Ornstein (1968) used a learning task in which he could control memory decay. He found that words paired with harsh sounds during learning were not retained as well as words paired with neutral sounds. Immediately after the learning task information storage and retention for the two groups, words paired with harsh sounds and worked paired with neutral sounds, was equal. Similarly the duration estimates of the learning period for the two groups were equal immediately after the learning period. After two weeks though the duration estimates of the harsh group were significantly shorter than those in the neutral group. Thus as the words paired with the harsh sounds faded from memory, the storage space associated with the learning period grew smaller and consequently the duration estimates of the learning period were shorter than those for the neutral sound group. This points to the importance of the amount of information remaining in storage for the estimation of duration.

A series of experiments in which information coding was manipulated suggests a relationship between duration and the manner in which information is coded and stored. Over a series of 5 min. intervals, Ornstein (1968) presented a number of tones at a constant frequency. In the easily codable condition each sound was repeated in a block of 20 presentations and in the noncodable condition the sounds were randomly presented. The data show that duration in the noncodable condition was relatively overestimated. In the easily codable condition, it seems that the information can be more economically stored with a usage of smaller storage space.

The manner in which data is stored is dependent upon the perceptual set with which the observer perceived the material as well as the inherent structure of the material. The conceptual schemes and labels with which the input is perceived influences the manner in which it is coded and the size of its storage space. Ornstein (1968) trained observers to perceive a dance film by dividing it into either 2, 6, or 11 subunits. Duration estimates by the observers were found to function directly with the number of subunits they were trained to see. Perceiving the dance as two subunits allowed for the most economical storage of the data and allowed for the usage of the smallest storage space.

Duration and the Extraversion Dimension

Individuals can be characterized by their position along the extraversion-introversion dimension. This runs from pre-occupation with the inner world of the self in the extreme introvert to preoccupation with external reality in the extreme extrovert (Murphy, 1947). Thus a person may be devoted to interaction with the environment through mediation of exteroceptors or devoted to dwelling on cerebral and autonomic processes. In the case of the extravert it is expected that with the emphasis on the external environment data input and storage would be relatively high. The relatively greater amount of perceptual input and the consequent greater usage of storage space in the extravert as compared to the introvert would suggest that extraverts produce relatively larger estimates of duration. This was confirmed by Du Preez' (1967) findings that extraversion correlates positively with the estimation of duration.

CHAPTER II

EXPERIMENTAL DESIGN

In the present experiment it is assumed that the use of a summary label from which further information can be derived reduces the storage space relative to the situation where no meaningful label is already available. Without the availability of a summarizing label information must be stored in numerous discrete units. So in the example already introduced the summary label 6X0 involves less storage space than 830542 even though an equal number of elements are ultimately involved. In the case of 830542 all of the elements must be stored individually since their order is arbitrary and no pattern of redundant meaning exists. In the present experiment a film showing arbitrary movements of geometrical objects will be presented in one condition and in another condition it will be suggested to the same subjects that this material should be perceived in terms of social situations described by short summary labels i.e. going on a date, a fight, etc. The films presented in both conditions are different with respect to the direction of movement taken by the objects, but in all meaningful dimensions they are similar. That is the number of objects shown in the film is the same; the duration of the films in both conditions is equal; the number of movements the objects go through are identical in both conditions. The experimental manipulation lies in the instructions given to the subjects. In one of the conditions, the social perception condition, the subject has the benefit of using a social set with which to perceive the stimuli. In the social perception condition the subject also has the benefit of being able to remember what has occurred under the rubric of a simple social label. Since the details of what has occurred are coded into the label, it is assumed that less storage space is used in forming the memory. Thus Hypothesis I was derived:

> Hypothesis I: information perceived during an interval and interpreted as social behavior will result in shorter reproductions of that interval than a condition where similar stimuli are perceived as random movements of inanimate objects.

Since extraverts are more vigilant to the external environment than introverts, and consequently take in more data input, we predict:

Hypothesis II: extraversion correlates positively with the length of duration estimates.

CHAPTER III

METHOD

Subjects

Eighteen subjects, seven male and eleven female students, volunteered, for credit, from undergraduate psychology classes at Michigan State University.

Apparatus

The apparatus included a 16mm Keystone projector model K161, a 7 amp rheostat speed control, a 6 volt power pack, a clock timer, a telegraph key and hookup wire, and the Maudsley Personality Inventory (Eysenck, 1962).

