IDENTITY AND ORIENTATION PRIMING: IMAGERY AS PREPARATION FOR A DETECTION TASK

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M.M.M.

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CHAPTER I

INTRODUCTION

Background

When one thinks of imagery, one usually thinks of "having a picture in your mind." Galton's (1880) original questionnaire asking people to imagine and then describe the objects on their morning breakfast table is a good example of attempting to study this "picture" quality of imagery. As Boulding (1956) suggests, however, there may be many components contributing to this overall image. Comprising the image of a breakfast scene, for example, there may also be components of a spatial, temporal and relational nature. While these components of imagery have rarely come under direct investigation in studies of imagery, their significance in the individual's everyday uses of imagery are nonetheless important. Cooper and Shepard (1972), for instance, have related their work with the spatial aspects (i.e., mental rotation) of images to such everyday activities as

> assembling the pieces of a jigsaw puzzle; rearranging furniture in a room; finding and fitting together the variously-shaped parts of a complicated mechanical device; and (at a much more abstract, theoretical level) working out a creative solution to a problem in geometry, electrical engineering, stereo-chemistry, or theoretical physics (Cooper and Shepard, 1972, p. 98).

Other spatial transformations (e.g., translations, dilation, and reflections) which occur mentally may play a role in such diverse human activities as "choreography, gymnastics, modeling in clay, or solving problems in topography" (Cooper and Shepard, 1972, 98). In keeping with such general observations about the everyday contributions of imagery, studies dealing with the functional significance of mental imagery have appeared in the past few years (e.g., Bower, 1970; Huttenlocher, 1968; Paivio, 1971; Smothergill, Hughes, Timmons and Hutpo, 1975; Rawlings, Rawlings, Chen and Yilk, 1972). More recently, however, attention has also turned toward a study of the nature (or internal structure) of imagery (e.g., Brooks, 1968; Cooper and Shepard, 1972; Shepard and Chipman, 1970, Segal, 1971).

Purpose of the Study

The recent investigations of the nature of imagery have presented evidence on the coded form of internal representations and on the relationship between an image and the external object to which it corresponds. Segal and her associates (Segal, 1971; Segal and Fusella, 1970; Segal and Glicksman, 1967; Segal and Gordon, 1969) and Books (1968), for example, have demonstrated the visual nature of imagery, while Shepard and his associates (Cooper and Shepard, 1972; Shepard and Chipman, 1970; Shepard and Feng, 1972; Shepard and Metzler, 1971) have concentrated on providing evidence of an abstract isomorphism between the visual representation and an external visual stimulus. While these studies have yielded valuable insights into the nature of mental images, they have also heuristically provided new areas of investigation. One such area of research involves the contribution of identity and orientation information to the formation of an image. A closely related problem is found in the apparent ineffectiveness of priming with orientation information prior to a mental rotation task (Cooper and Shepard, 1972) in light of Kohlers' (Kohlers, 1968; Kohlers and Perkins, 1969) successful priming of a transformation mechanism in reading text presented in different orientations. Both areas are to be discussed in the present paper.

The purpose of this study is to investigate the mental representations of the identity and orientation information which contribute to the formation of a particular mental image. More specifically, it is an attempt to determine how the two components may interact under various experimental conditions designed to test the extent to which each contributes to the image. For example, the identity and orientation components may be intrinsic to one another within the image and information about one may be of no value in forming the image without information about the other. On the other hand, the components may be independent and may contribute equally to the formation of the image. Finally, the components may be independent, but may contribute unequally to formation of the image (i.e., one may be more fundamental for the formation of the image than the other). A review of the relevant literature is followed by two experiments designed to explore the relationship between the identity and orientation components of an image.

Review of the Literature

Imagery has long been a topic of investigation. The ancient Greeks wrestled with the phenomenon philosophically. Plato's impressions on a "wax tablet" were equivalent to the image; perceptions and thoughts impressed in such a way upon the mind were remembered for as long as the image lasted (Paivio, 1970). Images were also the basis of memory for Aristotle (Watson, 1971). Indeed, Aristotle insisted that thinking takes place in images and can never occur without them (a belief which was held until the investigations of the Würzburg school nearly two thousand two hundred and fifty years later).

Imagery came under scientific study with the pioneering efforts of Sir Francis Galton in the late nineteenth century. His early work was done in order

> to define the different degrees of vividness with which different persons have the faculty of recalling familiar scenes under the form of mental pictures, and the peculiarities of the mental visions of different persons (Galton, 1880, p. 21).

His results, which revealed a wide variety of individual differences in ability to produce "mental images," were a fascinating beginning to the study of imagery, but they did little to increase man's knowledge concerning the structure of the image itself. While Galton's initial work generated much interest, subjective concepts (such as imagery) and the introspective method used to study them soon fell into disrepute. Contributing heavily to this change in Zeitgeist was Watson's view that imagery was devoid of any functional significance (Paivio, 1971).

In the late 1950's, however, Kenneth Boulding produced a small book which revitalized the outmoded interest in imagery. Much of this new interest has dealt with the functional aspects of imagery. Research has been done, for instance, in memory facilitation through the use of imagery (Bower, 1970; Norman, 1969; Paivio, 1969, 1970), in solving problems requiring spatial arrangements (Huttenlocher, 1968), and in improvement of physical skill with mental practice (Rawlings, Rawlings, Chen and Yilk, 1972; Richardson, 1969). Even more recently, however, interest has turned toward the investigation of the nature or internal structure of images (e.g., Brooks, 1968; Cooper and Shepard, 1972; Shepard and Chipman, 1970; and Segal, 1971). This new area of research has been described as an effort to investigate

> the extent to which the internal representational process that we call mental images (whether memory images, imagination images, dreams, or hallucinations) have something in common with the internal representational processes that constitute our normal waking perceptions (Cooper and Shepard, 1972, p. 3).

While this description has been used by one group of researchers to describe their own work, it applies equally well to a whole series of studies taking this new approach of studying the nature of imagery.

The recent work investigating the modality or coded form of mental representations has involved the use of several paradigms. One such paradigm is that of selective interference. The idea behind this approach is that if imagery and perception are similar, they will make demands upon the same information processing systems and will thus be incompatible in the sense of interfering with one another if carried on at the same time. The relationship between an image and a percept was investigated in this manner by Segal and Gordon (1969) when they successfully blocked visual signals with visual imagery. This study was a reevaluation of the Perky effect. Perky (1910) had discovered that an image may be used to mask perception of an ordinarily supraliminal stimulus and that an image may pick up aspects of an unreported stimulus. Segal and Gordon (1969) hypothesized that the imagined object represents a source of internal noise which effectively reduces the signal-to-noise ratio of the neural activity and thus interferes with the detection of the visual signal during the imagery tasks.

Segal and Fusella (1970) investigated the Perky effect and included tasks (imaging and detecting percepts) in different and same modalities (auditory and visual). While there was some interference across different modalities, the results indicated the greatest disruption when the tasks were in the same modalities. Thus, they concluded that imagery does not cut down on general attention, but has the specific effect of interfering with the perception in the same modality. In a related study, Segal and Fusella (1971) also found that imagery in the auditory, gustatory, tactile and kinesthetic modes all have an effect (though much slighter than that of visual imagery) on the detection of the visual signal. Thus, Segal (1971) concluded that when imagery is in the same mode (i.e., visual) as the target stimulus in the signal detection task, the visual stimulus may be assimilated to the image (i.e., the visual signal is processed only to the extent that it relates to the visual image) and that, therefore, it is unavailable for detection as an external stimulus. If, however, the "cues from the stimulus appear in a different sense mode from his image, then he is more likely to process the signal as an event separate from his image, and sensory sensitivity is increased" (Segal, 1971, p. 84).

Segal and Glicksman (1967) found that body position will influence the ability of the subject to notice the stimulus in the Perky paradigm. When relaxed, the subject's imagery influences his perception, while when he is alert, the subject's perception influences his imagery. Thus, when the body was in a supine position (a body position "associated with relaxation, imagery, dreams, and other internal events" (Segal, 1971, p. 77), Segal and Glicksman found that the subjects failed to detect the stimulus. In a sitting position (a position more associated with alertness), however, they found that the subjects were more likely to notice the stimulus. Finally, while standing (a body position even more associated with activity and alertness), the subjects had the lowest threshold and detected the greatest number of stimuli. According to Segal (1971) the supine body position suggests relaxation and a sensory signal in the same mode as the image is assimilated into the image. Hence, the unique qualities of the stimulus are lost since the stimulus is processed only as it is related to the subject's image. A passage (cited by Segal, 1971) from Perky's original study gives examples of how the stimuli were assimilated into the subjects' images.

> One graduate observer apologized for her 'poor imagination,' and said she could get forms but not colors; as a matter of fact, she failed to see the color of the stimulus. Another graduate observer, who had had long experience in the laboratory and had worked to some extent with imagery, showed, both by the time of appearance of the image and by its characteristics (shape, position, size), that he was incorporating the perception in it, while he nevertheless supplied a context of pure imagery: the tomato was seen painted on a can; the book was a particular book whose title could be read; the lemon was lying on a table; the leaf was a pressed leaf with red markings on it (Perky, 1910, p. 432).

The more upright body position, on the other hand, alerts the subjects to a signal detection situation and the image itself is accomodated by the stimulus. In this instance, then, the properties of the stimulus suggest the properties of the image.

Similarly, Brooks (1967, 1968) has shown selective interferences between internal representations of either a primary verbal or spatial character. In his earlier (1967) study he presented subjects with instructions to place digits in certain positions within a matrix. In an experiment designed to test for interference between visualization and reading, instructions were given within a spatial mode (e.g., "In the next square to the left put a 7") or within a verbal mode (e.g., "In the next square to the bad put a 7"). Subjects received, then, either a spatial or a nonsense message. The messages were given either aurally (i.e., listening to the messages) or aurally and in written form (i.e., listening to the messages while reading them). The subjects' task was simply to repeat the message. The results of the experiment indicated that more errors were made in the spatial message when it had been given aural and written form than when presented only in the aural form. In a second experiment designed to show interference during the output stage (i.e., repeating the message), subjects learned each message to a criterion of one verbatim repetition. They then either repeated the key words of the spatial or nonsense message (up, down, right, left or quick, slow, good, bad) or they underlined the key words when they were presented as one of four printed options. More errors were made in the spatial task when output of the message involved reading. Thus the results of both studies indicated that reading interferes with "the internal representations of the spatial information" (Brooks, 1967, p. 298).

In Brooks' later (1968) study subjects engaged in either a spatial or verbal task. Thus, during the spatial task, subjects were instructed to form an image of a letter (in block form) and to classify the corners in the letter as being on the extreme top or bottom of the letter ("yes") or as being in between ("no"). For example, for the block letter "F" the responses starting from the lower left corner would be "yes, yes, yes, no, no, no, no, no, no, yes". (See Figure 1.) For the verbal condition S's classified words in a sentence as being either nouns ("yes") or non-nouns ("no"). For each task S's could respond in one of two ways; spatially (pointing to a "y" or "n" in different positions on an answer sheet) or verbally (saying "yes" or "no"). The results indicated that when the classification task and the response the S's were required to use were in the same mode (spatial or verbal), there was interference in the response (i.e., the time to complete the classification was longer than when the task and the response were in opposite modes).

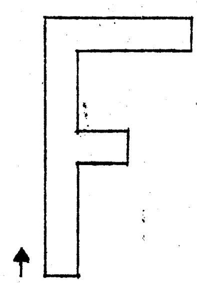


Figure 1. An Example of a Block Letter as Used in Brooks' (1968) Study

A second paradigm used to study the structure of imagery is that of the selective reduction of reaction time. In this approach the object is to facilitate detection of an external stimulus by having the subject prepared for that stimulus. As Cooper and Shepard (1972) suggest

> Accumulating evidence indicates that to be more prepared for a stimulus is to have, in advance, a more appropriate mental image; i.e., an image that is closer to the external stimulus is (sic) abstract internal structure, that is represented within the proper cognitive system and, perhaps, that is associated with the appropriate sensory modality (Cooper and Shepard, 1972, p. 7).

Posner, Boies, Eichelman and Taylor (1969) found that subjects could match a stored letter more rapidly with a physically identical letter (e.g., AA) than with a letter identical only in name (e.g., Aa). If the external stimulus is presented immediately after the cue letter, the match is made in about 90 msec. less time. However, after two seconds (when the visual representation of the first letter has faded), there is no difference between the two types of matches. Thus, when the subject has a visual representation of the letter in the appropriate cognitive system, he can make the match very rapidly. When the subject has the representation in a different form (as upper case rather than lower case or as an auditory-articulary code of the name of the letter), it takes more time to access the necessary information and then to make the match. In extending these findings to imagery, Posner et al. also showed that the match could be made between an internally generated represeresentation of the letter (as opposed to a visual-visual match) and an external stimulus. They presented subjects with the name of the letter in auditory form only and had them make the match. If the first letter was given in the auditory form 750 msec. prior to the presentation of the physical letter, the subjects were able to match the letters with reaction times identical to the visual-visual matches.

Peterson and Graham's (1974) study of visual detection and visual imagery combined the reasoning behind the selective interference and the reduction of reaction time techniques. They studied the implications of assuming that visual perception and visual imagery involve similar mechanisms. They reasoned that if this is true, then imagining an object while attempting to detect the object should aid in its detection because of the similar visual mechanisms involved in the imagery and perception tasks. By the same reasoning, detection of the object should be hindered by concurrent imagining of a dissimilar object. Thus, they predicted that compatible images would facilitate signal detection, while incompatible images would interfere with signal detection. These predictions were contrasted with those of Segal's (1971) assimilation theory of imagery. As discussed earlier, she suggested that images are made up of an assimilation of past memories and random sensory input. The more similar the internal representation (image) and external representation (perception) the more difficult it is to discriminate the external object. Thus, according to her view it would be predicted that compatible images would hinder signal detection, while incompatible images would facilitate signal detection.

Using a two-alternative forced-choice procedure in which an object was embedded in visual noise on one of two successively shown slides, Peterson and Graham (1974) tested the hypotheses using two groups of subjects. One group heard descriptions of objects and were instructed to imagine the descriptions before the detection task. The second group heard the descriptions, but was not instructed to use imagery during the detection task. The results showed that for the imagery groups, imagining the objects resulted in increased detection with the compatible slides and decreased detection with the incompatible slides. The control group also showed facilitation for the signal detection in the compatible slides, but showed neither interference nor facilitation in the incompatible slides. These results led Peterson and Graham to suggest that perhaps the facilitation shown by both groups for the compatible cuing condition was the result of the verbal phrases exerting "a priming effect for <u>both</u> groups when perception supported correct identification of the slide containing the picture" (Peterson and Graham, 1974, p. 514).

Weber and Harnish (1974) also investigated the visual aspect of imagery. They tested Hebb's "picture theory" of visually imagining words. Hebb (1966) had concluded that subjects' inability to spell a word, such as "university", represented as an image in their mind as rapidly backwards as forwards was proof that having an image is not like "having a picture in your mind" (Hebb, 1966, p. 43). Weber and Harnish (1974) suggested, however, that a long word such as "university" might overtax the visual imagery system. They suggested instead that a test with a shorter word, e.g., "toy," would be just as valid a test of the theory and would not tax the visual imagery system. Using three and five letter words, they used a probe technique to test objectively the subjects' images of the words. In some conditions they found that imagery and perceptual representations were comparable in the response time required for processing and they concluded that

> there exists a visual image operating memory with a fixed letter capacity for parallel processing that is less than that of the visual percept system. When the image capacity of the operating memory is strained or exceeded, differences in processing time between percept and image systems become apparent (Weber and Harnish, 1974, p. 30).

Shepard has done a series of studies using mental transformations to study imagery (Shepard and Metzler, 1971; Shepard and Feng, 1972; Cooper and Shepard, 1972). In the original study by Shepard and Metzler (1971) subjects had to determine whether drawings depicted three-dimensional objects of the same or different shapes. For half of the trials the objects were different (i.e., were the mirror images of one another), while for the other half of the trials they were identical in shape. The objects also differed by a rotation either in the two-dimensional plane or in depth (about a vertical axis in three-dimensional space). The results of the study indicated that when the two objects were of the same three-dimensional shape the reaction times to report this increased linearly with the angular difference between their portrayed orientations (from one second at 0° to four or five seconds at 180°). The authors concluded that the subjects performed the task by "mentally rotating" their mental representation of one of the objects until it was congruent with the other and then checking for a match or mismatch.

