The Effects of Stimulus Familiarity and Instructions

on Perceptual Strategies

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A thesis

presented to

the Faculty of Graduate Studies and Research

University of Manitoba

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In partial fulfillment

of the requirements for the degree

Master of Arts

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by

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February, 1971

ACKNOWLEDGEMENTS

ABSTRACT

In a review of the literature the possiblity that Ss not only

actively encode stimulus information but may do so in a variety of ways

in different situations was discussed. Such variations may reveal itself

in a recognition situation where factors such as stimulus familiarity

and Ss' foreknowledge of the type of stimuli in the search field may

result in Ss' selecting a particular acquisition (encoding) strategy

from amongst many strategies. Each strategy may be characterized as a

set of operations which more or less completely analyze stimuli. Further-

more, different strategies may reveal themselves in different stimulus

analysis times. Thus, the reaction time (RT) for recognizing stimuli

would be an adequate measure to detect differences in strategies.

The hypothesis that Ss' foreknowledge of one of two probabilities

(1.0 or .50) that a letter will be present in a search field containing

letters and randomly shaped figures would result in the selection of

different strategies for each probability was tested with the use of

5 groups containing 10 Ss each. Of less concern was the possibility of

the selection of different acquisition strategies for figures under the

two probability conditions. The analysis of the resultant RTs in the

5 groups showed that the major hypothesis was supported and the conclu-

sion was drawn that Ss had selected different acquisition strategies

under the two probability conditions. An unexpected RT function was

obtained for recognizing figures in the .50 probability condition.

The results of the present study were discussed in the light of

other activities of the Ss at the time of test; a particular pattern

recognition theory; and suggestions for further research. As well, the

implications of a variety of acquisition strategies for other perceptual

research was considered.

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INTRODUCTION

This investigation is concerned with the effects of stimulus familiarity and instructions in a recognition task. The main dependent variable is reaction time (RT) for signifying the position of a recognized stimulus in a multi-stimulus display. The major hypotheses of this study are that a) the visual system affords the possibility of many different strategies or methods of neurally representing visual stimuli, and b) the selection of any particular strategy at any time is done by the viewer. An underlying untested assumption in this investigation is that if there are two or more different strategies, the one allowing for the quickest and most accurate representation is chosen, especially when speed and accuracy are emphasized in a task. Thus, variables such as stimulus familiarity and/or instructions to subjects (Ss) may affect which representation strategy is selected and thereby affect RT.

The present study was undertaken because many previous studies do not afford Ss the possibility of displaying that they may have more than one strategy. Thus, the validity of conclusions derived from these studies is questionable. It might be the case that the visual system is other than what has been concluded from those studies or that those conclusions are valid only when pertaining to one set of stimuli. In either case, the skeptisism that is implied here can be justified if it can be shown that the same set of stimuli can be differentially reacted to under minimally different conditions.

Pattern Acquisition

The focus of this investigation is what is considered to be the first active S initiated event in the process of human perception, that of stimulus encoding. What is meant is that stimuli are encoded into some neural "language" that is both representational of the stimulus and relational to the previously encoded body of knowledge. The entire encoding process can be loosely divided into two segments. The first segment can be characterized by an invariant neural process that consistently represents the same stimulus in the same manner. The second segment can be characterized as a varying process wherein the representation of the stimulus can occur in many ways. The first segment, to which we now turn, will be discussed with the aim of emphasizing that up to a certain point in the visual system neural representation is fixed. This will be followed by a discussion of the second segment wherein varying processes may operate.

Invariant Neural Representation

The initial events in the visual system are known to be as follows. Energy from a distal stimulus initiates neural firing in the retina via the energy transducing properties of the rods and cones. Intra-retinal neural organization represents the stimulus in a code which may be characterized by the presence or absence of light energy (Kuffler, 1953). From the retina the fibres in the optic pathway carry this information towards the central areas of the brain. Up until this point the visual system is a passive inflexible one (except perhaps for the effect of the iris and the lens). The same distal stimulus will always elicit the same

neural response pattern which is predetermined by the physical construc-
tion of the visual system. A "green" light will always excite certain
cells in particular areas of the lateral geniculate body (De Valois, et
al., 1958). Thus, this part of the neural system is activated by the
distal stimulus and responds to it in a highly predictable manner.

The net result of this neural action is that a highly representa-
tional description of the stimulus in a more or less undistorted form
reaches central areas of the brain. It may be assumed that any pertur-
bations in the description at this point are minimal, and have very
little detrimental effect on subsequent processing of the stimulus infor-
mation or on an ultimate overt response.

Varying Neural Representation

At this point consideration of the neural correlate of the distal
stimulus must cease. Although not much is known about the neural activity
of the visual system between the post lateral geniculate afferent fibres
and the occipital cortex, a good deal is known about the emergent infor-
mation of that neural substrate. Perhaps one of the reasons for the
difficulty of investigation in this area is that the representational
process is no longer simply an afferent, passive one. Once central areas
of the brain are reached the stimulus information is itself affected as
well as affecting the neural system. Much evidence has been accrued
that this is indeed the case (e.g., Sperling, 1960; Averbach & Coriell,
1961; and Eriksen & Collins, 1967). As well, this same research has
also brought to light the ability of the neural apparatus to retain almost
complete stimulus information for a duration longer than mere neural

transmission time. This storage ability is herein called "iconic", a
term adopted from Neisser (1967). Sperling (1960) has found that this
iconic storage can last up to one second, during which time the stimulus
information must be salvaged for further use. Any information that is
not salvaged is completely lost.

Sperling also found that Ss were able to report a particular row
of a multi-row display after stimulus offset, i.e., they controlled the
process that encodes individual letters by holding it in readiness and
then, once a tone (which signalled a particular row) was presented,
directed that process to the particular row. One conclusion that may
be derived from this is that Ss are able to select a particular row and
report on it. This conclusion is the most important one for the present
study. This active, S-initiated selection means that the visual system
from this point (and all we can say is that it is some central area)
to the visual cortex may not be entirely afferent, but also efferent.

The finding of Sperling's that one can control the selection of
a row supports the notion that the viewer is able to selectively encode
or acquire parts of a stimulus, and need not acquire the entire stimulus.
It can be seen that this can be a crucial variable with patterned
stimuli (e.g., letters) where different areas of the stimulus carry
different structural information. In the case of non-patterned stimuli
(e.g., flash of light) this variable would most likely be of little
importance.