Stimulus Material

Twenty-two film animations showing two black triangles and a circle entering and exiting from an opening on one side were constructed. A rectangle, 3 X 4 in. with a 1 in. gap on one side was drawn on the blank side of graph paper 20 squares-to-the-inch (see Figure 1). A one half inch equilateral triangle, a three-quarter ince triangle, and a circle one half inch in diameter were cut from black construction paper and were used as the cartoon figures in the animation process.

The graph paper was mounted on the glass panel of a 20 X 15 in. light box with the ink side of the graph paper facing down. The light box consisted of a wooden box 20 X 15 X 5 in., two fluorescent bulbs, a switch for the bulbs, and the upper 20 X 15 in. panel was of frosted glass. When the bulbs were turned on it allowed the graph lines to show through, enabling the Experimenter to move the objects a specified number of squares for each exposure. After the objects were moved the proper number of boxes, the lights in the box were turned out so that the graph lines could not be detected in the film print. The light box was placed on the base of an animation stand with a 16 mm camera mounted directly overhead. A cable release was used to operate the shutter.

Each cartoon consists of three scenes of equal duration or an equal number of frames. A scene is, in the present experiment, defined as consisting of a discrete movement of one of the three objects. Thus a

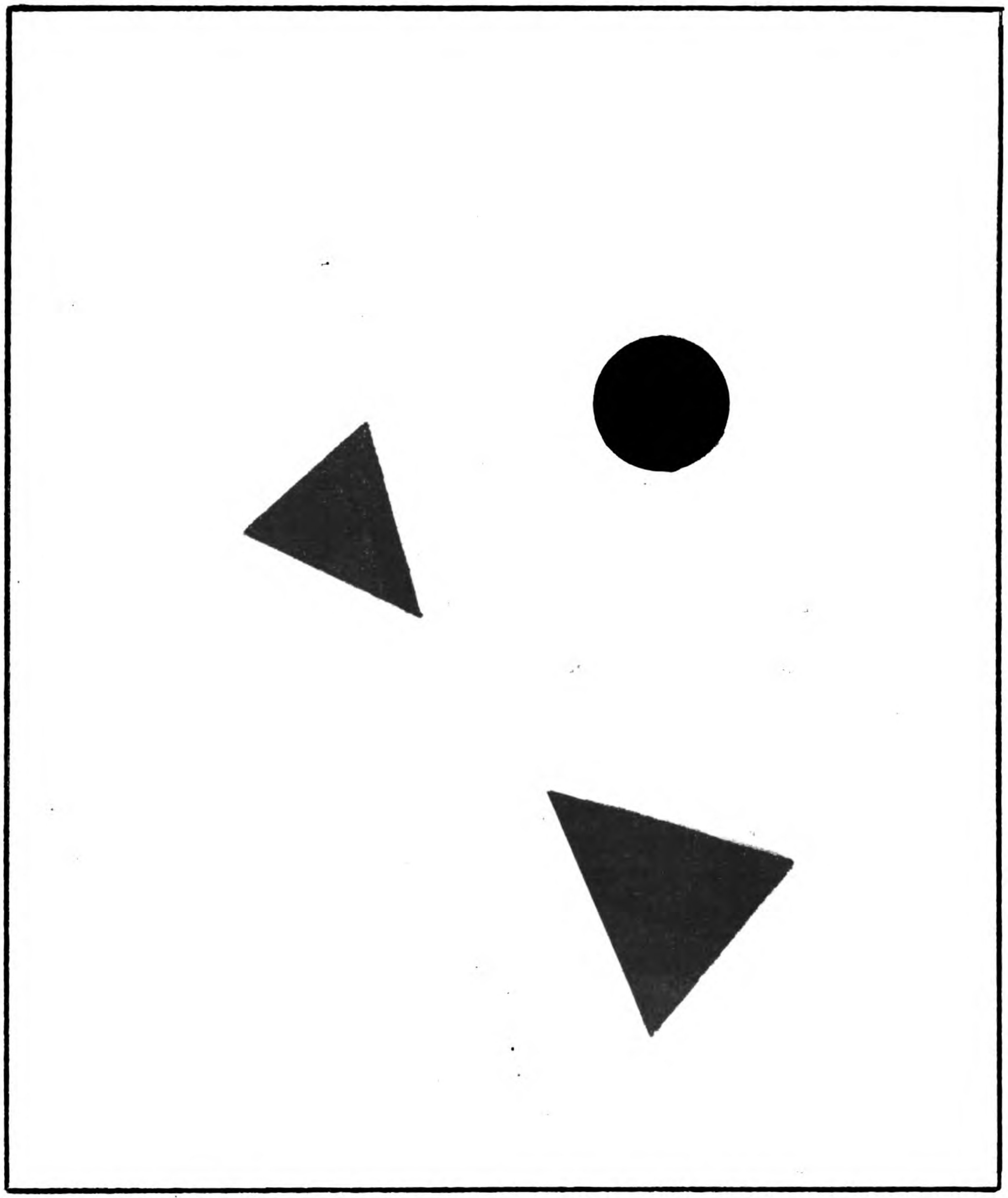

Fig. 1.--A sample frame of the cartoons.

cartoon 12 frames long consists of three scenes with four frames in each scene. In all of the cartoons objects were moved at the rate of 15 squares per frame over the graph paper. The movement patterns were arbitrarily determined. Two series of cartoons of 11 different durations were constructed making 22 cartoons altogether. The cartoons in each series were composed of the following number of frames: 6, 7, 8, 9, 10, 12, 15, 18, 21, 24, and 36 frames. With the projector running at 12 frames per second this makes the cartoons run for the following durations: .50, .58, .66, .75, .83, 1.0, 1.25, 1.50, 1.75, 2.0, 3.0 sec. Each cartoon was spliced onto a separate film loop between 3 feet of black leader.

Procedure

Prior to running each subject the order in which he received the social and physical perception condition was randomly determined. Secondly, the film strip of each duration which was to appear in the social and physical perception condition was randomly chosen from the two sets of equivalent films. Thirdly, the order of presentation of the films within each condition was randomly determined.

Upon entering the experimental room the subject was seated in a chair three feet in front of a 2 X 3 ft. projection screen. Depending upon which condition is given first, the following instructions were read by the experimenter:

Physical Perception Instructions

