THE PSYCHOLOGICAL MOMENT: COMPLEXITY OF PERCEPT AS A FACTOR IN THE TEMPORAL PROCESSING OF INPUT

A Thesis

Presented to

the Faculty of the Department of Psychology

The University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

Jerry Wayne Lester

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Abstract

Two studies were performed comparing a subject's ability to identify tachistoscopically presented letters to his ability to identify consonant-vowel-consonant (C.V.C.) trigrams presented in an identical manner. These two types of stimuli are regarded as causing percepts of differing levels of complexity, the C.V.C.s being more complex than the letters.

It was expected that the different levels of complexity would result in a difference in the length of the psychological moment. As described by Stroud (1956), this moment is a discreet segment of psychological time, within which all sensory input is treated as being simultaneous. A method of stimulus presentation developed by Ericksen and Collins (1968) was employed to eliminate a criticism of earlier studies, that the criteria of perceptual simultaneity was subjective.

Analysis of the results by non-parametric statistics showed that complexity of percept, as defined in this paper, had no effect on the length of the interval or moment of simultaneity. It is suggested, however, that the method presented might be advantageously employed in further investigation of individual differences in moment length.

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Introduction

The thesis proposed here is that complexity of percept may be important in determining the length of the psychological moment. Before the relevant background of this idea can be discussed it is necessary to define two of the terms. Throughout the remainder of this paper we shall mean by psychological moment that temporal interval within which an observer is unable to distinguish more than one sensory event. That is, regardless of the actual number of physically discrete stimulations, the observer is aware of only one perceptual or phenomenal experience. Obviously this definition does not specify either the nature of the stimulation or the actual temporal interval involved. Nor should it be construed to mean that only one such interval may be found. It is much more probable that the result of careful investigation of this question would indicate many different intervals, dependent on subject and stimulus variability, rather than that one interval would hold through changes in either subject or stimulus.

Complexity of percept is the more difficult of the two terms to define, even though we have chosen to avoid a long theoretical discussion of the "percept" part of the term. "Percept" will be taken to mean the operational criteria specified for it. For example, the definition in terms of one level of complexity is the identification of nonsense syllables presented tachistoscopically. Correct identification is interpreted as equivalent to having a correct percept of the stimulus. This rather rigid definition leads to some difficulties in the case of chance level guessing but prevents the even greater difficulties of trying to operationally specify what cannot be directly measured. Complexity as a variable has been only loosely defined or may even be considered as *a priori* or intuitively defined. However, the inclusion of the two tasks and their postulation as different orders of complexity was not without rationale. For the studies presented here the relationship of the two levels of complexity used seems to be obvious. The less complex level consisted of bilaterally symmetrical letters. The more complex level consists of consonant-vowel-consonant (C.V.C.) nonsense syllables composed of three letters of the type used in the less complex level. These two stimulus types were presented to subjects in a manner developed by Ericksen and Collins (1967) which allowed the precise investigation of the period of temporal integration. Essentially, the experiments aimed at better control of the complexity factor in a study of perceptual simultaneity to better describe the nature of the psychological moment concept.

Literature Review

There are essentially three types of articles dealing with the psychological moment. These are the strictly philosophical treatments, the theoretical psychological treatments, and those experimental articles which present data that are suggestive of a moment interpretation. The philosophical articles tend to indicate the logical necessity of a concept similar to that of a unitary chunk of consciousness or moment. Hodgson (1865) spoke of a "minimum of consciousness" within which all events are presented simultaneously, although we can distinguish their order through introspection and analysis of the relative strengths of the sensations. Clay (1882) defined the real or actual present as the coterminus of the past, which no longer exists and the future which has as yet no existence. The juncture of these two non-entities is logically also non-existent. Clay speaks of the "specious present" as a small and immediate part of the past which we treat as having actual existence. Boring (1942) cites a review of the philosophical treatment of time by Nichols (1891). Boring's summary was that the British empiricists were first to deal extensively with temporal perception. These philosophers, Hobbs, Locke, Berkeley and Hume believed that our concept of time arose from the succession of ideas. Reid (1785) and Thomas Brown (1820) pointed out that in order for a series of elements to have duration each element must have duration. Otherwise duration is made up of parts which have no duration which is obviously impossible. More recently Bergson (1950) in distinguishing between physical and real or psychological time has compared the latter to a melody. Although composed of analyzably different notes or units the actual perception is of a succession or evolution of the whole work.

Although earlier theorists had treated the subject (Wundt, 1874 and Czermak, 1857) the earliest clear discussion of the psychological moment by a psychologist is by William James (1890). He stated

> ...the practically cognized present is no knife edge. but a saddle-back, with a certain breadth of its own... this duration-block....We do not first feel one end and then feel the other...but we seem to feel the interval of time as a whole, with its two ends embedded in it.
>
> Date in time corresponds to position in space...the original experience of both is always of something given as a unit. (Principles of Psychology, V.1, pp. 609-610)

Wundt and James were in agreement on their atomistic concepts of time. (Heath, 1936)

There are no other comprehensive theoretical treatments of the moment concept until 1948. In this year Stroud (1956) developed a rather systematic treatment. He is credited with naming the unit of duration a "moment" (White, 1963). Earlier writers were not consistent in their name for the concept nor so comprehensive in their delineation. Stroud lists ten generalizations about his "moment" concept in the later article (1956). It is not necessary to list all of these generalizations here, but a few may be helpful in developing a meaning for the term "moment". Stroud deals with psychological time (T) and not physical time (t), maintaining Bergson's distinction. T is not a continuous variable. T is composed of units D such that .05 seconds $\leq$ D $\leq$ .2 seconds. This quantizing of T is the result of a scanning process according to Stroud. The scanning or sampling process reduces the amount of information in the input to the human organism by losing all order information within the period of the scan (D). Information about ordering of elements is the result of a sequence of scans. For instance the perception of movement is an inference or hypothesis based on the change or difference in spatial location of an object in one moment as compared to the preceding moment.

The idea of a scanning process has been postulated by others, notably Weiner (1948), and possible physiological bases for this scan are part of the relevant experimental data presented below. Both Weiner and Stroud present a concept which is related to the earlier work of Pitts and McCulloch (White, 1963).

