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The Effects of Conceptual Factors on Visual Masking

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THE EFFECTS OF CONCEPTUAL FACTORS ON VISUAL MASKING

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This Thesis submitted by Damon G. LaBarbera in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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ABSTRACT

Potter (1975, 1976) has shown that visual masks can exert effects both at the level of the icon and at higher levels of processing. Her methodology involved presenting pictures in a sequence at very fast rates, in order to mimic naturalistic saccadic viewing. The present study used a similar methodology in order to investigate whether a picture which violates an expectation about pictures in that series exerts more of a masking effect than a picture which coincides with the expectation.

Each of 38 subjects was shown 36 sequences of eight pictures. In nine trials, every picture in the trial was drawn from the same category. In 27 of the trials, seven pictures were from the same category, and one picture (the mask) was from a different category. The mask appeared in nine trials in the fourth position of the serial presentation, in nine trials in the fifth position, and in nine trials in the sixth position. Before each trial, the category of the majority of the pictures was announced. After each trial, subjects were given a forced-choice recognition task. Recognition of pictures presented in the series adjacent to non-conceptually related items was compared to recognition for items adjacent to conceptually related items.

Mask items tended to be remembered more frequently than conceptually related items located in the same serial position. In four of six comparisons, items adjacent to masks were recognized less frequently than control items. In one of six comparisons, items were remembered more frequently.

Thus, in a quickly presented series of conceptually related pictures, a non-conceptually related mask exerts more of a masking effect on adjacent items than does a conceptually related item. In some mask positions, however, this finding was not obtained. Possible explanations for the discrepancy are discussed.

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Mary C. Potter (1976) in examining the characteristics of memory for visual material, found that when pictures were presented very quickly in sequence subjects could more frequently "detect" a given target picture while the sequence was being shown than they could later in a recognition task. In two experiments, sequences of 16 color photographs were presented at rates of 113, 167, 250, or 333 msec per picture. A particular target was specified in advance for one group of subjects and their task was to "detect" that target while the sequence of pictures was being shown. The other group of subjects was given an immediate test of recognition memory for the pictures after the sequence had been run, and had no target specified in advance. The results of these experiments were that even when the target had only been specified by a title (e.g., boat) detection of a target was strikingly superior to later recognition memory. In a third experiment, it was found that when pictures were presented singly for about 120 msec and then followed by a visual stimulus (a "mask") consisting of irregular shapes of paper pasted onto a background, recognition memory was as accurate as detection had been. On the basis of these findings, Potter argued that, on average, a scene is understood and becomes immune to visual

masking within about 100 msec. Thus immune, it has time to consolidate and be remembered later. However, as experiments one and two suggest, pictures require about 300 msec of further processing before the memory representation becomes immune to masking from a following picture.

The purpose guiding this study was to extend Potter's research on visual masking as it relates to the characteristics of the mask, and the consolidation conditions needed to make a picture resistant to forgetting. Of special interest here is whether conceptual relatedness between a mask and a target makes any difference in the target's consolidation. A growing body of research indicates that conceptual relationships, even within the first moments of viewing time, play a role in various aspects of picture processing. The research presented here extends the investigation of conceptual relationships into the area of visual masking. In particular, the study addresses whether in a procedure used to mimic real world viewing conditions, conceptual relatedness between a visual mask and a preceding and following target affect later recall of the targets.

Several areas of research in visual perception are pertinent here. First, the area of visual masking provides the general background against which to study the effects of one visual stimulus on the perception of another. Second, an area of research indicating the importance of global processing suggests the importance, in viewing a

picture, of relationships between discrete elements of that picture. Some of these relationships which influence masking (for example, the probability that one object would be seen in the vicinity of another object) are related to conceptual factors. Finally, research leading to the postulation of schemas and the related notion of "frames" is pertinent because it provides a conceptualization for hypothesizing how and why conceptual relatedness might affect masking.

Masking--An Historical Overview

The phenonenon known as masking occurs when two stimuli are presented closely in time and the processing of one of those stimuli (the target) is reduced by the occurrence of the other stimulus (the mask). Research on masking can be described along a number of parameters. It can be defined in terms of time; backward masking occurs when the mask follows the target and forward masking occurs when the mask precedes the target. It can also be defined in terms of type of mask--whether, for example, the mask is a burst of light, or a pattern of lines. And when the mask is a pattern which does not spatially overlap with the target, the cases of backward and forward masking are known as metacontrast and paracontrast respectively. Thus the literature on masking is massive and complex and only that relating to the present study will be summarized here.

The initial studies on visual masking involved

relatively simple stimuli. Potter's (1976) work, described above, represents remarkable sophistication over early research in this area, in terms of methodology, stimulus complexity, and implications for higher order processing. A large corpus of work on visual masking by light (see reviews by Kahneman, 1969; Norman, 1965; and Raab, 1963) can be traced back as far as the 'forties (e.g., see Crawford, 1947). The procedure used in many of these studies involved a target stimulus which was a brief flash of light illuminating a small circular patch, and a masking stimulus which was a more intense flash, illuminating a larger area. Typically (see Kahneman, 1969) when the target stimulus preceded the masking stimulus by less than 50-100 msec, the threshold for its detection rose steeply, a form of backward masking known in this context as the Crawford effect.

