The Effects of Stimulus Familiarity and Instructions

on Perceptual Strategies

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Leslie S. Klein

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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 construction 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 representational description of the stimulus in a more or less undistorted form reaches central areas of the brain. It may be assumed that any perturbations in the description at this point are minimal, and have very little detrimental effect on subsequent processing of the stimulus information 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 information 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 centripital 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 concluded, then, that the iconic state exists as a central process in an area that at least is inervated by neurons which can carry auditory information. 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 experiments 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 recog-

nizing 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 recogni-

tion 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: pre-

attentive 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.