The well known Broca-Sulzer effect (Graham, 1965) is probably the oldest phenomenon subject to a moment interpretation. Boynton (1961) uses data by Katz (1959) to explain the nature of this effect. The subject was presented with a comparison field in his left eye and with a test field in his right eye. The task was to match the sensation of brightness received from his two eyes. Using good controls for adaptation, it was found that a test field presented for about 50 to 75 milliseconds was matched to a much brighter comparison field of 200 millisecond duration. This apparent enhancement of the effect of the shorter stimulus was typical of moderately high luminances. Boynton writes of this result:

> The most plausible explanation would seem to have something to do with the on-discharge that is characteristic of many of the neural units carrying the message about the flash to the brain. If the brightness sensation were related to the average number of impulses per unit time received during the flash, the obtained result would be expected. It should be pointed out in this regard that if time were quantized somehow in the input, and if brightness were related to the average input per time quantum, the same result would be expected. (Boynton, 1961, p. 742)

Woodworth (1938) reported a study by Stein (1928) that is also an early indication of the moment function. Stein presented letters composing words in a tachistoscope. He found that at intervals of 100 milliseconds or less the order of presentation of the letters had no effect. The subject was equally able to read a word presented in reverse sequence as in proper sequence.

Studies of apparent movement have not yielded any clear cut evidence for the existence of the moment. This is probably due to the confounding effects of stimulus intensity and location of stimulation (Sweet, 1953). Early studies of the phenomenon however, do state that the minimum interval for seen motion is .020 seconds (Exner, 1875) and the optimum value is .06 seconds (Wertheimer, 1912). Stroud (1956) pointed out that these values are well within the scope of a moment explanation. Given a moment duration of .1 sec. a .50 probability of two flashes not falling in the same moment would be reached at an I.S.I. of .05 seconds. The best description of temporal values in apparent motion studies would be given by the following statement from Stroud:

> ...the probability of seen movement would be zero at separation zero, rise linearly to unity at D (.1 sec.) remain at unity until 2 D (.2 sec.), and fall linearly to zero between 2 D and 3 D and be zero thereafter. (1956, p. 198)

A third area of research in which the moment concept is applicable is that of masking or metacontrast. The concept of moment would clarify to some extent the reason for the occurrence of masking. Ericksen and Collins (1965) have offered the opinion that the temporal resolution of the visual system is poor enough to allow confusion of successive events and hence masking occurs. Efron (1967) extended this well known idea of poor temporal resolution and proposed that the interval of confusion is a processing period for incoming stimuli. He used the example of color mixture.

> The existence of a processing period, a temporal interval during which information derived from a particular group of sensory receptors is integrated, can account for the fact that the observer had no awareness of the 20 m. sec. red flash. The perception was the result of the neural integration...over an interval of approximately 40 milliseconds.

> The existence of such a processing period can also account for examples of "retroactive" perceptual effects of a second stimulus. (Efron, 1967, pp. 722-723)

These effects, described by many authors (Crawford, 1947; Alpern, 1953; Kolers, 1962; Halliday and Mingay, 1961) have been attributed by Boynton (1961) to the quantization of time.

> If time is handled by the nervous system in discrete packages rather than as a continuous variable, any two stimuli that occur wholly or in part within the same "time frame" or...period would be expected to interfer with one another as separately perceptible events.

Fraisse (1966) does not agree with this explanation of masking. His study indicated that while visual simultaneity was dependent only on the total time of stimulus presentations the effect of masking was affected by shifting of intervals within this period. He also found no effect due to the use of letters as compared to geometric figures. There are considerable variations in his data and his criteria for simultaneity are not given. Also he reported that a later study shows simultaneity to be affected by the distribution of stimuli durations within a period of 100 milliseconds just as masking is.

Stroud (1956) used reaction time data from an early study by Woodrow (1914) to support his moment hypothesis. He described the distribution of reaction times as rectangular. Efron (1967) also reported studies which propose to show the "irreducible" component of reaction time to be approximately 73 to 75 milliseconds. A recent study by Borghi (1965) of one subject's reactions times over an extended period has shown the distribution of reaction times to be normal and not rectangular.

The last area of research in which use of the moment concept has been made is the one of temporal numerosity or perceptual rate. White (1963) published an extensive review of this area. Essentially he says that there exists a point in time at which the relationship between the number of stimuli presented and the number of stimuli perceived in a series changes. White found this point of change to be about 300 milliseconds after the onset of a series of visual or auditory stimuli. Pollack (1968) stated that the number of perceived pulses in an auditory stimulus is proportional to the number of .1 sec. periods which elapsed during the presentation.

All the above are interpreted by this writer to be generally in support of the usefulness of a concept such as a moment. There does not seem to be any direct evidence against the existence of this type of chunking of temporal input. The argument seems to be about the exact nature of the process and the relationship, if any, to physiological processes. We have already stated the description which Stroud gives of the moment. His is by no means the only possible one.

It is, however, the best described and most generally accepted concept. Stroud also does not relate his concept to any physiological process directly. Efron's (1967) "processing period" is more directly related to perceptual integration and does not directly deal with the perception of time as such. Allport (1968) proposed an alternative to Stroud's concept. Speaking of Stroud's moment as the "discrete moment hypothesis", Allport proposed a "traveling moment hypothesis". He also offered experimental evidence in support of the latter and directly against the former. The interpretation of this new concept is something like a period of availability of incoming information for integration. This seems to lead to an old problem in psychology, the homunculus. The little man who decides which elements to integrate or rather, if the elements are sequentially available, which part of the sequence to integrate. The experimental evidence is interesting in and of itself.