More typical of later research in the 'sixties and early 'seventies was Averbach and Coriell's study (1961) which instead of investigating the masking parameters of light, examined the effects of masking using more complex stimuli. Subjects were briefly shown two rows of letters. Soon after letter offset a ring appeared where the letter had been. Subjects failed to see the letter, indicating that backward masking had taken place. Following Averbach and Coriell's work, a multitude of experiments were performed examining the effects on masking of such

parameters as the time interval between mask and target (e.g., Schiller, 1965b), the relative intensities of the stimulus (e.g., Schiller and Smith, 1966) and size of the target arrays (e.g., Weisstein, 1966). The area was enthusiastically researched because it held important implications on the formulation of the "icon", the brief, veridical, sensory store, where such masking was presumed to be taking place.

Though the existence of visual masking is indisputable, the explanation for why it occurs is still argued. The major problem any explanation of masking must address is how two stimuli which do not overlap in time can interact. In backward masking, for example, a stimulus which follows another stimulus affects the perception of the earlier stimulus. A later event seems to be affecting an earlier one, and this appears illogical. The visual system, hence, must be regarded not only as a spatial one, but a temporal one as well. It must take time beyond the actual presentation period of a stimulus for that stimulus to be fully processed.

There have been two kinds of theory which account for masking and both share the idea that the visual response to a brief stimulus lasts much longer than the stimulus which caused it, and that consequently the two responses to the stimuli overlap in time. The two types of theories are (1) interruption theories and (2) summation theories

(Kahneman, 1968). The interruption theory argues that the consolidation of the target stimulus is interrupted somehow by the masking stimulus, while the summation theory contends that the target and masking stimulus are visually superimposed, much like a photographic double exposure.

Both interruption and summation theories have been well represented in the literature. Crawford (1947) posited an explanation which seems an early, if primitive, example of interruption theory. He viewed the masking effect as due to a difference in travel time to the brain of the two stimuli, with the more intense pulse arriving more quickly than the weaker pulse. If one views the nerve transmission of visual impulses as the biological metaphor for visual information processing, it is clear that the processing of stimuli was being interrupted by later stimuli. Though Crawford's explanation has been refuted by Boynton (1961) and others (Battersby and Wagman, 1959; Schiller, 1968), a more sophisticated neural model, which also relies on the notion of interruption, has been presented by Breitmeyer and Ganz (1976). These authors postulate two processing channels in the visual system: a "sustained system" and a "transient system". The sustained system is said to be operative when one fixates a stimulus, and processes information of a high spatial resolution. When a change in stimulus occurs, the transient system is activated; the transient system is involved in signalling the location,

or change in location of a stimulus. Masking occurs because the transient system inhibits the sustained system whenever a new stimulus is perceived.

Sperling (1963) has also described an interruption theory of visual noise masking. He argues that until the arrival of the masking stimulus, the central representation of a target stimulus would be available for processing or information extraction. He based his conclusion on an experiment in which he found that for every 10 msec that a backward mask, consisting of visual noise ("noise" refers to random dark on light configurations) was delayed beyond the onset of a test stimulus, consisting of an array of letters, the perceiver could report one more letter. Sperling reasoned that the visual noise was controlling the time that the test stimulus was available for processing, but not the adequecy of the test stimulus itself.

The summation theory is in contrast to the view that masking does not degrade the adequecy of the representation of the test stimulus. For example, Kinsbourne and Warrington (1962) argue that the neural response to visual noise summates with that from the test stimulus, degrading the primary visual representation by overloading the system. The system is less capable of conveying information about the testing stimulus not because the perceiver has less time to process it, but because the quality of the visual representation is poor. Thus, both summation theories and

interruption theories take into account temporal factors in visual information processing. Whatever theoretical position one takes, however, evidence shows that only when tachistoscopically presented stimuli are separated by at least 100 msec will the events be registered as separate (Mayzner, Tresselt, Helfer, 1967; Kahneman and Wolman, 1968; Turvey, 1973).

Masking At Higher Levels Than The Icon

The term "masking" has usually been applied to the phenomenon as it occurs on the "icon", the visual sensory register which holds veridical information for no longer than a second or so at most (Sperling, 1960). The research on masking was instrumental in the delineation of the icon's characteristics, such as retreival of information from this store (Sperling, 1960), the immediacy of the formation of the icon after the stimulus presentation (Spencer, 1969), and whether the icon is a peripheral or central process (Schiller, 1966). However, the notion of masking--of a stimulus interfering with a temporally close one--need not be limited to the icon. One of the major assumptions of the information processing approach is that processing of stimuli takes time--whatever the level of analysis. Below, in the discussion of Potter's (1969, 1975, 1976) work, we see that items presented closely in time must be interacting at a higher level than the icon.

Potter and Levy (1969) used a technique suggested by

Averbach and Coriell (1961) in which viewers briefly glimpsed pictures presented in a sequence at rates of up to eight per second. They proposed that this technique mimicked normal saccadic vision. (Saccades are the eye movements involved in visual information processing, usually occurring about every third of a second). The authors argued that pictures presented rapidly in this way are processed one by one for precisely the time each is in view. Analysis and storage continue only up until the next substantial visual change. An event will be remembered if it has been "consolidated" before the next substantial visual change occurs. Otherwise, processing will be interrupted, and the subsequent recognition of the picture will be lowered. Of interest is the fact that interference of consolidation occurred beyond the time that is associated with the icon. For example, pictures presented for 2 seconds were recognized later at a higher frequency than pictures presented for 1 second.

