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DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
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The Ohio State University
1976

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INTRODUCTION

An observer's response to tachistoscopically displayed information can seldom if ever be described by a simple psychophysical function which relates all of the physical characteristics of displays to response variability. This is a consequence of the fact that there is more information available in the environment than a perceiver can (or usually needs to) use. Hence, responses are selective relative to the total amount of information available, and depend in large degree upon the task characteristics and requirements. For this reason the replication of an experimental result often depends at least as much on instructional, motivational and learning variables as upon the formal similarity of stimulus materials employed.

The ability of a perceiver to select the information sources to which he will attend or respond has clear behavioral correlates at the molar level; one drives across town to see a motion picture, turns the head to see who is speaking, or scans a large painting to perceive its total composition. The activities have the common effect of positioning the sensorium at points in space which maximize the availability of the desired information, while minimizing that from unwanted sources.

Although it is not currently fashionable to consider activities such as walking and head-turning as examples of perceptual selection, some theorists (e.g., J. J. Gibson, 1966) have explicitly done so, pointing out that it is by these means that the majority of selection must be accomplished. Even though more subtle motor activities such as ocular adjustment have gained increasing acceptance as legitimate topics of perceptual investigation (Yarbus, 1967), the preponderance of the research on selection has emphasized activities of the visual nervous system not subject to direct observation, the purported function of which is to select from the information garnered in a single glance.

This approach, which has its roots in the early studies of the span of apprehension, is based upon two major assumptions: (a) that of an upper limit on the amount of visual information which can be resolved by the nervous system per unit time, and (b) that information overload results during perception of both complex environments and simple visual
displays, provided that viewing time is sufficiently limited. Despite protests to the contrary (Brunswik, 1956; J. J. Gibson, 1966), the kinds of selective processes occurring under both these conditions are usually thought to be identical, on the grounds that complex scenes must be perceived via the integration of memory traces established during successive glances or fixations (Hochberg, 1968).

The pattern for research on the problem of selection using tachistoscopic methods was established by Külpe (1904), who presented observers with brief visual displays consisting of colored syllables in various locations of the field of view. Following each display, the observer reported the value of one of the three "dimensions" (color, position, or syllable) to which he had been instructed, prior to the display, to pay particular attention (the primary dimension). On a few trials, following the report of the primary dimension, observers were also asked to report on the value of one of the two remaining (secondary) attributes of the display. The data indicated unequivocally that a secondary dimension was reported with less accuracy than a primary one. Külpe attributed this difference in performance to the increased phenomenal clarity of the attended aspect of the display, which he supposed to result from the Aufgabe or mental set provided by the advance instructions. Of the many different phenomenal fields which might have resulted from the presence of a given proximal stimulus, the instructional set was thought to give rise to one in which the attended dimension was represented with suggested clarity at the expense of the unattended aspects. It was further argued that this interpretation was supported by the observers' introspective accounts of the relative phenomenal clarity of the dimensions.

Although this explanation is introspectively appealing to anyone who has attempted to identify briefly displayed patterns, it is inadequate in the light of logical and methodological strictures of more behaviorally oriented theories of perception. One of the arguments countering Külpe's interpretation is that an observer's report of what was seen may be the product of mental processes other than, or in addition to, perception. Wilcocks (1925) demonstrated that simply by delaying the report of a primary dimension, the accuracy could be reduced to a level near that for Külpe's secondary dimension, which was always reported second. This finding directly implicated memorial influences, and led to the hypothesis that the effect of prior instructions might be on memory for what is perceived, rather than on the perception itself. Most subsequent research in this area has centered on attempts to distinguish between the "perceptual" and "memorial" accounts of the set effect through the
application of increasingly complex methodologies.

Chapman (1932) reasoned that an appropriate test of the perceptual hypothesis consisted of providing instructions either just before or just after the display. According to his logic, if selective memory were the complete account of the set effect, then instructions given immediately after the display (the After condition) should provide as much opportunity for selection as would instructions provided just before the display (the Before condition). If, on the other hand, the effect of set were on the initial perception of the display, then the Before condition should result in greater accuracy than the After condition, since only an instruction received prior to the display could affect perception. In an experiment similar to that of Külpe (1904), but incorporating the Before-After paradigm, Chapman (1932) observed an accuracy advantage for the Before condition in the case of two out of three display dimensions, and concluded that the influence of instructional set was on the initial perception of the display, rather than on the observers' memory for what had been perceived.

It is critical to note that the distinction drawn by Chapman between perception and memory was a temporal one, based upon logical rather than empirical grounds; perception occurs during the display, and memory thereafter. There is little to argue for the validity of such an assumption, but even if there were, it would not be clear that Chapman's experiment provided an unbiased test of the hypotheses involved. As Egeth (1967) has pointed out, observers in Chapman's After conditions were required to look away from the tachistoscope and read the instruction before beginning to respond, while those in the Before condition could respond without delay. This procedure leaves open the possibility that the difference in accuracy between the two conditions was merely the result of greater memory loss prior to responding in the After than in the Before condition.

Chapman's experiment and subsequent criticisms of it raise two important and related questions. The first involves the appropriateness of using the Before-After paradigm to distinguish between the memorial and perceptual hypothesis. Any procedure which requires observers in an After condition to wait for an instruction before responding has the effect of confounding memory loss due to either decay (Sperling, 1960) or interference (Peterson & Peterson, 1959) with perceptual differences. Since memory loss from either of these sources can be very rapid, the difficulties which Chapman (1932) attempted to overcome with the use of the Before-After technique are instead compounded.
The second problem, which is of much more import than the first, involves the grounds for making a temporal distinction between perception and memory. Current information-processing analyses of cognitive activities indicates that memory systems are involved very early in the processing of visual information (Sperling, 1960; Averbach & Coriell, 1961), and that events characterized as perceptual may continue to occur for a period of time following the termination of a display (Haber, 1969; Haber & Hershenson, 1973). A serious question is thus raised concerning the propriety of a distinction between perception and memory, and if such a distinction is made, how it is relevant to the issue of set effects.

In order to make sensible statements about perceptual effects and how they differ from nonperceptual ones, a meaningful criterion must be adopted governing the use of the terms, whether in a descriptive or explanatory role. With the exception of a few theorists (e.g., Broadbent, 1958), there has been a general reluctance to equate perception uniquely with any hypothetical mental process, or even with a well defined subset of such processes. More often, there has been a tendency to call such processes "perceptual" if they are engaged in the processing of environmental information, as opposed to hallucination, dreams, etc. Haber (1969) for example, calls "perceptual"

all those processes concerned with the translation of stimulus energy falling on the receptor surface into the reports of experience, responses to that stimulation, and memory persisting beyond the termination of that stimulation (p. 1).

This identification of perceptual processes on the basis of the "external information" criterion means that the term "perception" is not used to distinguish one set of mental processes from another, but to distinguish one kind of organismic activity from others. The activities involved in this subclass of behavior are those in which responses are related to environmental information gained through the senses.

The notion that perception is characterized by a kind of activity or kind of explanation which does not have the status of an intervening variable is based upon a criterion of "externality." When thus defined, the study of perception is characterized by situations in which the variability in responding accounted for the variables of stimulation is maximized, while that accounted for by all other sources
(e.g., response system characteristics) is minimized (Arnoult, 1967, p. 5).

The particular version of the externality criterion to be applied here is that the terms "perception" and "perceptual" are meaningfully used to describe a functional relationship between stimulus variability and response variability, rather than a subset of internal processes. An organism is said to perceive the difference between X and not-X if it can be trained to respond in a systematically different fashion to X and not-X (Cornsweet, 1970). This usage is neutral with respect to the existence, kinds, or durations of the mental events intervening between the available information in the environment, and the response to it. It is a usage which is similar to Brunswik's (1956) concept of distal achievement through vicarious functioning, and to Gibson's (1959) "activities which keep an organism in touch with its environment." The success of an organism in perceiving is measured by the degree to which it is able to respond differentially to different environmental states.