Shepard and Feng (1972) showed that subjects could report on specific structural features of letters which they had mentally rotated to a specified degree. The letter "N", for example, appears as a letter "Z" when rotated 90°. The results of their study showed that it took longer to make transformations of a longer nature (e.g., longer for 180° than for 90°). This provided more evidence that images were of a "basically spatial character (Cooper and Shepard, 1972, p. 12).

Shepard and Feng (1972) also did work with more complex sequences of imagined transformations. In this study subjects mentally folded connected squares into the shape of a cube. When the subjects did the mental folding task, they had to decide whether two arrows placed on the sides of two of the six squares would touch when the squares were folded to form the cube. (See Figure 2.) The subjects' response times to report their decision increased linearly with the sum of the number of squares which would have been involved (to make the arrows touch), if the folding had actually been done. Based on the results from such studies, Shepard proposes a "second-order" isomorphism between "(a) the relations among alternative external objects, and (b) the relations among their corresponding internal representations" (Shepard and Chipman, 1970, p. 2) as opposed to a "first-order" isomorphism which would suggest a structural isomorphism between the external object and its internal representation. The "second-order" isomorphism suggests, instead, that the subjects' mental processing is analagous to the physical process, that is,

> whatever neurophysiological events are taking place while one is merely imagining the external process in question--these events have much in common with the internal events that occur when one is actually perceiving the external process itself (Shepard and Feng, 1972, p. 242).

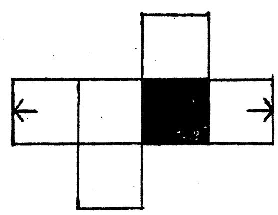


Figure 2. An Example of Six Squares to be Folded into a Cube as Used in Shepard and Chipman (1970)

Shepard and Klun (1972) required their subjects to discriminate between a letter in its normal version and its mirror image. The subjects saw 12 alphanumeric characters presented at different angles from 0° to 180° and they had to discriminate the normal letters ("normal") from the mirror images ("backwards"). The results showed that the response times increased with the angular departure from 0° (upright) position of the letter. In another experiment the authors attempted to find more direct evidence for imagery. In the first study it had been hypothesized that the subjects were rotating the presented character back to the upright position and matching it with a stored image of a normal letter. In the second study, however, the authors tried to force the rotation of the image to occur before the presentation of the actual stimulus character. Subjects again made the discrimination between "normal" and "backward" letters, but in this experiment they were given cues as to the identity or the orientation of the visual stimulus before it was presented. Thus, the subject was given either the identity, the orientation, or both the identity and the orientation of the stimulus letter before its actual presentation.

> The major results of this experiment were (a) that, as in the previous study, with no advance information reaction time was a monotonically increasing function of angle of rotation; (b) that, when either identity information or orientation information was provided alone, reaction time again increased with angular departure from upright in much the same way as when there was no advance information; and, finally, (c) that, when <u>both</u> identity and orientation information were provided in advance, the reaction-time function flattened considerably and, indeed, for some subjects became uniformly low and completely horizontal (Cooper and Shepard, 1972, p. 19).

From these results, the authors first suggest that the subjects were more able to "rotate a mental image of a particular, concrete object than to rotate a general, abstract frame of reference" (Cooper and Shepard, 1972, p. 20).

In more recent work Cooper and Shepard (1972) have turned to refining the results of their previous studies. In one experiment they sought to determine the time required to prepare for and to respond to a rotated stimulus. Specifically they tested how reaction time depends "both upon the angle of the tilted stimulus and upon the duration of the advance information as to that angle" (Cooper and Shepard, 1972, p. 21). They reasoned that if the subjects did indeed carry out some sort of mental transformation of the image of the stimulus then "this process should require more time for its completion as the orientation indicated in the advance information departs by larger angles from the standard upright orientation" (Cooper and Shepard, 1972, p. 21). Further, if the subject is not given enough time to make the transformation before the onset of the stimulus, then the reaction time to respond to the stimulus will increase as the subject will have to make some further transformation after the appearance of the stimulus.

In the experiment subjects had only to discriminate between normal versions of six alphanumeric characters and their mirror images as they appeared in six orientations within a picture frame. Subjects were given visual cues (advance information) as to the upcoming stimulus. Identity cues consisted of an outline drawing of the normal, upright version of the upcoming test stimulus and orientation cues consisted of an arrow pointing in the direction at which the top of the test stimulus would appear. Subjects received either no advance information, identity cue alone, orientation cue alone, a combined representation of identity and orientation information (i.e., a drawing of the stimulus tilted as the test stimulus) or both the identity and the orientation information presented in sequence. In this last condition the identity cue was given and then was followed by the orientation cue for 100, 400, 700, or 1000 msec. followed immediately by the stimulus. Again reaction time was the dependent variable.

This experiment was designed, in part, to test a corollary to the basic principle of second-order isomorphism, that is,

> while one is on the course of imagining the external process--one passes through an ordered set of internal states of special relation to or readiness for the successive states of the external process (Shepard and Feng, 1972, p. 242).

The empirical findings as interpreted theoretically show, in part, that

> Mental rotation is an analog process with a serial structure bearing a one-to-one relationship to the corresponding physical rotation. The time required (mentally) to rotate from an orientation A to an orientation C is just the sum of the times required to rotate from A to some intermediate orientation B, and to rotate from B to C . . . Moreover, in mentally rotating an object between any two widely separated orientations, A and C, the internal process passes through the mental image corresponding to that same object in some intermediate orientation, . . . Consequently, the orientation at which the subject is most prepared for the appearance of that object at each moment is actually rotating with respect to the external world (Cooper and Shepard, 1972, pp. 95-96).

The most important result of the study with respect to the present paper was that

> under the conditions of this experiment, subjects can only rotate the mental representation of a specific, concrete object or character. They evidently are not able to rotate a general, abstract frame of reference (Cooper and Shepard, 1972, p. 50).

The authors reach this conclusion from the following results. When the subject is given the identity cue and is then presented with the orientation cue for 1000 msec., there is a virtually flat reaction-time function for the different orientation of the stimuli. The subject is completely prepared for the stimulus. When, however, the subject is given the orientation cue alone the resulting curve of the reaction times is very similar to the curves produced in the no information, identity alone and the identity and then orientation cue for 100 msec. conditions. In each of these conditions the subjects were not able to use any orientation cues (in the first two conditions because such information was not given and in the last condition because there was not enough time to generate an image before the stimulus was presented).

The authors point out, however, that they

> are not saying that the advance presentation of orientation information alone has no effect on subsequent reaction time--only that it has no effect on the way in which reaction time depends upon the orientation of the ensuing test stimulus (Cooper and Shepard, 1972, p. 51).

The effect seems to be the same as that of presenting the identity cue alone, i.e., it cuts down on the reaction times for all orientations by 100 msec. The authors propose an information processing model in which the 100 msec. savings in reaction time is attributed to a shortened time needed to identify the test stimulus or the orientation.

Cooper and Shepard (1972) conclude that their work has shown several things about the nature of the image. They state that the internal representation of an external object (i.e., the image)

> has an internal structure that is itself to some extent analogically related to the structure of its corresponding external object. For, during the process of rotation, the parts and the relationships among the parts must be transformed in very constrained ways in order to enable the kind of rapid, template-like match against an ensuing visual stimulus that we have demonstrated here.
>
> Clearly, the internal representation cannot adequately be regarded either as an undifferentiated neural event (such as the activation of a particular neuron or population of mutually interchangeable neurons) at the neurophysiological level, or simply as an unanalyzable symbol at the information-processing level. In further work it may be established that the rotational process is essentially continuous (or at least carried out in many small steps) and, also, that the internal representation preserves the essential metric relationships within the object during such a process (Cooper and Shepard, 1972, p. 99).

Shepard's work investigates the active manipulation of images. Thus, while his experiments involve mental transformations of a particular image, they do not attempt to directly investigate the relationship between the possible identity and orientation components within a particular image.

Another line of evidence suggesting the relationship between the identity and orientation components of imagery comes from the work of Kolers (Kolers, 1968; Kolers and Perkins, 1969a; Kolers and Perkins, 1969b). Kolers' work has been with the orientation of letters and their perceptual recognition. The normal procedure used in his studies is to present letters in different transformations, i.e., normal, mirror image, rotated (a mirror image rotated on a horizontal axis) and inverted (a normal letter rotated on a horizontal axis) to subjects, to measure how long it takes them to read a passage, and then to analyze their errors. The results of this work have shown that "the orientation of an object may--like its brightness or contour--be a primitive characteristic used in the construction of its perceptual representation" (Kolers, 1968, p. 57). In one study, which used English speaking subjects to read transformations of English (reading from left to right) and Hebrew speaking subjects to read Hebrew (reading from right to left), Kolers found that the different transformations of text required different amounts of time to read. The identity in the order of difficulty of transformations across languages that normally go in opposite directions, however, implies

> a mechanism of a higher-order than orientation-sensitive detectors. Such a higher-order mechanism appears to be concerned with the recognition of visually transformed objects, yet is object-independent, in contrast to object-dependent detectors. That is to say, the typical 'feature-detector' is selectively sensitive to objects in specific orientations, making it geometry-specific. The mechanisms revealed in the present experiment, by contrast, are transformation-specific rather than object-specific: The mechanisms appear to be indifferent to the specific geometry of elements they operate on but perform identical operations upon them (Kolers, 1968, p. 63).

While Kolers' work deals with perception, it also has implications for an identical orientation (transformations) component of imagery independent of an identity component. This finding contrasts with the results of Shepard's work. Specifically, while Kolers' work does suggest an ability to adopt a particular orientation set, Shepard's work suggests that orientation information alone cannot be used as preparation for his mental rotation task.

The rationale behind the present two experiments is the same as that underlying much of the previously cited literature, that is, "to be more prepared for a stimulus is to have, in advance, a more appropriate mental image" (Cooper and Shepard, 1972, p. 7). In the present experiments subjects were primed with information about the identity and/or orientation of an upcoming test stimulus in order to study the relationship between the two components in contributing to an "appropriate mental image." In Experiment I subjects were given advance information about either the identity or the orientation of an upcoming stimulus. Using this information they were instructed to form a mental representation of that one component (thus forming a representation of "part of" the overall image) in order to detect the second type of information in the test stimulus. Comparison of the degree to which each type of information (as one component of an image) contributed to the correct identification of the second type of information was expected to indicate the relative contribution of each component to the formation of an image. In Experiment II the subjects received correct and/or incorrect information about the identity and orientation of an upcoming stimulus in order that they might form images having components which were either compatible or incompatible with the actual form of the test stimulus. In this experiment the "more appropriate mental image" was expected to result in more correct identifications of the test stimuli. Comparisons of the results produced by the different cues were expected to indicate which type of information was more important in the detection task and thus which might be considered more fundamental for the formation of the image. The results of the two experiments were thus expected to provide information about the relationship between the identity and orientation components of imagery and about the contribution of each to the formation of the image.

CHAPTER II

EXPERIMENT I

Purpose

The purpose of this study was to investigate the identity and orientation components of imagery by exploring the relationship between the two components in terms of their contributions to the formation of an image. The study was designed as an attempt to have subjects generate a mental representation of one component (thus "separating" the components) by priming them with either the identity or orientation of an upcoming test stimulus and to investigate the extent to which each component contributes to the formation of an image by testing the subjects' ability to detect the second type of information in a stimulus object. Thus the subjects were primed with the identity of the stimulus character (and were instructed to detect its orientation) or they were primed with the orientation of the stimulus character (and were instructed to detect its identity). This methodology is of particular interest in its attempt to prime with orientation information. The simple detection task in the present experiment combines the basic identification operation involved in Kolers' reading task (e.g., Kolers and Perkins, 1969a) with the more analytical single stimulus approach found in Shepard's work (e.g., Cooper and Shepard, 1972) in an attempt to produce the effect of orientation priming. Males and females were included as groups to assess possible sex differences in the ability to do the task. Imagery and control groups were used in the experiment to assess the possibility that the subjects might make different uses of the information under the two conditions, and finally, cued and noncued trials were included to provide baseline data on the ability of the subjects to detect the identity or orientation of the stimulus objects without advance information. In order to provide information which could contribute to the interpretation of a possible finding of no differences between the imagery and control groups, self-report data was collected from the subjects regarding use of imagery in the task. In a further effort to differentiate between the identity and orientation priming operations a scaling for fatigue was also included.

Method

Subjects

Sixty-four undergraduate student volunteers enrolled in lower division psychology courses served as subjects. They received extra credit for their participation. Sixteen subjects (eight males and eight females) were randomly assigned to each between group condition.

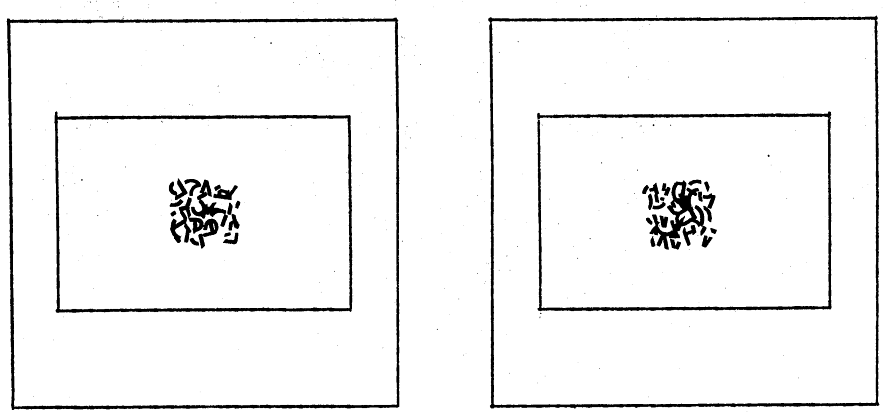
Design

The design was a Type SPF-222.2 design (Kirk, 1968, p. 294) with repeated measures. The between-subjects treatments were imagery instruction (imagery instruction or control), type of cue (identity or orientation) and sex of the subject. The within-subjects treatment was type of trial (cued and not cued).

Materials and Apparatus

Throughout the experiment the subjects were shown slides containing visual noise and slides containing a letter masked by the visual noise. The slides were prepared by pressing upper-case Chartpak Velvet Touch Lettering (Helvetica 12PT./M5212CL) on acetate transparencies and then mounting them as slides. A visual noise slide was prepared by overlapping two transparencies each of which contained a patterned mask made by randomly positioning cut-up sections from five letters within a 1 cm. by 1 cm. area in the center of the slide. The five letters for each mask were chosen randomly for each transparency from the upper-case letters on the Chartpak sheet with the restrictions that at least one letter was always a letter which contained at least one curved line and that G, J and R were not used. To prepare a slide with a masked letter one of the three target letters (G, J or R) was positioned in one of the three orientations (0°, 120° or 240°) and was centered on a transparency. Cut-up sections from five letters (selected as described above for the visual noise slides) were placed around the letter. Finally, a transparency prepared as for a visual noise slide was placed over the transparency containing the letter and they were mounted as one slide. (See Figure 3 for examples of the slides.)

Six carousels of slides were prepared for presentation of the stimuli. Each carousel contained two blocks of slides, each of which contained the nine possible letter and orientation treatment combinations arranged in two-slide sequences (a visual noise slide and a slide containing a letter) with a blank space between each sequence. A particular letter and orientation treatment combination was presented as the first slide in a sequence in one block and as the second slide in a sequence in the other. The letters appeared in the first slide of a sequence not more than five times in either block of slides. The nine sequences within each block were arranged in random order with the restrictions that not more than two sequences in a row contained the same letter or orientation.