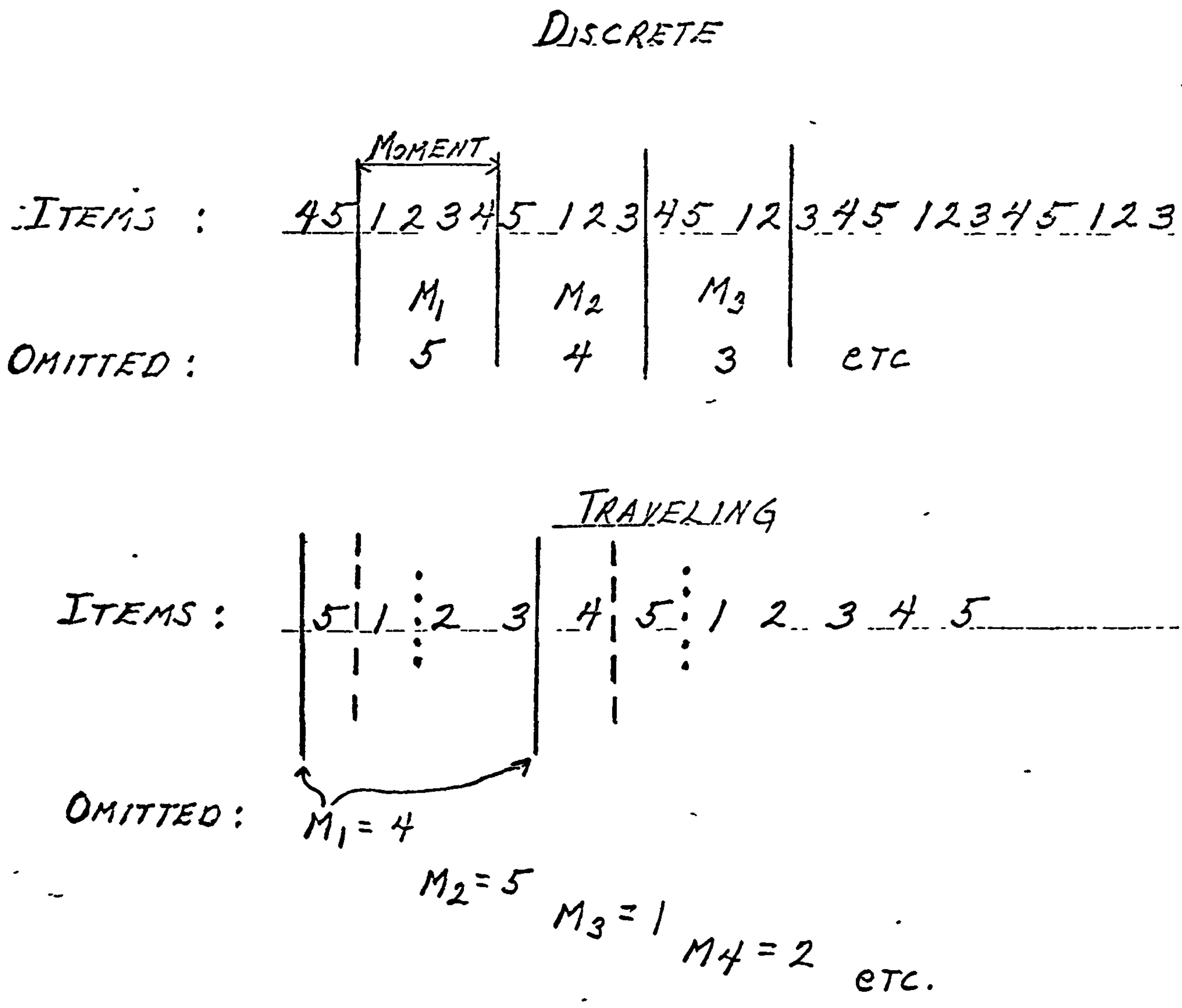
Using an oscilloscope. Allport established a series of lines stepped vertically up the screen. He adjusted the cycling time of the oscilloscope so that all of the lines, which were etched one per sweep, would be seen simultaneously. He found the average period of simultaneity to be 70 to 96 milliseconds depending on conditions of brightness and other factors. He asked his twelve subjects to adjust the cycling time so that they saw a shadow bar replacing one of the lines.

This resulted when the cycling period was greater than the period of simultaneity or moment. Using an interesting logic he was able to demonstrate that a discrete moment hypothesis would predict motion of the shadow bar in a direction opposite the sequence of the sweep, while his traveling moment hypothesis predicted movement in sequence with the sweep. (See Figure 1.)

The segments of the numbered series represent those lines visible in a single moment. The numbers below represent those lines which would be missing in successive moments and hence the direction of movement of the shadow bar. The traveling moment would produce an effect like moving a window over the series that exposed only four of the five repeated integers. This, as one can readily see, would produce an effect like the one actually reported in this study. The shadow bar moves in sequence or order of the series.

Apart from the theoretical nature of the concept there is some disagreement as to the possible bases for the phenomenon. There are those who believe that the moment is the result of peripheral processes. Ericksen and Collins (1968) have suggested that the off receptors in the eye may act as discontinuity detectors and serve to parcel stimuli into moments. Woodworth (1938) stated that the results Stein (1928) obtained could be explained by "retinal lag". These statements concerning a peripheral mechanism are

FIGURE 1


DISCRETE
MOMENT
ITEMS :
45 1234 5 123 45 12 345 12345 123
M1 M2 M3
OMITTED :
5 4 3 ETC
TRAVELING
ITEMS :
5 1 2 3 4 5 1 2 3 4 5
OMITTED :
M1 = 4
M2 = 5
M3 = 1
M4 = 2
ETC.

moderated by Boynton (1961) and White (1963). Boynton stated that "although the locus of the ipsilateral effect is largely peripheral. the contralateral experiments show that masking can also take place higher in the visual system (p. 748)." Here, of course, one must remember that masking is attributed to the temporal chunking of the moment processes. White goes further and states that he believes a central mechanism is responsible for the moment effect because of studies in modalities other than vision, although "the sense of vision may be a special case, since there appeared to be a second rate-limiting process, apparently at the retinal level. which acts upon the visual input." (White, 1963, p. 11)

By far the majority of work on this aspect of the moment has attempted to relate the periodic central activity to the length of the moment. Although a detailed discussion of the technical features of this work is beyond our scope, two excellent reviews of the area are available (White, 1963; Harter, 1967). White presents a study by Murphee (1954) in which the span of simultaneity was found for 50 subjects. The average span was 95 milliseconds. The mean period of the alpha cycle for these same 50 subjects was found to be 98 milliseconds. On the basis of this and other experiments Murphee concluded that a relationship between these two phenomena did exist. White also concluded "that there is a cyclic process, or a number of similar processes, in the central nervous system which interacts with afferent neural activity in such a way as to establish an upper limit of the perceptual rate for the various sense modalities." (White, 1963, p. 10)

Harter presented two possible central mechanisms or rather two bases for the same mechanism. One mechanism involves a process of cortical scanning and postulates the alpha rhytm. The second involves a cycle of excitability which raises and lowers the threshold of various cortical cells involved in specific processing operations. This latter mechanism is the one favored by Harter and would also explain the intensity effects reported by other researchers (Boynton, 1961; White, 1963; Ericksen and Collins, 1968).