It is also proposed that the term "perceptual set" is neutral with respect to the issue of internal locus. "Set" reflects covariability between differences in the accuracy of responding and differences in prior information made available to a perceiver. A primary issue, therefore, is one of determining the nature of the environmental information used by an observer in becoming set.

The Before-After paradigm represents a discrimination task in which an observer must discriminate among a set of alternative patterns, usually on the basis of information gained during the brief presentation of one of those alternatives. Considering the task as one of discrimination makes it clear that the difference in the information available in the Before and After conditions is the same as that available to account for the improvement of accuracy of discrimination as a function of practice. In each case there is an improvement in performance which covaries with differences in the information previously available to the perceiver. The primary thesis of the present argument is that this covariation is a manifestation of the same phenomenon of perceptual learning, and that the same analysis of the effect is appropriate to perceptual set as to increased ability to discriminate in general. This argument is based upon the logic of Owen (in press), who has suggested that the effect of prior experience on subsequent perceiving can be analyzed in psychophysical terms if the differences in previous experience have been directly controlled. If these
original differences are later demonstrated to be correlated with differences in perception, then a psychophysical relationship between prior experience and subsequent perceiving has been effectively established. In the case of both continued practice in discrimination and set, such a psychophysical analysis can be based upon the frequency with which an observer has been given opportunity to isolate the information needed for the required discrimination.

E. J. Gibson (1969; E. J. Gibson & Levin, 1975) and Garner (1974) have suggested that visual perception of patterns is based upon the ability of perceivers to distinguish a given pattern from other, alternative patterns which might have occurred instead. This ability to discriminate is thought to depend on the existence of distinctive features which allow an observer to specify a pattern by isolating those of its characteristics which differentiate it from those which might have occurred in its place. This relationship between distinctive features, populations, and the members of the populations has recently been stated by Gibson and Levin in the following terms:

In order to identify something as unique, we must know its alternatives—what it might have been, but isn't quite. Things come in finite sets, and there are feature contrasts within the set that are shared in different degrees by the members of the set. We shall refer to these as "distinctive features" which permit specification with respect to a set of alternatives (p. 15).

Much of the analytical power of this view is based upon the hypothesis that a pattern is specified only in relation to a set of alternatives, and that knowledge of the relationships among the members of that set is a prerequisite to accurate discrimination. The more opportunity a perceiver has to discover the distinctive features of a set of alternatives, the better will be his discrimination performance. This improvement comes about as an observer learns to depend upon those feature contrasts which are distinctive, and to ignore those which are not. There is ample evidence to indicate that the relationship between a given pattern and those from which it must be discriminated is appropriate to the analysis of performance in a variety of tasks (Barron, 1975; E. J. Gibson, J. J. Gibson, Pick, & Osser, 1962; E. J. Gibson & Yonas, 1966; Rabbitt, 1967; Yonas, 1969). When distinctive-feature information is made available, observers learn to utilize it in becoming more proficient in discrimination performance. The net effect of this increased
reliance upon the distinctive features which specify members of a set of alternatives, is that members of the set become functionally more distinctive than they were prior to such learning.

Working from a similar point of view, Lawrence and Coles (1954) proposed that when an observer must choose which of several alternatives corresponds to a briefly displayed item, knowing in advance what the alternatives are should become increasingly important as those alternatives become more and more similar. This prediction was based upon the hypothesis that advance information about the nature of the alternatives might allow an observer to become set or "tuned" to perceive the features which are distinctive for that set of alternatives. The more similar the set of alternatives, the greater will be the benefit of knowing in advance of the display which features are critical, since there will, as a rule, be fewer such features for similar than for dissimilar alternatives.

The logic of Lawrence and Coles is identical to that of E. J. Gibson and Garner. The ability to discriminate among a set of alternatives depends upon knowledge of how those alternatives differ. In the typical discrimination-learning task (e.g., Yonas, 1969) part of the improvement in performance as a function of practice can be attributed to the fact that the observer learns to isolate the distinctive features within the set of patterns employed in the experiment. The difference between observers at early and late stages of learning is, thus, a difference in the amount of uncertainty about what information is critical to the solution of the problem presented on each trial of the experiment. This uncertainty is gradually reduced as the observer isolates the distinctive features of the set of patterns, so that there is a focusing on those which are useful, rather than those which are not distinctive.

The set experiment proposed by Lawrence and Coles represents a comparison between two similar levels of uncertainty. Observers in the After condition face essentially the same problem as that early in discrimination learning—lack of knowledge about what features to look for in order to be able to solve the discrimination problem. Observers in the Before condition, on the other hand, have at their disposal the same kind of "prior" information available in late stages of discrimination learning; they are allowed to peruse the restricted set of alternatives prior to the display, and to isolate the particular features which are distinctive within that set. In the case of both the discrimination and set tasks, the
advantage afforded by this information relative to the control condition of no such information (early in learning or After condition) should be, in part, a function of the similarity of the alternative patterns. The more similar that set, the greater will be the advantage of prior specification of distinctive features, because of the relative paucity of them.

Lawrence and Coles (1954) provided observers with four verbal alternatives either before or after the brief display of a picture of one of the objects named by the alternatives. In addition, the visual similarity of the four objects named on each trial was manipulated in order to evaluate the hypothesis that prior information allowed observers to focus on the critical features of the display. The results of the experiment indicated neither a difference between Before and After conditions nor the expected interaction with the similarity of the alternatives, thus failing to support the hypothesis of selective perception based upon prior information.

In considering this conclusion, however, it is important to note that the alternatives provided to the observers by Lawrence and Coles were words, whereas the population of patterns among which they were required to discriminate were pictures, and to consider, as did Egeth (1967) the possible effects of such advance information.

Exactly how might a perceptual process be modified by these verbal alternatives—what critical features will distinguish reliably among the four classes of objects, and just where in the picture should the subject look for those features, assuming that he is fortunate enough to think of some before the stimulus is flashed. It is suggested here that a proper design to test the hypothesis that perceptual selectivity exists would use pictorial stimuli. Then the subjects would have an opportunity to peruse the set of alternatives in order to find features which can distinguish among the alternatives, and they could set themselves to look for those features when the stimulus is flashed (p. 43).

Egeth and Smith (1967) replicated the Lawrence and Coles (1954) experiment using pictures as alternatives, either before, after, or before and after the brief display of a picture. They found that alternatives presented in the Before-and-After condition resulted in superior performance.
to the After-only condition, and that the magnitude of the advantage was greatest for similar alternatives, as had been predicted by Lawrence and Coles. Under the prior information condition observers responded to the similar alternatives as though they were functionally less similar than did observers in the After-only condition.

In a recent series of experiments, Pachella (1975) examined the effect of advance information in a task in which only a single alternative (either a picture or a word) was presented either before or after a brief pictorial display. Observers were required to respond "same" or "different" depending on whether the briefly displayed picture corresponded to the alternative. It was found that the pictorial-alternative-Before condition resulted in greater accuracy than the corresponding After condition, but that there was no difference in the accuracy of observers in the verbal-alternative-Before and -After conditions. This pattern is consistent with the results of both Lawrence and Coles (1954) and Egeth and Smith (1967), thus supporting Egeth's (1967) contention that verbal alternatives failed to provide sufficiently specific information to allow observers to become set. As a further test of this hypothesis, Pachella performed a second experiment which employed the same verbal alternative conditions as the first, but in which observers were given pretraining on the day before the main experiment. This pretraining consisted of a single paired-associate trial for each word-picture pair used in the experiment. Following this pretraining it was found that the verbal-alternative-Before condition resulted in an improvement of performance of roughly the same magnitude as the pictorial-alternative-Before condition of the first experiment. It would thus appear that observers were able to use associative information gained during the training session in becoming set.