But even within the time span of approximately one second which has been associated with iconic storage (Sperling, 1960), masking at a higher order has been shown to occur. Potter (1975) had viewers briefly glimpse pictures presented in a sequence at rates up to eight per second (125 msec each). Subjects were asked to look for a target in the sequence, and respond as soon as they saw it. Subjects were supplied with either a verbal description of

the target, or actually shown the target prior to the trial. Even at the fastest rates of presentation, subjects could "detect" complex pictures 70% of the time. However, few pictures presented sequentially at these speeds were recognized (by another group of subjects) in a subsequent memory task. It follows from the results that (1) if subjects could match a verbal label of the target with the target itself, then processing beyond the level of the icon, which is only a sensory store, was occurring. It also follows that (2) something akin to masking was taking place, since the immediate detection memory for an item was higher than the subsequent recognition memory for items. At quick rates of presentation, therefore, processing proceeded to a point where matching could take place, but the item was nonetheless prevented from consolidating in memory. It was also found that subjects recognized a target picture as accurately and almost as rapidly when they knew only its meaning given by a name as when they had seen it. The level of processing was such that a name description was about coequal to a visual description, even at speeds of 125 msec. The implication is not, of course, that the icon does not exist; rather, it seems that even with iconic storage, a picture can be quickly abstracted to a high level of meaning, but will be forgotten (or "masked") unless there is an uninterrupted period of further consolidation.

In an extension of this work, Potter (1976) suggested that there is a short term conceptual memory for an image; it occurs during a period after identification, during which the memory trace is highly vulnerable to interference. The nature of the interfering stimulus, however, is all-important. On the basis of tachistoscopic presentation of pictures, Potter argued that, on average, a scene is understood and so becomes immune to ordinary visual masking within about 100 msec (by "ordinary" masking, she refers to masking by visual noise) but requires about 300 msec of further processing before the memory representation is resistent to masking from a following stimulus. Again, here is evidence that masking is occurring at a level in the processing hierarchy where a random noise mask, and a mask consisting of a picture do not exert an identical effect.

Under ordinary conditions, consolidation of pictures, and their subsequent recognition, is excellent. For example, Shephard (1967) found that recognition for 600 pictures presented one at a time was 98% when the recognition task involved selecting the target picture from a single distractor. The high performance drops off drastically when the presentation time for each picture is reduced from several seconds to the brief intervals researchers such as Potter (1975, 1976) have used. The longer the picture is presented the more likely it is to be remembered (Lutz and Sheirer, 1974;

Weaver and Stanny, 1978). Though the effect of stimulus duration seems both empirically and intuitively obvious, a related question has a less self-evident answer. The question is "How much consolidation in memory can take place when the stimulus is removed from view", and was addressed by Intraub (1980). Using a procedure similar to Potter's, she found that pictures shown in sequence for 110 msec each with an interstimulus interval (ISI) of 5890 msec were later recognized almost as well as pictures shown for the full six seconds. Thus, in the absence of masking, processing for a removed picture still proceeds. The period of processing extends beyond the icon, she argues, though it is still susceptible to masking by a picture but not a noise mask.

Intraub offers further evidence that, under certain conditions, masking occurs at a high level of processing. She found that filling a 5 sec ISI with a to-be-ignored picture which was the same on all trials had little or no masking effect on the briefly presented picture. This indicates that the characteristics of an effective mask may be even more specific than had been expected. Not only is visual stimulation alone not always sufficient to mask an image, but even another picture, if it is not novel or otherwise important to the subject, may not have the characteristics sufficient to interfere with the consolidation in memory of a target. Just any picture will not always

be effective as a mask. What, then, are the characteristics of the visual mask which produce different degrees of masking? One possibility to be explored in this research is that conceptual relatedness between the mask and the target affect consolidation in memory. The term "conceptual relatedness" is meant to refer to similarity in category between two items. For example, both a bus and a car belong to the category of motor vehicles and are, in the present terminology, "conceptually related".

Global Processing in Picture Viewing

Recently there has been increased recognition that global features of a visual array play a significant role in perception. That perception is not merely a matter of gathering discrete bits of data about particular objects in the environment has been a view which has existed from very early psychological theories of perception. However, the notion has been given different emphasis, and has taken a different form in recent years. A brief discussion of the influence of this idea to modern psychology is presented below.

The belief in the wholeness of perception was a fundamental characteristic of the Gestalt movement (Kohler, 1929). This influential school of psychology emphasized that we tend to see particular patterns in visual configurations, rather than perceiving a composite of component parts. Though Gestalt psychology eventually waned in influence,

students of perception, no matter what particular orientation they ascribed to, have not been able to ignore the inevitable existence of differential perception of stimuli as a function of other stimuli in the configuration. For example, the notion that "context" plays an important role in perception has been incorporated into the information processing models of Bruner (1957), Morton (1969), Neisser (1967), Norman (1968) and Wickelgren (1979).

Picture viewing, as well, has shown context effects. Palmer (1975) established for subjects the context for an object by showing a visual scene. Then the subject was briefly shown a picture of a target object that was either appropriate (a toaster was shown after a kitchen scene has been presented) or inappropriate for the scene. There were two types of inappropriate objects--those that looked like possible appropriate objects (a mailbox looking like a toaster) and those that bore no resemblance to potentially plausible objects in that given scene. The task was to name the object and rate the confidence of the response. Objects were correctly identified about twice as often when the preceding context was appropriate than when it was inappropriate. Correct responses and confusions with visually similar objects depended strongly on both the contextual condition and the particular target object presented. In addition, some objects were presented with

no preceding context. Without this context, performance was less accurate than that for either an appropriate or inappropriate object following some context.