While the articles presented here are by no means exhaustive of the literature they do provide a representative sample of the types of data available. Certainly the diversity of evidence for the moment concept indicates it usefulness. The nature of this concept however, prevents any direct test of its existence. The main arguments then, tend to revolve around the exact nature of the moment, and its possible physiological basis. It is to this secondary debate that we now address ourselves.

Method

Two studies were conducted to elucidate the nature of the psychological moment. These studies were similar, but differed in that the second of the two used a randomized order of presentation for the inter-stimulus intervals (I.S.I.s) employed. Both studies sought to manipulate the complexity of tachistoscopically presented stimuli. Two levels of complexity were used in both studies, single letters and C.V.C.s (consonant-vowel-consonant nonsense words).

Although other experimenters have eliminated subjects for failure to reach a criterion level of performance on practice trials (Ericksen and Collins, 1968), this practice was felt to be a danger to unbiased subject selection. Therefore, an alternative procedure of familiarization through a simulated learning task was adopted. Before each complexity level was presented for T-scope identification the subject was asked to learn a group of possible stimulus objects. Although there were 10 possibilities learned for each level of complexity only 5 at each level were presented for identification.

The stimuli were presented as letter or C.V.C. forms contained in an otherwise nonpatterned field of black dots. In fact, the patterns were presented as two separate fields of dots which only formed a meaningful pattern if the subject integrated the separate presentations into one perceptual experience. Since the fields overlapped in their spacial position the integration required was a temporal one, as the various I.S.I.s intervened between the two presentations. If the subject successfully named the stimulus form presented, it was taken to mean that he had organized the two temporal events into a single unit or moment. An unsuccessful trial indicated that the two events had not been so organized. This objective measure of perceptual simultaneity allowed the possible effect of complexity on the interval of integration to be examined.

STUDY I: A subject was required to perform four tasks in this study. He first learned (or attempted to learn) a list of stimulus objects, either letters or C.V.C.s. He then was asked to identify 5 of the 10 stimuli as the five were presented one at a time in a tachistoscope. The S then learned or attempted the alternative list (letters or C.V.C.s). And the last task was to identify those five stimuli from the second list which were presented one at a time in the T-scope.

SUBJECTS: There were 6 male and 4 female graduate psychology students who volunteered to participate in Study I. Their ages ranged from 23 to 34 years. All had normal or corrected to normal vision. None of them were aware of the purpose of the experiment nor had they served in any similar studies previously.

MATERIALS: The learning or familiarization tasks' stimuli were two lists. (See Table I.) The lists of letters or

TABLE I

MOV	A *
TAH *	T *
TOH	M *
MOH *	H *
VAH *	C
MUV *	R
VOT	U
TOV *	N
TUV	I
VAM	O *

CONSONANT-VOWEL-CONSONANT (C.V.C.s) and LETTERS used in learning and identification tasks. (* DENOTES THOSE USED IN IDENTIFICATION TASK)

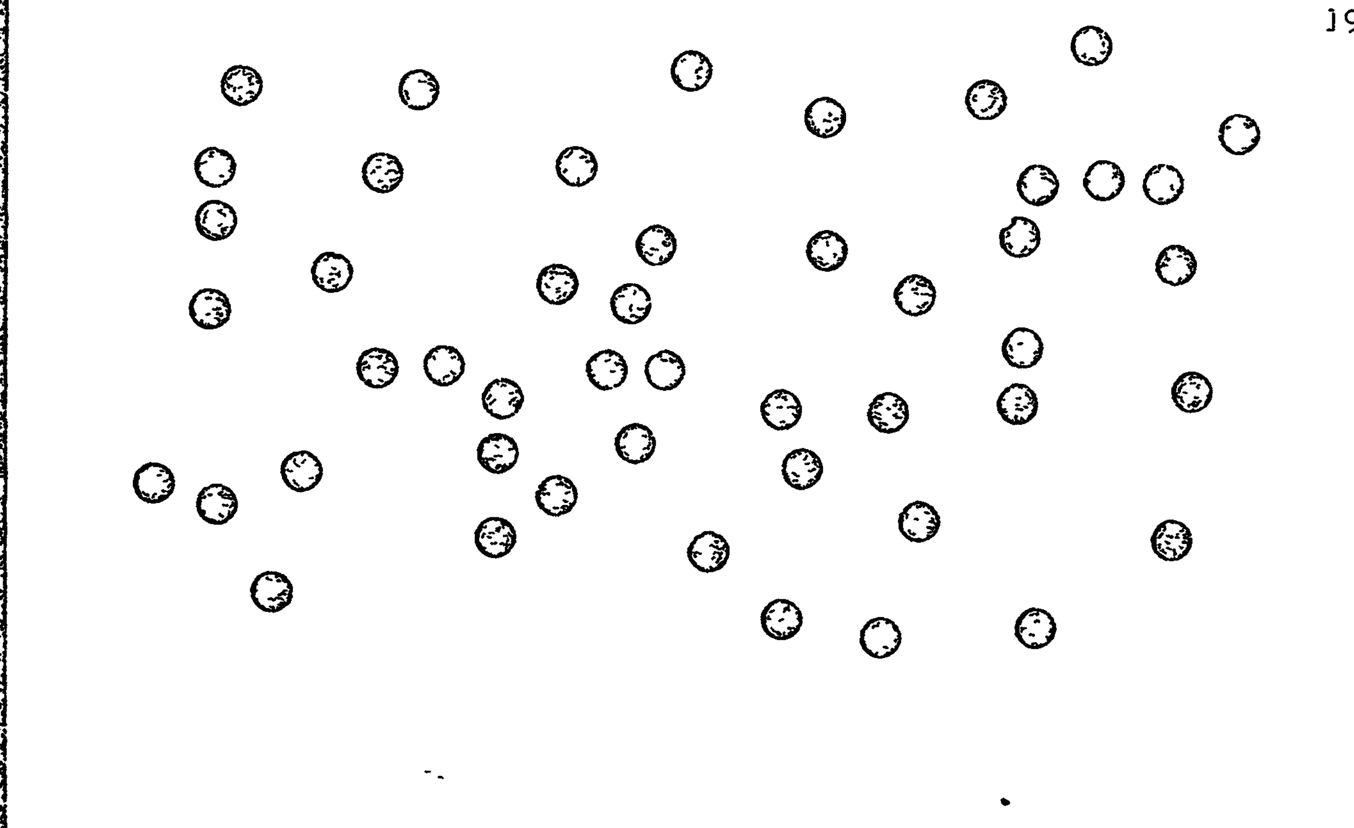
C.V.C.s were presented on 2" x 2" cards at a distance of about 30" from the S. They were composed of block printed letters ½" in height.