While Pachella's results appear to be compelling evidence for the specificity argument of Egeth (1967), such an interpretation must be made with caution. Although the reduction of the Before-After paradigm to a single alternative same-different task has appealing methodological advantages, the differences between single- and multiple-alternative versions of the task have sufficient import to warrant caution, particularly unless there are additional operations in common between the experiments to be compared. As a general rule, the analytical power of the Before-After paradigm depends upon the extent to which differences in performance under the two conditions are related to the effect of at least one independent manipulation. Without the application of such additional (converging) operations, the mere presence or absence of a Before-After performance
difference is not tied to any particular set of concepts, and remains subject to a variety of interpretations. In the multiple-alternative form of the task employed by Egeth and Smith, the magnitude of the Before-After difference was modulated by the similarity of the alternatives. The physical similarity of a set of alternative patterns is known to affect the ability of an observer to distinguish among them (Kaplan, Yonas, & Shurcliff, 1966). The fact that Egeth and Smith found the magnitude of set effects to be a function of such similarity indicates that any explanation of the effect of set should be cast in terms of constructs which are, at the same time, appropriate to the discussion of visual discriminability effects in general. One such formulation is that the presentation of advance information serves to reduce the similarity of a set of alternatives by increasing their discriminability, i.e., by specifying those features which are relevant to the discrimination among the patterns.

The nature of the information afforded by a single alternative in the same-different version of the paradigm is less easily specified than in the multiple-alternative case. In the same-different task, the observer presumably bases his decision on the information he is able to gain during the briefly-exposed display. That decision can be characterized as a discrimination between the alternative which was shown and what Garner (1974) has termed an "inferred set" which might have occurred. Thus, if the observer is not knowledgeable about the actual composition of the population of patterns involved, the difficulty of that discrimination, and the features upon which it is based, goes uncontrolled, since it will depend upon the observer's assumptions about the nature of the patterns which did not appear, but might have.

Since the pictures employed by Pachella (1975) were of common objects which had previously been judged to be dissimilar, it is likely that observers in the Before condition were able to reasonably infer which features of those objects were distinctive in terms of the population of common objects even not knowing precisely which objects those might be. A violin, for example, has characteristics which are quiet unlike those of most other common objects which would be judged to be dissimilar. A single verbal alternative, however, apparently failed to convey such information unless it was first associatively paired with the particular pictorial exemplar used in the experiment. Such pretraining provides an associative basis for the specification of the characteristics which distinguish a given pattern from those which might appear instead. Evidence for such associatively-based specification of visual information has been documented
by Posner (Posner, Boies, Eichelman, & Taylor, 1969), who found that observers apparently perform same-different tasks with letters on the basis of their physical characteristics, even under conditions where only the name of one of the letters is provided by the experimenter.

Thus, although Pachella's (1975) results are consistent with the discrimination-by distinctive-feature analysis, no direct evidence is available to make the comparison between single- and multiple-alternative forms of the Before-After test above question. One of the purposes of the experiments reported below was to deal with this issue. If it is the case that in Pachella's experiments the single alternative provided information about distinctive features based upon prior knowledge of the relevant differences among common objects, and if the specification of patterns within a set depends upon the isolation of such differences, then depriving the observer of knowledge about the set from which the patterns are taken should reduce or eliminate the advantage of an advance alternative. Such an alternative would convey no useful information, since that information is defined only relative to the other members of the pattern population. In terms of the psychophysical language of Owen (in press), if the important parameter of prior experience is the frequency with which observers have isolated pertinent information, then this manipulation should minimize the effect of advance information. This hypothesis was tested in Experiment I below, by employing a population of patterns with which observers were unfamiliar (randomly generated polygons), and by providing no opportunity to learn about relevant distinctive differences between members of the set. In other respects, the experiment resembles the pictorial-alternative conditions of Pachella (1975).

The second experiment further elaborates the discrimination analysis of set effects by examining the effects of varying the frequency with which observers were given opportunity to isolate the information relevant to the discrimination required in the Before-After test. The manipulation of this frequency variable affords an opportunity to establish a psychophysical relationship between that parameter of prior experience and subsequent differences in the accuracy of discrimination, as suggested by Owen.
EXPERIMENT I

Method

Observers
Twenty-six volunteers, sixteen females and ten males, were recruited from introductory psychology courses at Ohio State University for use as observers. None had ever participated in a tachistoscopic experiment, and each received course credit for his or her participation.

Stimulus Materials
A total of 340 different randomly generated, closed polygons from the Brown and Owen (1967) sample were selected for use as stimuli. They were constructed according to Attnave and Arnoult's (1956) Method I rules, with the additional constraint that no three points might lie along a single vector. They were computer-drawn on white paper and photographed using high contrast black and white film. The negatives of these photographs were mounted in 2 x 2 in. slide frames, and when projected appeared as white outlines on a black background. Two identical versions of each slide were prepared.

Apparatus
The apparatus included a two-channel Scientific Prototype tachistoscope logic panel which drove two high intensity hydrogen flash tubes, each mounted behind a diffusing glass in Kodak RA 960 random-access slide projectors which had been modified for that purpose. The flash tubes were capable of rise and decay times of less than 1 msec. A third projection channel consisted of an unmodified Kodak RA 960 random-access projector fitted with chromatic filters chosen to approximate the color and brightness provided by the hydrogen flash tubes. The onset and offset of this channel was controlled by a solenoid-driven blade shutter. The first two channels were used to project an alternative form either before or after the flashed form.

The three projectors were arranged with the aid of mirrors to project to the same location on a 6.2 x 6.2 cm back-projection screen which was viewed by the observer from an adjoining room at a distance of about 136 cm. The largest polygon subtended a visual angle of 2 deg. 20 min., while the smallest was 1 deg. 40 min. of visual arc. The visual noise mask covered the entire viewing area, and consisted of a 62 x 62 matrix, a randomly-selected half of the cells of
which were filled. Each cell projected to a size of .1 cm. sq., corresponding to a visual angle of about 4 min.

The timing and sequencing of events were controlled by a Hunter Model 1516 millisecond timer, which was triggered when the observer pressed a footpedal. Responses were made verbally over an intercom to the experimenter who recorded them on a previously prepared form, selected the slides for the next trial, and then informed the observer when he was ready to proceed. During the entire experiment the observer was seated in a semidarkened room, the only illumination provided by an overhead red lamp, and wore a set of headphones over which broad band white noise was played at 65 dB sound pressure level, which prevented hearing the experimental apparatus, but allowed communication over the intercom.
Design and Procedure

Pilot data had previously indicated the existence of substantial differences in the ability of different observers to respond with accuracy to tachistoscopic presentations of the patterns described above. Two steps were therefore taken to render the experiment maximally sensitive to the existence of set effects. The Before-After manipulation was treated as a within-observers variable, and complete within-observers replications of the experiment were performed on different days. In addition, an attempt was made prior to the Before-After test sessions to isolate task parameters for each observer which would approximately equate task difficulty, thus avoiding potential ceiling and floor effects which might obscure set effects. The first session of the experiment was used to set task parameters and provide practice, while the second and third sessions were used to gather data relating to the issue of set.

Parameter Setting and Practice - Session I

During the first session a detection task was employed to determine a mask-pattern contrast level which would be used for each observer during the main experiment. A series of blocks of twenty trials each was conducted for this purpose. On each trial the observer was presented with a test flash of 100 msec. duration, preceded and followed by the visual noise mask. On a randomly determined half of the trials a polygon was projected during the flash, while on the remaining trials an opaque slide was selected by the experimenter prior to the test flash. The sequence of events during each of these trials is illustrated in Figure 1(a).

Following each test flash the observer responded by saying "yes" or "no" depending on whether he or she decided that a polygon had been projected (see Appendix A for the text of instructions to observers). Between blocks of twenty trials the experimenter adjusted the illumination level of the visual noise mask for the next block of trials. This procedure continued until the observer's "hit" rate ("yes" given that a polygon was projected) was in the range of 70 to 80%. At least one additional block of trials was then conducted to verify the stability of performance, and that setting of the mask illumination level was then recorded for use with that observer throughout the remainder of the experiment.
Figure 1. Sequence and durations of the events in (a) the parameter-setting, (b) the Before, and (c) the After conditions of Experiment I. Dark areas represent the visual noise shown in milliseconds.
Same-Different Practice

Following the determination of an appropriate mask-pattern contrast level for an observer, which generally required about 35 minutes, eighty trials of practice with the same-different task were conducted. This task was similar in nature to that employed during the parameter-setting trials, with the exceptions that (a) each test flash contained a polygon, and (b) 1 second following the offset of the test flash a single alternative polygon was projected for 2.5 seconds. The observer was required to respond by saying "same" or "different" depending on whether he or she decided the flashed and alternative polygons were identical. An equal number of "same" and "different" trials were included, the order of which was randomly determined. Twenty of the original 340 polygons were employed during the first session, with the remaining 320 reserved for use during the main experimental sessions.