Another important conclusion can be drawn from Sperling's study.
Up to now (historically) there has been no evidence for efferent centri-
pital pathways in the visual system that directly act upon retinal

coding and subsequent transmission to just beyond the lateral geniculate.

Thus, auditory information, in Sperling's case a tone, most likely does

not affect visual afferent information below the post lateral geniculate

level. A suggestion that selection of the critical row is a function of

directed eye movement is not tenable because the reaction time for the

eye is longer than the duration of the stimulus display. It can be con-

cluded, then, that the iconic state exists as a central process in an

area that at least is inervated by neurons which can carry auditory in-

formation. The locus of this area may be just the one pointed out

previously - where there is the least amount of knowledge about the

activities of the physiological substrate.

Other evidence for an active acquisition process comes from experi-

ments using a visual masking technique. A visual mask is a stimulus that

is presented before (forward) or after (backward) the critical stimulus.

A typical finding is that if either a forward or a backward mask is

presented, Ss' ability to report the visual information is degraded

(Eriksen & Lappin, 1964). It can be assumed that the presentation of

the mask just after stimulus offset detrimentally affects the iconic

storage of information about the stimulus. Of interest for the present

purpose though, is the effect of the backward mask on individual items

in the stimulus display, not the entire display.

Averbach and Coriell (1961) found that when a circular backward

mask is presented encircling the position where a letter had been

presented, Ss' ability to report the letter was poorer than with other

types of masks due to the encircled stimulus being partially "erased".

The effect is even more profound when the backward mask exactly surrounds

the outside contours of the critical stimulus. Werner (1935) reported that when a black disc was surrounded by a circular backward mask, it phenomenally disappeared. Similar results have been found by Fehrer and Raab (1963) using lighted squares, and by Spencer (1969) with a patterned backward mask (overlapping W's). One explanation of this phenomenon is that the borders of the stimulus may have to be constructed or synthesized over time (Spencer, 1969; Neisser, 1967; and Werner, 1935). Thus, if the borders of the stimulus are surrounded by a second stimulus they are constructed to the detriment of the first figure. If the borders of the first figure are not constructed then it is entirely lost. This explanation implies an activity which is S-initiated, i.e., synthesis of borders.

Further support for the notion that encoding is an S controlled activity is that it can be affected by various attention levels. Posner, Boies, Eichelman and Taylor (1969) found that a distracting task that did not mask the visual stimulus still affected its use in a physical matching task. The distractor task had apparently hindered the Ss in synthesizing the visual stimulus.

It has been shown than neural representation of a distal visual stimulus is at first fixed and passive. Once this representation reaches central areas it is retained by the iconic process for a period of up to one second, during which time the stimulus or parts of it are actively acquired for further use. This activity can be selective and under the control of the viewer. An interesting offshoot to this conceptualization is that Ss may have available to them more than one procedure or strategy for acquiring stimulus information. It is to the consideration of the possibility of more than one strategy that we now turn.

Strategies

For the present purposes the term 'strategy' will apply to a procedure or set of activities that can by used to acquire stimulus information. If there is more than one strategy then there is the possibility that the viewer may be able to select one of them at one time and another at a later time. Possible determinants of the selection may be familiarity of the stimuli, previously defined instructions giving foreknowledge of the type of stimuli to be acquired, and desired speed or accuracy. The possible effects of familiarity on the selection of strategies will now be discussed.

First, the term 'familiarity' needs clarification. 'Familiarity' as used here refers to the number of times a stimulus has been acquired. It can be seen that this is directly related to the common use of 'familiarity.'

It is important to note that nearly all the work on iconic storage has used types of stimuli that can adequately be classified as familiar, i.e., letters, numbers, and regular geometric shapes. Also, such stimuli have almost without exception been used in all varieties of visual perception and recognition experiments. One result of the effort put into all these studies is that there is now a large body of knowledge about the behavior of the visual system with reference to this singular class of stimuli. The problem with this body of knowledge, as Garner (1970) points out, is the same as the problem in intensively investigating a single organism or studying the effects of a stimulus with only one task. The body of knowledge derived from these studies is pertinent to only one thing, be it stimulus, organism, or task, and the extensibility of this

knowlege is highly questionable. In other words to draw general conclusions from studies using only one class of stimuli is to deny the organism the opportunity to display behavior that may differ radically or even slightly from those conclusions.

Garner (1970) has advocated that the nature of the stimuli be more intensely investigated to allow us to properly ask questions about how information may be processed. As an example Garner states that a S may covertly integrate dimensions of a stimulus and then respond on the basis of this new, derived dimension. So in this case the stimulus itself should be investigated first to see whether it has dimensions which are readily integrated or not. This argument can be extended to familiar stimuli. In general it is assumed that a very familiar stimulus (e.g., a letter) is always acquired in the same manner. However, this is just an assumption: Ss may acquire letters in many different ways. An investigation of these methods would not only reveal more information about the visual process with common stimuli, but may also give insight as to possible operations with less familiar stimuli. Necessary to this line of reasoning is the notion that there is more than one operation that may be done with stimulus information and that these operations are under the control of the viewer.

Despite the constrained nature of experiments using familiar stimuli, many do show evidence that supports the possibility that strategies used by Ss can affect their performance in certain tasks. For example Miller, Bruner, and Postman (1954) found that once Ss had correctly perceived two out of a string of eight letters that were tachistoscopically presented, the closer the eight letters were to English text the more

correct the Ss were in reporting and placing the remaining letters. At
an exposure duration that did not allow Ss to correctly perceive and
report more than one letter they were not able to properly assess the
statistical nature of the entire string of letters, and thus were not
able to select an acquisition strategy to help them acquire more letters.
Moreover, at this duration the levels of approximation to English text
did not result in differential reports. Thus, the familiarity of the
eight letters which was determined by their statistical similarity to
English, evoked an efficient encoding strategy once two letters were
correctly perceived.