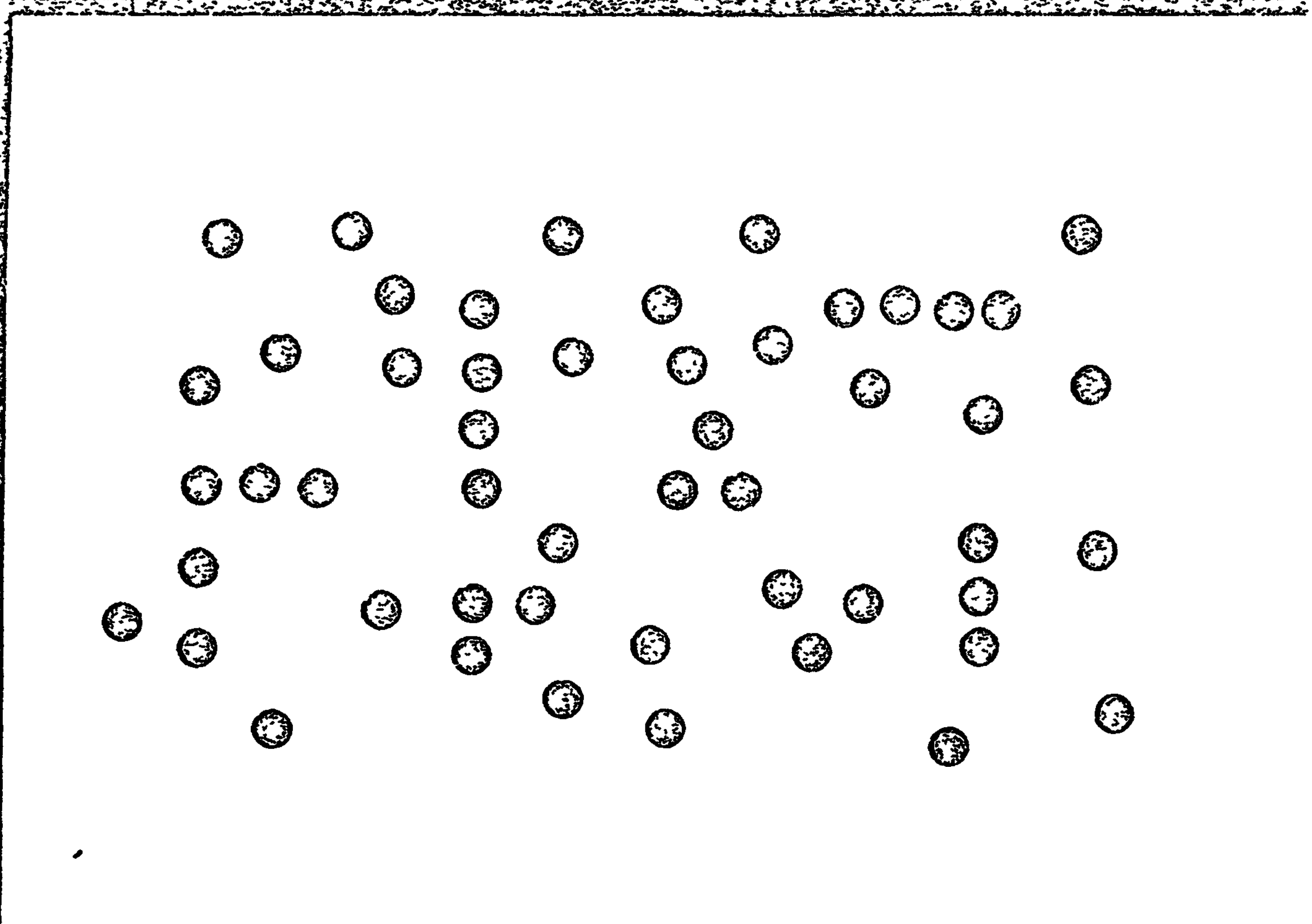
The identification tasks' stimuli were presented in a Scientific Prototype tachistoscope (Model G.B.). They were each constructed as two separate 5" x 7" cards covered by a seemingly nonpatterned collection of dots when seen separately. When the two patterns were presented in the tachistoscope in proper fashion a pattern corresponding to one of the letters or C.V.C.s was discernable (See Figure II).