Palmer's exploration of context effects in an entire scene is reflective of a trend, within the last 10 years or so, of evaluating the perception of complex inter-related stimuli, rather than the perception of isolated stimuli. Many researchers have become disenchanted with research which examines only the perception of simple stimuli. Some tachistoscopic research, for example, has been criticized for this reason; the detractors claim that the visual configuration presented to the subject is too artificial. Normal viewing, they argue, does not involve perception of simple split-second images, but rather involves exploration of the complex visual world in which we normally find ourselves. Neisser (1976) comments upon the contrived nature of such tachistoscopically presented images:

> Such displays are very close to not existing at all. They last only for a fragment of a second, and lack all temporal coherence with what preceded or what will follow them. They lack any spatial link with their surroundings, being physically as well as temporally disconnected from the rest of the world. (pp. 35-36)

The trend toward the study of more complex stimuli is exemplified by Biederman's work (1972, 1981) which has explored how the inter-relationships of stimuli composing entire scenes affects processing. His examination of the importance of global processing--the processing of holistic information about a scene--has further extended the notion of context. Whereas early researchers viewed context in relatively simple terms (for example the presence of an item adjacent to a target item) Biederman (1981) has described how context is an important factor in highly complex scenes. He describes two kinds of relationships among objects in a contextually coherent scene. Syntactic relationships take into account more physical aspects of a scene; for example, the fact that objects usually rest atop other objects or surfaces and the fact that objects usually are not transparent. Semantic relationships involve a referential meaning component; for example, semantic constraints involve the probability that an object will occur in a given scene, the probability that an object will appear in certain locations, and the fact that objects have certain size relationships. A brief review of Biederman's work, which suggests the importance for processing of syntactic and semantic relationships, is presented below.

Biederman (1972) had subjects view real world scenes presented for durations of 300, 500, or 700 msec. He also

manipulated the variable of "jumbling". Jumbled scenes were scenes that were cut into segments, put back together in a jumbled way, and presented to subjects. Biederman compared accuracy of cued object identification in coherent and jumbled scenes, and found that jumbling reduced accuracy. This indicates that processing of a component stimulus is dependent upon the coherence of the entire scene, indicating the importance of semantic and syntactic constraints.

In another study, Biederman, Rabinowitz, Glass and Stacy (1974) replicated the earlier work of Biederman (1972), this time using exposure durations of 20, 50, 100 and 300 msec, intervals shorter than the average fixation. Even at these very high speeds jumbling reduced the accuracy of identification of cued objects in a scene, suggesting that very early in viewing, incoherence of the scene reduces the ability of subjects to recognize objects. In this study, Biederman et al. also examined the effects of jumbling upon the ability of subjects to label a briefly presented scene. Subjects were given a choice of labels to choose from. It was found that their ability to label a scene was reduced more by jumbling when the choice labels were similar (i.e., where particular objects would be of less informational value) than when they were very dissimilar. This indicated that holistic information is of value in discriminating among labels. Hence, two kinds

of information were posited as being derived from a single fixation on a scene--holistic information and information about particular objects.

Navon (1977) has provided more evidence of the importance of global characteristics in picture viewing. He argued that acquisition of global information takes precedence over the acquisition of local information in viewing a picture--in other words, that we see the "forest before the trees". Navon had subjects view patterns in which global configurations were formed of smaller stimuli which were identical to the global configurations. For example, a large letter "H" was constructed of little "H"s, or a large letter "S" was formed from many smaller "S"s. At the same time Navon constructed stimuli analogous to the Stroop color-word test: a large "H", for example, was constructed of little "S"s, or a large letter "S" was formed from many smaller "H"s. Subjects were asked to identify either the local or global pattern of such stimuli. Whereas the identity of the small characters (local information) had no effect on recognition of the large characters (global information), global cues which conflicted with the local ones did inhibit the response to the local level. Hence, Navon argued that the perception of the whole is precedent to the perception of the parts. Others, however, have taken issue with Navon's study (Kinchla and Wolfe, 1979; Pomerantz and Sager, 1977). Kinchla and Wolfe (1979), for

example, found that by altering the size of the visual configuration, local elements could interfere with the perception of global elements. Neither global nor local elements were found, under all circumstances, to be precedent over the other. However, though research in this area has garnered valuable data, the question of whether global or local information enjoys precedence may be an overly simplistic argument. Perceivers undoubtedly gain and use information about both early in viewing.

Other evidence that global information is gathered early in viewing comes from eye movement studies. Eye movements, these studies show, are not random, but reflect systematic and directed behavior which can give insight about what sort of information is being attended to at any given point in the viewing process. In one of the earliest of such experiments, Buswell (1935) found two basic patterns of eye movements as viewing of complex scenes occurred. He found (1) a general survey in which the eyes moved in short pauses over the picture and (2) longer eye fixations in a more concentrated area usually appearing after the survey scan. Buswell also found that the length of the average fixation increased as subjects proceeded to view the picture, suggesting that as viewing progressed, more time was spent processing the detail of the picture. Mackworth and Morandi (1967) provided more direct evidence that early in the viewing process the entire picture seems

to be "sized up" by the perceiver. They found that the location and density of eye fixations of subjects was directly related to ratings of informativeness of particular portions of the picture given by a different group of raters. Mackworth and Morandi suggested that informative areas are fixated as effectively during the first 2 seconds as they are during the last 2 seconds, indicating that vision is guided early to the informative parts of a picture, and hence that information about large parts of the scene are obtained during the early moments of the viewing process.