A series of film sequences showing geometrical objects being moved through a box will be shown to you. In order to muffle the sound of the projector you will wear earphones during the experiment. When the experimenter says OK the projector will be turned on and in about 2 more seconds the movie screen will light up and the film will begin. Immediately after the animation ends, that is when the screen goes dark, depress the switch for a duration equal to the actual duration of the film you have just viewed. When making your duration estimate, estimate only the duration of the actual film animation when the screen is illuminated and not the entire duration when the projector is on. After you have made your estimate the experimenter will ask you to describe the movements of the objects which occurred in the film. You may describe them in terms of length, and direction. You will be given two practice trials after which the experiment will begin.

Social Perception Instructions

A series of film animations showing people and their movements around a house will be shown to you. In the cartoon the people are represented by a large triangle, a small triangle and circle. The house is represented by a rectangle. Think of these objects as people. In order to muffle the sound of the projector

> you will wear earphones during the experiment. When the experimenter says OK the projector will be turned on and in about 2 more seconds the movie screen will light up and the cartoon will begin. You will know when the cartoon has ended for the screen will go black. Immediately after the end of the cartoon depress the switch for a duration equal to the actual duration of the cartoon you have just viewed. When making your duration estimate, estimate only the duration of the actual cartoon when the screen is illuminated and not the entire duration when the projector is running. After you have made your estimate the experimenter will ask you to describe the social situation portrayed in the cartoon. A two or three word description will suffice i.e. a party, an escape, etc. You will be given 2 practice trials after which the experiment will begin.

The telegraph key switch hooked up to the clock timer was placed in front of the subject who was seated at a desk. The clock timer registered the length of duration for which the switch was depressed. The subject was asked to put on earphones so as to muffle the projector noise. The lights were turned out and a sample film strip was placed in the projector which ran at 12 frames per second. Each film loop was placed in the projector so that 24 frames of opaque leader ran past the lamp before the film began. This gave a preparatory period of two seconds between the turning on of the projector and the beginning of the cartoon. The two films of .50 sec duration served as the sample films for all subjects. In each condition one of these two sample films was shown twice to the subject before the experiment began. After the cartoon was over the screen went blank. The projector was kept running until the subject completed his reproduction of the duration of the cartoon. After the projector was turned off the subject was asked for the description of the cartoon.