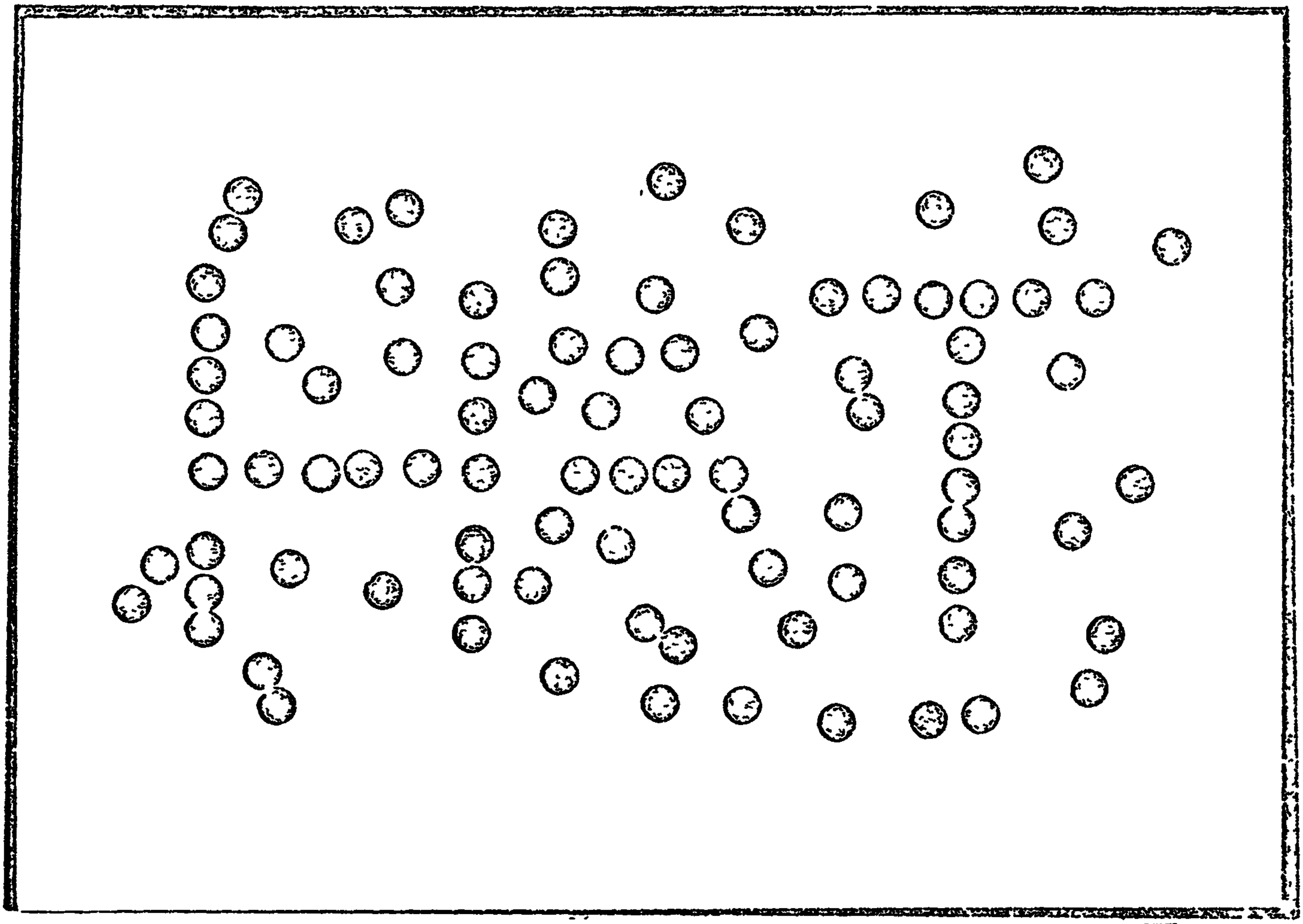
Study I employed six different I.S.I.s. These were intervals of 250 msec., 100 msec., 75 msec., 50 msec., 25 msec., and a sixth presentation with no I.S.I., in which the two stimulus halves were presented simultaneously for 7.5 msec. With all other I.S.I.s the interval was timed from the off-set of the first stimulus to the onset of the second stimulus (actually stimulus half). Each stimulus half was presented for 7.5 msec.

PROCEDURE: The learning task was presented for the appropriate level of complexity, either letters or C.V.C.s, by the following instructions:

> I am going to show you a list of 10 (letters or C.V.C.s as appropriate). I will present them to you at a steady rate on these cards. Between each presentation I will reorder the cards. After you have seen the entire list five times I will allow you to write down as many of the items as you can remember in 3 minutes. If you do not correctly write all 10 items







> I will show them to you again and you will be allowed to write the list again. We will continue until you have written all 10 items correctly. The order in which you write the items is not important but you must write all 10 items.

The subject was asked whether he understood the instructions and if not they were explained. Otherwise stimuli were presented at a rate of approximately 3 sec. per card with a pause for shuffling the cards between each presentation of the list for 5 complete presentations. The intertrial interval varied after the fifth and succeeding trials depending on how rapidly the S was satisfied with his reproduction of the list, up to 3 minutes. This task immediately proceeded the identification tasks for each of the complexity levels involved.

For the identification task: a counterbalanced order of presentation between subjects for letters and for C.V.C.s was used to prevent any systematic stimulus order effect. That is, a coin toss determined that the first subject would receive letters as the first level of complexity and C.V.C.s as the second. This order was alternated for each succeeding subject. Within a particular level of complexity individual stimuli were systematically placed in each of the five possible positions or orders equally often. The intervals between stimuli were presented in a fixed sequence from the longest I.S.I. (250 msec.) to the shortest (simultaneous or overlapping presentation). The same stimulus pattern was presented at each interval for five trials. The subject was not told whether his guesses as to the particular stimuli being presented were right or not. It was felt that since the identification of the stimulus was not easy at any I.S.I., and was probably harder for the longer I.S.I.'s, there would be no effect due to the large number of presentations (30) of each stimulus so long as there was no feedback. This, unfortunately, was not the case.

Each S was seated at the T-scope and the cross present in the center of the adaptation field was pointed out. S was then read the following instructions:

> I will now show you some of the same (letters or C.V.C.s as appropriate) that you have just learned. They will be of the same printed form as before but they will be composed of black dots which are visible that are not part of the pattern of the letter (C.V.C).
>
> These patterns of dots will be presented very briefly and you may have difficulty distinguishing what the item is that is contained in the pattern. But I want you to try and guess on each trial what the item is that is being presented. Each pattern will be presented several times. I cannot tell you whether or not you have guessed correctly. I will tell you each time a new pattern is to be given.
>
> Please guess on each trial as to the letter (or C.V.C.) contained in the pattern of dots. The pattern will appear centered about the cross you can see now.

Each trial consisted of the presentation of:

(1) the adaptation field (white with a black cross)

(2) the first stimulus half pattern for 7.5 msec.

(3) the proper I.S.I. dark interval (250 msec. to no interval)

(4) the second stimulus half pattern for 7.5 msec.

(5) the bright adaptation field

(6) S's verbal response

(7) E's recording of the response

Step number 3 was omitted on the simultaneous presentation and steps 2 and 4 were combined.

After S had completed 5 trials at each of the 6 intervals for each of the 5 stimulus items there was a short rest period. Then the alternative list (C.V.C.s or letters) was presented for the learning task. After this, the second identification task, identical to the first but using the new stimulus type, was presented. The entire procedure required approximately one hour and 15 minutes.

STUDY II: This study was in most essential aspects the same as Study I. The variation from Study I was in the subject population and the design used for stimulus and interval usage. In order to control for various extraneous effects it was necessary to employ a Greco-Latin Square design (Winer, 1962). It was possible in this way to control the effects of order and its possible interactions with intervals (I.S.I.s) and with stimuli. Also, any systematic interaction of interval with stimulus was avoided by using each possible pairing only once. The avoidance of such interactions is the purpose of this design.

The subject was required to perform the same four tasks on this study as in the first. The same sequence of 1) learning, 2) identification, 3) learning, and 4) identification was again employed. A reduction in time required for each subject was achieved by setting the maximum number of trials allowed for list learning at 10 and because this design required fewer identification trials for each subject. Only 25 trials at each complexity level or a total of 50 trials were required for each subject. The amount of time required for the whole procedure was about 30 to 45 minutes.