Main Experiment - Sessions II and III

During each of the remaining two experimental sessions, which were conducted on different days, each observer performed 80 trials under each of the two major conditions of the experiment, Before and After. Half the observers underwent the Before condition first on each day, with the rest experiencing the After condition first. The sequence and duration of each of the events under these conditions is illustrated in Figure 1(b) and 1(c). After having watched the test flash and the alternative on each trial, observers responded by saying "same" or "different," and giving a confidence rating ranging from one to three. "One" was used to indicate the least confidence, and "three" the most confidence in the correctness of the same-different judgment (see Appendix B for the text of instructions to observers). In all cases the visual noise mask remained on the screen except when a pattern was being projected.

The order of presentation of patterns was randomized independently for each observer during each session within the limits of the following constraints: (a) each of the 320 polygons was used exactly once as an alternative and once in a test flash for each observer during the experiment; (b) each polygon appeared an equal number of times in "same" and "different" trials across observers; (c) each polygon appeared equally often at each of the four levels of practice across observers, and (d) the number of "same" and "different" trials was equal within each block of eighty. These restrictions were made to insure that the results obtained would not be due to any particular combination of forms with conditions or level of practice, and to prevent form-specific learning from occurring during the course of the experiment. Each of the last two sessions required about one hour, including a short rest break between the two blocks of trials.
Results

The statistic used to measure accuracy of performance was $A_g$, a nonparametric and response bias free estimate of percent correct, corresponding to the area under an observer's ROC curve (Pollack, Norman, & Galanter, 1964). An $A_g$ score was computed for each observer under each condition for each of the two final sessions of the experiment (see Appendix C). The resulting proportions were subjected to an arcsin transformation ($X' = 2 \text{arcsin } X^2$) in order to ensure independence of means and variances (Winer, 1971, Pp. 400-401), and then to a 2 (Orders of Conditions) x 2 (Sessions) x 2 (Conditions) analysis of variance. The results of this analysis revealed that none of these factors or the interactions among them approached the .05 level of significance (see Appendix D). The mean values of $A_g$ under the major conditions are shown in Table 1.

The data for individual observers were examined for evidence of strategy differences which might have obscured a set effect for some observers by the presence of an opposite trend in others. Figure 2 illustrates the relationship between the magnitude of the Before-After difference on each of the last two days for each observer. The difference in accuracy on the two days showed almost no relationship ($r = -0.10$).

Since Pachella (1975) reported that observers in the Before condition of his experiments were, on the average, more confident of their "same" responses than those in the After condition, even when there was no significant difference in their accuracy, the distributions of confidence ratings in the present experiment were examined for a similar trend. Inspection of the data in Table 2 reveals that the overall distribution of confidence ratings under the Before and After conditions was strikingly similar. Under both conditions observers distributed their confidence ratings about evenly across categories when responding "different," while using medium confidence ratings more often when responding "same." There is no indication, however, that the Before-After manipulation per se had any effect on the confidence of the responses of observers in the present experiment.
Table 1

Mean Percentage of Area under the ROC Curve as a Function of Sessions and Conditions in Experiment I

<table>
<thead>
<tr>
<th></th>
<th>Session II</th>
<th>Session III</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>70.5</td>
<td>73.3</td>
<td>71.9</td>
</tr>
<tr>
<td>After</td>
<td>70.9</td>
<td>72.4</td>
<td>71.7</td>
</tr>
<tr>
<td>Mean</td>
<td>70.7</td>
<td>72.9</td>
<td>71.8</td>
</tr>
</tbody>
</table>
Figure 2. Scatterplot of the difference in $A_g$ scores for the Before and After conditions of Experiment I during the final two sessions. Each observer is represented by a single point.
Table 2
Percentage of "Same" and "Different" Responses at Each Confidence Level in Experiment I

<table>
<thead>
<tr>
<th>Confidence</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>same</td>
<td>27.1</td>
<td>41.0</td>
<td>31.9</td>
</tr>
<tr>
<td>different</td>
<td>33.1</td>
<td>33.5</td>
<td>33.4</td>
</tr>
<tr>
<td>After</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>same</td>
<td>26.5</td>
<td>44.9</td>
<td>28.6</td>
</tr>
<tr>
<td>different</td>
<td>30.9</td>
<td>34.2</td>
<td>34.9</td>
</tr>
</tbody>
</table>
Discussion

The failure to observe a set effect in Experiment I is somewhat surprising, especially considering the magnitude of the effect reported by Pachella (1975). The major difference between Pachella's pictorial alternative conditions and the present experiment is that observers in this experiment had no previous experience with the patterns involved, and were not allowed to become familiar with specific patterns during the course of the experiment. One need not accept the statistical hypothesis of no set effect in the above experiment to conclude that there exists a marked difference in the ability of observers to become set under the conditions of the two experiments. The information afforded by a single alternative provided in advance is apparently useful only if an observer knows how that alternative differs from the remaining members of the pattern population from which it must be discriminated.

In the present experiment the population of potential patterns was essentially infinite. Observers had no opportunity to isolate the distinctive differences of the population - a criterion suggested by Gibson and Levin (1975) for the ability to improve in the ability to discriminate among them. Randomly generated polygons are not constrained in the ways that real objects are, and this fact apparently prevented observers from gaining information from an advance alternative which would be useful in discriminating it from the remaining members of the population. This finding is, in principle, the same as that of Lawrence and Coles (1954); the information supplied in advance was not of a type which was useful to observers.

The fact that observers in this experiment were unable to use the information potentially available from an advance alternative is consistent with the hypothesis that the perceptual utility of such information is a function of the frequency with which it has been employed in past discrimination problems. Experiment II was designed to deal more explicitly with this frequency variable.

It appears, on the basis of the results of Experiment I, that learning about the abstract or higher order variables which specify the statistical or general ways in which a population of patterns differ does not provide a basis for improved ability to discriminate among particular members of
that population. A similar result has been reported by Yonas (1969), who found that the perceptual strategy of learning to depend upon a specific distinctive feature did not transfer to a new set of patterns when the same strategy but a different feature was relevant. Aside from general task-learning effects, the result of discrimination practice in Yonas' data appeared to be restricted to discriminations among the particular set of practiced patterns, rather than generalizing to the pattern population as a whole. That is, the most important variable was the frequency with which particular patterns were discriminated, rather than the frequency of discrimination among the same general kind of patterns.

Experiment II examined the effect of the two different levels of controlled discrimination practice relevant to the above hypothesis. All observers were given extensive practice in discriminating among a set of twelve patterns. For half the observers these were the same patterns subsequently employed in a Before-After test, while for the remainder of the observers the patterns were from the same population, but were a different twelve. The first of these groups, therefore, were given experience with the particular differences among patterns which would be relevant in the Before-After test, while the second group was given practice with differences of only the same general kind. For both groups, of course, learning of specific differences was possible during the conduct of the Before-After test itself.

A second variable which was included along with that of training was the nature of the patterns employed. For half the observers the patterns employed during both the practice and Before-After portions of the experiment were randomly generated polygons similar to those in the first experiment. For the remaining observers the patterns were outline drawings of common objects. If frequency of prior experience is an important determinant of the ability to use advance information in discrimination, then it might be expected that the representative patterns might enjoy the same potential advantage of discriminability as a set of randomly generated patterns with which an observer had already had practice in discrimination. This prediction, however, would run counter to the findings of Yonas (1969), who observed that the improvement attributable to the isolation of distinctive differences did not transfer to a new set of patterns, even though the patterns were letters, with which observers are very familiar. This restriction of the effect of frequency of prior discrimination to the particular set of patterns practiced can be taken to indicate that learning which results from discrimination practice is specific to the set of
patterns practiced, rather depending on extra-experimental familiarity with real-world objects which seldom need to be discriminated rapidly or under conditions of marginal stimulation.
EXPERIMENT II

Method

Observers
Thirty-two undergraduate students, 24 males and 8 females, enrolled in introductory psychology courses at Ohio State University were recruited as observers. None had ever participated in a tachistoscopic experiment, and each received course credit.