Morin, Konick, Troxwell and McPherson (1965) used different types
of "overlearned" stimuli in a study of information content and reaction
time (RT). The five types of stimuli they used were faces, animals,
colors, regular geometric shapes, and letters. They found that for the
first four types of stimuli RT was a negatively accelerated function
when plotted against increasing information. In the case of letters,
RT exhibited a zero slope. Morin et al. showed that the letters evoked
the quickest and most efficient acquisition strategy. In general it is
safe to say that the acquisition of letters is carried out by the most
frequently used, best rehearsed acquisition strategy (or strategies). It
is not surprising that the letters in the Morin et al. study exhibited
the RT function for "overlearned" stimuli they expected, and not the other
four types of stimuli.

Orders of approximation to English text (as in Miller et al., 1954)
have also been used to study the left to right encoding process for read-
ing English. Mewhort, Merickle, and Bryden (1969) found that the left

to right sequence apparently was not optional (in adults) and that the

more familiar the material the quicker the left to right encoding process

operated. Thus, encoding strategies used to process the material at

the left of the display allowed for the selection of strategies that

facilitated encoding at the right of the display. As well, the compulsive

nature of the process which left "no option" as regards working across

the display from left to right, suggests that this process is so well

rehearsed that once the stimulus material was known by the S he automati-

cally selected a tried and true procedure. Trying to force the Ss to

work in the opposite direction, as Mewhort, et al. did, was not successful.

Evidence for this advantageous strategy effect can be found in

many experimental techniques. Hamid (1969) found that symmetrical

stimuli had lower recognition thresholds than asymmetrical stimuli,

suggesting again that parts of a stimulus once perceived could aid in

selecting strategies to encode the rest of the stimulus. Estes and

Taylor (1966) have found that repeating a critical letter in a multiple

letter search field decreased the RT to finding those letters. These

findings are consonant with Attneave's (1954) suggestion that the infor-

mation redundancy of symmetrical figures may aid the efficient encoding

of visual stimuli.

It has also been found that even with non-patterned stimuli (e.g.,

light configurations) the recognition of a repeated item was faster than

for a non-repeated item (Kornblum, 1968; Bertelson, 1963). Again this

suggests the utility of using successful and efficient encoding strategies.

However, the repetition effect is not completely predictable. Doherty

(1968) found that in a length discrimination task repetition resulted in

increased RT. Thus, for different tasks different strategies may be

invoked.

Effect of Instructions on the Selection of Strategies

Aside from the familiarity of stimuli, strategies may be selected

on the basis of prior knowledge of what is desired. For example, this

condition can be established by instructing Ss to attend to particular

features of the display before it is presented. A review paper by Haber

(1966) describes many articles dealing with experimenter (E)-determined

strategies in a discussion of perceptual enhancement and response priming.

He states that much support has been garnered for the presence of both

these activities but that a definitive conclusion as to which one best

describes the situation is not possible. Implied throughout this dis-

cussion is that Ss may have available more than one strategy and that

the E's instructions sample among these. Indeed, one of the reasons

for the inconclusive nature of these studies as a whole is that Es do

not really know what particular strategy is being sampled, only that it

works. Thus, to reflect back to Garner's (1970) argument, Ss may be

doing things with the stimuli that are unknown to E and thereby emit

(as far as E knows) confounding responses.

Most of the studies in this section have dealt with strategies

that seemed entirely compulsive in nature. That is, fixed strategy

selection has been exemplified. However, it must be kept in mind that

Ss may have available to them different strategies (as in Sperling, 1960;

Averbach & Coriell, 1961; and Doherty, 1968) but may not use them

especially in tasks involving speed of response. The subtlety of

strategies must not be underestimated. For example, two studies

(Fehrer & Raab, 1963; and Fehrer & Biederman, 1962) had Ss respond

both by verbal report and by pressing a key to flashes of light that

were and were not backward masked. In the masked condition the first

stimulus was phenomenally not present (i.e., there was no verbal

report) but in both conditions Ss' finger RTs were the same. They had

responded to the "unseen" stimulus as if it were present. These experi-

ments demonstrate that stimuli may be encoded by strategies pertinent

to one mode of response (non-verbal) and not strategies pertinent to

another mode of response (verbal) and, of course, they further support

the notion of the existence of more than one strategy.

It has been shown that there is substantial evidence for the

existence of many strategies for acquiring stimuli and that the

selection of strategies can be determined by instructions to the viewer

or by the stimulus itself. Particularly in the case of familiar

stimuli, strategies used by Ss may give little information as to the

flexibility of the visual process. The problem that arises however,

is that in order for a stimulus to be deemed familiar it must first be

recognizable, i.e., as having being acquired before. The problem of

recognition is discussed in theories of pattern recognition, to which

we now turn.

Pattern Recognition

One approach to the problem of recognition has been that "...the input activate a stored representation already in memory and it is the representation that is subsequently activated and "recognized" on recognition trials (Price & Slive, 1970, p. 378)." Price and Slive have intimated that this internal representation is an auditory one. This is consonant with many investigators' conclusions of the fate of stimulus information in post iconic memory (Sperling, 1963; Neisser, 1967; Posner, Boies et al., 1969). However, recognition need not be only an auditory process. Posner, Boies, Eichleman, and Taylor (1969), Blake, Fox, and Lappin (1970), and Taylor and Reilly (1969) found that when two stimuli were physically the same the RT for Ss to respond "same" was faster than when two stimuli are nominally the same, suggesting that acquired visual information is sufficient for a recognition process to proceed.

To say that acquired information is the basic unit of recognition is not enough. In some manner the process of acquisition must be described and elaborated and this is usually accomplished in the context of pattern recognition theories. Historically, two major hypotheses have been examined - template matching and feature analysis (Neisser, 1967).

The basic tenet of template matching theory is that there exists an isomorphic neural correlate for every perceived stimulus. Patterns are recognized if the input 'matches' the neural template. A logical extension of this approach is that all visual stimuli are neurally represented. Thus, a novel orientation of an otherwise familiar stimulus may not be recognized because there is no template to match it. If this

theory were true, the number of distinct neural representations would be
simply astounding. Furthermore, the search of memory for the correct
template would be very time consuming. These two factors — the number of
templates and the time for recognition — immediately cast doubt on the
viability of this approach. It is also important to note that a notion
of many active stimulus acquisition strategies is very difficult to work
into this theory. For this reason (and a lack of experimental support —
see Neisser, 1967) no further consideration of this theory will be given
and a far more likely theory will be described, that of feature analysis.