Antes (1974) further examined the time course of picture viewing. The eye movements of a group of subjects were recorded as they viewed each of ten pictures for 20 seconds. The pictures had been divided into meaningful sections and subjectively rated for their informativeness. Antes found a pattern of eye movements more complex than had earlier been recorded. The density and duration of fixations, as well as the extent of the saccades, were not consistent throughout the viewing period. Mean informativeness of locations fixated decreased over time, reaching an asymptote at about 10 sec. Mean duration of fixations showed a steady increase and mean extent of saccadic eye movements showed a steady decrease as viewing time progressed. Descriptively, the pattern was as follows: subjects originally made many long saccades to fixate informative

elements for short amounts of time. This behavior gradually evolved to fixating informative features less frequently, with longer examination of less informative areas. Again, Antes' (1974) data provides evidence that an awareness of the entire picture (at least to the extent of a subject's being able to locate and fixate on informative areas) occurs early in the viewing process.

The findings concerning the acquisition of global information early in viewing have implications for the choice of methodology employed to study the processing of pictures in sequence. In Potter's (1975, 1976) studies, for example, there was no consistent global information in the sequence presented, and thus the sequences may have been highly artificial and unlike real world viewing. When subjects are unable to extract global information--when, for example, early expectations about the content of the picture sequence are violated by the presence of items not normally seen in the presence of other items, processing may be altered. As described above, Biederman (1974) found that even at exposure durations quicker than those used by Potter (1975, 1976) and Intraub (1981), a jumbled picture affected later recall of cued items within that picture. Thus, even at the very short intervals used in the method of presenting pictures sequentially, the jumble of images of non-related pictures which falls on the retina must have an impact on processing. To make a serial presentation

of pictures more naturalistic, two things are advisable. First, the pictures should possess some contextual coherence with each other. Second, at the beginning of the sequence, the viewer should be provided with information about the "gist" of the pictures to be shown. Such information would hopefully correspond to the early information extracted by perceivers in real world scenes. Otherwise, the lack of consistent global information in a picture sequence--the violation, for example, of early expectations about the content of pictures by the presence of pictures not normally seen in the presence of the other pictures--may cause processing of the scene to be altered.

Schemas and Frames

Another area of work is also relevent to the proposed experiment--that of "schemas" and "frames". In particular, the work of Friedman (1979) is germane here. Friedman argues that when an optic array is viewed, a "frame", consisting of a cognitive embodiment of one's expectations and anticipations about a scene is invoked, or "instantiated". The frame guides viewing: specifically, items consistent with the instantiated frame will be processed rapidly, while incongruous or unexpected items not consistent with the frame will take longer to process and require more processing resources. Presuming that, in a sequential presentation of pictures, there was provided both contextual coherence between pictures and early information about the

gist of such pictures to subjects, there would be, following from the work of Friedman, an alteration of processing characteristics later evinced by poorer memory for those items which immediately preceded or followed an unexpected item in that sequence. If the subject expects a certain type of picture, the inclusion of an incongruous item may require additional processing resources. The item may thus draw resources away from the processing of neighboring items, thus effectively masking them.

Since the notion of frames is so important to the formulation of the experiment to be proposed, a history of the different conceptualizations which led up to this idea will be traced here. The notion of "schema" a forerunner of the notion of "frames" gained widespread familiarity with Bartlett's (1932) publication of Remembering, and became a handy concept to describe the perception of information at a molar level. A number of authors have used the idea of schemas to account for effects attributable to semantic relations--or their violations (Biederman, 1972; Bruner, 1957; Miller, Gallanter and Pribram, 1960; Minsky, 1975; Neisser, 1976). Across authors, a schema is generally meant to imply an organization of past reactions or experiences which serve to guide perception and (in Piagetian theory) action.

Theorizing about schemas has undergone some evolution over the years (Penland, 1979). As Penland describes,

Bartlett emphasized the behavioral aspects of schemas proposing them as organizers of past action rather than past impressions. However, he also argued that "orientation" was one of the primary functions of schemas. Orientation implied that personal interests, values, and needs were involved in perception. Perceivers alter new input so that it is congruent with their schemas. For example, in a classic study, Sir Bartlett read a Kwakiutl Indian folktale to a group of British (experimental) subjects, and then asked them to recall the story. Knowing little about Indian customs and beliefs, the Britons altered the story and omitted details so that it conformed to their own culture and become more sensible to them. As time passed between the telling and the retelling, the story became more altered. The mental framework into which new facts and ideas were incorporated modified the input, changing it into a more meaningful entity.

Piaget's (1954) notion of schema has, along with Bartlett's, been enormously influential. His idea of the interaction of assimilation and accommodation underlies many of the present formulations of schema. Assimilation is the function by which experienced knowledge of the world is incorporated into preexisting knowledge structures. Accommodation is the process by which existing knowledge structures are modified in accordance with novel events.

Closely related to the idea of schema is that of

frames. Friedman (1979) argues that when viewing a scene, expectations about that particular scene "instantiate" or evoke a frame. These expectations may be derived from early glimpses of the scene or from experimentally induced primes such as thematic descriptions, or category or object names. When the object of perception is expected (when it it is part of the frame) processing is guided by these anticipations--processing is "top down". Encoding of expected objects requires only feature "detection", a procedure requiring relatively few processing resources. On the other hand, when an object is unexpected with respect to the frame, "bottom up" analysis of the visual stimulus must occur. "Analysis" requires more processing resources than "detection".

What precisely determines which particular frame is instantiated? According to Friedman, a particular frame is instantiated by "obligatory" objects--objects closely related to the theme or meaning of a scene. For example, a refrigerator, because of the perceiver's past experience, would be an obligatory object in a kitchen scene, and would serve to instantiate the appropriate frame. After all, a kitchen is more or less "obliged" to have a refrigerator.