Stimulus Materials
Eight sets of 12 patterns each were selected for use. Four of the sets were composed of randomly selected members of the population of polygons employed in Experiment I. The remaining four sets consisted of twenty-sided, closed polygons which had previously been shown to have high representational value (Haas, 1968), i.e., each could be readily identified by observers as an outline drawing of a real object. Examples of each of these two types of patterns are shown in Figure 3.

After all 96 patterns had been equated for area, the randomly-generated and representative forms (hereafter called Random and Meaningful, respectively) were found to have mean perimeters which were not reliably different by a two-tailed t test ($t(94) = 1.29, p > .20$). Another variable which has been found to influence discriminability of such forms is angular variability (Brown & Owen, 1967). Random figures were found to have reliably greater variability of internal angles than did the Meaningful forms ($t(94) = 6.39, p < .001$). The visual noise mask which was used consisted of a 24 x 24 cell matrix in which a randomly determined half of the cells were filled.

Apparatus
Displays were generated on a cathode ray tube (CRT) controlled by an Imlac Corporation PDS-4 minicomputer, which also generated a new visual noise mask by a random process before each trial, and recorded responses for subsequent analysis.
Figure 3. Examples of (a) the randomly generated, and (b) the representative patterns employed in Experiment II.
Design and Procedure

Each observer participated in two experimental sessions conducted on different days. During the first session a training task was employed, the purpose of which was to familiarize the observer with one of the sets of twelve patterns. During the second session each observer was tested under both Before and After conditions in a same-different task like that used in Experiment I. In addition to the Before-After manipulation, the variables of interest in Experiment II were: (a) Training, i.e., whether the set of twelve forms used during the Before-After test were the same as those used during the training session, and (b) Form Type, i.e., whether the forms employed on the two occasions were Random or Meaningful. The latter two manipulations were between-observers, while the Before-After manipulation was within-observers. The transfer conditions of the design are illustrated in Figure 4.

Training - Session I

The purpose of the initial session of the experiment was to give each observer training in the discrimination of the forms of one of the eight sets described above. The task selected for this purpose was similar to that introduced by Sternberg (1966). On each of 192 trials, three of the twelve possible forms appeared simultaneously on the CRT and remained in view for six seconds. Two seconds after the offset of these three memory forms, a single test form appeared on the CRT and remained there for 2.5 seconds. The observer was required to respond as quickly as possible without making an error by pressing one button to indicate that the test form was identical to one of the three memory forms for that trial, or another to indicate that it was not. (See Appendix E for the text of instructions to observers.)

The composition of the series of trials was randomly arranged under the restrictions that each of the twelve forms was used equally often, both as a memory form and a test form, that each appear equally often as a test form in positive and negative trials, and that there be an equal number of positive and negative trials. Each of the four different sets of Random and Meaningful forms was used for an equal number of observers. The entire session consisted of two blocks of 96 trials each, with a five minute rest break between the two blocks. The total time required per observer was about 55 minutes.
Figure 4. Transfer conditions of Experiment II.
Before-After Test - Session II

During the second session observers underwent transfer to a new task in which the experimental conditions were defined by the combinations of Training and Type, discussed above. The four possible combinations of these variables gave rise to the four major between-observers conditions of the experiment, Relevant-Random, Relevant-Meaningful, Irrelevant-Random, and Irrelevant-Meaningful, designated RR, RM, IR, and IM, respectively (see Figure 4). Six male and two female observers were assigned to each of these groups.

During the second session, each observer performed 96 trials under each of the two within-observer conditions, Before and After, which are defined as in Experiment I. The temporal characteristics of the events under each of these conditions are illustrated in Figure 5. In the Before condition a single alternative was presented for four seconds, followed by the visual noise mask which appeared for 1 second. A briefly-presented form then appeared for 33.3 msec, followed by the visual noise mask for 1 second. The word "respond" then appeared on the CRT and remained in view until the observer responded, first by pressing a button to indicate whether the two forms were identical or different, and then by pressing one of the three buttons to indicate confidence level. The After condition was identical in all respects except that the single alternative appeared on the CRT only following the postpattern mask. (See Appendix F for the text of instructions to observers.)

Half of the eight observers in each transfer condition underwent the Before condition first, the remaining four observers experienced the After condition first. Each of the eight sets of forms was again employed with an equal number of observers. The session was conducted in two blocks of 96 trials, with a rest break between the two blocks while the experimenter read new instructions to the observer. The time required for this session varied slightly from one observer to the next, owing to the fact that the 4-second, intertrial interval did not commence until both responses had been completed, and observers were instructed to take as long as they needed in order to be as accurate as possible. The session required between 50 and 65 minutes for most observers.
Figure 5. Sequence and durations of the events in (a) the Before, and (b) the After conditions of Experiment II. Dark areas represent the visual noise mask. Event durations are shown in milliseconds.
Results

An Ag score was computed for each observer under both the Before and After conditions (see Appendix G). These proportions were subjected first to an arcsin transformation and then to a 2 (Training) x 2 (Pattern Type) x 2 (Conditions) x 2 (Orders of Conditions) mixed-design analysis of variance. The results of this analysis (see Appendix H) revealed that the only statistically reliable effects were Conditions (Before vs. After), $F(1,24) = 29.63, p < .001$, and the interaction of Conditions with Training, $F(1,24) = 6.34, p < .025$. The nature of these effects is shown in Table 3. The Before condition resulted in more accurate performance than did the After condition, and the magnitude of this advantage was greater for the Irrelevant than for the Relevant Training conditions. Neither the main effect for Pattern Type nor any interaction involving it approached significance.

By way of contrast with Experiment I, in which only 14 of the 26 observers showed an overall advantage for the Before over the After condition, 26 of the 32 observers in Experiment II did so.
Table 3
Mean Percentage of Area under the ROC Curve as a Function of Conditions in Experiment II

<table>
<thead>
<tr>
<th></th>
<th>Relevant Before</th>
<th>Relevant After</th>
<th>Irrelevant Before</th>
<th>Irrelevant After</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>92.2</td>
<td>90.0</td>
<td>94.1</td>
<td>87.1</td>
<td>90.8</td>
</tr>
<tr>
<td>Meaningful</td>
<td>93.5</td>
<td>91.3</td>
<td>92.5</td>
<td>85.9</td>
<td>90.8</td>
</tr>
<tr>
<td>Mean</td>
<td>92.8</td>
<td>90.7</td>
<td>93.3</td>
<td>86.5</td>
<td>90.8</td>
</tr>
</tbody>
</table>
DISCUSSION

The goal of the research reported here was to examine experimentally some of the implications of considering perceptual set within the theoretical context of discrimination based upon learning about differences among patterns and the psychophysical relationship between frequency of previous discrimination and the accuracy of subsequent performance. Fundamental to this approach is the assumption that the information required for discriminating among patterns consists of feature contrasts which specify the ways in which a given pattern differs from the other members of the population from which it must be discriminated. Such feature contrasts are defined only relative to sets of patterns, and not by the individual members themselves. The greater the physical differences among the members of the set, or the greater the facility of an observer in isolating those differences, the more accurate will be discrimination performance.

The first hypothesis of interest in the present experiments was that, if discriminations are made on the basis of differences between members of a set, then restricting a perceiver's access to information about the composition of that set should reduce his ability to discriminate among the members. That is, although an alternative may supply information about its own characteristics, it cannot be of aid in a discrimination problem unless the observer also has specific information about how it differs from other possible patterns. In psychophysical terms, the accuracy of discrimination must be shown to be a function of the frequency with which the information required for a particular problem has been used by an observer in the past.