After the second condition was administered, the subject was given the Maudsley Personality Inventory (Eysenck, 1962).

CHAPTER IV

RESULTS

The range of extraversion scores on the Maudsley Personality Inventory was from 7 to 42 with a mean of 30.17.

The subjects made a time estimate of the intervals in the social and the physical perception condition. Thus, for each of the 10 intervals the 18 subjects made a time estimate in the physical perception condition and in the social perception condition. The means of all the time estimates at each interval and within each condition are presented in graphic form in Figure 2.

The data were analyzed by a two-way condition x interval type analysis of variance. This analysis showed a significant main effect of interval length ($F = 19.23$, $df = 9$, $p < .001$). The main effect for the conditions was not significant. Thus Hypothesis I was not supported by this test of the main effect. The interaction of condition x interval was significant ($F = 21.87$, $df = 9$, $p < .001$). These data are summarized in Table 1.

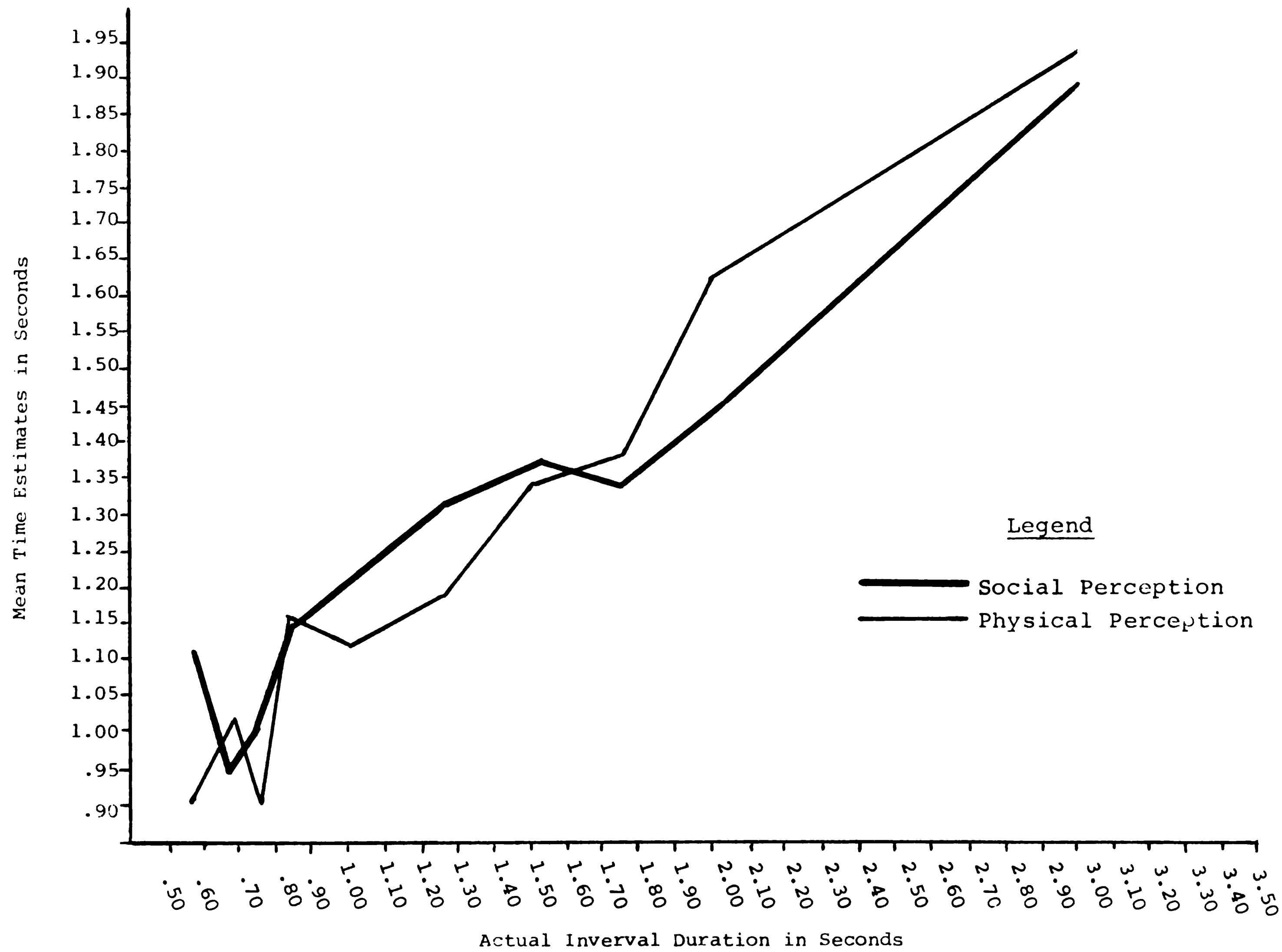

Fig. 2.--Mean Time Estimates with Respect to Actual Interval Duration

TABLE 1

SUMMARY TABLE OF ANALYSIS OF VARIANCE COMPARING TIME ESTIMATES WITH RESPECT TO PERCEPTUAL CONDITION AND LENGTH OF THE TIME ESTIMATE

Source	SS	df	MS	F
Total	581.43	359		
A (Condition)	.08	1	.08	.53
B (Interval)	26.92	9	2.99	19.93***
AXB	29.55	9	3.28	21.87***
Error	51.32	340	.15	

***$p < .001$

Each subject's time estimate across the 10 intervals in both the social and physical perception condition was computed. This yielded 18 sums for the social perception condition and 18 sums for the physical perception condition. For each condition the correlation of the subjects' sum time estimate with the subjects' extraversion score was computed using the Pearson product moment formula. The correlation of the total time estimated in both conditions with extraversion was also computed. These results are presented in Table 2.