To test her theory, Friedman hypothesized that, because unexpected objects are "analyzed" rather than "detected", the degree of detail available to an observer

will be greater for objects that are unexpected than are expected. She presented subjects with six complex line drawings, the themes of which were announced before presentation. Eye movements were recorded while subjects scanned each scene. The duration of the first eye fixation on an object was a function of the a-priori likelihood that the fixated object would be present in the particular scene. This suggests that when a person expects an object to appear in a scene, relatively short first fixations occur on these objects. "Detection", which requires relatively less information than "analysis", is involved. In addition, Friedman found that subjects were more likely to notice transformations or alterations of unexpected objects than expected objects. In her view, this occurs because in the course of bottom-up processing (processing in which expectencies do not play a role) more details about an object are encoded.

Present Experiment

A quick summary of the research presented here reveals the problm which the present study addresses. The basic area which underlies the present study is that of visual masking. Research indicates that, on average, a scene is understood and becomes immune to visual masking from a following stimulus composed of odd shapes within about 100 msec. However, the scene requires additional time to become immune to masking from a following picture (Potter,

1975). Additionally, Intraub (1980) found that a to-be-ignored picture will exert less of a masking influence, under some conditions, than a picture which is novel. This research indicates that characteristics of the mask, which can only be discriminated at a high cognitive level (higher than the icon) have differential effects on the extent of masking.

The methodology which Potter and Intraub used consisted of presenting in series pictures for brief periods of time. The picture had no contextual relationship between them. In view of research which indicates the importance of contextual relationships for viewing (Biederman, 1972; Biederman et al., 1974) their methodology was not conducive to a viewing situation generalizable to real world viewing.

In the present study, a modification of Potter's (1975, 1976) and Intraub's (1980) method of serial presentation was employed to test whether objects are more prone to masking by items which are conceptually related. Pictures from a particular category (e.g., animals) were presented serially. Thus semantic relations normally seen in the real world were mimicked.

Subjects were informed verbally before the presentation of the sequence about the category of objects to be viewed. A non-gist item (the mask) was presented in some of the series, in predetermined serial positions. In effect,

every item was masking every other item in the series and the particular effect of the non-gist item was measured against a control condition where the corresponding position was occupied by a conceptually related item. The prediction was that the resources needed to process the non-gist mask would detract from resources available to the processing of adjacent items. This follows from Friedman's (1979) work, in which more processing resources are required for an unexpected item--in this case the mask. A non-gist item will therefore exert more of a masking effect than a conceptually related item. Thus, those pictures presented adjacent to the mask would be recognized less accurately than pictures in the equivalent position in the control condition.

CHAPTER II

METHODOLOGY

Design

The problem under investigation required that an incongruous item (the mask) be embedded at a particular place in a sequence of otherwise conceptually related pictures. The position of the mask was not in the same place on all trials. The subsequent recognition of that mask, along with items adjacent to that mask, was compared against that of items in equivalent positions in a control condition: that is, a sequence in which all items were conceptually related, with no masks. Besides the control trials, there were three other groups of trials, with each group consisting of trials composed of eight line drawings. In the first group, all items were conceptually related except for the fourth item, which was randomly chosen from an entirely different class of objects. In the second group of trials, all items were conceptually related except for the fifth item, and in the third group of trials, all items were conceptually related except for the sixth item. For the sake of word economy, these three groups will be referred to as Mask Four, Mask Five, and Mask Six.

Each of 38 subjects received nine trials each of the control, Mask Four, Mask Five, and Mask Six conditions. The trials of all groups were randomly mixed, and presented

during a single experimental session. Accuracy of picture recognition was measured in a forced-choice recognition test, in which subjects attempted to recognize all items in the previously presented sequence. Mean accuracy for items adjacent to the mask in each of the experimental groups was compared to items in equivalent serial positions in the control group with six a-priori *t*-tests.

Subjects

The subjects were 38 University of North Dakota students participating in the experiment for credit for various undergraduate courses during the summer and regular fall semester. Participation was limited to those students reporting normal vision with or without correction. The data from one student was excluded because she reported after the experiment that she had not been wearing glasses and could barely see the images.

Stimuli

Test pictures. The approximately 250 line drawings used as stimuli were obtained from Snodgras and Vanderwart's (1980) compilation of line drawing stimuli. The stimulus pictures are unstylized depictions of objects and animals drawn with black lines, and given some minimal shading. The authors standardized the stimuli on four variables: name agreement, image agreement, familiarity, and visual complexity. The authors also grouped all pictures into various subcategories (e.g., animals, vehicles, clothing,

etc.) and each item was, in addition, rated as to the degree it exemplified a category. For example, though a spoon might well exemplify the category "kitchen utensils", a broom would poorly exemplify that same category, and thus receive a lower rating.

In the present study, items from Snodgras and Vanderwort's compilation which were very poor exemplars were eliminated, though this involved a somewhat subjective and arbitrary decision about what rating would comprise the cut off point between an adequate and inadequate exemplar. Also eliminated were items which were visually confusable with other items in the same group. For example, the drawing of a thumb and of a finger (in the category "body parts") were almost indestinguishable in design, even upon close examination. Several categories were entirely eliminated when they consisted of many items which were poor exemplars, or when they consisted largely of items which appeared in other categories. Finally, several categories were omitted because they were not constituted of a sufficient number of exemplars. A requisite 15 items were needed in any category since a trial consisted of 7 items in the experimental conditions (8 in the control) and 7 more items from the same group were needed as distractors for the forced choice recognition task. In one case, a new category ("flying things") was composed of items from three unused categories ("insects", "birds",

"toys"). See Appendix A for a list of categories and exemplars. A final change was the renaming of the category "four footed animals" to "animals". This was done to increase the number of good exemplars in this category.