Only an abbreviated description of feature analysis will be given
here. For a more complete account see Neisser (1967). In essence,
feature analysis is a process whereby specific features of the stimulus
are analyzed, not the stimulus as a whole. The process is an hierarchical
one with ascendingly more complex analyzers. For example, one low-level
analyzer may 'search for' a certain angle in a stimulus, and another low-
level analyzer may 'search for' enclosed spaces. The results of these
analyses are probability statements as to the presence of the particular
feature. A higher-level analyzer may analyze the output of the lower-level
analyzers and compute the probability of the joint occurrence of the
particular angle and enclosed spaces. The next higher lever analyzer
works on the output of the second level analyzer. The process continues
until the probability of a set of features being present in the stimulus
is sufficient for a 'recognition.'

An important aspect of this theory is that the probability required
by the system in order to recognize a stimulus is variable. For example,

in conditions where there is little penalty for an incorrect recognition a low probability for some features may be all that is required to recognize a stimulus. In other conditions a higher probability may be required. In either event the conditions are established before the recognition task. Thus, a S's desire to be 100% correct in recognizing a stimulus may be reflected by high probabilities as criteria for recognizing the stimulus. Thus, an acquisition strategy may be nothing more than a set of probabilities imposed upon the hierarchical recognition process.

Spencer (1969) has used a patterned backward mask to corroborate Neisser's theory. "The results seem to support an interpretation of the pattern mask preventing the completion of the hierarchical stages of processing, i.e., controlling processing time (Spencer, 1969, p. 139)." As well, the theory has been substantiated by Neisser (1964) incorporating Ss' introspective reports and has practical utility in pattern recognition by computer (Nadler, 1968). Nadler's "Empyrean" program is based on Selfridge's (1959) Pandemonium paradigm which is the same one Neisser had adapted.

Another theory proposed by Neisser (1967, Ch. 4) and supported by Beller (1969) is that stimulus analysis proceeds in two stages: preattentive and focal attentive. The preattentive process makes a holistic analysis of the stimulus and guides the focal attentive process to parts of the stimulus. The focal attentive process is the active pattern recognition process described previously. It acts to synthesize and analyze the visual stimulus. Thus the preattentive stage may parse up a stimulus to facilitate acquisition by the focal attentive process by

guiding it to more pertinent or 'valuable' parts of the stimulus.

The feature analysis theory of recognition may be well suited in supporting the idea of many strategies, the effect of familiarity in selecting strategies, and even the stimulus synthesis process described in the first section.

Statement of the Problem

It has been shown that the process for acquiring a stimulus for any period longer than 1 sec. is an active one. Moreover, the possibility that this active acquisition may proceed in many ways by the selection of various acquisition strategies has been discussed. Lastly, a pattern recognition theory has been described that is flexible enough to accomodate concepts such as different strategies and active acquisition.

In the light of the above considerations, and particularly the previous discussion of the effects of familiarity, the question arises whether experimental results based on the use of familiar stimuli afford a wide insight into the visual process. Especially in studies where Ss know what type of stimuli is being used prior to or just after the experimental procedure begins, the Ss may select strategies that allow them to take "short cuts" in the recognition process.

The problem may be characterized in the following manner. Suppose a S knows before the test that he will have to search for the letter A amongst a display of letters. A "short cut" in this case would be to select a strategy that allows for analyzing each display letter looking for two features: a point at the top and an enclosed space. In this manner the display letters would only be partially acquired. Although this process may not reveal itself in dependent measures such as amount of correct recognition, it may show up in the speed of recognition. Partial acquisition would result in less time being spent in analyzing each letter than if all the features of each letter were analyzed.

However, if the S does not know the type of stimuli he will have to search among, or if they are not familiar (given he is searching for a

letter), then he may have to acquire more of each stimulus in the display to ensure a correct recognition. This would result in a longer reaction time than the above condition.

Since by definition unfamiliar stimuli cannot be acquired by well rehearsed strategies, then a S's foreknowledge that he will have to search for an unfamiliar stimulus amongst other unfamiliar stimuli may not be advantageous.

The manipulations implied above are the following. Place Ss in a condition where they must search for a familiar stimulus (e.g., a letter) and an unfamiliar stimulus in a multi-stimulus display where either the familiar stimulus or the unfamiliar stimulus is present with a probability of 0.50. In such a condition Ss only have half as much certainty about the presence of the familiar stimulus and would probably more completely analyze each stimulus in the display to ensure a correct recognition.

If Ss have available only one strategy for acquiring familiar stimuli then Ss' reaction times should be the same in the above condition as in a condition where the probability of the presence of the familiar stimulus in a mixed display of familiar and unfamiliar stimuli is 1.0. As well, this would hold if Ss were looking for an unfamiliar stimulus in a mixed display.

One problem that may arise in the former condition is the difficulty of determining the reaction times for the letters alone. However, this difficulty can be overcome if it can be shown that Ss search for and analyze the letters before the unfamiliar stimuli. This notion is

consonant with the preattentive theory discussed previously. If in a mixed display where the probability of the sought for letter or unfamiliar stimulus is 0.50, Ss' reaction times for letters are shorter than for unfamiliar stimuli and there is some difference in the reaction times which show more complete processing of individual letters than in the 1.0 probability situation, then this notion would be supported.

The main hypotheses for the present experiment are: a) In a heterogeneous (mixed unfamiliar and familiar stimuli) search field Ss will search for and analyze the familiar before the unfamiliar stimuli; and b) foreknowledge of the probability of the presence of the critical stimulus (the sought for stimulus) in the search field will not affect recognition time for individual unfamiliar stimuli and will result in a greater reaction time for familiar stimuli when the probability is 0.50 than when the probability is 1.0.

Design

Five groups of ten Ss each were investigated with each group of Ss receiving different instructions and/or different types of search fields. In all groups Ss went through 200 recognition test trials. Each trial consisted of a first slide with a letter and an unfamiliar figure on it and a second slide (the test slide) containing five stimuli. One of the stimuli on the first slide, the critical stimulus, was present on the test slide.

Two groups of Ss were instructed that the critical stimulus would be a letter. In one of these groups (condition L) the ten Ss were told that all five stimuli on the test slide were letters and in the other group of ten Ss (condition ML) they were told that letters and figures were on the test slide.

In each of two more groups Ss were told that the critical stimulus would be an unfamiliar figure. In one of these groups (condition F) the ten Ss were told that all five stimuli on the test slide were figures and in the other group (condition MF) the ten Ss were told that both figures and letters were on the test slide.