Visual Noise

The Letter "R" at 120° Masked by Visual Noise

Figure 3. Examples of a Slide Containing Visual Noise and a Slide Containing a Letter Masked by Visual Noise

Seven masking transparencies were prepared for positioning over the subjects' viewing screen by pressing Chartpak acetate matte shading film onto transparencies measuring 13 by 22 cm. The shading film was all 30 lines to the inch and ranged from 10 to 70 percent shading (see Appendix A). Darker shading masks were devised by overlapping two of the above transparencies on the viewing screen.

Two slide projectors were used in the experiment. A Kodak Ektagraphic Slide Projector Model B-2 was used in presenting the slides for the instructions and for the first nine practice trials. In addition the projector remainded on as a source of additional light to diminish the contrast during the rest of the experiment. A Kodak Carousel 750 Projector used used in presenting the slides to establish the shading film criterion and for the experimental trials. Both projectors were situated 70 cm. behind the viewing screen and were slightly angled so that their projections overlapped. The viewing screen measured 25 by 42 cm. and was mounted at eye level on a black wooden frame measuring 52 by 79 cm. The subjects sat at a standard classroom desk situated approximately 76 to 81 cm. in front of the screen (when the subjects requested, they were allowed to move the desk forward or backward slightly). The target letters were back-projected to a height of 1.27 cm.

Procedure

The instructions which were given the subjects appear in Appendix B. After entering the experimental situation, the subjects were given training in recognizing the three test letters in the three orientations. All subjects received nine initial practice trials (one for each letter-orientation treatment combination) each consisting of a two slide sequence. Within each sequence one of the two slides contained a simple mask and the other contained a mask as well as one of the three letters (G, J or R) in one of the three orientations (0°, 120° or 240°). Figure 4 depicts each of the three stimulus letters in each of the three orientations. The subjects' task was to indicate which one of the two slides contained the test letter. Subjects in the identity cue condition were further required to indicate the orientation of the letter (by drawing an arrow in the direction in which the top of the letter was pointing), while subjects in the orientation cue condition were required to indicate the identity of the letter (by writing the letter). Figure 4 depicts the three orientations in terms of degrees on a circle, times on a clock and response arrows. The experimenter signalled the presentation of each practice trial by saying "now" immediately before the presentation of the first slide in each sequence. For the practice trials the slides were each shown for .25 seconds and were followed by a blank interval of approximately 7 seconds during which the subjects marked their answer sheets.

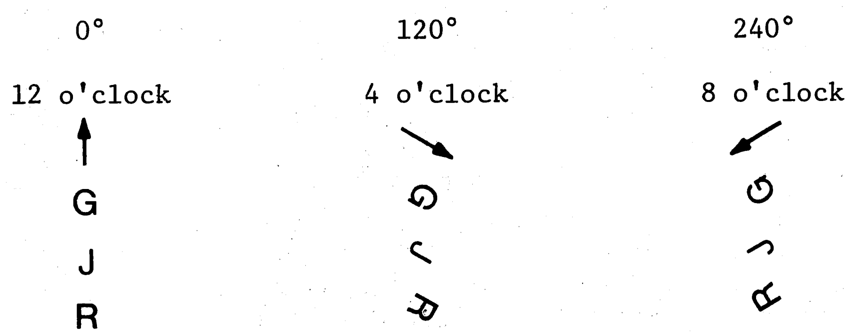


Figure 4. The Three Letters and Three Orientations Used as Test Stimuli in Experiment I

The answer sheets each contained 18 sets of two adjacent boxes. Within each set of two, the box on the left represented the first slide of a sequence and the box on the right represented the second slide. Thus, the subjects assigned the target letter to one of the two slides and identified the test stimulus by writing the letter (or by drawing an arrow) in the appropriate box. If the subject had missed more than half of the nine practice trials, the trials were rerun.

In order to equate the subjects in their initial ability to detect the stimuli, they were calibrated using the masking transparencies. To do this a 40 percent shading film was taped to the viewing screen and the subject was given 18 practice trials using a random selection of the experimental stimuli. (For the calibration trials the carousels were shown in reverse order.) This process was repeated up to three times (using a lighter or darker shading film and a different carousel) until the percent of shading at which the subject missed 50 percent of the identifications could be approximated (scoring again was for correct identification of the target stimulus identity or orientation only and not for the correct slide). A shading film of ten percent darker value than the shading film identified in the above selection process was then taped to the viewing screen and the subject was run on all experimental trials using this mask.

The subjects in the imagery group were instructed to form a mental representation of the cued identity information (or the cued orientation information) while the subjects in the control group did not receive such instructions. The identity information was cued by the name of the stimulus letter (e.g., "R") and the orientation information was cued by the hour on a clock face indicated by the corresponding degrees of a circle (e.g., "4" for an orientation of 120°). All cues were given aurally and the cue also served as a signal that the first slide of the sequence would follow in three seconds. For the noncued trials the word "now" served as the signal that the first slide in the sequence would follow in three seconds. Each slide was shown for .25 seconds and the blank interval following each sequence was approximately 5 seconds in length.

The six carousels were presented in random order to each subject for the experimental trials. The slides in each carousel were run entirely as cued or noncued trials. Half of the subjects began with the noncued condition and half began with the cued condition. At the conclusion of the experimental trials the subjects completed a short questionnaire (see Appendix C). The questionnaire required the subjects to rate the vividness of any imagery they reported and to rate how fatiguing they found the task to be. The imagery vividness was rated on a 7 point scale with No. 1 being "Perfectly clear and vivid as the actual experience" and No. 7 being "No image present at all, you only know that you are thinking of the object." Fatigue was rated on a 5 point scale with No. 1 being "Not fatiguing at all" and No. 5 being "One of the most fatiguing things you've ever done."

Results

As in Peterson and Graham's (1974) study there were, in effect, two parts to the experimental task. The subjects had to assign the target letter to one of the two slides (a two-alternative forced choice procedure focusing on the abilities of the subjects to detect the presence of the stimulus) and they also had to correctly identify the identity or the orientation of the stimulus letter (a requirement which demanded that perception of the stimulus be sufficient for such identification). Four performance categories were based on the possible combinations of performance on the two parts of the subjects' task. The most stringent and unambiguous measure of the subjects' ability to detect and identify the stimulus is found in the number of slides correctly assigned and correctly identified. The primary analysis of the experiment was based on this measure, abbreviated as correct slide--correct response. A second unambiguous measure is found in the number of slides incorrectly assigned and incorrectly identified. This category is abbreviated incorrect slide--incorrect response and represents inadequate perception of the target stimulus. The categories of correct slide--incorrect response and incorrect slide--correct response are ambiguous categories which are most readily explained in terms of guessing strategies (see Peterson and Graham, 1974, for a further discussion) and little attention was given to them.

The analyses for the four performance categories are found in Appendix D. The results of the analyses indicated no sex differences for any of the performance categories. An interaction between type of cue and sex of the subject was found in the correct slide--incorrect response performance category, $F(1,56) = 4.71$, $p < .05$, but simple effects tests (also presented in Appendix D) revealed no significant differences between the levels of the treatment combinations. Since no sex differences were indicated by the analyses, the data were collapsed over the sex of the subject conditions and the analyses reported below are for the data in this form. A table of means and standard deviations for the four performance categories appears in Table I. The total possible score for each mean was 54 and the chance level of performance was 8.1 responses.

TABLE I

MEANS AND STANDARD DEVIATIONS FOR THE FOUR PERFORMANCE CATEGORIES OF EXPERIMENT I

Conditions	Cued		Not Cued	
	Means	S.D.	Means	S.D.
Correct Slide-- Correct Response:				
Imagery				
Identity Cue	26.7499	9.2412	25.0624	8.6831
Orientation Cue	25.0000	8.1975	24.5625	6.0549
Control				
Identity Cue	27.9375	6.0052	23.4374	5.8077
Orientation Cue	27.2500	6.8362	26.5624	8.4456
Incorrect Slide-- Incorrect Response:				
Imagery				
Identity Cue	8.4375	3.6873	8.9375	4.5088
Orientation Cue	10.0625	4.5383	10.3750	4.7732
Control				
Identity Cue	7.5000	3.9328	8.8750	3.5379
Orientation Cue	8.1250	4.3646	8.0000	3.9158
Correct Slide-- Incorrect Response:				
Imagery				
Identity Cue	13.6250	4.7452	14.1875	3.7633
Orientation Cue	12.8750	4.6458	13.1250	3.0741
Control				
Identity Cue	14.0625	2.6700	14.9375	4.6400
Orientation Cue	14.2500	3.5870	15.0625	4.1064
Incorrect Slide-- Correct Response:				
Imagery				
Identity Cue	5.2500	2.5949	5.8125	2.8336
Orientation Cue	6.0000	2.5820	5.8125	2.6387
Control				
Identity Cue	4.5000	2.9439	6.5625	2.6825
Orientation Cue	4.3750	2.2472	4.3750	2.6300

The analysis of variance summary table for the correct slide--correct response performance category is presented in Table II. The results of the three factor overall analysis indicated that the main effects for imagery instruction and for the type of cue were not significant, $F(1,60) = .31$, $p > .05$ and $F(1,60) = .0007$, $p > .05$ respectively. As depicted in Figure 5, however, the cued trials produced more correct detections than noncued trials, $F(1, 60) = 5.58$, $p < .05$, even though the effect is numerically small as shown in Table I. Although an interaction effect between the type of cue and the type of trial is suggested in Figure 5, it was not detected by the analysis. Subanalyses were done for the identity cue and the orientation cue groups and the analysis of variance summary tables are presented in Tables III and IV respectively. The two factor analysis of variance for the identity cue condition indicated that the main effect for imagery instruction was not significant, $F(1,30) = .38$, $p > .05$, but that the cued trials produced significantly more correct responses than did the noncued trials, $F(1,30) = 10.48$, $p < .01$. The analysis of variance for the orientation cue condition indicated that neither main effect was significant, $F(1,30) = .83$, $p > .05$ for imagery instruction and $F(1,30) = .21$, $p > .05$ for the type of cue. As indicated in Figure 5, then, the overall effect of cuing is attributable to the difference between cued and noncued trials in the identity cue condition.

No significant effects were found in the overall analysis or in the subanalyses of the incorrect slide--incorrect response performance category. The analysis of variance summary tables are found in Appendix E. The analysis of variance summary tables for the correct slide--incorrect response and incorrect slide--correct response performance

TABLE II

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE OVERALL ANALYSIS OF THE CORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Instruction (A)	1	29.0703	.3094
Type of Cue (C)	1	.0703	.0007
A x C	1	43.9453	.4677
Subj. W. Groups	60	93.9532	
Within Subjects			
Type of Trial (B)	1	106.9453	5.5786*
A x B	1	18.7578	.9785
B x C	1	51.2578	2.6738
A x B x C	1	13.1328	.6850
B x Subj. W. Groups	60	19.1707	

$*p < .05$

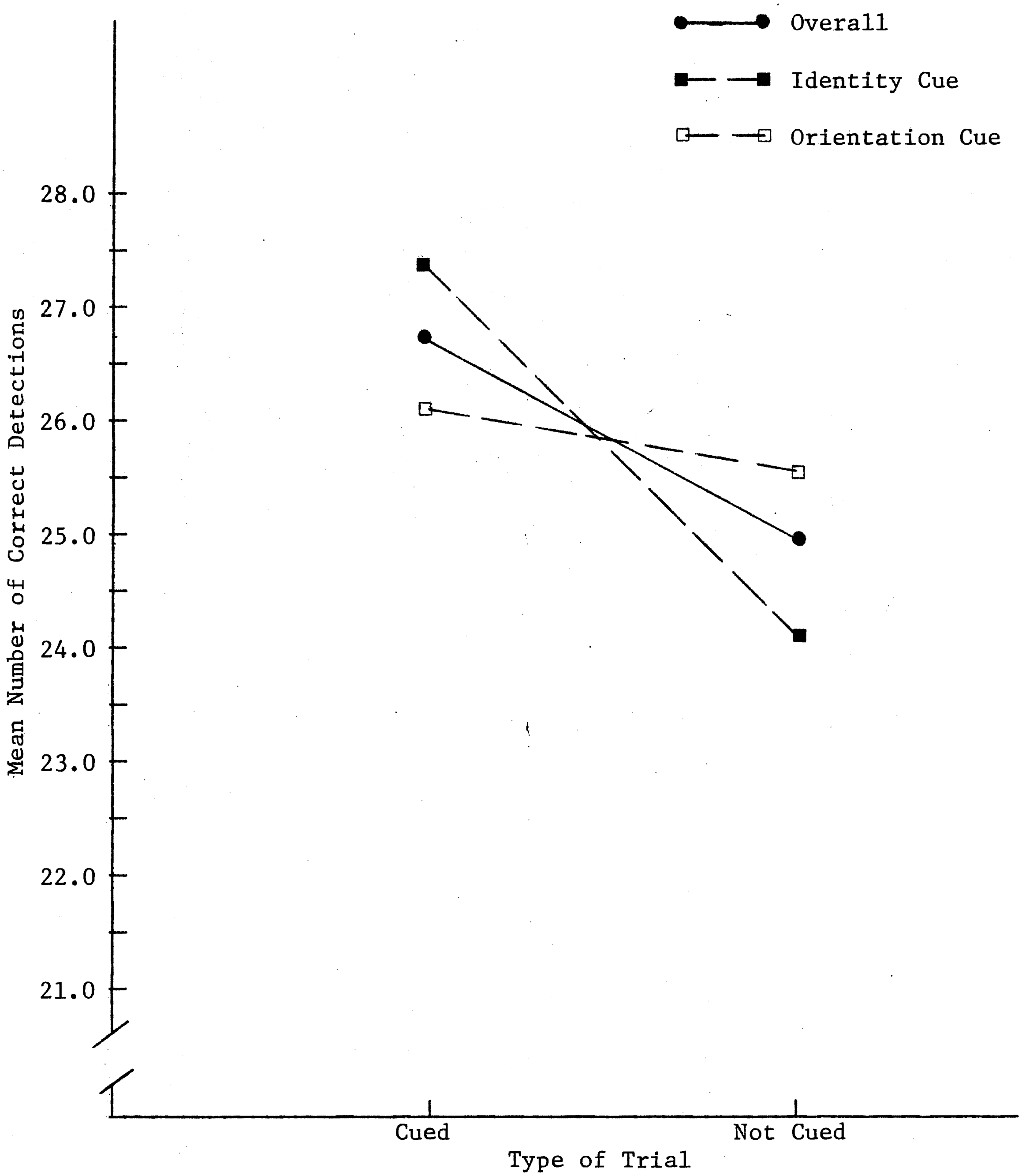


Figure 5. Cued and Noncued Trials in the Overall Analysis and the Subanalyses of the Correct Slide--Correct Response Performance Category of Experiment I

TABLE III

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IDENTITY CUE SUBANALYSIS OF THE CORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	37.5156	.3754
Subj. W. Groups	30	99.9434	
Within Subjects			
Trial Condition (B)	1	153.1406	10.4802**
A x B	1	17.0156	1.1645
B x Subj. W. Groups	30	14.6123	

**$p < .01$

TABLE IV

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE ORIENTATION CUE SUBANALYSIS OF THE CORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	72.2500	.8330
Subj. W. Groups	30	86.7392	
Within Subjects			
Trial Condition (B)	1	5.0625	.2090
A x B	1	.2500	.0103
B x Subj. W. Groups	30	24.2223	

categories are presented in Appendixes F and G, respectively. No significant effects were found in the overall analysis or in the subanalyses of the correct slide--incorrect response performance category. The overall analysis of the incorrect slide--correct response performance category also indicated no significant results. The subanalysis of the identity cue condition, however, indicated that the noncued trials produced significantly more correct responses than did the cued trials, $F(1,30) = 5.50$, $p < .05$. The subanalysis of the orientation cue condition indicated that the imagery condition produced significantly more correct responses than did the control condition $F(1,30) = 5.05$, $p < .05$. All data in this performance category were well below the chance level of performance, however.