TABLE 2

CORRELATIONS OF TIME ESTIMATES WITH EXTRAVERSION

Estimate	r	p	df
Social Perception	.23	.10	16
Physical Perception	.66	.005	16
Total: Physical and Social Estimates	.45	.05	16

For the correlation of time estimates in the social perception condition and extraversion r = .23. This was found to be insignificant at the .05 level of confidence. For the correlation of time estimates in the physical perception condition and extraversion r = .66. This correlation was found to be significant at the .005 level of confidence. For the correlation of total time estimated with extraversion r = .45. This was found significant at the .05 level of confidence. Although the correlation of time estimated in the social perception condition and extraversion was insignificant, the correlation and extraversion was significant and so provided support for Hypothesis II.

Additional Results

The data were analyzed for sex differences in the length of duration estimates. For each subject the sum of the two time estimates for each interval was computed. For each interval the mean of these sums was computed separately for males and females.

An analysis of variance was performed comparing the means for the females with the means for males. This analysis showed a significant effect of interval length ($F = 34.50$, $df = 9$, $p < .001$). Also a significant effect of gender was found ($F = 34.50$, $df = 1$, $p < .001$). These data are summarized in Table 3. Figure 3 shows that the males consistently made longer time estimates than the females.

TABLE 3

SUMMARY TABLE OF ANALYSIS OF VARIANCE COMPARING THE MEANS OF THE SUMS OF THE SOCIAL AND PHYSICAL TIME ESTIMATES WITH RESPECT TO GENDER

Source	SS	df	MS	F
Total	7.14	20		
A (Sex)	.69	1	.69	34.50***
B (Interval)	6.25	9	.69	34.50***
Error	.20	9	.02	