The stimuli were arranged into 43 trials (36 experimental trials plus seven practice trials), with each trial having eight drawings. The 36 trials were divided so that there were nine in each of the mask positions, and nine in the control condition. The large number of pictures ensured that no single picture would appear in a critical position--either as a mask or adjacent to a mask--more than twice.

Sequences of pictures were photographed one frame at a time with a Beaulieu camera on 16 mm Kodachrome film. Each picture occupied three frames on the film, so that when the film was run at 16 fps (standard silent speed) on an ordinary projector, each stimulus appeared on the screen for 188 msec. Though stimuli varied somewhat in size, each occupied about 36 square inches on the screen at maximum.

Response items. On the slide from which the subjects made a forced choice recognition, there were 16 items. All the items which appeared in the sequence, plus seven additional items from the announced category, plus a non-conceptually related item were randomly arranged on the

slide. The slide containing the table of alternatives was presented on the same screen onto which the sequence of pictures had been projected. A number underneath each response alternative was used by the subject when responding. Instead of recording the name of the object which he had seen, the subject merely recorded the number underneath.

Procedure

Upon arrival at the experimenting room, subjects were seated about 10 feet from the screen, in a semicircle of seats. Size of each group tested averaged about five subjects and ranged from four to seven.

Both written and oral instructions were given. The verbal instructions paraphrased the written instructions which were printed along the top of the answer sheet (see Appendix B for a sample answer sheet). It was explained that (1) the subjects would see a very rapid presentation of pictures (2) these pictures would be mostly from one category group (3) subjects would be told at the beginning of the trial which category to expect (4) they should pick from the table of alternatives what objects they remembered seeing and (5) if they could not remember eight pictures, they should guess, so they recorded a total of eight. They were also told that their choices did not have to be listed in the order they remembered seeing them. Subjects were given seven practice trials, and then experimental

trials were run. The entire procedure, including practice trials and debriefing, lasted about 50 minutes.

Trials were presented in random order so that no trials from a particular mask position were clustered together more than three times in a row. All subjects received the same random order of trials.

CHAPTER III

RESULTS

Each subject yielded nine responses on the recognition task for each serial position for each of the trial groups. The mean number of correct recognitions by subject for each serial position in each group of trials is shown in Table 1. Standard deviations are also listed in this table. Means show a range of 4.3 to 7.8 for conceptually related items, 5.1 to 7.4 for masks and 4.7 to 5.6 for items adjacent to masks. There was a possible range of zero to nine, with 4.5 corresponding to chance responding. Scores for all positions in the control group, Mask Four, Mask Five, and Mask Six are graphed in Figure 1.

Target Items

In order to test for the effects of conceptual masking, six a-priori comparisons were made between means for items adjacent to masks, and items in the corresponding position in the control group. One tailed tests were used.

Four of six a-priori comparisons reached significance (see Table 2). Thus, in four of six cases, items adjacent to the mask were recognized more poorly than items in the same serial position in the control group. Two item positions (items adjacent to a mask in the fifth position) which did not reach significance in the desired direction tended to be recognized with _greater_ accuracy than

TABLE 1

Means and Standard Deviations for Serial Positions Across Experimental Trials

	Serial Positions							
	1	2	3	4	5	6	7	8
Control	5.16	5.34	5.34	4.82	5.84	5.11	5.84	7.76
	(1.4)	(1.38)	(1.49)	(1.47)	(1.46)	(1.52)	(1.27)	(1.45)
Mask 4	5.10	5.13	4.66*	5.11	5.13*	5.00	5.53	7.60
	(1.6)	(1.39)	(1.46)	(1.72)	(1.65)	(1.55)	(1.36)	(1.18)
Mask 5	4.34	5.60	5.26	5.55*	6.26	5.55*	5.08	6.63
	(1.58)	(1.43)	(1.54)	(1.31)	(1.63)	(1.43)	(1.42)	(1.34)
Mask 6	5.45	5.39	5.45	4.42	4.90*	7.42	4.79*	7.21
	(1.33)	(2.21)	(1.62)	(1.5)	(1.47)	(1.16)	(1.16)	(1.26)

Note. Standard deviations are in parenthesis, mask items are underlined, and critical items are marked with an asterisk.