In the last condition (M) Ss were told that the critical stimulus would either be a letter or an unfamiliar figure on any one trial and that there were both letters and figures on the test slide.

Thus, in conditions L and ML the probability of a letter being critical was 1.0. Any difference in RT between these two groups would most likely be due to the decreased number of letters in condition ML.

Similarly in conditions F and MF the probability of a figure being critical was 1.0 and any difference in the RT could be attributed

to the difference in the number of figures.

A minor hypothesis can now be stated. The RT for the letters in conditions L and ML will be less than the RT for figures in conditions F and MF because by definition letters are more familiar and evoke well rehearsed encoding strategies.

In condition M where the probability of the letter or the figure on the test slide being critical was 0.50, if the Ss sought and analyzed the letters first, then their RT for the letters would not be different from the RT of Ss for letters in condition ML given that Ss have only one encoding strategy. If there is a difference, then the possibility that there is more than one acquisition strategy would be enhanced.

Method

Stimulus Selection

Two classes of 20 stimuli each were developed. The familiar class consisted of 20 capital letters. The excluded letters were F, I, O, P, Q, and S.

The unfamiliar class of stimuli consisted of figures from Vanderplass and Garvin (1959). Each of 75 randomly formed straight line figures were shown to two groups under slightly different conditions. Group 1 ($\underline{N}$ = 36) was instructed to rate each figure on a five point scale of familiarity. Group 2 ($\underline{N}$ = 50) was instructed in a manner similar to Vanderplass and Garvin, i.e., $\underline{Ss}$ were to give a rating of $\underline{1}$ if the stimulus had no meaning to them, $\underline{2}$ if it had some meaning, or $\underline{3}$ if and only if they could put a verbal label on it.

The figures with the lowest overall mean ratings of familiarity, meaning, and content (Vanderplass and Garvin) were selected. The Vanderplass and Garvin codes for these figures are given in Appendix 1.

Stimulus Configuration

Initial slide construction. Each of the 20 letters was randomly paired with ten different figures yielding 200 initial slides. In all cases the initial slide contained two stimuli, with the letter above the figure.

Test slide construction. All test slides had five stimuli positioned as the five dots on a die. In conditions L and F each of the 20 stimuli (in the letters and figures classes respectively) were twice placed in each of the five possible positions on the test slide

with a different set of four stimuli filling the remaining positions
each time. This procedure yielded 200 slides in each condition. In
the M, ML, and MF conditions in order to have the overall number of
letters across 200 trials equal the number of figures, 100 test slides
were constructed with three letters and two figures (3L-2F) and the
remaining 100 had two letters and three figures (2L-3F). The 100
3L-2F slides were divided into two sets of 50 slides each, one for
critical letters and the other for critical figures. In both sets the
20 stimuli of each class were twice used plus an additional randomly
selected 10 from each class making up 50 slides in each set. In a
similar manner the 100 2L-3F slides were constructed.

In the 200 test slides in condition L, the 200 in condition F,
and the 200 which served as test slides in conditions ML, MF, and M, the
frequencies and the positions of the four non-critical stimuli were
balanced.

With the aid of a random number table the three slide groups of
200 test slides each were placed into slide trays with five trays per
group. The same 200 initial slides were used in all conditions to
reduce variability that may result from pairing different letters and
figures in different conditions.

Apparatus

The slides were projected onto the back of a translucent screen
by a Kodak Carousel projector equipped with an external shutter. Two
Hunter Interval Timers controlled the intervals of slide change and,
via a shutter control unit, the interval of initial slide presentation.

The response apparatus consisted of five miniature push buttons on an inclined plane in front of the screen in the same configuration as the stimuli on the test slide. Pressing a button activated a relay which in turn lighted an indicator light and closed the shutter. A Hunter Klockounter measured the duration that the shutter was opened in milliseconds (msec.).

The time sequence was as follows. The initial slide was projected for one second and, one second later, was followed by the test slide. The test slide remained exposed until S had responded. Between all slides the screen was dark.

After each response the experimenter recorded the RT, which button had been pressed, and the confidence rating (see next section).

Subjects and Procedure

Fifty male volunteers fulfilling course requirements from the University of Manitoba subject pool were randomly assigned to the five conditions. The data from 12 other Ss were not analyzed due to equipment failure.

All Ss were instructed that they were in an experiment in which their speed and accuracy at recognizing patterns were being investigated.

Each S was given instructions and two example trials pertinent to his particular group (see Design). Subjects were then instructed to press the button on the box below the screen that was in the same relative position as the critical stimulus on the test slide. All Ss used the index finger of their favoured hand to activate the buttons. Subjects were instructed that when not pressing a button they were to

rest their finger on the table just in front of the button box. In this way it was ensured that all Ss began the button pressing response at the same place.

Furthermore, Ss were asked to give confidence ratings as to how sure they were that they were correct on a scale of one to five. Subjects were lastly instructed that at the end of the trials they would be administered a recall and/or familiarity test of the stimuli used in the experiment. Thus, Ss in conditions L, ML, F, and MF had to attend to the non-critical stimuli on the slides. In this way these Ss were equated to those in conditions M who as well had to attend to all stimuli.

Each S went through 238 trials consisting of the fourth tray followed by trays 1, 2, 3, 4 (again), and 5. The first 38 trials were not analyzed. At the end of the trials Ss were given the recall and/or familiarity test.

Results

The major hypothesis for the present investigation was that if Ss'

reaction times (RT) for critical letters would be longer per letter in

condition M than in condition ML, thus supporting the contention that Ss

had at least two acquisition strategies for the letters: one for use

when the probability of a letter being critical was 1.0 (condition ML)

and the other for use when the probability of a letter being critical was

0.50 (condition M).

Before continuing it may be helpful to review and clarify the

stimulus conditions of interest. In conditions ML and MF Ss were told

that they would be looking for a critical letter or figure (respectively)

amongst a set of mixed letters and figures. In condition M Ss were look-

ing for both letters and figures as critical stimuli, amongst letters and

figures. For the purposes of most analyses the RTs to critical letters

and critical figures were separated. Henceforth, M(CL) will refer to

condition M, critical letters, and M(CF) will refer to condition M,

critical figures.