***p < .001.

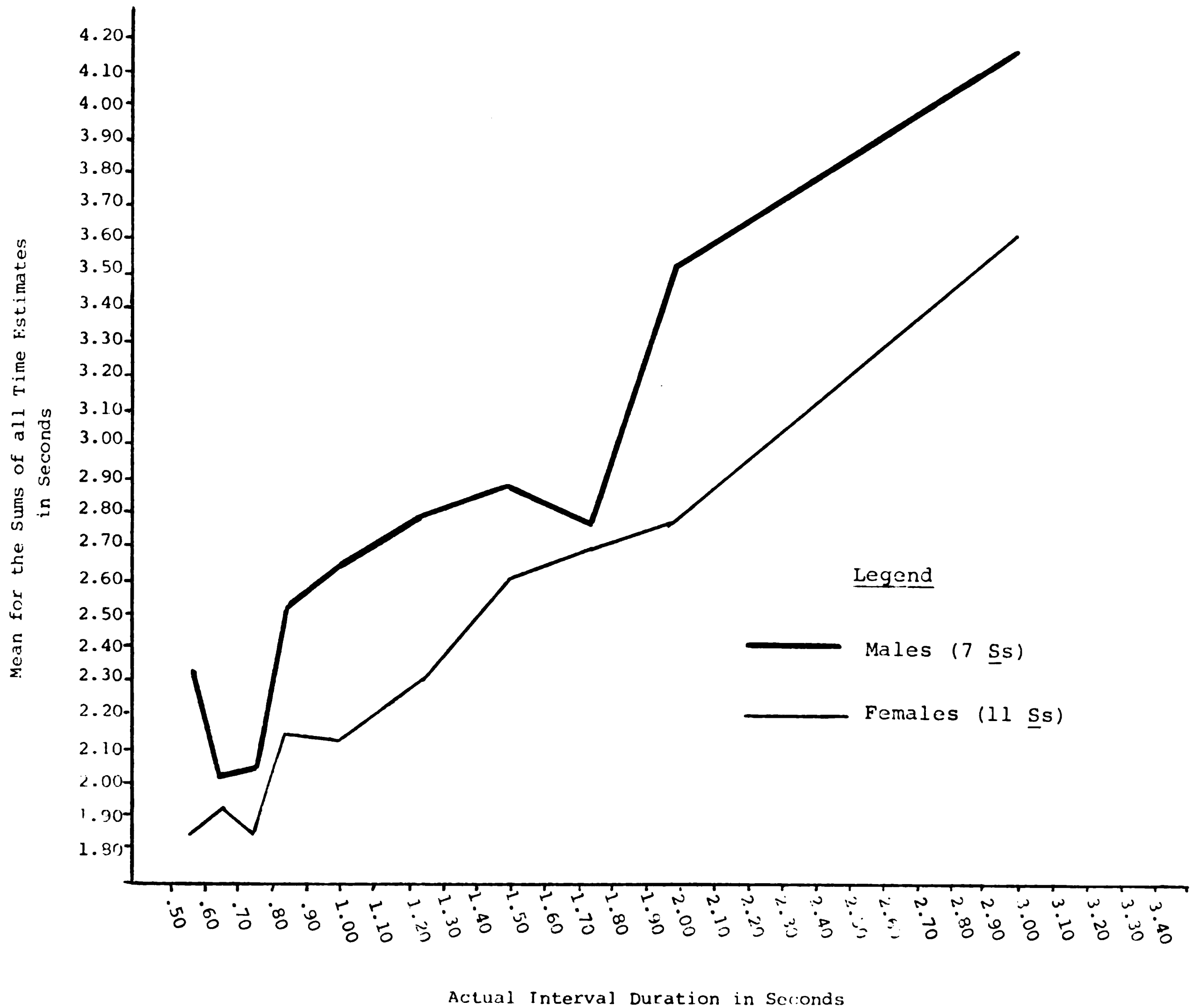

Fig. 3.--Mean for the Sums of all Time Estimates with Respect to Gender.

CHAPTER V

DISCUSSION

The analysis of variance showed that there was a significant difference amongst the temporal estimates across intervals. That is as the objective interval length got longer so did the estimates of these intervals. This suggests that the subjects in this experiment achieved some degree of accuracy, beyond chance, in estimating the duration of the intervals.

The analysis showed that there was not a significant main effect difference between the length of the duration estimates across the social and physical perception conditions. Hypothesis I was not supported by this finding. Possible true differences resulting from the two conditions may have been washed out by residual projector noise, audible despite the use of earphones. This noise was constant and uniform while the projector was turned on in both conditions. Attention to the projector noise provided added stimulation which could have served as cues for temporal estimation in both conditions. The presence of these constant cues from the noise may have caused the subjects to pay less attention to visual stimuli upon which the experimental manipulation was based. This constant error flattened possible differences in experimental effects.

The analysis shows an interaction effect: interval x condition. Below intervals of 1.60 seconds duration estimates in the social perception condition tend to be higher than those in the physical perception condition. For intervals greater than 1.60 seconds estimates in the physical perception condition tend to be larger than those in the social perception condition (see Figure 2). The social labels used in the social perception condition may have been an incumbrance to absorbing the visual input during the shorter intervals. The task of both absorbing the cartoon story and finding a suitable label for it, was too complex for such short intervals. The search for a label may interfere with the storage of information, and cause it to occupy a larger storage space and thus lead to larger time estimates. As the intervals got larger than 1.60 seconds the social coding seemed useful in reducing the time estimates below those in the physical perception condition. The use of social labels may have been effective in reducing the size of the storage space occupied by the information only in the intervals greater than 1.60 seconds. The presence of this interaction effect suggests that intervals of much longer duration should be used to accentuate the benefit of reducing the storage space via social labels. The use of larger intervals may allow larger differences between the two conditions to develop and provide a more clear-cut test for Hypothesis I.