The mean imagery vividness and fatigue ratings for the four groups are presented in Figures 6 and 7, respectively. All subjects in the imagery condition cue group reported imagery while one subject in the imagery orientation cue group and the control orientation cue group and three subjects in the control identity cue group reported "No image present, only know you are thinking of the object." A value of 1.0 would indicate very vivid imagery and 7.0 would indicate the rating described above. An analysis of variance (CRF-22 deisgn, Kirk, 1968, p. 173) was performed on the data and the summary table appears in Table V. The results of the analysis indicated that no significant effects, $F(1,60) = 1.0079$, $p > .05$ for imagery instruction and $F(1,60) = .7216$, $p > .05$ for type of cue. The number of subjects in each group reporting each rating is depicted in Figure 6. The figure indicates that imaging the identity cue was a fairly well defined task for the subjects, at least in the sense that all subjects reported imagery and were in

Imagery-
Condition Cue

$\overline{X} = 3.125$

Imagery-
Orientation Cue

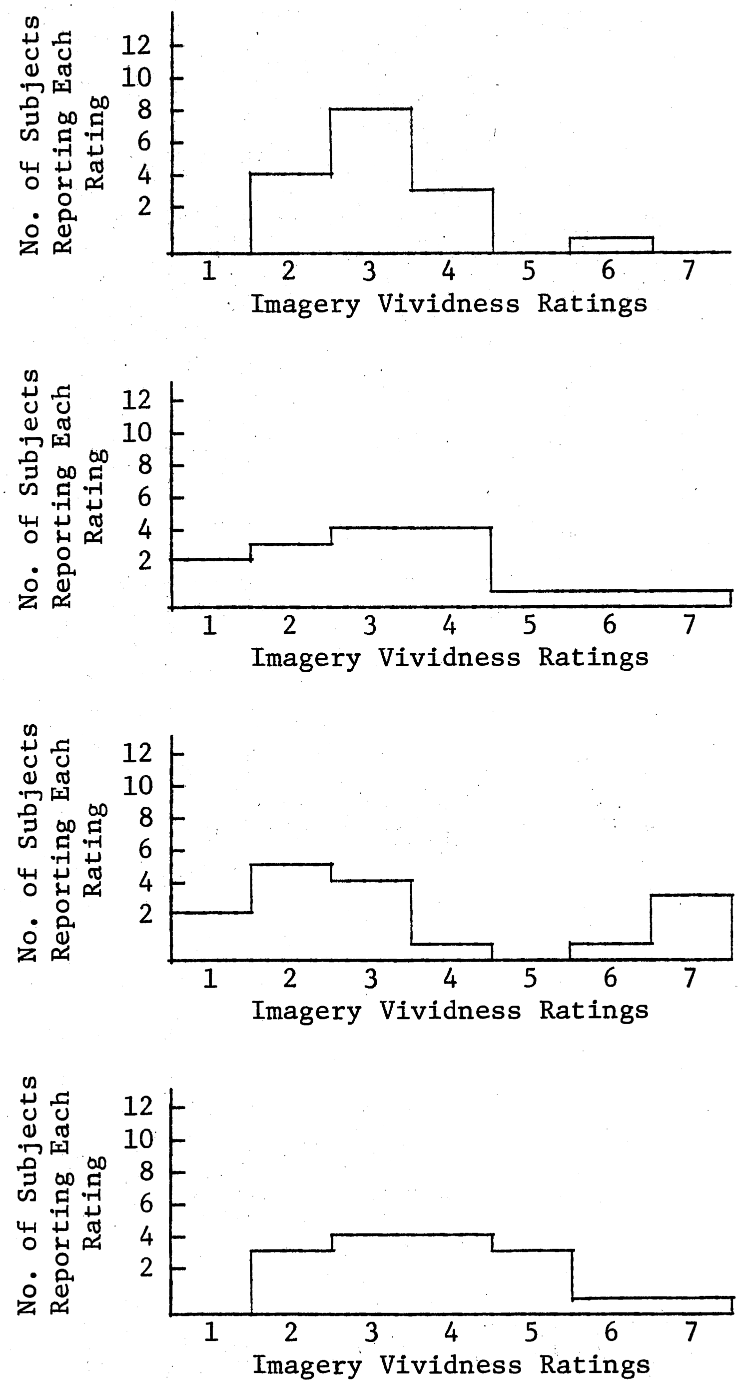
$\overline{X} = 3.375$

Control-
Identity Cue

$\overline{X} = 3.438$

Control-
Orientation Cue

$\overline{X} = 3.875$



Note: The vertical axis represents the number of subjects reporting each rating and the horizontal axis represents the imagery vividness scale. 1 = vivid as the actual experience, ..., 7 = no image present at all.

Figure 6. The Imagery Vividness Ratings for the Four Experimental Groups of Experiment I

Imagery-
Identity Cue

$\bar{X}$ = 3.000

Imagery-
Orientation Cue

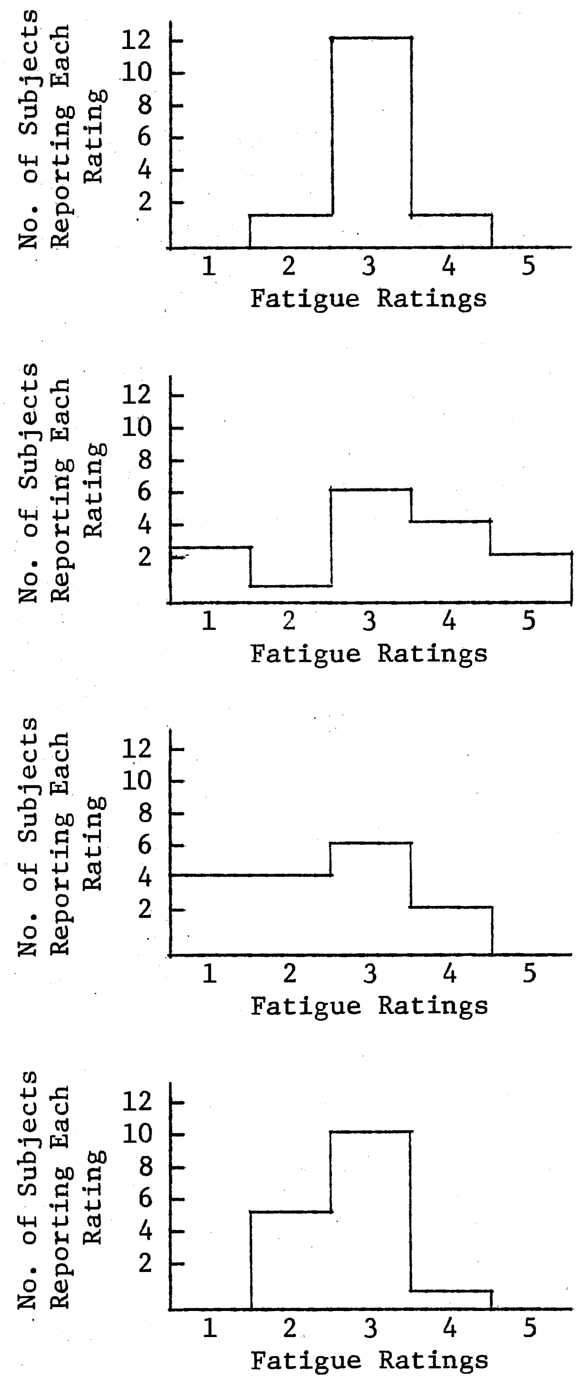
$\bar{X}$ = 3.250

Control-
Identity Cue

$\bar{X}$ = 2.375

Control-
Orientation Cue

$\bar{X}$ = 2.750



Note: The vertical axis represents the number of subjects reporting each rating and the horizontal axis represents the fatigue scale. 1 = not fatiguing at all, ..., 5 = one of the most fatiguing things you've ever done.

Figure 7. The Fatigue Ratings for the Four Experimental Groups of Experiment I

general agreement about its vividness. Instructions to image the orientation cue, on the other hand, produced a wide variety of ratings. The control identity cue group was somewhat bimodal suggesting that subjects either did or did not image the cue. And finally the control orientation cue group also produced a wide range of ratings.

TABLE V

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IMAGERY VIVIDNESS RATINGS OF EXPERIMENT I

Source	df	MS	F
Imagery Instruction (A)	1	2.6406	1.0079
Type of Cue (B)	1	1.8906	.7216
A x B	1	.1407	.0537
Within Cell	60	2.6198	

For the fatigue ratings a value of 1.0 would indicate no fatigue and a rating of 5.0 would indicate a great deal of fatigue. A two-way analysis of variance (CRF-22 design, Kirk, 1968, p. 173) was performed on the data and a summary table is presented in Table VI. The results of the analysis indicated that the fatigue ratings for the imagery groups were significantly higher than those of the control groups, $F(1,60) = 9.88$, $p < .01$, but there were no significant differences between the identity cue and the orientation cue groups, $F(1,60) = 3.05$, $p > .05$. The number of subjects in each group reporting each rating is depicted in Figure 7. The figure indicates again that imaging the identity cue was a fairly well defined task in the sense that the subjects were in agreement as to the amount of fatigue the task produced. The imaging of the orientation cue produced fatigue ratings which (in accord with the imagery ratings) ranged across the entire scale. For the control groups priming with the identity information produced varied fatigue ratings, while priming with orientation information produced fairly good agreement as to the fatigue ratings.

TABLE VI

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE FATIGUE RATINGS OF EXPERIMENT I

Source	df	MS	*F*
Imagery Instruction (A)	1	5.0625	9.8780**
Type of Cue (B)	1	1.5625	3.0488
A x B	1	.0625	.1219
Within Cell	60	.5125	

**$p < .01$

Discussion

The finding of no significant differences between the imagery and control groups for both the identity and the orientation cue groups can be explained in terms of the processes involved in attempting to image each type of information. For the identity cue group the self-report data clearly suggests that this was a result of the self-instructed use of imagery by 13 of the 16 subjects in the control group. The implication is that subjects primed with identity information (in both imagery and control groups) used the information to form an image of the letter (assumedly in its familiar upright position). The wide range of ratings for the two orientation cue groups would seem to indicate that the no difference finding in this instance was due to the subjects inability to form an image of an abstract frame of reference (although the imagery instructions may have produced attempts to do so).

While the overall analysis of the correct slide--correct response data indicated no significant differences between the identity and orientation cue groups, the results of the subanalyses suggested that different psychological processes were involved in the two tasks. Thus, while the results indicated no significant differences in priming with the identity and orientation information with either the cued or noncued trials, the evidence is also clear (when the comparisons are made separately within each type of cue condition) that priming with the identity information (to detect the orientation of the stimulus) was much more effective than priming with the orientation information (to detect the identity of the stimulus). The priming of orientation information thus appears to have been ineffective for this task. These results correspond with Cooper and Shepard's (1972) findings that subjects in their experiments could not rotate an abstract frame of reference in order to prepare for a detection task.

The evidence suggests then that the subjects used the identity information to form an image of the letter for use in detecting the orientation of the test stimulus, but that they could not, however, make efficient use of the orientation cue in detecting the identity of the test stimulus. Cooper and Shepard (1972) suggest in their study that perhaps

> It may be that the determination of identity precedes the determination of orientation . . . For, while the identity of a character can often be recognized on the basis of orientation invariant features (e.g., curvature, enclosed space, two free ends, etc., for 'R') the orientation may be difficult to determine without knowing anything about the identity of the character and, hence, about which is top and which is the bottom end of that character (Cooper and Shepard, 1972, p. 61-62).

The verbal responses to the question "How did you do the task?" indicated that the subjects in the present experiment were indeed using feature detection strategies to identify the letter and then deciding which orientation the letter was in. This strategy would do much to explain the efficient use of the identity cue information in detecting the orientation information in the test stimulus.

The important point to note about the identity and orientation cues is that, unlike the implications of the results from Cooper and Shepard's task involving rotation of the image, in the present experiment the two types of cues do not have "approximately the same effect" (Cooper and Shepard, 1972, p. 51). The evidence from this experiment suggests, instead, that mental representations of the identity and orientation components contribute unequally to the formation of an image. The implication here is that the identity component appears to contribute more to the formation of an image as it carries enough information for the formation of an image or the activation of an image representation. Further, the evidence suggests that in the detection task it is this identity information which constitutes the basis of the "more appropriate image" which is used in detecting test stimulus. Experiment II further tested this concept of "appropriate image" and the contribution of each component to it.

CHAPTER III

EXPERIMENT II

Purpose

Experiment II was designed to further investigate the relationship between the identity and orientation components of an image. According to the reasoning of Peterson and Graham (1974), if visual perception and imagery involve the same mechanisms, then imaging an object should facilitate detection of the object. Further, they reasoned that while compatible images (i.e., the image and the stimulus are the "same" object) should facilitate detection, incompatible images (i.e., the image and the stimulus are different objects) should hinder detection. This reasoning can be extended to the contributions of the identity and orientation component to the formation of an "appropriate image" as preparation for a test stimulus. Thus, knowledge about the contribution of each component to an image should be gained by a measure of the detection of the test stimulus when the components of the image are compatible and/or incompatible with the identity and the orientation of the stimulus object. Hence, detection of a test stimulus should be facilitated when the component which contributes the most information to the formation of the appropriate image is compatible with that of the test stimulus and should be hindered when the same component is incompatible with that of the test stimulus. In the present experiment, then, the subjects were to form an image based on identity and orientation cues which matched the test stimulus in one of four ways: both identity and orientation, identity only, orientation only, or in neither the identity nor the orientation. As a secondary consideration in the experiment half of the subjects received the identity cue first and half received the orientation cue first in order to assess whether presentation order effected the processing of the information in the task. Self-report data for imagery vividness ratings and fatigue were also collected.

Method

Subjects

Thirty-two undergraduate student volunteers enrolled in lower division psychology courses served as subjects. They received course credit for their participation. Sixteen subjects (eight males and eight females) were randomly assigned to each between group condition.

Design

The design was a Type SPF-2.4 design (Kirk, 1968, p. 248) with repeated measures. The between-subjects treatments were type of cue given first (identity or orientation) and the within-subjects treatments were the degree of match between the cue and the test stimulus (B, both the identity and the orientation matched; I, only the identity matched; O, only the orientation matched; and N, neither the identity nor the orientation matched). The four degrees of match between the cue and the test stimulus are illustrated in Figure 8.

In addition, another analysis of the Type SPF-22.22 design (Kirk, 1968, p. 311) with repeated measures was done on the data. The between subjects treatments were type of cue given first (identity or orientation) and the sex of the subject. The within-subjects treatments were type of identity cue match (agree and disagree with the stimulus) and type of orientation cue match (agree and disagree with the stimulus).

Degree of Match Between Cue and Stimulus	Cue Given (R at 0°)	Stimulus
B - Both the identity and the orientation of the cue match the stimulus.	R	R
I - Only the identity of the cue matches the stimulus.	R	
O - Only the orientation of the cue matches the stimulus.	R	G
N - Neither the identity nor the orientation of the cue match the stimulus.	R	

Figure 8. Degrees of Matching Between the Cues and the Stimuli

Materials and Apparatus

The stimuli were the slides in the six carousels used in Experiment I. The cues were selected for each slide so that with the presentation of two paired carousels (36 sequences) each of the nine letter-orientation treatment combinations had been cued once with a B, I, O and N cue. The I, O and N cues were chosen randomly for each test stimulus by assigning it the identity and/or orientation of one of the other stimuli in the experiment with the restriction that there be no more than three of the same cue (either identity or orientation) given in a row when the stimuli were presented to the subjects.

The specifications for the projectors and the general set up of the apparatus were the same as those in Experiment I.

Procedure

As in Experiment I the experiment consisted of the presentation of a series of two slide sequences containing a simple mask and a masked letter. The subjects were always given both a letter identity and a letter orientation cue (e.g., "12,R" and "R,12" both designated the letter R at the 0° or 12 o'clock orientation). The subjects were required to indicate both the identity and the orientation of the target letter as well as to indicate the slide in which the letter appeared.

The subjects used the same answer sheets as used in Experiment I. The left and right boxes again were used to indicate the first and second slides. The subjects identified the stimulus by writing the letter above the appropriate box and they indicated the orientation of the stimulus by drawing an arrow (corresponding to an orientation of 12 o'clock, 4 o'clock, or 8 o'clock, i.e., 0°, 120° or 240°, respectively) in the box below the letter.