To test the major hypothesis it was first necessary to establish

that in condition M Ss had analyzed the letters on the test slide before

the figures. Otherwise, any difference in RT to letters between condition

ML and sub-condition M(CL) could be attributed to the increased complexity

of the task in sub-condition M(CL). To examine the hypothesis that

letters were analyzed before figures in condition M it was necessary to

examine the RTs to critical figures in condition MF and sub-condition M(CF).

In condition MF where the probability of a figure being critical

was 1.0 the mean RT to two figures on the test slide was 1.059 sec. and the

mean RT to three figures was 1.126 sec. (see Figure 1, function 2). This
is a highly significant difference (t(9) = 6.83, p <.001). In sub-
condition M(CF) where the probability of a figure being critical was 0.50
the mean RT to two figures was 1.506 sec. and the mean RT to three fig-
ures was 1.520 sec. (Figure 1, function 1). This is a non-significant
difference (t(9) = 0.629, p >.05). Generally, the difference in RTs
between condition MF and sub-condition M(CF) can be attributed to the
increased complexity of the task in M(CF).

In a study discussed previously, Morin et al., (1965) found that
the RT to stimuli increased with set size except for letters. As can be
seen in Figure 1 this finding is replicated for figures in condition MF.
The finding of no difference in RT between two and three figures in sub-
condition M(CF) might be attributed to the possibilities that Ss had pre-
information that a figure would be critical and, as well, that Ss had
some knowledge of the structural information about the figures. In dis-
cussing these two factors it can also be shown that Ss analyzed letters
before figures in condition M. The study that supports the primary aspect
of this explanation (i.e., preinformation) was conducted by Forrin and
Morin (1967).

Forrin and Morin (1967) found that when Ss had "preinformation"
as to the class of a to-be-recognized stimulus, the mean RT for a set
size of four stimuli was less than the mean RT for a set size of two
stimuli. When Ss had no preinformation the typical findings was obtained
i.e., increased set size resulted in increased RT. Forrin and Morin,
however, did not offer an explanation as to how preinformation eliminated
RT differences across set size.

The finding in the present study for figures in sub-condition M(CF) is similar to the results in the Forrin and Morin (1967) preinformation condition. It can be assumed then that Ss had some information as to what class of stimuli was critical when analyzing figures in sub-condition M(CF). This information was derivable in only one way, i.e., by analyzing the letters before the figures and not finding a critical letter. Consideration as to why this explanation will not serve in condition MF (involving the secondary circumstance mentioned earlier - that of structural information) will be presented in the Discussion section.

Since the above results show that Ss analyzed letters first in condition M, comparisons can be made between the RTs to critical letters in condition ML and the RT to critical letters in condition M (actually sub-condition M(CL). Figure 1, function 4 shows the mean RT for two letters in condition ML (0.820 sec.) and for three letters (0.847) sec.). This difference is not significant (t(9) = 1.64, p >.05) and reflects the typical finding for letters (e.g., Morin, et al., 1965). However, the difference between the mean RT for two letters (1.043 sec.) and for three letters (1.125 sec.) in sub-condition M(CL) is highly significant (t (9) = 3.33, p <.001, see Figure 1, function 3). This last finding can be interpreted as meaning that Ss in sub-condition M(CL) spent more time analyzing the letters than Ss in condition ML. It can be assumed that Ss more completely analyzed the letters in sub-condition M(CL) and thus supports the major hypothesis that there is more than one acquisition strategy for letters: at least one for use when the probability of a letter being critical was 1.0 (condition ML) and one for use when the probability of a letter being critical was 0.50 [condition M(CL)]

All the above analyses were for correct responses. In general RT varied significantly across all conditions ($\underline{F}(4,45) = 15.67$, $\underline{p} < .01$). Subsequent analysis with the Duncan Multiple Range test showed that the mean RT in condition M differed significantly from all other means, except for condition F, at the .01 level. A similar analysis showed that the porportion correct also varied significantly across all conditions ($\underline{F}(4,45) = 13.32$, $\underline{p} < .01$). Moreover, there was a perfect correlation between the rank order of the conditions with the shortest RT and the highest proportion corrrect. However, an analysis of the mean confidence ratings revealed that in all conditions $\underline{S}$s were equally confident when correctly responding ($\underline{F}(4,45) = 3.02$, $\underline{p} > .05$).

The recall and familiarity tests were carried out only to fulfill the instructions given to the $\underline{S}$s. Consequently, the data derived from these tests were not analyzed.
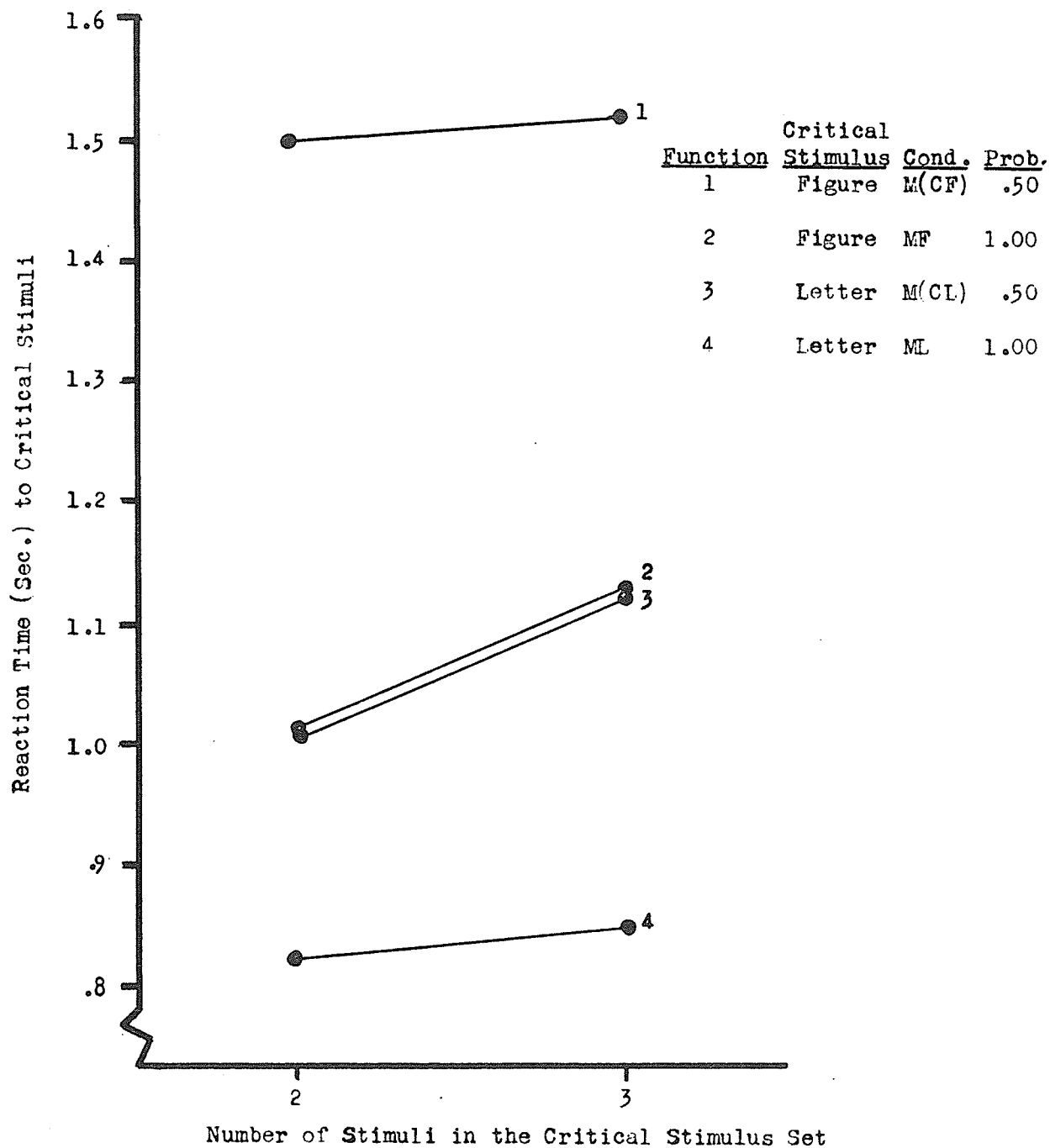
Fig. 1. Mean reaction times for critical letters and critical figures
with respective set sizes of two and three stimuli on the test
slide.