The effect of variation in the frequency with which specific information about the population was made available can be deduced from the results of the experiments reported by comparing conditions under which that frequency was controlled. The specific opportunities for obtaining information about differences among patterns included: (a) learning during discrimination pretraining, (b) learning during the experimental task, and (c) extra-experimental familiarity. The last of these three proved to have no effect, and discussion of it will be postponed. The combinations of the remaining two which were examined in the experiments are shown in Table 4.
Table 4

Possible Sources of Information About Differences Among Pattern Population Members in Experiments I and II

<table>
<thead>
<tr>
<th></th>
<th>Pretraining</th>
<th>Within-Session Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment I</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Experiment II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrelevant</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Relevant</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
A comparison of accuracy of performance under the conditions of interest (see Tables 1 and 2) reveals that the existence and magnitude of the Before-After difference depended primarily on the amount of practice using the information required for specific discriminations. The greatest effects were observed when moderate amounts of such practice were given (irrelevant pretraining), and were smallest when the greatest amounts (relevant pretraining) and least amounts (Experiment I) were given.

This pattern of results indicates that advance information about a single alternative is useful in increasing discrimination accuracy only if observers: (a) have some experience in discriminating a particular set of patterns, and (b) are not already so highly practiced in discriminating among members of the set that the advance information is redundant with what is already known on the basis of prior perceptual learning.

A failure to distinguish between these two limiting conditions can lead to the conclusion that the lack of a Before-After difference always constitutes evidence against the hypothesis of perceptual selectivity. Such a conclusion can be misleading. The fact that no difference is found because the observer is able to become set on the basis of information gained from prior learning as well as he can on the basis of information provided in advance by the experimenter, actually constitutes evidence for the selectivity of perception, rather than against it. If the information provided in the Before condition reduces no more uncertainty than that which an observer can reduce on the basis of his own prior learning, then the Before-After manipulation is insensitive to the ability of that observer to select information.

There are three relevant classes of outcomes from Before-After experiments, defined by the limiting cases described above, in which little or no difference is observed between Before and After conditions, and intermediate cases in which such a difference is found to exist. These three cases will be discussed individually because they form a framework for understanding the relationship between the typical experimental manipulations and outcomes of experiments in the tradition of the Before-After paradigm.

**Case I: No Set Effects Due to Lack of Information or Learning**

The first case consists of potential outcomes in which no difference is found between performance under Before and After conditions because the observer is unable to use the information provided by the experimenter. Such a limitation may occur either because the information supplied is intrinsically uninformative relative to the set of patterns to be
discriminated, or because the observer has not learned how to use the information which is provided. Homely examples of such advance information are included in the following illustrative examples:

(a) Go look for Ms. X when she arrives at the airport; you will recognize (discriminate) her because she will be wearing clothing.

(b) Go look for Ms. X when she arrives at the airport; you will recognize (discriminate) her because she will be wearing a snood.

In (a), the instructional information supplied is not useful because it does not serve to isolate information about the desired object which is distinctive relative to the remainder of the population from which it must be discriminated. In (b), the information provided can be used only by a perceiver who happens to know what a snood is and has the appropriate history of having used such information previously.

A number of experiments have been reported in which the failure to observe Before-After performance differences is apparently related to the limiting conditions of this case. Lawrence and Coles (1954), for example, found no increase in accuracy when verbal alternatives were provided prior to a pictorial display. As Egeth (1967) suggested, such advance alternatives cannot supply sufficiently specific information to allow an observer to become prepared, since each word refers to a class of objects having a variety of different characteristics. Pachella (1975) observed the same lack of effect with a single verbal alternative, finding that unless the observer knew just which exemplar of the verbal category was intended, such information in advance did not aid perceiving. Pretraining which specified the item, however, allowed the observers to become set to almost the same degree as those who received pictorial alternatives.

Experiment I, reported above, illustrates a different, but highly related limitation on performance. Since observers were precluded from obtaining any information about the specific contrasts which could distinguish the members of the set of patterns employed, viewing a single alternative in advance was not effective in increasing the accuracy of discrimination. Perceivable differences are defined only by contrasts between patterns within a set, and reducing knowledge about that set of alternatives, as was done in this experiment, eliminated the opportunity for observers to isolate distinctive characteristics by viewing one of those patterns.
In summary, the first limiting condition on Before-After differences is defined by either the irrelevance of the information supplied by the experimenter in advance, or by the lack of an appropriate history of learning on the part of an observer which would allow the isolation and use of information about specific differences between patterns. Under neither of these circumstances is information made available which is useful for increasing the accuracy with which patterns can be discriminated.

Case II: Set Effects Based Upon Perceptually Useful Prior Information

Case II is represented by those circumstances under which the limitations defined under Case I are overcome by increasing the relevance or specificity of the information provided to the observer, resulting in an increase in the accuracy of performance under the Before condition relative to the After condition. The conceptual nature of the information required for such a shift in accuracy as a function of the increased usefulness of the information provided is illustrated by the following examples:

(a) Go look for Ms. X when she arrives at the airport; you will recognize (discriminate) her because she is wearing a green and purple polka-dot jumpsuit just like the one in this picture.

(b) Go look for Ms. X when she arrives at the airport; you will recognize (discriminate) her because she has a mole in the same place as your wife does.

In (a), an observer's prior uncertainty is reduced by making directly available information which is perceptually useful in discriminating the desired object from others which might appear. In (b), the prior uncertainty is reduced by making available associative information which is perceptually useful in the same way. Whether such associative information is actually useful is contingent upon the observer's having isolated the relevant differences in the past, and having the proper associative basis for identifying that prior perceiving with the meaning of the words in the instruction provided. This is the type of relationship observed by Pachella (1975) only after observers had been given the opportunity to associate a picture with the word which was to be used as the advance information. Such a manipulation of prior learning experience increases the specificity if the information provided about differences between alternatives in the same fashion as does the
substitution of pictorial alternatives (Egeth & Smith, 1967) for verbal ones (Lawrence & Coles, 1954).

Another means of overcoming the limiting properties of Case I is by increasing the information an observer has about the nature of the pattern population from which a particular alternative must be discriminated. If, for example, it is known that the only person who will be arriving at the airport wearing clothing is Ms. X, then that information becomes quite useful. Such a relationship can either be learned over a period of observation and discrimination practice, or the explicit presentation of it to an observer in advance of a discrimination problem. This is the type of manipulation involved in Experiment II above. The size of the set of patterns employed was restricted to allow learning about specific differences during the course of the experiment (irrelevant pretraining condition). Even though the patterns and procedures were similar in other respects to those of Experiment I, this opportunity to learn about the differences between patterns which were seen many times, enabled observers to use the information provided by a single alternative in becoming set to look for the differences they had isolated between that particular alternative and the remaining eleven patterns.

A manipulation which increases the information about differences between patterns, therefore, increases the ability of the observer to become set. An important distinction which arises in this connection is that between information which is directly available via the sensory systems and that which is perceptually useful. Egeth (1967) was correct in pointing out that in order to be effective, advance alternatives must bear a specific relationship to the perceivable features of the pattern which the observer must attempt to see. It is not the case, however, that that relationship must be one of psychophysical isomorphism, as he appears to suggest. Rather, it must supply the observer with perceptually useful information about differences, either directly or associatively. As Pachella (1975) demonstrated, the information specified by an arbitrarily associated alternative (a word) can, under the proper circumstances, supply very specific and perceptually useful information, even though none of that information itself is directly available in the word pattern.