The instructions given the subjects appear in Appendix H. Upon entering the experimental situation, the subjects were given the same general training in recognizing the three target letters in the three orientations and received the same practice trials as the subjects in Experiment I. The general procedure used to find the 50 percent calibration was also the same as that used in Experiment I except that scoring was for both identity and orientation correct.

The subjects were told about the possible disagreement between a cue and the stimulus (i.e., they were told that sometimes the cues they were given would match the stimulus in both the identity and orientation, that sometimes they would match in identity only or in orientation only and that sometimes they wouldn't match at all). They were reminded, however, that since the cue would at least partly match the stimulus most of the time, it was to their benefit to go ahead and imagine the cues (rather than to disregard them). The six carousels were presented in random order to each subject for the experimental trials in the same manner as in the previous experiment. At the conclusion of the experimental trials the subjects completed a short questionnaire about the experiment (see Appendix I) which again included the imagery vividness and fatigue scales.

Results

As in Experiment I the subjects' task included the two requirements of correctly assigning the target letter to one of the two slides and correctly identifying the stimulus. For this experiment four performance categories were scored. The four categories were as follows: both correct, in which <u>both</u> the identity and the orientation of the target letter were correctly identified; identity only correct, in which only the <u>identity</u> of the target letter was correctly identified; orientation only correct, in which only the <u>orientation</u> of the target letter was correctly identified; and neither correct, in which <u>neither</u> the identity nor the orientation of the target letter was correctly identified. In the both correct, identity only correct and orientation only correct performance categories the slides were all correctly assigned, while in the neither correct category the slides were all incorrectly assigned. Thus the neither correct category was equivalent to the incorrect slide--incorrect response category of Experiment I and the other three categories corresponded (in varying degrees) to the correct slide--correct response category of Experiment I. A table of means and standard deviations for the four performance categories is presented in Table VII. The total possible score for each mean was 27 and the chance level of performance was 1.475.

The two-factor analysis of variance summary tables for the four performance categories are presented in Tables VIII, IX, X, and XI. The main effect for type of cue given first was not significant for any of the performance categories. All four analyses indicated, however, that the main effect for the degree of match between the cue and the stimulus was significant: for both correct, $F(3,90) = 26.78$, $p < .001$; for identity only correct, $F(3,90) = 12.10$, $p < .001$; for orientation only correct, $F(3,90) = 19.79$, $p < .001$; and for neither correct, $F(3,90) = 13.65$, $p < .001$. For convenience the results of the four analyses are presented in Figure 9, but the four functions should be considered separately.

In order to examine these effects more closely Newman-Keuls tests were performed. (The tests are presented in Appendix J.) The results are indicated by the letters adjacent to each plotted position in Figure 9. Within the range of each function plotted in the figure, the letter positions having the same letter do not differ significantly, while the letter positions having different letters do differ significantly.

TABLE VII

MEANS AND STANDARD DEVIATIONS FOR THE FOUR PERFORMANCE CATEGORIES OF EXPERIMENT II

Conditions	Degree of Match Between Cue and Stimulus: Both Identity and Orientation	Identity Only	Orientation Only	Neither
Both Identity and Orientation Correct:				
Identity Cue First				
Mean	13.6250	9.5625	11.3125	9.2500
S.D.	3.4034	4.3813	5.7818	3.2558
Orientation Cue First				
Mean	14.3125	10.1250	12.0000	9.8750
S.D.	3.4394	2.8954	3.8297	2.6802
Identity Only Correct:				
Identity Cue First				
Mean	3.3125	2.6875	5.3750	2.5000
S.D.	2.4418	1.8154	2.5788	1.5916
Orientation Cue First				
Mean	3.5000	2.3750	4.7500	2.1875
S.D.	2.0331	1.5864	2.9777	1.3276
Orientation Only Correct:				
Identity Cue First				
Mean	1.7500	4.2500	1.7500	3.3125
S.D.	1.6533	2.1134	1.2383	1.8154
Orientation Cue First				
Mean	1.4375	3.5625	1.5625	3.0000
S.D.	1.2633	1.9311	1.1529	2.0331
Neither Identity nor Orientation Correct/ Also Wrong Slide:				
Identity Cue First				
Mean	1.3125	2.1875	1.2500	3.0625
S.D.	1.0782	1.6008	1.2910	1.6919
Orientation Cue First				
Mean	1.1875	1.8125	1.4375	3.5000
S.D.	.6551	1.3276	1.6317	2.3381

TABLE VIII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE BOTH IDENTITY AND ORIENTATION CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	13.1328	.3010
Subj. W. Groups	30	43.6368	
Within Subjects			
Degree of Match (B)	3	132.0703	26.7750***
A x B	3	.0286	.0058
B x Subj. W. Groups	90	4.9326	

***$p < .001$

TABLE IX

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IDENTITY ONLY CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	2.2578	.3995
Subj. W. Groups	30	5.6515	
Within Subjects			
Degree of Match (B)	3	49.2578	12.1045***
A x B	3	.9036	.2221
B x Subj. W. Groups	90	4.0694	

***$p < .001$

TABLE X

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE ORIENTATION ONLY CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	4.5000	.8869
Subj. W. Groups	30	5.0739	
Within Subjects			
Degree of Match (B)	3	41.7812	19.7889***
A x B	3	.3750	.1776
B x Subj. W. Groups	90	2.1113	

***p < .001

TABLE XI

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE NEITHER IDENTITY NOR ORIENTATION CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	.0312	.0089
Subj. W. Groups	30	3.5281	
Within Subjects			
Degree of Match (B)	3	28.0625	14.6179***
A x B	3	1.0104	.5263
B x Subj. W. Groups	90	1.9197	

***p < .001

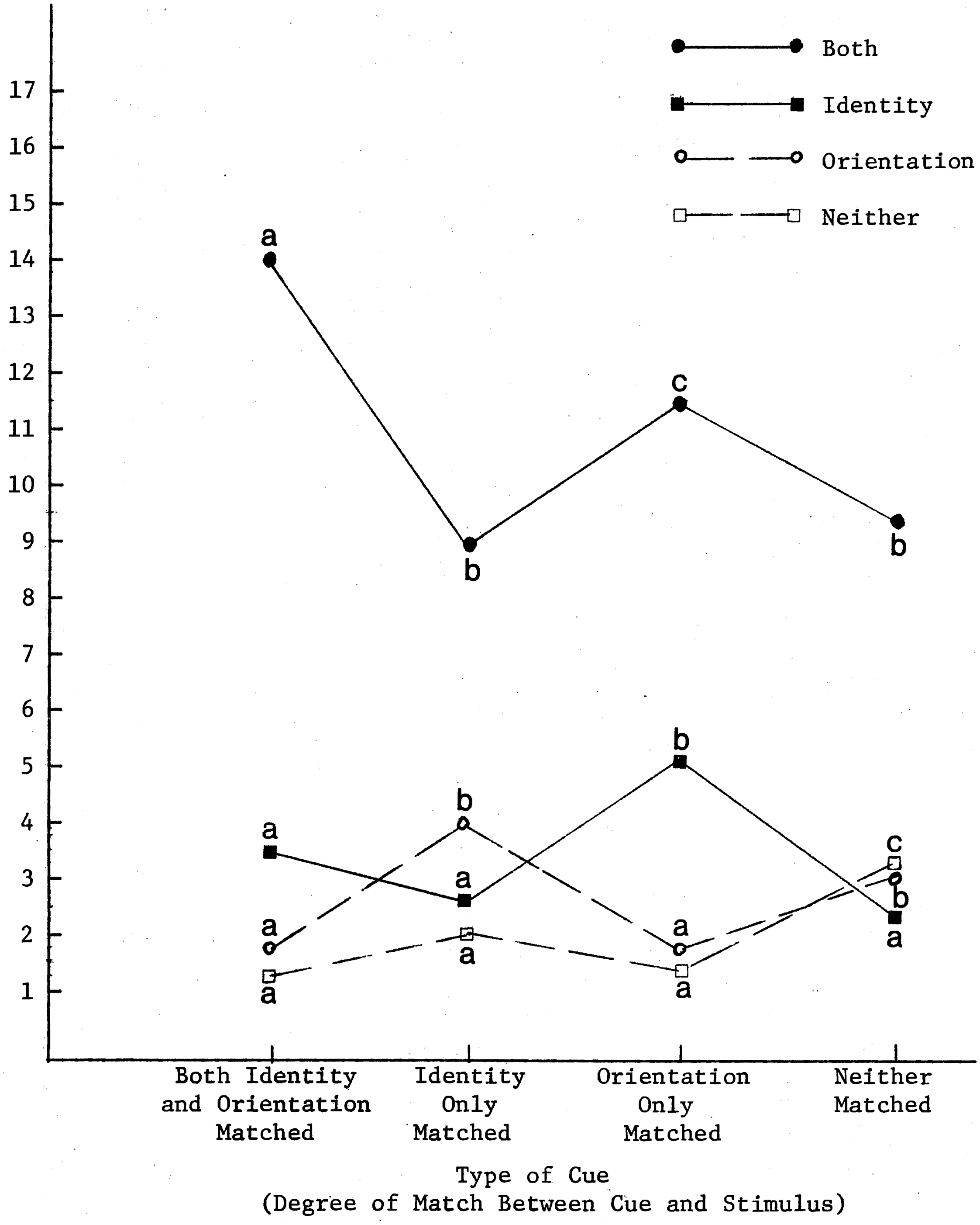


Figure 9. Mean Number of Responses for Each Type of Cue in the Four Performance Categories of Experiment II

The results of the Newman-Keuls tests indicated that for the both correct performance category the I cues and the N cues did not differ significantly. The B cues and the O cues, on the other hand, did differ significantly from each other and from the I and N cues. For the identity only correct performance category the O cues were significantly different from the B, I and N cues and these cues did not differ significantly from one another. For the orientation only correct performance category the B and O cues did not differ significantly. The I and N cues, however, did differ significantly from each other and from the B and O cues. Finally, for the neither correct performance category only the N cues were significantly different from the other cues.

It is apparent that the subjects could identify both the identity and the orientation of the stimuli fairly readily as is indicated by the large number of responses in the both correct performance category. According to the data in this performance category receiving the I cue (which includes both compatible identity and incompatible orientation information) was no more helpful than receiving two incompatible cues. Correct orientation information was quite important, however, and contributed significantly to correct detection of the stimuli whether combined with compatible or incompatible identity information.

Interesting comparisons are also found in the identity only and orientation only correct performance categories with the results from the I and O cues. Figure 9 suggests, for example, that the correct identity information aided in detection of the orientation of the stimulus and that correct orientation information aided in detection of the identity of the stimulus. A two-factor analysis of variance (RBF-22 design, Kirk, 1968, p. 237) was performed on these data. The analysis of variance summary table is presented in Table XII. Due to the post hoc nature of this analysis a higher level of significance (.01) was adopted. The results of this analysis indicated that the main effect for the degree of match was nonsignificant, $F(1,93) = .1657$, $p > .05$, while the orientation only correct performance category had more correct detections than the identity only correct category, $F(1,93) = 8.6417$, $p < .01$. The interaction of the cue types and the performance categories was also significant, $F(1,93) = 48.88$, $p < .001$. Simple effects tests were performed and the summary table appears in Table XIII. The results indicated that there were more orientation detections than identity detections at the identity cue level, $F(1,93) = 7.92$, $p < .01$ and there were significantly more identity detections than orientation detections at the orientation cue level, $F(1,93) = 48.60$, $p < .001$. It appears then that within these performance categories, receiving correct identity cue (with an incorrect orientation cue) aided in detection of the orientation information and receiving a correct orientation cue (with an incorrect identity cue) aided in detection of the identity information of the test stimulus.

A table of means and standard deviations for the SPF-22.22 analyses appears in Appendix K. The results of the SPF-22.22 analysis for the both correct performance category is presented in Table XIV. In this performance category the main effects for identity cue and for orientation cue were significant, $F(1,28) = 15.57$, $p < .001$ and $F(1,28) = 57.88$, $p < .001$, respectively. The interaction between these two experimental conditions (as depicted in Figure 10) was also significant, $F(1,28) = 5.22$, $p < .05$. Simple effects tests were performed on the data and appear in Table XV. The tests indicated that identity cues which agreed

TABLE XII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IDENTITY AND ORIENTATION DEGREES OF MATCH AND THE IDENTITY ONLY AND ORIENTATION ONLY CORRECT PERFORMANCE CATEGORIES

Source	df	MS	F
Blocks	31	5.1146	1.3390
Treatments	3		
Degree of Match (A)	1	.6328	.1657
Performance Category (B)	1	33.0078	8.6417**
A x B	1	182.8828	47.8801***
Residual	93	3.8196	

**p < .01
***p < .001

TABLE XIII

SUMMARY OF THE SIMPLE EFFECTS TESTS OF THE IDENTITY AND ORIENTATION DEGREES OF MATCH AND THE IDENTITY ONLY AND ORIENTATION ONLY CORRECT PERFORMANCE CATEGORIES

Source	df	MS	F
Degree of Match (A)			
A at b_1	1	102.5156	26.8394***
A at b_2	1	81.0000	21.2064***
Performance Category (B)			
B at a_1	1	30.2500	7.9197**
B at a_2	1	185.6406	48.6021***
A x B	1	182.8196	47.8801***
Residual	93	3.8196	

**p < .01
***p < .001

TABLE XIV

SUMMARY OF THE SPF-22.22 ANALYSIS OF VARIANCE FOR THE BOTH IDENTITY AND ORIENTATION CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	13.1328	.3071
Sex of Subject (C)	1	18.7578	.4386
A x C	1	92.8203	2.1703
Subj. W. Groups	28	42.7686	
Within Subjects			
Identity Cue (B)	1	53.8203	15.5704***
A x B	1	.0078	.0023
B x C	1	.9453	.2735
A x B x C	1	.1953	.0565
B x Subj. W. Groups	28	3.4565	
Orientation Cue (D)	1	309.3828	57.8824***
A x D	1	.0703	.0132
C x D	1	9.5703	1.7905
A x C x D	1	.0703	.0132
D x Subj. W. Groups	28	5.3450	
B x D	1	33.0078	5.2251*
A x B x D	1	.0078	.0012
B x C x D	1	5.6953	.9016
A x B x C x D	1	4.1328	.6542
B x D x Subj. W. Groups	28	6.3171	

*p < .05
***p < .001

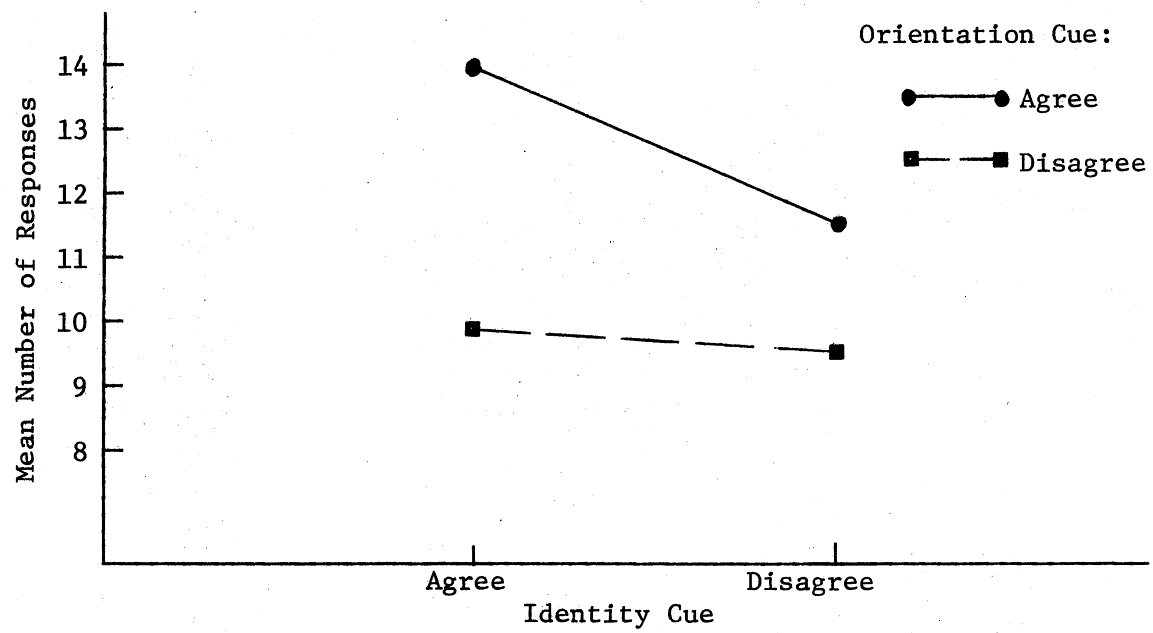


Figure 10. Identity Cue and Orientation Cue for the SPF-22.22 Analysis of the Both Correct Performance Category of Experiment II

TABLE XV

SUMMARY OF THE SIMPLE EFFECTS TESTS FOR THE SPF-22.22 ANALYSIS FOR THE BOTH IDENTITY AND ORIENTATION CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Identity Cue (B)			
B at d_1	1	85.5624	17.5085***
B at d_2	1	1.2656	.2590
Error B at d_1	56	4.8869	
Orientation Cue (D)			
D at b_1	1	272.2499	46.6893***
D at b_2	1	70.1406	12.0287**
Error D at b_j	56	5.8311	

**$p < .01$
***$p < .001$

with the stimuli helped the subject more than those which disagreed with the stimuli, but only when the orientation cues also agreed with the stimuli. There was no difference between identity cues when the orientation cues disagreed with the stimuli. The simple effects tests also indicated that orientation cues which agreed with the stimuli produced significantly more correct responses, regardless of whether or not the identity cues agreed with the stimuli.