Discussion

From the results of the present experiment it can be concluded

that not only may Ss have available to them more than one acquisition

strategy at any one time but also that certain task variables such as

uncertainty can affect which strategy will be selected. In the present

experiment it seemed that when Ss were certain of a stimulus being in

the search field one type of strategy was selected and when they were not

certain that a stimulus was in the test field they selected another type

of strategy which involved a more complete or at least more time con-

suming analysis of the individual letters. Theoretically, these findings

tend to support the feature analysis conceptualization of pattern recog-

nition that was described in the introduction. It may be that a strategy

is simply a set of more or less stringent probability criteria for the

hierarchical analyzers. More stringent criteria may result in more time

consuming analyses. A more complete test of this feature analysis theory

will be discussed later.

Aside from the detailed analyses of individual letters and figures

on the test slides, Ss were engaged in another type of activity which

actually preceded these analyses. This activity was the determination

of whether a stimulus that occupied a particular position on the test

slide belonged to the class of figure or letters.

In condition MF, for example, Ss knew that they were looking for a

figure. In this case it was not necessary to analyze the letters that

were on the test slide; it was advantageous simply to disregard them.

As pointed out earlier, the mean RT to two figures in th is condition was

significantly less than the mean RT to three figures. This tends to

rule out the notion that all the stimuli on the test slide were analyzed simultaneously, i.e., in parallel. Two viable explanations for this difference are: (1) The figures were analyzed sequentially. Thus on the average it would take longer to analyze three figures to find the critical figure than it would to analyze two figures. (2) Subjects first eliminated two letters and analyzed the remaining three figures in parallel, or they may have eliminated three letters and analyzed the remaining two figures in parallel. Thus, the important variable may have been the number of letters that were eliminated: the more letters eliminated the quicker the RT. Both these explanations are consistent with the data and it is likely that they both describe Ss' activities at different times.

The second explanation above may also in part account for the equivalence in the mean RT between two and three figures in sub-condition M(CF). The task in this condition not only consisted of eliminating letters but also analyzing them in detail. As well, some structural information may have been garnered about the figures as they were being eliminated (at first). This information may have been used to reduce the analysis time of the figures once it was found that a letter was not critical. Thus, the time absorbed by the detailed analysis of the letters plus the time saved by previously attained information about the figures, may have reduced the relative analysis time between two and three figures.

The above conceptualization is speculation at best. Nonetheless, it serves to point out that in all conditions and particularly in the conditions with mixed stimuli, part of the RT to critical stimuli can be attributed to search time as well as analysis time. More precisely,

differential RTs may in part be attributed to differences in test slide

search strategies. Perhaps in certain circumstances stimuli were analyzed

in parallel and in other circumstances stimuli were analyzed sequentially.

The lack of the difference between the mean RTs for the two set

sizes in condition ML and in sub-condition M(CF) (Figure 1, functions 4

and 1) show that these stimuli may have been processed simultaneously

with respect to their individual conditions. By a close examination of

these two conditions it may be possible to outline a set of circumstances

that may partially determine when Ss used simultaneous processing proce-

dures. Subjects in conditions ML and M(CF) knew that letters and figures

(respectively) were critical because they were informed about the letters,

and derived this information about the figures by analyzing letters first

and not finding a critical letter. Also, they had some structural infor-

mation about the letters before they were analyzed in condition ML

(letters are very familiar stimuli) and similarly had some structural

information about the figures that was derived when figures were being

eliminated for the purpose of analyzing the letters first. Thus, a cir-

cumstance of knowledge of the critical stimulus class and a small amount

of information may call for simultaneous processing. It should be noted

that in condition MF (Figure 1, function 2) Ss had no structural informa-

tion and thereby it may not have been facilitatory to use simultaneous

processing. The present investigation was not designed to test for such

circumstances, but they do merit investigation.

Although certain notions about feature analysis and preattentive

processes (Neisser, 1967) can easily be applied to Ss' behavior in the

present task, these notions can and should be tested. For example, it

would be expected that in condition MF $\underline{S}$s would be able to distinguish

between letters and figures, but would only be able to recall the figures

and not the letters. The preattentive theory would state that this is

the case because only holistic analysis of the slide was undertaken, and

the letters were just classified as such, not that each letter was ana-

lyzed in detail (recognized). Furthermore, it should be the case that

in sub-condition M(CF) where figures were critical (but letters were

analyzed first) the letters on any particular slide should be recallable

to a high degree. Although not presently investigated, these tests and

others would more convincingly ascertain the validity of Neisser's

theories.