The fact that the manipulation of pattern type in Experiment II failed to have a significant effect on the ability of observers to discriminate supports the conclusion that the information which observers learn to use in making difficult or speeded discriminations among members of a restricted set of alternatives is specific to the physical differences among the members. Garner (1974) has used the term
intrinsic structure to refer to the relationships among the physical characteristics of a set of patterns, as opposed to extrinsic structure, which refers to relationships among the associative characteristics of the patterns. Much of the available evidence points to the conclusion that in discrimination tasks which require observers to distinguish patterns either very quickly or accurately under conditions of rapid presentation, the intrinsic or physical structure of the set of alternatives is of more utility than the extrinsic or associative structure of the set (Gould & Peeples, 1970; Posner & Mitchell, 1967; Yonas, 1969). It is rare, in everyday perceiving, that rapid discriminations must be made on the basis of information as scanty as that available in tachistoscopic presentations. It is even much less likely that they are often required between the kinds of objects represented in experiments of this variety. It is not surprising, therefore, that in situations in which discriminations are required on the basis of tachistoscopic presentation, extralexperimental familiarity is less useful than the specific differences between the set of patterns involved, if those differences can be learned during the conduct of the experiment itself. Indeed, since it appears that the differences used in discriminating tachistopically presented patterns are those which are specific to the intrinsic structure of the set, the information normally used in specifying common objects may be inadequate or inappropriate for the performance of discriminations as difficult as those in tachistoscopic tasks.

Case III: Lack of Set Effects Resulting from Redundant Prior Information

Case III is an additional limiting condition on Before-After differences, resulting from the fact that even if advance information is specific and relevant, it may be redundant with or even inferior to that which is already available to an observer because of his learning history in the discrimination of the patterns involved. An instruction such as:

Go look for Ms. X when she arrives at the airport; you will recognize (discriminate) her because she will be wearing green gloves

will be of little aid if Ms. X also happens to be a close personal friend who is seen almost every day. In that case, the matter of the green gloves, although relevant and potentially useful under other circumstances, can reduce little uncertainty under these conditions because there is little to be reduced. It would be a mistake, however, to conclude...
that, since such relevant advance information does not result in a set effect, perception is not selective. The issue, then, is one of discovering the source of the information upon which that selection is based and the conditions under which advance information is efficacious.

An example of this limiting condition is seen in the results of Experiment II in the comparison of the Relevant and Irrelevant Training conditions. Whereas information supplied by the advance alternative was useful for observers with moderate frequency of prior discriminations among the members of the pattern population (Irrelevant Training), the same information was not as useful in increasing the accuracy of those observers who were more highly practiced in making the required discriminations (Relevant Training).

This interpretation is further supported by the results of an experiment in which Gummerman (1971) varied the size of the pattern set used in a Before-After paradigm. He found that whereas the presentation of two alternatives in the Before condition was useful to observers when any one of sixteen possible patterns might have been flashed, the same alternatives resulted in no improvement in performance over the After condition when one of only four patterns was flashed. Extensive practice in discrimination of a small set of patterns provides an observer the opportunity to isolate difference information which will be very nearly as useful as information afforded by alternatives presented in advance. Again, however, this result does not imply that selection does not occur in the case of the small pattern set, but rather, that it is not functionally related to the Before-After manipulation. It is a function of the frequency with which the required discriminations have been made in the past.

A similar result has been reported by Sperling (Sperling, Budiansky, Spivak, & Johnson, 1971), who found when observers were required to detect the presence of a numeral in rapid sequence of alphabetic displays, a reliable but small advantage when the observer knew in advance which numeral was the target. Considering the large amount of practice most observers have had in specific discriminations among letters, it is not surprising that they have been able to discover difference information very nearly as useful as that afforded by an advance alternative.

The potential outcomes of Before-After experiments described above are manifestations of two phenomena: (a) the ability of observers to utilize difference information afforded by advance instruction, and (b) the degree of observers' prior learning with a set of alternative patterns, which reduces the relative usefulness of such advance information. In more general terms, it appears that the most
important variable in determining the magnitude of set effects in the Before-After paradigm is the frequency with which the required discriminations have been made in the past, the form of that function being an inverted-U, with limitations imposed by inability to use advance information on the one hand, and lack of need for such information on the other.

The specification of the form of such a psychophysical relationship does not, of course, define the precise nature of the information employed by observers. The specific differences among patterns were not controlled in the present experiments, and such control is ultimately necessary to the delineation of what information is learned by observers in the performance of this task. The fact that useful information is learned and used by observers in becoming set, and that set can be related psychophysically to the frequency of past discriminations is, nevertheless, a significant step in integrating the phenomenon of set with the mainstream of study in perceptual learning. Rather than existing as a phenomenon apart, the study of set effects in the Before-After paradigm offers an opportunity for the application of logic of a psychophysics of prior experience as outlined by Owen (in press). Specifically, the paradigm provides, through the control of parameters of previous perceiving, a tool for the investigation of the relationship and influence of prior perceiving and associative learning on subsequent perceptual activity.
LIST OF REFERENCES


Arnoult, M. D. Perception as behavior. Presidential address delivered at the Southwestern Psychological Association annual meeting in Houston, Texas, on April 28, 1967.


Haber, R. N. Perception and thought: An information-processing analysis. In J. F. Voss (Ed.), *Approaches to thought*. Columbus, Ohio: Merrill, 1969.


Külp, O. Bericht über den 1st Kongress für experimentelle Psychologie, 1904, 36-68.


FOOTNOTES

1 Although the propriety of using such introspective reports as converging evidence is open to debate, it is not an uncommon practice (e.g., Neisser, 1963; Pachella, 1975). The arguments surrounding the use and interpretation of such data are beyond the scope of the present discussion, but they have been considered in detail by Natsoulas (1967, 1968, 1970, 1974). For purposes of the present discussion it is important only that Külpe (1904) observed accuracy differences as a function of his instructional conditions.

2 The use of the Before-and-After condition in place of the Before-only was suggested (Long, Reid & Henneman, 1960) because of the possibility that having to remember the alternatives during the brief display might place an additional load on observers in a Before-only condition, thus obscuring a set effect. To the extent that this is correct, then the Before-only condition represents a more conservative test for the presence of such effects.

3 The same-different (single alternative) version of the task has two primary advantages. First, it reduces the memory load imposed under the Before condition (see Footnote 2). To the extent that such a memory load impairs concurrent perceiving (Shulman & Greenberg, 1971), this smaller memory load is desirable. Second, when confidence ratings are taken along with same-different responses, the data can be analyzed in terms of the area under the ROC curve (Pollock, Norman & Galanter, 1964), a procedure which eliminates the effects of response bias (i.e., a tendency to respond "same" more often than "different" or vice versa).

4 The terms "random" and "meaningful" are used here only to indicate that the forms were sampled from different populations, and not to imply how much observers reported the patterns to "look like" something. In fact, virtually all the observers in pilot experiments reported having assigned names to the randomly-generated patterns. The major difference was that the labeling of a particular representative form is highly consistent across observers (Haas, 1968).
The temporal parameters of the Before-After test in Experiment II are somewhat different from those of Experiment I. These changes were made primarily to conform more nearly to exposure durations of other experiments in which set effects have been observed, primarily those of Pachella (1975). In general, the differences between the two experiments were considered to be of less consequence than among the experiments of Lawrence & Coles (1954), Egeth & Smith (1967), and Pachella (1975). The major concern was to insure a level of accuracy intermediate between chance and perfect performance.
APPENDIX A

Detection task instructions for Experiment I

The purpose of this experiment is to allow us to determine how quickly people are able to visually perceive forms. In general, we wish to determine how well a very briefly-presented form can be recognized. I will be glad to tell you the exact details of the experiment following the last session.

You should be aware that this experiment requires that you return for two additional sessions following this one, and that you will receive three hours of experimental credit for your participation. Following today's session we will schedule the remaining sessions according to the times when we can be here together. Will you agree to the two additional sessions? It is important that you be present for each session on time, since our schedule is very tight, and your being late could cause inconvenience for the subject who follows you.

Now let me explain the nature of today's task more fully. On each of the first series of test trials today, a geometric form will be flashed on the screen in front of you for a very brief time. Before and following the flash you will see only the dot pattern which is now on the screen. This dot pattern is not part of the test, but is simply to prevent you from seeing anything on the screen except during the brief flash. Your task for this first set of trials will simply be to tell me whether or not you see a form appear on the screen during the flash. The task will be made somewhat more difficult because on half of the trials no form will actually be present—only a flash with no form. You should therefore watch very carefully to determine whether a form appears or not. If you see anything during the flash, even part of a form, you should respond by saying "yes" loudly enough so that I can hear you over the intercom. If you see nothing during the brief flash, then you should say "no." Do you understand how you are to respond on each trial?