The SPF-22.22 analyses for the identity only, orientation only and neither correct performance categories are presented in Appendix L. In the identity only correct performance category the identity cue and orientation cue main effects were both significant, $F(1,28) = 6.19$, $p < .05$ and $F(1,28) = 21.90$, $p < .001$, respectively. The interaction was also significant, $F(1,28) = 6.99$, $p < .05$ and simple effects tests (also presented in Appendix L) indicated again that identity cues which agreed with the stimulus produced significantly more responses than those which disagreed, but only when the orientation cues also agreed with the stimuli. Once again there was no significant difference between the identity cues when the orientation cues disagreed with the stimuli. The simple effects tests also indicated that when the identity cues agreed with the stimuli, there was no significant difference between the orientation cues. When the identity cues disagreed with the stimuli, however, significantly more responses were produced by orientation cues which agreed with the stimuli than by orientation cues which disagreed with the stimuli.

In the orientation only correct performance category the main effect for orientation cue was significant, $F(1,28) = 35.61$, $p < .001$, while the main effect for identity cue was not significant, $F(1,28) = 1.96$, $p > .05$. The interaction between the identity cues and orientation cues was significant, however, $F(1,28) = 4.49$, $p < .05$. Simple effects tests (presented in Appendix K) revealed the following about this interaction: there was no significant difference between identity cues when the orientation cues agreed with the stimuli, but when the orientation cues disagreed with the stimuli, the identity cues which agreed with the stimuli produced more responses than the identity cues which disagreed with the stimuli, and for both the identity cue conditions the orientation cues which disagreed with the stimuli produced more responses than the orientation cues which agreed with the stimuli.

In the neither correct performance category the identity cues which disagreed with the stimuli produced more responses than those which agreed, $F(1,28) = 13.46$, $p < .01$ and the orientation cues which disagreed with the stimuli also produced more responses than those which agreed, $F(1,28) = 39.68$, $p < .001$. No interactions in the analysis were significant.

The imagery vividness and fatigue ratings are given in Appendix M. In accord with the instructional set all subjects reported using imagery in the task. On both scales the ratings for the two groups were quite similar and indicated that the subjects rated their imagery as being rather clear and vivid and that they found the task to be "somewhat fatiguing."

Discussion

It is apparent that the subjects could identify the test stimuli most readily when given the information which would allow the formation of the "most appropriate image," i.e., when both the identity and the orientation cues matched the stimulus. According to the data in the both correct performance category the I cue and the N cue conditions did not produce significantly different results. This suggests that an image based on an incorrect orientation cue (whether it contains correct identity information or not) produces more errors than an image based on an incorrect identity cue (which contains correct orientation information). The results of the SPF-22.22 analysis also indicated that when the orientation cue did not match the stimulus, it made no difference whether the identity cue matched or did not match the stimulus. When the orientation cue matched the stimulus, however, performance was better when the identity cue matched the stimulus than when it did not match the stimulus. Thus orientation priming (when used in conjunction with identity priming) is very effective for this detection task. In this experiment then it at first appears that the most fundamental component of the image is correct orientation information. Other results of the experiment suggest a refinement of this conclusion, however.

Looking at several lines of evidence suggests that while the orientation cue is important in this task, its importance lies in allowing an efficient matching of the identity information in the image to the stimulus. The data for the orientation only correct performance category, for instance, as plotted in Figure 9 takes a form somewhat parallel to that of the both correct performance category data, thus suggesting that somewhat the same processes were taking place. One possibility is suggested by the results of Experiment I in that the subjects had to determine the identity information in the stimulus first and then determine the orientation information. What separates the two performance categories then is simply whether or not the subject successfully completed only one or both parts of the task. Further evidence for this suggestion is also found in the subjects' verbal responses to the question "How did you do the task?". Fourteen subjects out of 32 specifically stated that they had looked for the letter identity first and then determined its orientation.

The orientation only correct and the neither correct performance categories are also somewhat parallel in Figure 9 suggesting again similarities between the two. In this case it would appear that if the subject could not identify the identity information, he would very likely also not be able to determine the orientation information. It is well to note, however, that many values in these two performance categories are quite low (and in many cases approach or are below the chance performance level) and must therefore be considered with caution.

The intriguing results of the analysis on the I and O cues and the identity and orientation only performance categories can be understood in terms of the need to determine the identity of the test stimulus before its orientation can be identified. When set to determine first the identity of the stimulus (most likely by using the image as a template against which to match the stimulus) and receiving an I cue (which by definition contains incorrect orientation information), the subject finds the stimulus is in the wrong orientation for such a match. In this sense, both components of his image are incompatible with the stimulus. Even so, the correct identity information in the stimulus must allow for determination of the orientation of the stimulus even though the identity information is lost. On the other hand, when receiving an O cue, the subject's image is in the correct orientation for an efficient match with the identity of the stimulus. There is no apparent reason for not identifying the orientation in this instance (other than the subject's apparent concentration on the identity information and the extra time it took to determine the identity when a mismatch between the identity information in the cue and the stimulus takes place).

Thus, the two components work together in this experiment to allow efficient determination of the information in the stimulus. The most important component of the image for the actual determination of the stimulus information was once again the identity information, but the orientation information allowed for its efficient use.

While Maccoby and Jacklin (1974) report sex differences for orientation tasks (males are better), there appears to be no sex differences for the tasks in the experiments presented here. There were three significant interactions in the SPF-22.22 analysis of Experiment II, but the low number (out of 32 F-tests involving sex of the subject) and the fact that the main effect for sex of the subject was never significant would seem to indicate that the significance in these instances was due to chance.

CHAPTER IV

CONCLUSION AND SUMMARY

Conclusion

The two experiments in the present study suggest that the identity component contains the fundamental information for an image representation. Indeed, the results from the first experiment suggest that a mental representation of the identity information formed the basis for an image whether or not the subjects were instructed to use imagery in the task. The orientation information (an abstract frame of reference) on the other hand, was not sufficient for the formation of an image nor was it effective in priming for detection of the test stimuli. In the second experiment the orientation information was found to be the most valuable to the subject in completing the task. This finding must be viewed in light of the evidence that the subjects were using the identity information to determine the identity of the stimulus before determining its orientation. The correct orientation cue merely allowed sufficient processing of these operations. Stated differently, the results of this second experiment indicate that both the identity and the orientation information contribute to the image, but that the orientation information sets up the image for efficient use of the identity information.

These results are in accordance with the findings of Cooper and Shepard (1972) when they suggested that subjects could not rotate an abstract frame of reference and that in their task the identification of the identity and orientation of the test stimuli was "not carried out independently, in parallel" (Cooper and Shepard, 1972, p. 62). Rather, in light of the evidence of the present study, the orientation of an image can be seen as inherent in its identity (normally, of course, the orientation is thought of in the upright (12 o'clock) position).

These results have implications for the nature of mental representations. Pylyshyn (1973) suggests that internal mental representations are not visual in nature (i.e., do not structurally resemble their corresponding external objects). In his view images are reducible to a small number of "logically independent descriptive propositions" (Pylyshyn, 1973, p. 7). Thus, for instance, in the case of a particular object one would find the identity and orientation of the character represented as separate underlying propositions. The results of the present study, however, again confirm the visual nature of imagery as seen in the ineffectiveness of the orientation priming unless combined with identity information (which thus provides an image to orient). The results of the present study also suggest the correspondence of the internal mental representation to the external stimulus in the finding that the detection task in the second experiment could be successfully completed most readily when the image was in a corresponding orientation with the test stimulus, whether or not the identity information was the same for the cue and the stimulus.

Summary

Two experiments investigated the relationship between identity and orientation components of imagery. In the first experiment subjects

detected the identity and orientation of test stimuli after being cued with orientation or identity information respectively. In the second experiment the subjects identified both the identity and the orientation aspects of the stimulus after being cued with information which matched the stimulus in both identity and orientation, identity or orientation alone, or neither identity or orientation. The results of the two experiments indicated that the identity information is fundamental to the formation of an image and that orientation priming is ineffective without identity information. When combined with identity information, however, the orientation cuing becomes the more necessary information for the detection task. These results concur with the concept of imagery as a visual experience in which an image bears a structural relationship to its external representation.

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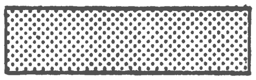
APPENDIXES

APPENDIX A

EXAMPLES OF SHADING FILM

EXAMPLES OF SHADING FILM



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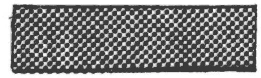

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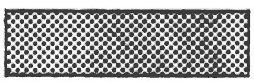

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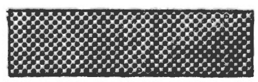

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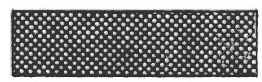
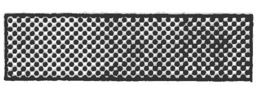
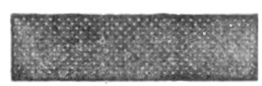


Cat. No. AX30-60M
(30 Line--60%)



Cat. No. AX30-30M
(30 Line--30%)



Cat. No. AX30-70M
(30 Line--70%)

APPENDIX B

INSTRUCTIONS FOR EXPERIMENT I

INSTRUCTIONS FOR EXPERIMENT I

The following instructions were read to the subjects after they were seated in front of the viewing screen. The basic instructions for the practice trials are given for the orientation cue condition with any changes for the identity cue condition given within brackets. Instructions for the actual experimental trials are given for both the orientation cue (noncue first) condition and the identity cue (cue first) condition. The instructions for the experimental trials are given for the control condition, with the special instructions for the imagery conditions found within brackets. The final section of instructions was the same for all subjects.

This is a study on how well people may detect different forms under different conditions. I will be asking you to detect letters of the alphabet as they appear in different orientations. The three letters you will see will be "G", "J", and "R". (G, J, and R each appear on a slide as the experimenter reads each letter name.) The three orientations that the letters will appear in will be those made by rotating each letter in a circle so that the top of the letter points to 12 o'clock, 4 o'clock or 8 o'clock. (A circle with a line labelled to indicate the appropriate orientation position appears on a slide as the experimenter describes each of the orientations in terms of times shown on a clock.)

During the experiment then, the letter "G" could appear in the 12 o'clock orientation, the 4 o'clock orientation or the 8 o'clock orientation. Likewise, the letter "J" could appear at 12 o'clock, or at 4 o'clock, or at 8 o'clock. Finally, the letter "R" could also appear at 12 o'clock, or 4 o'clock, or 8 o'clock. (A slide of each letter in each orientation is shown as the experimenter reads the appropriate description.) Are there any questions?

During the actual experiment you will see a series of pairs of slides. In each pair one slide will contain a letter and some random lines, and the other slide will contain random lines only. A slide with random lines only will look something like this. Just a jumble of lines. (An example is shown.) A slide with a letter and random lines will look something like this. (An example is shown.) You can see the letter "R"? Half of the time the letter will appear in the first slide of a pair and half of the time it will appear in the second slide. After you see the two slides, you will have five seconds to write your response and to be ready for the next slide pair.

Your task is to indicate the letter you saw and whether it appeared in the first or second slide. Your answer sheets contain sets of two adjacent boxes, one set for each trial. You will indicate your response by writing the letter you saw in the appropriate box. If the letter appeared in the first slide, write the letter in the box on the left and if the letter appeared in the second slide, write the letter in the box on the right. [Your task is to indicate the orientation of the letter you saw and whether it appeared in the first or second slide. Your answer sheets contain sets of two adjacent boxes, one set for each trial. To indicate the orientation of the letter draw an arrow in the appropriate box on your answer sheet indicating the direction in which the top of the letter was pointing. Thus you would indicate the orientations like this: 12 o'clock would be indicated by an arrow pointing straight up, 4 o'clock would be indicated by an arrow pointing down toward the right and 8 o'clock would be indicated by an arrow pointing down toward the left. (Three slides showing the appropriate marking of the answer sheet are shown as the experimenter describes them.) Are there any questions? If the letter appeared in the first slide of the slide pair, draw the arrow in the box on the left and if the letter appeared in the second slide of the slide pair, draw the arrow in the box on the right.] Do you have any questions?

Let me show you what a trial looks like so you will know exactly what I want you to do. I will say "now" and then you will see the two slides presented very rapidly like this (an example is shown). The first slide was just random lines. (This slide is shown again.) The second slide had the letter "G" pointed toward 8 o'clock. (This slide is shown again and the experimenter makes sure the subject can see the letter.) So you would have written the letter "G" [put an arrow pointing toward 8 o'clock] in the second box because the letter was in the second slide.

Let's try some practice trials. I will say "now" before each slide pair is shown. Each slide will appear very briefly. After you have seen each slide pair, you will have five seconds to indicate your response and to be ready for the next slide pair. Do not leave any blanks on your answer sheet. Always indicate the correct slide and the identity of the letter by writing the letter in the appropriate box. [Always indicate the correct slide and the orientation of the letter by drawing the arrow in the appropriate box.] Do not mark your answer sheet until after both the slides have been shown. Do you have any questions?

There will be nine pairs of slides in this first practice session so you'll just use the first half of your answer sheet. This is just practice so if you have any questions at any time, just stop and ask me. Remember, I will say "now", you'll see two slides and then you will have five seconds to write your response. (The nine practice slide pairs are shown.)

O.K., just let me score this. (The experimenter collects the answer sheet and scores it. If less than half are correct, the slides are shown again in reverse order.) This time I'm going to make it a little harder on you by putting up this screen. This time we'll do exactly the same thing, except that there will be 18 slide pairs. (The 18 slide pairs are shown. The experimenter collects the answer sheet and scores it. This is repeated up to two more times using darker shading film each time until the subject's 50 percent correct criterion point can be approximated.)

Orientation Cue (Noncue First)

For this part of the experiment I will say "now" before each slide pair is shown. Remember to always indicate the correct slide and the identity of the letter by writing the letter in the appropriate box. Do not mark your answer sheet until after both of the slides in a pair have been shown. Do not leave any blanks on your answer sheet. Do you have any questions? (The subjects are shown the first set of slides in the noncued condition.)