One puzzling finding was obtained in condition M. As mentioned

previously condition M could be broken down into a sub-condition when

letters were critical, M(CL), and a sub-condition when figures were

critical, M(CF). Since on any slide there were either two letters and

three figures or three letters and two figures, and since it was found

the letters were analyzed in detail before figures, then it would be the

case that in sub-condition M(CF) with two figures on the slide $\underline{S}$s analyzed

three letters (and rejected them) before analyzing and responding to one

of two figures. It would be expected then, that the RT to two figures

in sub-condition M(CF) would be very close to the RT to three letters in

sub-condition M(CL). However, as can be seen in Figure 1 (functions 1

and 3) there is a difference of approximately 380 msec. At present, no

good explanation for this difference presents itself, but the increase in

RT to two figures over the RT to three letters may represent "switching time" from analysis strategies pertinent to letters to analysis strategies pertinent to figures, as well as "switching time" from simultaneous to parallel processes.

The present findings shed light on the importance of task variables when investigating perceptual processes. In short, it has been shown that a variable such as uncertainty has resulted in the selection of different perceptual processes which in turn resulted in different overt behaviors. Related variables such as anxiety and risk-payoff schedules may also be important. The one factor that all these variables might reduce to may be characterized as a desired speed versus accuracy contingency.

A direct implication of these findings is that it is questionable to use letters and particularly other patterned figures as stimuli when investigating relations such as contained information and RT. Usually, one of the assumptions of such investigations is that the stimuli operate as functional units representing finite amounts of information (once the stimulus set size has been established). However, this may not be the case. Although the acquisition strategies for letters are so well rehearsed that differential RTs are usually not obtained, the opposite is found with stimuli that do not have as well rehearsed strategies. In general it is found that the larger the set size the longer the RT to any one stimulus in the set. The reason for this may be that $\underline{S}$s select acquisition strategies which afford more complete stimulus analysis and thereby result in longer RTs, and not that the reduced information contained by each stimulus directly results in longer RTs.

Actually, both information content and acquisition strategies probably contribute to stimulus processing time. It is reasonable to believe that stimulus acquisition is the interpolated variable in visual stimulus processing tasks. Thus, it is important to investigate the variability of acquisition strategies and the task-stimulus conditions which determine that variability.

Summary

The findings of the present study support implications in the literature of the possibility of many perceptual strategies for the acquisition of visual distal stimuli. Furthermore, it was shown that certainty on the part of the $\underline{S}$ can be a determining variable for the selection of particular strategies in different situations. It was shown that this variable can affect the acquisition speed of highly familiar stimuli, e.g., letters, which throws doubt on the use of such stimuli in studies of information processing which assume their information content to be constant.

General support was garnered for Neisser's (1967) conception of the pattern recognition process, but further, more detailed investigation was suggested. Lastly, caution was expressed in the use of any patterned stimuli in perceptual studies without controlling or considering situational variables.

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APPENDIX 1

Random Figures Code

The following are the Vanderplass and Garvin (1959) codes for the
20 randomly shaped figures used in the present study. "Points" refers
to the number of points contained by the stimuli in each group and
"Number" refers to the number code of each stimulus in each group.
Generally, the higher the number (max. of 30) the lower the association
value.

	Points			
	6	8	12	16
	12	13	17	28
	13	21	24	29
Number	23	26	27	30
	27	28	28	
	29	29	30	
	30	30		

APPENDIX 2

Mean Reaction Times (Seconds) for Correct Recognitions
in all Conditions

Condition

	L	ML	F	MF	M
	0.82749	0.82308	0.97634	1.07360	1.30468
	0.87684	0.74301	1.26593	0.94399	1.59781
	0.85558	0.70625	1.20158	0.92332	1.27091
	0.83004	0.93058	1.13135	1.40669	1.16978
Reaction Times	0.94566	1.08107	1.44428	1.10466	1.45988
	0.75054	0.76762	0.95614	1.06248	0.99966
	0.80984	0.86606	1.26280	1.06816	1.26852
	0.91095	0.82873	1.30997	1.14936	1.07608
	0.76219	0.83641	2.02855	1.20590	1.61968
	0.85789	0.74592	1.36718	1.00093	1.22764

APPENDIX 2 (Cont'd.)

Mean Reaction Times (Seconds) for Correct Recognitions for
2 and 3 Letters in Condition ML

	Subject	2	3
	1	.81128	.83579
	2	.73842	.74810
	3	.69240	.72056
	4	.89990	.96427
Reaction Times	5	1.11958	1.04086
	6	.75463	.78144
	7	.85148	.88189
	8	.80147	.85959
	9	.77694	.90110
	10	.75262	.73847

APPENDIX 2 (Cont'd.)

Mean Reaction Times (Seconds) for Correct Recognitions
for 2 and 3 Figures in Condition MF

Number of Figures

	Subject	2	3
	1	1.03450	1.10791
	2	.91364	.97368
	3	.91484	.93133
	4	1.35236	1.45598
Reaction Times	5	1.09040	1.11656
	6	1.03054	1.09090
	7	1.03378	1.09967
	8	1.11297	1.18200
	9	1.14337	1.26401
	10	.96384	1.03535

APPENDIX 2 (Cont'd.)

Breakdown of Reaction Times (Seconds) for Correct
Recognitions in Condition M

The following are the mean reaction times in sub-conditions M(CL)

and M(CF) for 2 and 3 letters or figures (respectivley).

		M(CL)		M(CF)	
	Subject	2 Letters	3 Letters	2 Figures	3 Figures
	1	1.07344	1.16816	1.48265	1.48285
	2	1.24357	1.36665	1.95047	1.85287
	3	1.03046	1.18250	1.38427	1.46843
Reaction Times	4	.97131	1.02649	1.34960	1.33474
	5	1.27991	1.19736	1.67235	1.65026
	6	.87881	.87963	1.15648	1.08170
	7	.92414	.97710	1.57695	1.58337
	8	.81970	.97020	1.24851	1.33481
	9	1.28252	1.38882	1.79972	1.95899
	10	.92511	1.09704	1.42418	1.45163