The exact procedure, then, will be as follows. As soon as I have finished reading the instructions, I will go out and close the door to allow your eyes to become as sensitive as possible before we begin. This will take about 3 or 4
minutes. When we are ready to begin, I will tell you over
the intercom to put on the headphones lying in front of you.
You should not take them off again until I tell you to do so.
What you will hear is a "hissing" noise which may seem rather
loud at first, but you will soon get used to it. This noise
is to prevent you from being distracted by any noises in the
hallway outside. When we are ready to begin each test trial
you will hear me say "ready" over the intercom. You may then
start the trial by pressing the foot pedal on the floor. Do
not press the pedal until you hear me say "ready," and do
not hold it down. After you press the pedal, there will be
a short pause, and then you will hear a short break in the
hissing noise. This is to warn you that the flash is about
to appear on the screen. The flash will actually appear
about 1 second following this warning. After the flash you
must decide whether you saw a form or any part of a form in
the flash, and respond by saying "yes" or "no." As soon as
we are ready to begin the next test trial, I will again
say "ready" and you may then press the foot pedal again to
begin the next trial. Do you have any questions about the
procedure I have explained? Following a number of these
trials, I will give you a short break, and then give you
more instructions concerning the next phase of the task.
Please remember to keep your headphones on except when I tell
you to remove them, and please do not move the chair or lean
forward to get any closer to the screen than you now are.
APPENDIX B

Same-different instructions for Experiment I

For the remainder of the experiment your task will be somewhat different than the trials you have just performed. To be specific, on each of the test trials from now on, you will see two forms. One of the forms will be on the screen for several seconds, enough time for you to look at it and memorize it as well as you can. The other form will be flashed briefly like those you have just been seeing. There will, however, be a form flashed on every trial, that is, there will be no test trials in which the flash is blank. Your task on these trials will be to tell me whether the two forms you see are identical or whether they are different from each other. You will indicate your response to me by saying "same" or "different" over the intercom. Forms which are different are always different in shape—that is, you will never see a form rotated on its side, or in a different place; when they are different, they will always be different in shape.

During the remainder of the experiment you will receive two different kinds of test trials. During some blocks of trials the flash will appear first, followed by the longer-lasting form, while on other blocks the longer-lasting form will appear first, followed by the flash. Your task in both cases is the same: to determine whether the two forms are "same" or "different." Do you understand what you will be seeing and how you are to respond?

In addition to saying "same" or "different" on each test trial, I would like you to indicate to me how certain you are that your response is correct. You will do this by using a number from 1 to 3. The number 1 means that you did not see anything in the flash and are therefore guessing whether or not it was the same as the longer-lasting form, while 3 means that you are certain your response is correct. The number 2, of course, is intermediate, and means that you saw something; you are not really certain of your response but you are also not simply guessing. So, on each trial, you should respond by saying "same" or "different" and giving me a number from 1 to 3. Do you understand how to respond on each trial?

On all of the trials you will continue to hear the warning signal in your headphones just before the flash, and the other procedures will be the same, that is, you should
wait for me to say "ready" before you start a test trial by pressing the foot pedal. Do you have any questions about the task?

I will always tell you in advance of the block of test trials which type they will be. When I tell you over the intercom when we are ready to begin, please replace your headphones.
APPENDIX C

Percentage of areas under the ROC curve for each observer under each condition for the last two sessions of Experiment I

<table>
<thead>
<tr>
<th>Observer</th>
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<th>Session 1 After</th>
<th>Session 2 Before</th>
<th>Session 2 After</th>
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<td>71.8</td>
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<tr>
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APPENDIX D

Analysis of variance summary table for Experiment I

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APPENDIX E

Training instructions for Experiment II

The purpose of this experiment is to help us understand how people perceive and remember visual form. During today's session you will be performing a task in which, on each problem, you will be shown three different forms similar to this one (experimenter shows the observer a sample form). These three forms will appear on the screen in front of you in a row, and will remain there for several seconds. During this time you should examine them closely, trying to remember as much about them as you can. Following the presentation of these three memory forms, the screen will go blank for a short period, and then a single test form will appear. Your task will be to decide as quickly as you can without making an error, whether this test form is the same as one of the three memory forms you just saw. You should indicate your decision by pressing the lower righthand button on the panel in front of you if you think it was the same, and the lower lefthand one if you think it was not.

Since there are only twelve different forms which will appear during the entire session today, each one will appear in a number of problems, sometimes as a memory form, and sometimes as a test form. On each problem, however, you need only be concerned with whether the test form matches one of the three memory forms for that problem. Do you fully understand the nature of the task, and how you are to respond?

It is very important that you try not to make errors. The task may seem somewhat difficult at first, but it will become much easier as you become familiar with the forms.

Today's session will consist of two blocks of 96 problems each, and each block will require about 25 minutes. I will give you a short rest break after the first block. Try to remain as attentive and alert as you possibly can. I will tell you over the intercom when we are ready to begin. Do you have any questions?
APPENDIX F

Same-different task instructions for Experiment II

Today's task is somewhat different and more difficult than that which you performed during your last session. On each problem you will be shown two forms on the screen, one after the other, and your task will be to decide whether the two are the same or different. What will make the task difficult is that one of the forms will appear on the screen for only a very brief period of time, and it will be preceded and followed by a checkerboard pattern, which will make the form even more difficult to see. You will have to pay close attention to see it, and even then you may succeed in seeing only a part of it, or sometimes even nothing at all.

On each problem you should indicate whether you think the two forms were "same" or "different" in the same way as you did before; the lower righthand button for "same," and the lower lefthand one for "different." In addition, I would like you to indicate how confident you are that your response is correct. Do this by pressing one of the three buttons in the upper row. The leftmost button means "not certain," and indicates that you are really only guessing. The button in the middle means "partly certain," and denotes that while you are not simply guessing, you are also not completely sure of your answer. The button on the far right means that you are quite certain your response is correct. Do you understand how you are to respond on each problem? First press one of the buttons for "same" or "different," and then one of the three in the upper row to indicate your confidence. I am not at all interested in how quickly you respond, so take all the time you need in order to be correct as often as you possibly can. The exact sequence of events during the first block of 96 problems today will be as follows:

Before condition
The first thing which you will see on the screen on each problem is a single form which will remain in view for several seconds. Study it carefully and try to remember it as well as you can. When this form disappears, it will be replaced by the checkerboard for one second. The second
form will then appear very briefly in place of the checkerboard, and then be replaced by the checkerboard again for one second. The word "respond" will appear on the screen and remain there until you have completed both of your responses for that problem. After your second response the word will disappear and there will be a pause of several seconds before a new form appears on the screen at the beginning of the next problem.

**After condition**

The first thing which you will see on the screen on each problem is the checkerboard pattern. After it has been on for one second, the first form will appear briefly in its place, and then the checkerboard will reappear for one second. Following this, the second form will appear on the screen and will remain there for several seconds, followed by the word "respond." This word will remain on the screen until you have completed both of your responses for that problem. After your second response the word will disappear and there will be a pause of several seconds before the checkerboard again appears on the screen to begin the next problem.

**Both conditions**

Do you fully understand the task I have explained? Remember not to respond until the word "respond" appears on the screen. Speed is not at all important in this task, and you should take all the time you need in order to be as accurate as you possibly can. Once again there will be two blocks of 96 problems each, and I will give you a rest break between blocks while I explain the next part of the task to you. Do you have any questions before we begin?
APPENDIX G

Percentage of area under the ROC curve for each observer in Experiment II

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<th>Irrelevant Training</th>
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</table>

<table>
<thead>
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<th></th>
<th>Relevant Training</th>
<th>Irrelevant Training</th>
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<tbody>
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<td>Random Patterns</td>
<td>Random Patterns</td>
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<td>After</td>
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APPENDIX H

Analysis of variance summary table for Experiment II

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* p < .025
** p < .001