For this next part of the experiment the procedure will be a little different. Before each trial I will tell you the orientation of the letter that you will see in that trial. So I will say "12", "4" or "8". [When you hear the orientation cue, imagine the orientation in your mind so that you will be ready to identify the letter when it appears on the screen. You will have three seconds in which to form a good image before the first slide appears. Do you have any questions?] Your task is the same as before: indicate the correct slide and the identity of the letter by writing the letter in the appropriate box. Do not mark your answer sheet until after both of the slides in a pair have been shown. Remember, I will tell you the orientation of the letter. [Hearing the letter orientation will signal you to imagine the orientation in your mind so that you will be ready to identify the letter when it appears on the screen.] Do not, however, turn your head or body in any way. Do you have any questions? (Subjects are shown the first set of slides in the cued condition.)

This time I will just say "now" before each slide pair.

This time I will tell you the orientation of the letter that you will see in each trial. [Remember to imagine the orientation in your mind so that you will be ready to identify the letter when it appears.] Do not move your head or body in any way. (The above two sets of instructions are repeated appropriately as the sets of slides are shown. There is a short break between each block as the experimenter collects the answer sheets, codes them and changes the carousel. If the subject shows signs of boredom or fatigue, he is encouraged to continue at this time.)

Identity Cue (Cue First)

For this part of the experiment I will cue you before each slide pair is shown by telling you the identity of the letter that you will see in that slide pair. [When you hear the letter identity, visually imagine the letter so that you have it in your mind during the two slides. Imagining something visually is like picturing it in your mind. You will have three seconds in which to form a good image before the first slide appears. Do you have any questions?] Remember to always indicate the correct slide and the orientation of the letter by drawing an arrow in the appropriate box. Do not mark your answer sheet until after both of the slides in a pair have been shown. Do not leave any blanks on your answer sheet. Do you have any questions? [O.K., I will give you the letter identity and you will visually imagine the letter during both slides of the slide pair.] (Subjects are shown the first set of slides in the cued condition.)

For this next part of the experiment I will just say "now" before each slide pair is shown. Your task is the same as before: indicate the correct slide and the orientation of the letter by drawing an arrow in the appropriate box. Do not mark your answer sheet until after both slides in a pair have been shown. Do you have any questions? (Subjects are shown the first set of slides in the noncued condition.)

This time I will give you the letter identity before each slide pair. [Remember to visually imagine the letter so that you are picturing it in your mind during both the slides of the slide pair.]

This time I will just say "now" before each slide pair. (The above two sets of instructions are repeated appropriately as the sets of slides are shown. There is a short break between each block as the experimenter collects the answer sheets, codes them and changes the carousel. If the subject shows signs of boredom or fatigue he is encouraged to continue at this time.)

You will be happy to know that that was the last one. There is one more thing I'd like you to do before you leave. That's to fill out this questionnaire as best you can. The first question deals with anything you can tell me about any plan or strategy you used to do the task such as where you looked on the screen or what you looked for. The third question deals with when you heard the identity (orientation) cue. It asks whether or not you formed an image of the cue in your mind. An image is like a picture in your mind. Some people do form images and some don't. [It asks whether or not you actually formed an image or picture of the cue in your mind. Some people do and some don't.] If you did, then rate the image according to how vivid or real it seemed to you. Make sure you are rating the image you had in your mind before you saw anything on the screen. If you have any questions, just ask me. (After filling out the questionnaire, the subject is debriefed as to the purpose of the experiment. Before he leaves the subject is asked not to discuss the exact task with other students.)

APPENDIX C

QUESTIONNAIRE FOR EXPERIMENT I

1. Briefly describe how you did the task.

2. Did you notice a difference between how you did the task when you were not given a cue (the experimenter just said "now" before each slide pair) and when you were given a cue? Yes No Briefly describe the difference.

3. Having a "visual image" is like having a picture in your mind. Did you use imagery in doing the task? Yes No

   How would you rate any imagery that you used in doing the task?

   1. Perfectly clear and vivid as the actual experience.
   2. Very clear and comparable in vividness to the actual experience.
   3. Moderately clear and vivid.
   4. Not clear or vivid, but recognizable.
   5. Vague and dim.
   6. So vague and dim as to be hardly discernible.
   7. No image present at all, you only know that you are thinking of the object.

4. Rate the task as to how fatiguing you found it to be.

   1. Not fatiguing at all.
   2. Not very fatiguing.
   3. Somewhat fatiguing.
   4. Very fatiguing.
   5. One of the most fatiguing things you've ever done.

5. Use the space below for any comments about the experiment.

APPENDIX D

ANALYSES FOR THE FOUR PERFORMANCE CATEGORIES OF EXPERIMENT I WITH SEX OF THE SUBJECT INCLUDED

TABLE XVI

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE CORRECT SLIDE--
CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I
WITH SEX OF THE SUBJECT INCLUDED

Source	df	MS	F
Between Subjects			
Imagery Instruction (A)	1	29.0703	.3115
Type of Cue (C)	1	.0703	.0008
Sex of Subject (D)	1	.1953	.0021
A x C	1	43.9453	.4709
A x D	1	354.4453	3.7980
C x D	1	56.4453	.6048
A x C x D	1	.0078	.0001
Subj. W. Groups	56	93.3230	
Within Subjects			
Type of Trial (B)	1	106.9453	5.3495*
A x B	1	18.7578	.9383
B x C	1	51.2578	2.5640
B x D	1	20.3203	1.0164
A x B x C	1	13.1328	.6569
A x B x D	1	3.4453	.1723
B x C x D	1	6.5703	.3287
A x B x C x D	1	.3828	.0191
B x Subj. W. Groups	56	19.9917	

*$p < .05$

TABLE XVII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE CORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I WITH SEX OF THE SUBJECT INCLUDED

Source	df	MS	F
Between Subjects			
Imagery Instruction (A)	1	40.5000	2.0954
Type of Cue (C)	1	4.5000	.2328
Sex of Subject (D)	1	2.5312	.1310
A x C	1	9.0312	.4673
A x D	1	66.1250	3.4212
C x D	1	91.1250	4.7147*
A x C x D	1	3.7812	.1956
Subj. W. Groups	56	19.3279	
Within Subjects			
Type of Trial (B)	1	12.5000	1.1674
A x B	1	1.5312	.1430
B x C	1	.2812	.0263
B x D	1	21.1250	1.9730
A x B x C	1	.1250	.0017
A x B x D	1	7.0312	.6567
A x C x D	1	3.7812	.1956
B x C x D	1	5.2812	.4932
A x B x C x D	1	12.5000	1.1674
B x Subj. W. Groups	56	10.7072	

*$p < .05$

TABLE XVIII

SIMPLE EFFECTS TESTS FOR THE CORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I WITH SEX OF THE SUBJECT INCLUDED

Source	df	MS	F
Type of Cue (C)			
C at d_1	1	27.563	1.4261
C at d_2	1	68.062	3.5214
Error C at d_1	56	19.328	
Sex of Subject (D)			
D at c_1	1	31.641	1.6370
D at c_2	1	62.016	3.2086
Error D at c_k	56	19.328	

TABLE XIX

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE INCORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I WITH SEX OF THE SUBJECT INCLUDED

Source	df	MS	F
Between Subjects			
Imagery Instruction (A)	1	18.7578	2.1235
Type of Cue (C)	1	4.8828	.5528
Sex of Subject (D)	1	2.2578	.2578
A x C	1	18.7578	2.1235
A x D	1	6.5703	.7438
C x D	1	.9453	.1070
A x C x D	1	27.1953	3.0786
Subj. W. Groups	56	8.8335	
Within Subjects			
Type of Trial (B)	1	11.8828	2.2187
A x B	1	5.6953	1.0634
B x C	1	15.8203	2.9539
B x D	1	.0078	.0015
A x B x C	1	3.4453	.6433
A x B x D	1	.0703	.0131
A x C x D	1	27.1953	3.0786
B x C x D	1	10.6953	1.9970
A x B x C x D	1	.9453	.1765
B x Subj. W. Groups	56	5.3557	

TABLE XX

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE INCORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I WITH SEX OF THE SUBJECT INCLUDED

Source	df	MS	F
Between Subjects			
Imagery Instruction (A)	1	56.4453	2.4025
Type of Cue (C)	1	15.8203	.6703
Sex of Subject (D)	1	.1953	.0083
A x C	1	21.9453	.9341
A x D	1	59.1328	2.5169
C x D	1	10.6953	.4552
A x C x D	1	11.8828	.5058
Subj. W. Groups	56	23.4942	
Within Subjects			
Type of Trial (B)	1	8.5078	.7031
A x B	1	.3828	.0316
B x C	1	5.6953	.4706
B x D	1	.0703	.0058
A x B x C	1	3.4453	.2847
A x B x D	1	.3828	.0316
B x C x D	1	4.8828	.4035
A x B x C x D	1	14.4453	1.1937
B x Subj. W. Groups	56	12.1012	

APPENDIX E

ANALYSIS OF VARIANCE SUMMARY TABLES FOR THE

INCORRECT SLIDE--INCORRECT RESPONSE

PERFORMANCE CATEGORY OF

EXPERIMENT I

TABLE XXI

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE OVERALL ANALYSIS OF THE INCORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	56.4453	2.4233
Cue Condition (C)	1	15.8203	.6792
A x C	1	21.9453	.9421
Subj. W. Groups	60	23.2931	
Within Subjects			
Trial Condition (B)	1	8.5078	.7319
A x B	1	.3828	.0329
B x C	1	5.6953	.4900
A x B x C	1	3.4453	.2964
B x Subj. W. Groups	60	11.6242	

TABLE XXII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IDENTITY CUE SUBANALYSIS OF THE INCORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	22.5625	1.1748
Subj. W. Groups	30	19.2061	
Within Subjects			
Trial Condition (B)	1	14.0625	1.3322
A x B	1	20.2500	1.9183
B x Subj. W. Groups	30	10.5559	

TABLE XXIII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE ORIENTATION CUE SUBANALYSIS OF THE INCORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	74.3906	2.7798
Subj. W. Groups	30	26.7614	
Within Subjects			
Trial Condition (B)	1	.1406	.0116
A x B	1	.7656	.0632
B x Subj. W. Groups	30	12.1195	

APPENDIX F

ANALYSIS OF VARIANCE SUMMARY TABLES FOR THE CORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

TABLE XXIV

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE OVERALL ANALYSIS OF THE CORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	40.5000	1.9503
Cue Condition (C)	1	4.5000	.2167
A x C	1	9.0312	.4349
Subj. W. Groups	60	20.7655	
Within Subjects			
Trial Condition (B)	1	12.5000	1.1618
A x B	1	1.5312	.1423
B x C	1	.2812	.0261
A x B x C	1	.1250	.0116
B x Subj. W. Groups	60	10.7590	

TABLE XXV

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IDENTITY CUE SUBANALYSIS OF THE CORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	5.6406	.2445
Subj. W. Groups	30	23.0738	
Within Subjects			
Trial Condition (B)	1	8.2656	.8615
A x B	1	.3906	.0407
B x Subj. W. Groups	30	9.5944	

TABLE XXVI

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE ORIENTATION CUE SUBANALYSIS OF THE CORRECT SLIDE--INCORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	43.8906	2.3780
Subj. W. Groups	30	18.4572	
Within Subjects			
Trial Condition (B)	1	4.5156	.3787
A x B	1	1.2656	.1061
B x Subj. W. Groups	30	11.9236	

APPENDIX G

ANALYSIS OF VARIANCE SUMMARY TABLES FOR THE

INCORRECT SLIDE--CORRECT RESPONSE

PERFORMANCE CATEGORY OF

EXPERIMENT I

TABLE XXVII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE OVERALL ANALYSIS OF THE INCORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	18.7578	2.1169
Cue Condition (C)	1	4.8828	.5511
A x C	1	18.7578	2.1169
Subj. W. Groups	60	8.8608	
Within Subjects			
Trial Condition (B)	1	11.8828	2.2878
A x B	1	5.6953	1.0965
B x C	1	15.8203	3.0459
A x B x C	1	3.4453	.6633
B x Subj. W. Groups	60	5.1940	

TABLE XXVIII

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE IDENTITY CUE SUBANALYSIS OF THE INCORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	0.0000	0.0000
Subj. W. Groups	30	10.2978	
Within Subjects			
Trial Condition	1	27.5625	5.4967*
A x B	1	9.0000	1.7948
B x Subj. W. Groups	30	5.0144	

*p < .05

TABLE XXIX

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE ORIENTATION CUE SUBANALYSIS OF THE INCORRECT SLIDE--CORRECT RESPONSE PERFORMANCE CATEGORY OF EXPERIMENT I

Source	df	MS	F
Between Subjects			
Imagery Condition (A)	1	37.5156	5.0534*
Subj. W. Groups	30	7.4239	
Within Subjects			
Trial Condition (B)	1	.1406	.0262
A x B	1	.1406	.0262
B x Subj. W. Groups	30	5.3737	

*p < .05

APPENDIX H

INSTRUCTIONS FOR EXPERIMENT II

INSTRUCTIONS FOR EXPERIMENT II

The following instructions were read to the subjects after they were seated in front of the viewing screen. The instructions given here are for the orientation cue first condition. When different from this condition, the instructions for the identity cue first condition are given within brackets.

This is a study on how well people can detect different forms under different conditions. I will be asking you to detect letters of the alphabet as they appear in different orientations. The three letters you will see will be "G", "J", and "R". (G, J, and R each appear on a slide as the experimenter reads each letter name.) The three orientations that the letters will appear in will be those made by rotating each letter in a circle so that the top of the letter points to 12 o'clock, 4 o'clock, and 8 o'clock. (A circle with a line labelled to indicate the appropriate orientation position appears on a slide as the experimenter describes the orientations in terms of times shown on a clock.)

During the experiment then, the letter "G" could appear in the 12 o'clock orientation, the 4 o'clock orientation or the 8 o'clock orientation. Likewise, the letter "J" could appear at 12 o'clock, or at 4 o'clock, or at 8 o'clock. Finally, the letter "R" could also appear at 12 o'clock, or 4 o'clock, or 8 o'clock. (A slide of each of the above is shown as the experimenter reads the appropriate description.) Are there any questions?

During the actual experiment you will see a series of pairs of slides. In each pair one slide will contain a letter and some random lines, and the other slide will contain random lines only. A slide with random lines only will look something like this. Just a jumble of lines. (An example is shown.) A slide with a letter and random lines will look something like this. (An example is shown.) You can see the letter "R"? Half of the time the letter will appear in the first slide of a pair and half of the time it will appear in the second slide. After you see the two slides, you will have five seconds to write your response and to be ready for the next slide pair.

Your task is to indicate the letter you saw and its orientation. Your answer sheets contain 18 sets of two adjacent boxes, one set for each trial. You will indicate your response by writing the letter <u>above</u> the appropriate box in the set and by placing an arrow to indicate the orientation of the letter <u>in</u> the appropriate box. To indicate the orientation of the letter, draw an arrow indicating the direction in which the top of the letter was pointing. Thus, you would indicate the orientations like this: 12 o'clock would be indicated by an arrow pointing straight up, 4 o'clock would be indicated by an arrow pointing down toward the right and 8 o'clock would be indicated by an arrow pointing down toward the left. (Three slides showing the appropriate marking of the answer sheet are shown as the experimenter describes them.) Are there any questions?

If the letter appeared in the first slide, write the letter above the box on the left and if the letter appeared in the second slide, write the letter above the box on the right. The arrow, of course, is placed in the box below the letter.

Let me show you what a trial looks like so you will know exactly what I want you to do. I will say "now" and then you will see two slides presented very rapidly, like this. (An example is shown.) The first slide was just random lines. The second slide had the letter "G" pointed toward 8 o'clock. (Each of the two slides is shown again.) So you would have written the letter "G" above the second box and you would have drawn an arrow pointing toward 8 o'clock in the second box because the letter was in the second slide. (The experimenter points to the appropriate box on the subject's answer sheet.)

Let's try some practice trials. I will say "now" before each slide pair is shown. Each slide will appear very briefly. After you have seen each slide pair, you will have five seconds to indicate your response and to be ready for the next slide pair. Do not leave any blanks on your answer sheet. Always indicate the correct slide as well as the letter and its orientation by writing the letter <u>above</u> and the arrow <u>in</u> the appropriate box. Do not mark your answer sheet until after both the slides have been shown. There will be nine sets of slides in the practice session so you'll just use the first half of the answer sheet. This is just practice so if you have any questions at any time, just stop and ask me.