SUBJECTS: The subjects were 10 students from an undergraduate psychology course who volunteered to participate in this experiment. There were five males and five females whose ages ranged from 20 to 27 years. All subjects reported normal or corrected to normal vision. No subject knew the purpose of the experiment.

MATERIALS: These were the same as in Study I with the exception that the I.S.I. of 50 msec. length was deleted from the procedure. The remaining I.S.I.s were of lengths 250, 100, 75, 25, and 0 msec.s. This last was again an overlapping presentation for the normal period of stimulus presentation (7.5 msec.).

PROCEDURE: As was previously explained, the randomized pairing of stimulus with I.S.I. and the systematic presenting in all possible orders was assumed to preclude any interaction effects. This also meant that each S would get only five trials with each stimulus and at each I.S.I. The same instructions were used as in Study I. But since the S's had not all learned the lists in the 10 trials alloted, they were allowed to retain their last written attempts at reproducing the list, with corrections supplied for the errors. If at any time S attempted to guess an item not on the corrected list he was instructed to consult the list and guess again.

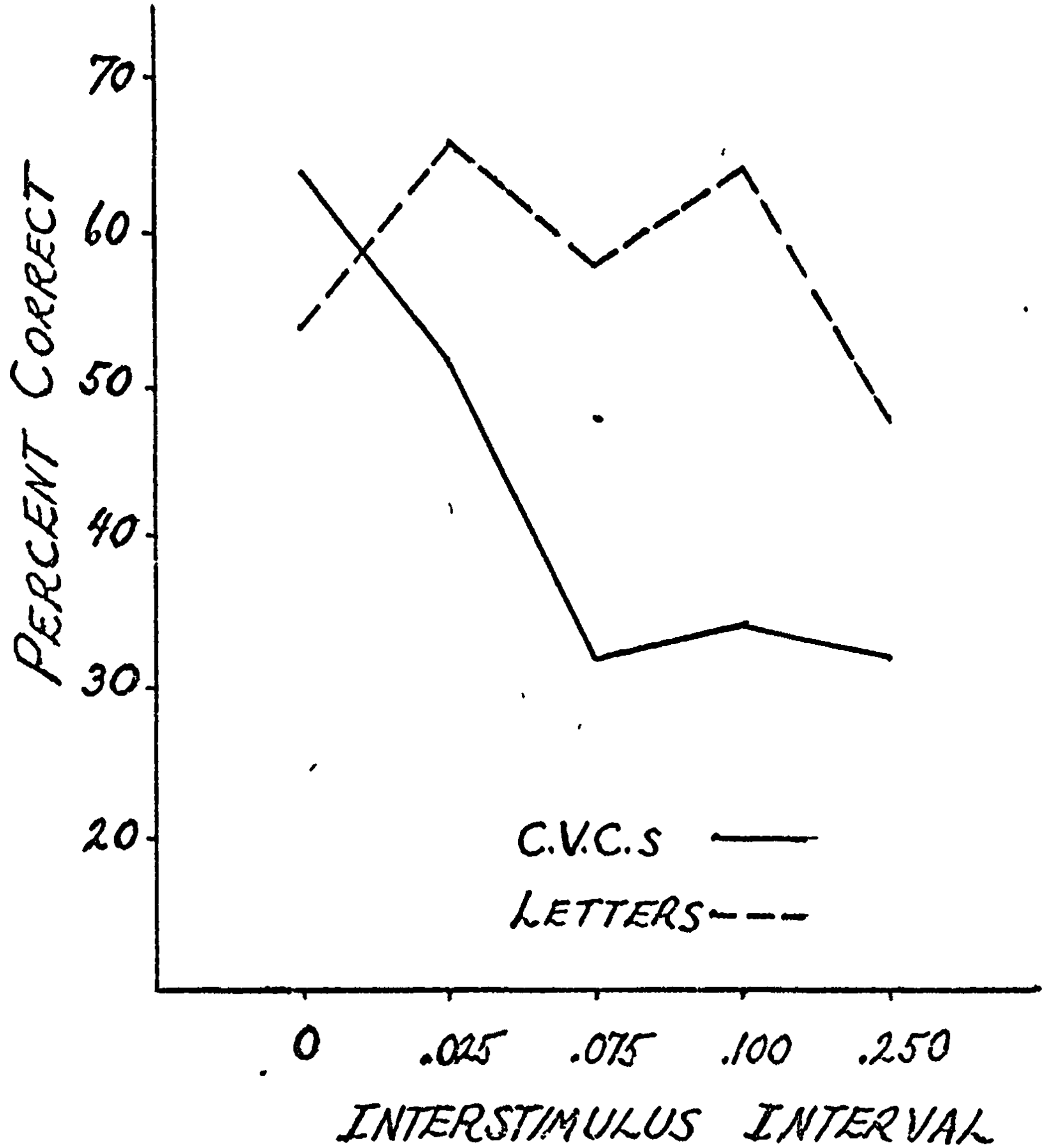
Results

Due to the similarity of the two studies performed the results of both studies will be considered here. There were essentially four results which have a direct bearing on the interpretation of these studies. The first two items of importance are those indices which indicate whether the postulated difference in complexity level did in fact exist. This contention of differences in the complexity of C.V.C.s as compared to letters is supported by the different rates at which the two stimulus lists were learned. In both studies all subjects required a greater number of trials to learn the list of C.V.C.s than to learn the list of letters. A sign test of these results yielded a probability of obtaining these results by chance of less than .01 (i.e., $p < .01$). The mean number of trials for letters in both studies is less than 8 and for C.V.C.s is just greater than 10 trials (actually 12.3 when no cutoff was employed).

The second finding which supports the complexity difference idea is found in the overall ability of these subjects to identify letters more frequently than C.V.C.s. On all conditions the subjects were better able on the average to identify letters than C.V.C.s. The first study yielded only one person who identified more letters than C.V.C.s ($p < .01$). The second study showed that two of ten subjects were better able to identify words than letters ($p < .06$). This result of better identification of letters than C.V.C.s cannot be attributed to a greater visual area being required for C.V.C.s than for letters since the stimuli were constructed to eliminate this effect. Letters when used alone had a total area as great as C.V.C.s. For these reasons it is apparent that two different complexity levels were in fact presented.