It cannot be determined just what effect the instructions had in establishing their respective cognitive set i.e. viewing the stimuli as people in social interaction and physical objects moving randomly. It is questionable whether the social labels helped the subjects store the information in a more compact storage space. Informal comments of the subjects indicate that during the social perception condition they spent much of the time trying to find a good summary label without paying much attention to the content of the cartoons. Thus the amount of information presented and stored by the subject is conjectural. Since there is question about whether the amount of information actually stored by the subject was controlled the validity of this experiment as an adequate test of the hypotheses is in doubt.

A more direct and easily controllable procedure to test whether duration estimates vary with the amount of presented information would be to vary the number of movements of the animation figures, while holding the duration of the cartoon constant. It would be predicted from the theory presented in this paper that the number of movements would correlate with the duration estimates. An alternative procedure is to present simple geometric figures in which complexity i.e. information can be controlled and quantified. In this instance the correlation of stimulus complexity and duration estimate can be looked at and a positive correlation would be predicted. By the use of these methods the amount of information presented to the subject is no longer an intervening variable but a measurable quantity.

Hypothesis II that extraversion and duration estimate are positively correlated received some support from the data. Duration estimates in the physical perception condition had a positive high correlation with extraversion; while the duration estimates in the social perception condition had a low positive but insignificant correlation with extraversion. The discrepancy between the correlation of extraversion time estimation in the two conditions is curious.

Time estimation should correlate positively with extraversion since the concept of extraversion implies heightened vigilance to the environment and thus a higher level of information input and information storage.

It is suggested that the nature of the instructions in the social perception condition distracted the subjects' attention away from the content of the animation. The subjects were busy trying to find a good social label and presumably unable to absorb the content of the cartoon. If in the social perception condition the stimuli were not attended to and the information from the cartoons not stored in memory the expected relationship between extraversion and duration estimates would dissipate. The relationship between extraversion and time estimation might no longer hold since the input of information is disturbed by the labeling process. The expected correlation of extraversion and time estimation depends upon subjects high in extraversion storing more information input than those lower in extraversion. If the subjects in the social perception condition were distracted from the cartoon stimuli and were relatively unattentive to the environment then it might be expected that they all processed an approximately equal amount of information. Thus their time estimations would be approximately equal. Because the high correlation of extraversion and duration estimates gave some support to Hypothesis II, it would be worthwhile to explore this relationship through another experimental design such as those described above.

The data show that intervals below 1.25 seconds tended to be overestimated and intervals larger than 1.25 seconds were underestimated. This places the indifference interval for this experiment around 1.25 seconds. The indifference interval is the duration of time which is most accurately estimated and in this study durations around 1.25 seconds were most accurately estimated. Fraisse (1963) has pointed out that the indifference interval has generally been thought of as 0.7 seconds. However Woodrow (1951) and Ornstein (1968) show that few studies have actually found the indifference interval to be 0.7 seconds. They have found that the indifference interval has ranged from 0.7 seconds up to 3.0 seconds. It seems that there is no single duration which is most accurately estimated by all subjects under all experimental circumstances. The indifference interval seems to result from the particular stimulus conditions of the experiment rather than a basic physiological process. Woodrow (1951) holds that there is no stationary indifference interval, but that the indifference interval must be defined statistically as a most probable outcome or an average. The results of this experiment showing an indifference interval of about 1.25 seconds suggest that the indifference interval is not a constant of 0.7 seconds. The indifference interval is probably a function of the experimental conditions.

The differences in the length of the time estimates made by males and females is significant, showing that males consistently made larger time estimates relative to females in this study. Some research reviewed by Orme (1969) suggests that females are less accurate in their time estimates while other research shows that females tend to make longer time estimates than males. The inconsistency of all of these findings may be due to differences in experimental procedure. Illumination can be cast on this matter by the comparison of male and female time estimates involving the various methods of temporal judgment: verbal estimation, the production and reproduction method. It may be that the variables of each individual experiment influence male and female estimates differentially. This interaction effect of gender and experimental situation could account for the inconsistency of findings regarding time estimation of males and females.

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