I will say "now", you will see two slides and then you will have five seconds to write your response. (The nine practice trials are given.)

Just let me score this. (The experimenter collects the answer sheet and scores it. If less than half are correct, the slides are shown again in reverse order.) O.K., this time I'm going to make it a little harder on you by putting up this screen. This time we'll do exactly the same thing, except that there will be 18 pairs of slides. (Repeated up to two times using darker shading film each time until the subject's 50 percent correct criterion point can be approximated.)

For this next part of the experiment, the procedure will be just a little different. Before each trial I will cue you with the letter orientation and identity. For instance, I will say, "12, G" and you'll expect to see the letter "G" in the 12 o'clock orientation. [For instance, I will say "G, 12" and you'll expect to see the letter "G" in the 12 o'clock orientation.] When you hear the cue, visually imagine the letter in that specific orientation so that you have it in your mind during the two slides. Imagining something visually is like picturing it in your mind. Do you know what I'm talking about? The cue will not always exactly match the letter you will see. Sometimes the cue will match the letter in both the identity and the orientation. At other times the cue will match only the letter identity or only the letter orientation. Finally, sometimes the cue won't match the letter you see at all. Most of the time, however, the cue will match the letter you see in at least one way (identity or orientation) so it is best for you to imagine the cue that I give you. Do you have any questions?

Remember that I will cue you before each slide pair. When you hear the cue, visually imagine the letter in that specific orientation so that you have it in your mind during the two slides. You will have three seconds after you hear the cue to form the image before the first slide in the pair appears. Do not leave any blanks on your answer sheet. Always indicate the correct slide as well as the letter identity and orientation by writing the letter above and the arrow in the appropriate box. Do not mark your answer sheet until both of the slides have been shown. Do you have any questions? (The subjects are shown the six blocks of slides and are appropriately cued before each slide pair. There is a short break between each block as the experimenter collects the answer sheets, codes them, and changes the carousel. If the subject shows signs of boredom or fatigue, he is encouraged to continue at this time).

You will be happy to know that that was the last one. There is one more thing I'd like you to do before you leave. That's to fill out this questionnaire as best you can. The first question deals with anything you can tell me about any plan or strategy you used to do the task such as where you looked on the screen or what you looked for. The third question deals with when I gave you the cue. It asks whether or not you actually formed an image or picture of the cue in your mind. Some people do and some don't. If you did, then rate the image according to how vivid or real it seemed to you. But make sure you are rating the image you had in your mind before you saw anything on the screen. If you have any questions just ask me. (After filling out the questionnaire, the subject is debriefed as to the purpose of the experiment. Before he leaves the subject is asked not to discuss the exact task with other students.)

APPENDIX I

QUESTIONNAIRE FOR EXPERIMENT II

1. Briefly describe how you did the task.

2. Having a "visual image" is like having a picture in your mind. Did you use imagery in doing the task? Yes No

   How would you rate any imagery that you used in doing the task?

   1. Perfectly clear and vivid as the actual experience.
   2. Very clear and comparable in vividness to the actual experience.
   3. Moderately clear and vivid.
   4. Not clear or vivid, but recognizable.
   5. Vague and dim.
   6. So vague and dim as to be hardly discernible.
   7. No image present at all, you only know that you are thinking of the object.

3. Rate the task as to how fatiguing you found it to be.

   1. Not fatiguing at all.
   2. Not very fatiguing.
   3. Somewhat fatiguing.
   4. Very fatiguing.
   5. One of the most fatiguing things you've ever done.

4. Use the space below for any comments about the experiment.

APPENDIX J

NEWMAN-KEULS TESTS FOR

EXPERIMENT II

TABLE XXX

NEWMAN-KEULS TEST ON MEAN NUMBER OF RESPONSES IN THE BOTH IDENTITY AND ORIENTATION CORRECT PERFORMANCE CATEGORY

Degree of Match	Neither	Identity	Orientation	Both	r	$q_{.99}(5,90)$	$s_{\bar{d}}q_{.99}(r,90)^a$
Means	9.5625	9.8438	11.6562	13.9688			
Neither		.2813	2.0937**	4.4063**	4	4.54	1.7824
Identity			1.8124**	4.1250**	3	4.24	1.6646
Orientation				2.3126**	2	3.73	1.4644

[a] $s_{\bar{d}} = .3926$

$^{**}p < .01$

TABLE XXXI

NEWMAN-KEULS TEST ON MEAN NUMBER OF RESPONSES IN THE IDENTITY ONLY CORRECT PERFORMANCE CATEGORY

Degree of Match	Neither	Identity	Both	Orientation	r	$q_{.99}(r,90)$	$s_{\bar{d}}q_{.99}(r,90)$[a]
Means	2.3475	2.5312	3.4062	5.0625			
Neither		.1837	1.0587	2.7150**	4	4.54	1.6190
Identity			.875	2.5313**	3	4.24	1.5120
Both				1.6563**	2	3.73	1.3301

[a] $s_{\bar{d}} = .3566$

**$p < .01$

TABLE XXXII

NEWMAN-KEULS TEST ON MEAN NUMBER OF RESPONSES IN THE ORIENTATION ONLY CORRECT PERFORMANCE CATEGORY

Degree of Match	Both	Orientation	Neither	Identity	r	$q_{.99}(r,90)$	$s_{\bar{d}}q_{.99}(r,90)$[a]
Means	1.5938	1.6562	3.1562	3.9062			
Both		.0624	1.5624**	2.3124**	4	4.54	1.1663
Orientation			1.5000**	2.2500**	3	4.24	1.0892
Neither				.7500*	2	3.73	.9582

[a] $s_{\bar{d}} = .2569$

* $q_{.95}(2,90) = 2.82$; $s_{\bar{d}}.95\ (2,90) = .7244$; $p < .05$

**$p < .01$

TABLE XXXIII

NEWMAN-KEULS TEST ON MEAN NUMBER OF RESPONSES IN THE NEITHER CORRECT PERFORMANCE CATEGORY

Degree of Match	Both	Orientation	Identity	Neither	r	$q_{.99}(r,90)$	$s_{\bar{d}}q_{.99}(r,90)^a$
Means	1.2500	1.3438	2.0000	3.2812			
Both		.0938	.7500	2.0312**	4	4.54	1.1118
Orientation				1.9374**	3	4.24	1.0383
Identity				1.2812**	3	3.73	.9135

[a] $s_{\bar{d}} = 2.449$

**$p < .01$

APPENDIX K

MEANS AND STANDARD DEVIATIONS FOR THE

SPF-22.22 ANALYSIS OF EXPERIMENT II

TABLE XXXIV

MEANS AND STANDARD DEVIATIONS FOR THE SPF-22.22 ANALYSIS OF EXPERIMENT II

	Identity Cue: Agree — Orientation Cue: Agree	Identity Cue: Agree — Orientation Cue: Disagree	Identity Cue: Disagree — Orientation Cue: Agree	Identity Cue: Disagree — Orientation Cue: Disagree
Both Correct				
Cue Given First				
Identity				
Female				
Mean	13.125	8.750	10.125	9.375
S.D.	4.324	3.059	4.291	3.502
Male				
Mean	15.500	11.500	13.875	10.375
S.D.	1.852	2.070	2.232	1.598
Orientation				
Female				
Mean	13.750	10.125	11.625	10.125
S.D.	4.268	5.276	6.435	3.834
Male				
Mean	13.500	9.000	11.000	8.375
S.D.	2.564	3.546	5.477	2.504
Identity Only Correct				
Identity				
Female				
Mean	4.625	2.750	6.375	2.125
S.D.	1.685	1.669	3.293	1.808
Male				
Mean	2.375	2.000	3.125	2.250
S.D.	1.768	1.512	1.458	.707
Orientation				
Female				
Mean	3.500	1.500	5.500	2.000
S.D.	3.071	1.604	2.928	1.195
Male				
Mean	3.125	3.875	5.250	3.000
S.D.	1.808	1.126	2.376	1.852
Orientation Correct Only				
Identity				
Female				
Mean	.875	3.500	1.375	2.125
S.D.	1.126	2.450	1.302	1.356
Male				
Mean	2.000	3.625	1.750	3.875
S.D.	1.195	1.408	1.035	2.295

TABLE XXXIV (Continued)

	Identity Cue			
	Agree		Disagree	
	Orientation Cue		Orientation Cue	
	Agree	Disagree	Agree	Disagree
Orientation Correct Only (Continued)				
Orientation				
Female				
Mean	1.250	4.375	1.625	2.750
S.D.	1.035	2.560	1.302	1.982
Male				
Mean	2.250	4.375	1.625	2.750
S.D.	2.053	1.760	1.302	1.982
Neither Correct				
Identity				
Female				
Mean	1.250	2.000	1.500	3.625
S.D.	1.282	1.604	1.773	1.408
Male				
Mean	1.125	2.375	1.125	2.500
S.D.	1.126	1.685	.354	1.852
Orientation				
Female				
Mean	1.250	1.875	1.875	3.250
S.D.	.707	1.356	1.553	2.121
Male				
Mean	1.125	1.750	1.000	3.875
S.D.	.641	1.389	1.690	2.532

APPENDIX L

SPF-22.22 ANALYSES AND SIMPLE EFFECTS TESTS FOR

THREE PERFORMANCE CATEGORIES OF

EXPERIMENT II

TABLE XXXV

SUMMARY OF THE SPF-22.22 ANALYSIS OF VARIANCE FOR THE IDENTITY ONLY CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	2.2578	.5079
Sex of Subject (C)	1	5.6953	1.2812
A x C	1	39.3828	8.8595**
Subj. W. Groups	28	4.4452	
Within Subjects			
Identity Cue (B)	1	17.2578	6.1879*
A x B	1	1.3203	.4734
B x C	1	.9453	.3389
A x B x C	1	.6328	.2269
B x Subj. W. Groups	28	2.7889	
Orientation Cue (D)	1	103.3203	21.9015***
A x D	1	.0703	.0149
C x D	1	39.3828	8.3482**
A x C x D	1	.3828	.0811
D x Subj. W. Groups	28	4.7174	
B x D	1	27.1953	6.9889*
A x B x D	1	1.3203	.3393
B x C x D	1	.0373	.0181
A x B x C x D	1	5.6953	1.4636
B x D x Subj. W. Groups	28	3.8912	

*p < .05
**p < .01
***p < .001

TABLE XXXVI

SUMMARY OF THE SIMPLE EFFECTS TESTS FOR THE SPF-22.22 ANALYSIS FOR THE IDENTITY ONLY CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Cue Given First (A)			
A at c_1	1	11.3906	18.0000***
A at c_2	1	30.2500	47.8025***
Error A at c_k	28	.6328	
Sex of Subject (C)			
C at a_1	1	37.5156	59.2840***
C at a_2	1	7.5625	11.9506**
Error C at a_i	28	.6328	
C at d_1	1	37.5156	8.1887**
C at d_2	1	7.5625	1.6507
Error C at d_1	56	4.5814	
Identity Cue (B)			
B at d_1	1	43.8906	13.1405***
B at d_2	1	.5625	.1684
Error B at d_1	56	3.3401	
Orientation (D)			
D at b_1	1	12.2500	2.8459
D at b_2	1	118.2656	27.4757***
Error D at b_j	56	4.3043	
D at c_1	1	135.1406	28.6467***
D at c_2	1	7.5625	1.6031
Error D at c_k	56	4.7174	

**$p < .01$
***$p < .001$

TABLE XXXVII

SUMMARY OF THE SPF-22.22 ANALYSIS OF VARIANCE FOR THE ORIENTATION ONLY CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	4.5000	.9244
Sex of Subject (C)	1	15.1250	3.1069
A x C	1	.7812	.1605
Subj. W. Groups	28	4.8682	
Within Subjects			
Identity Cue (B)	1	3.7812	1.9584
A x B	1	.5000	.2590
B x C	1	1.1250	.5827
A x B x C	1	.0312	.0162
B x Subj. W. Groups	28	1.9307	
Orientation Cue (D)	1	116.2812	35.6087***
A x D	1	.5000	.1531
C x D	1	.0000	.0000
A x C x D	1	.2812	.0861
D x Subj. W. Groups	28	3.2655	
B x D	1	5.2812	4.4906*
A x B x D	1	.1250	.1063
B x C x D	1	10.1250	8.6093**
A x B x C x D	1	.0312	.0266
B x D x Subj. W. Groups	28	1.1760	

*p < .05
**p < .01
***p < .001

TABLE XXXVIII

SUMMARY OF THE SIMPLE EFFECTS TESTS FOR THE SPF-22.22 ANALYSIS FOR THE ORIENTATION ONLY CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Sex of Subject (C)			
C at b_1d_1	1	9.0312	1.7101
C at b_1d_2	1	.0312	.0059
C at b_2d_1	1	.7812	.1479
C at b_2d_2	1	16.5312	3.1301
Error C at b_jd_1	28	5.2812	
Identity Cue (B)			
B at d_1	1	.0625	.0402
B at d_2	1	9.0000	5.7938*
Error B at d_1	56	1.5534	
B at c_1d_1	1	1.5312	.9857
B at c_1d_2	1	18.0000	11.7551**
B at c_2d_1	1	.7812	.5029
B at c_2d_2	1	.0000	.0000
Error B at c_kd_1	56	1.5533	
Orientation Cue (D)			
D at b_1	1	85.5625	38.5279***
D at b_2	1	36.0000	16.2104***
Error at b_j	56	2.2208	
D at b_1c_1	1	66.1250	29.7754***
D at b_1c_2	1	24.5000	11.0321**
D at b_2c_1	1	7.0312	3.1661
D at b_2c_2	1	34.0312	15.3239***
Error D at b_jc_k	56	2.2208	
BC at d_1	1	2.2500	1.4484
BC at d_2	1	9.0000	5.7938*
Error BC at d_1	56	1.5534	
BD at c_1	1	15.0156	12.7678**
BD at c_2	1	.3906	.3321
Error BD at c_k	56	1.1760	
CD at b_1	1	5.0625	2.2796
CD at b_2	1	5.0625	2.2796
Error CD at b_j	56	2.2208	

*p < .05; **p < .01; ***p < .001

TABLE XXXIX

SUMMARY OF THE SPF-22.22 ANALYSIS OF VARIANCE FOR THE NEITHER CORRECT PERFORMANCE CATEGORY OF EXPERIMENT II

Source	df	MS	F
Between Subjects			
Cue Given First (A)	1	.1250	.0335
Sex of Subject (C)	1	1.5312	.4105
A x C	1	.2812	.0754
Subj. W. Groups	28	3.7298	
Within Subjects			
Identity Cue (B)	1	18.0000	13.4626**
A x B	1	2.0000	1.4958
B x C	1	1.5312	1.1453
A x B x C	1	1.5312	1.1453
B x Subj. W. Groups	28	1.3370	
Orientation Cue (D)	1	60.5000	39.6848***
A x D	1	.0000	.0000
C x D	1	.7812	.5125
A x C x D	1	1.5312	1.0044
D x Subj. W. Groups	28	1.5245	
B x D	1	10.1250	3.5247
A x B x D	1	1.1250	.3916
B x C x D	1	.0312	.0109
A x B x C x D	1	3.7812	1.3163
B x D x Subj. W. Groups	28	2.8726	

**$p < .01$
***$p < .001$

APPENDIX M

MEAN RATINGS FOR IMAGERY VIVIDNESS

AND FATIGUE FOR EXPERIMENT II

TABLE XL

MEAN RATINGS FOR IMAGERY VIVIDNESS AND FATIGUE FOR EXPERIMENT II[a]

	Imagery Vividness[b]	Fatigue[c]
Identity Cue First	2.625	2.938
Orientation Cue First	2.812	2.875

[a]n = 16.

[b]1 = vivid as the actual experience, ..., 7 = no image present at all.

[c]1 = not fatiguing at all, ..., 5 = one of the most fatiguing things you've ever done.

VITA

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