The third finding of importance for the interpretation of these studies concerns the intervals employed. As previously noted the range of intervals reported or postulated for the psychological moment is from less than .050 seconds to approximately .300 seconds. The intervals used for the present studies ranged from .0075 to .265 seconds. This range was covered by six different presentation intervals for the first study, and by five intervals in the second. The length of the intervals was altered by varying the interstimulus interval without changing the actual presentation time for the stimulus halves themselves. The primary treatment then is the length of the I.S.I. and not so much the total length of the interval. A Friedman two-way analysis of variance by ranks indicates that in the first study the probability of finding the observed differences in treatments or intervals identification rates is less than 1 in a thousand cases ($p < .001$). This study however had a confounded order effect because the various treatments or intervals were always presented in the

FIGURE 3



70
60
50
40
30
20
PERCENT CORRECT
C.V.C.S
LETTERS
0
.025
.075
.100
.250
INTERSTIMULUS INTERVAL

same order to all subjects. When this effect of order was controlled by presenting the intervals randomly to each subject, the apparent effect of intervals disappears. An identical Friedman test on the results of Study II indicates a probability of slightly less than 50 out of 100 cases ($.30 < p < .50$). The actual values for these tests are Study one. $X_r^2 = 38.4$, df = 5 and Study two, $X_r^2 = 4.8$, df = 4.

From these results it is apparent that the intervals between stimuli and the total length of the presentation interval had no real effect on a subject's ability to recognize or identify the stimuli presented. Since the first study does have a deceptively significant effect for intervals another analysis of the interaction between complexity level and interstimulus interval was performed. This test should have been significant for both studies if complexity did have an effect on the length of the psychological moment. However, in neither case did the Friedman test yield a result less likely than 5 chances per 100 cases. The actual values and associated probabilities were for Study one, $X_r^2 = 9.43$, df = 5, $.10 > p > .05$ and for Study two, $X_r^2 = 4.14$, df = 4, $.50 < p < .30$.

Discussion

It has been suggested that psychological variables (specifically complexity of percept) may be pertinent in determining in a given period the physical or objective length of the psychological moment or temporal quantum. This suggestion does not correspond entirely with other formulations of the moment concept. Although Stroud (1955) defined the psychological moment in terms of behavioral data, he and other writers have implied a physiological process, of one sort or another, which is the cause of this temporal chunking. Bartley (1951) attributed a limiting value of about 20 reported flashes per second, regardless of the actual rate of flashing to the intrinsic discharge characteristics of retinal ganglion cells. Woodworth (1938, p. 689) explained some curious results of a tachistoscopic study, by Stein, in terms of retinal lag, a peripheral process. The latest treatment of the peripheral process interpretation of the results presented in the literature is by Eriksen and Collins (1968). These authors considered the possibility of an interaction between a sensory trace decay function and a psychological moment as an explanation for their data. None of these peripheral interpretations of the data would admit to an effect of perceptual complexity or other non-physiological variables. In this, the present study can offer very weak support of a non-negative sort. Neither should these positions admit to any large effect due to practice, since they postulate a very mechanical, simplistic process. Here the present study can offer only weak negative arguments in the order effect of Study one. Obviously the peripheral interpretations are not seriously affected by this study.

Other writers have suggested a more central physiological mechanism as the cause of temporal chunking. Murphee (1954) points to a correlation between the frequency of an individual's alpha cycle and the "span of simultaneity." White (1963) discusses several other studies, including some using sound and tactile stimuli, and concludes that the overall similarity in perceptual rate between sense modalities must indicate a basic central process as responsible agent. It seemed reasonable to expect that if a central process were involved it might be of a variable or self-regulating nature. This concept of a feedback system is widespread in descriptions of C.N.S. functioning. The possibility of a self regulating system is also suggested by the different intervals of simultaneity or moment lengths reported in the literature (see Review). This diversity in a postulated physiological process could be accounted for by at least two possibilities. Either the system did operate as outlined and responded to the complexity (or difficulty) of the input to be processed, or the methods of investigation employed by the various experimenters allowed extraneous variability in subjects responses.

In considering the second possibility, extraneous variability in responses, White (1963) was led to use the temporal numerosity method instead of one of perceived simultaneity, since the latter method allows the subject to select his own criteria for simultaneity. The method presented here avoids the problem of response variability due to criteria differences in that, the experimenter is able to select a particular success ratio for his definition of simultaneity. This by no means removes individual differences in length of moments but simply offers a better method for their investigation.

Use of the method described in this paper, or a similar one, leaves the first of the two possibilities suggested as an explanation for reported variability in moment lengths. That is, if one eliminates extraneous subject variability and finds that perceived simultaneity varies in interval with the manipulation of complexity of input, then one has an explanation for the reported variability of moment lengths apart from methodological problems. Unfortunately, this was not the case. Complexity of percept as defined in this paper had no effect on the length of the psychological moment. As with any study accepting the null hypothesis there must be cautionary statements about the need for replication with other subjects and other types of stimuli. By way of negative justification for the further employment of this controlled method of perceptual simultaneity, is the possibility of an artifactual effect of repetitive stimulation, as in temporal numerosity studies, being accepted as a real psychological phenomenon.

Speaking positively, the application of this more precise method to studies of perceptual simultaneity and the psychological moment would most probably reveal some very interesting data in terms of individual differences. If the graph in Figure 3 were based on data for an individual rather than grouped data, it would be possible to select some value of correctness as a threshold for simultaneity. The usual value for such thresholds is the level of stimulation which is perceived correctly 50 percent of the time. Although the number of presentations is small and the gradation of the temporal dimension too coarse for really valid determination, it is instructive to notice the effect of such a dichotomizing of the response distributions. The upper line describing the mean correct percentages for letter identification is above the selected threshold value at all intervals (I.S.I.s) up to 250 msec. The lower line is below threshold value at all intervals greater than 25 msec. Given enough observations on enough subjects to achieve some measure of reliability, it would be possible from such results to make statements concerning the actual threshold interval for perceptual simultaneity and the effect of complexity on same. While the results here are suggestive of an alternative treatment and conclusion they are too insubstantial for more than illustrative purposes. Further investigations using more traditional psychophysical techniques might be made in this area.

The net result of the studies reported here is presentation of an objective method for the determination of an individual's threshold of perceptual simultaneity and a perforce weak negative statement regarding complexity of percept as a factor in the process determining that threshold.

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