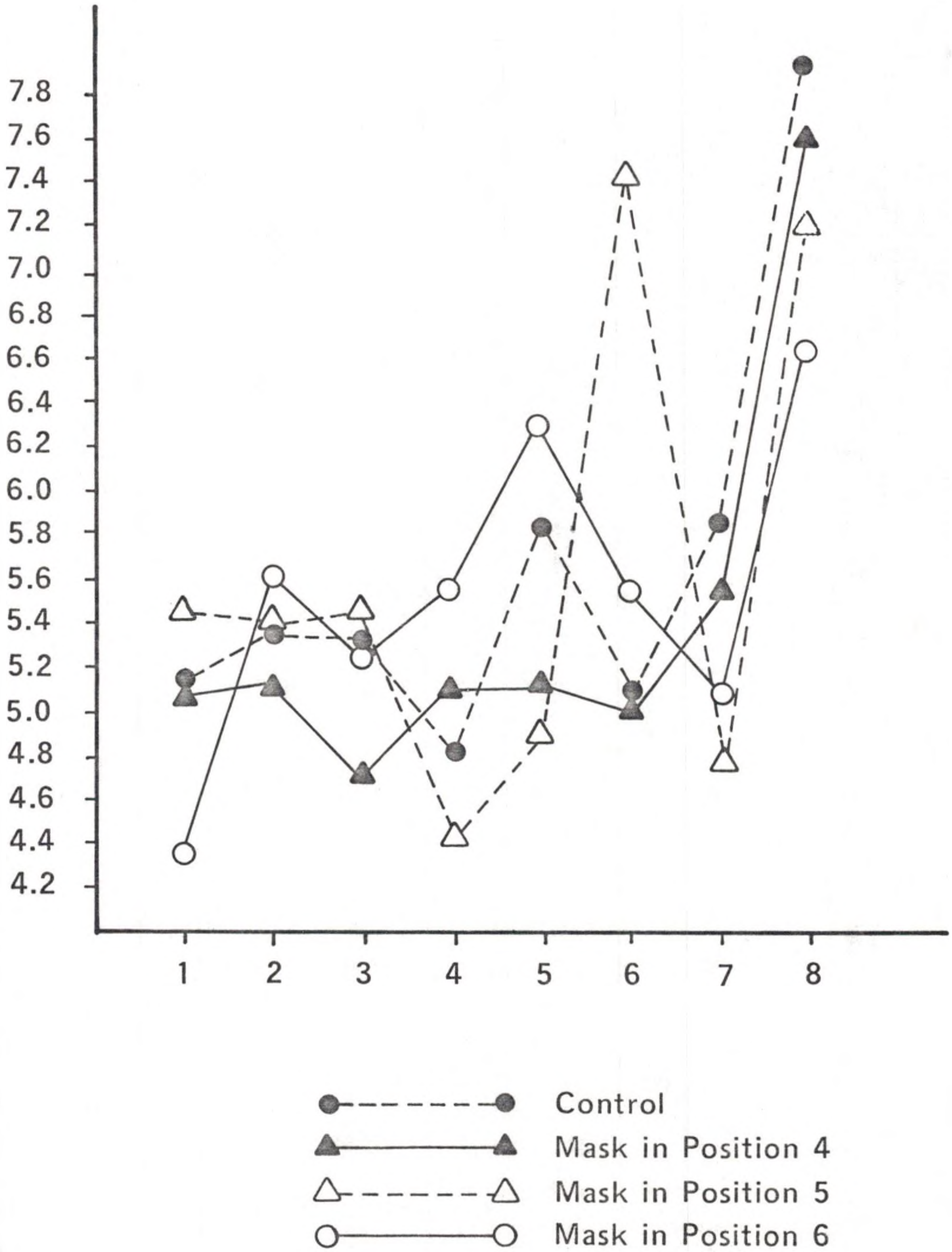
TABLE 2

Comparisons of Items Adjacent to
Masks with Control Items

	Serial Position				
	3	4	5	6	7
Mask 4	2.093**		1.8437*		
Mask 5		-2.275		-1.2851	
Mask 6			2.982***		4.1399****

* sig. at .05 level for one tailed test
** sig. at .025 level for one tailed test
*** sig. at .005 level for one tailed test
****sig. at .00005 level for one tailed test

Figure 1
Means for Serial Positions
across Experimental Trials



corresponding control items.

Because the recognition accuracy for the critical items in Mask Five was discordant not only with the experimental prediction but with the findings from Mask Four and Mask Six, further analysis of these items was undertaken. It was questioned whether particularities of those items in the fourth and sixth position may have elevated their recognition frequency. It is possible that visual properties of the pictures might have made them easier to remember. In order to examine this possibility, the recognition accuracy of these pictures was examined when these same pictures appeared in other trial groups (control, Mask Four, Mask Six), and in other serial positions, excluding those serial positions which constituted a mask position, a position next to a mask, or the last position in a sequence of pictures. It was found that, when they appeared elsewhere, those pictures in position four in Mask Five were recognized 60.5% of the time. When presented elsewhere, those in position six in Mask Five were recognized 63.2% of the time. When the pictures were presented in positions adjacent to the mask in the fifth position, they were recognized 61% of the time in both cases. It seems therefore that peculiarities of the pictures used did not much influence the high (relative to prediction) rate of recognition for these

pictures. It should be noted that this preceding analysis is merely suggestive. Some of the pictures which appeared in the fourth and sixth position in Mask Five did not appear elsewhere in the experiment, and could not be figured in the computation.

Mask Items

In addition to the six a-priori tests comparing items adjacent to masks and corresponding items in the control condition, accuracy scores on mask recognition were analyzed to determine if additional processing occurred with the masks. The assumption is that if masks were recognized at higher rates then there is evidence of increased use of resources during mask processing. The results were that when the mask was in the sixth position, recognition was significantly elevated over control, $\underline{t}(37) = 8.0127$, $p < .0005$. Raw scores indicate that masks in the fifth position were recognized with greater frequency than conceptually related items, and this increased recognition approached significance, $\underline{t}(37) = 1.506$, $p < .1$. The $\underline{t}$ value for masks in position five may have reached significance if not for the unusually high frequency of recognition for this serial position in the control group, which reduced the potential t value. In the fourth position, the mask was recognized with greater frequency than the control, but the difference did not reach statistical significance. It seems, there-

fore, that there is at least some evidence that processing for masks, at least when they are in the fifth and sixth positions in a series of eight, demands more resources than items which are not conceptually different from other items in the series.

CHAPTER IV

DISCUSSION

The present experiment attempted to explore whether conceptual factors influenced visual masking. Masking was described as the inhibitory effect on processing by a stimulus (the mask) on another stimulus which closely precedes or follows it. Masking was also said to be operative both at the level of the sensory register (the icon) and at higher levels of processing. Since a growing body of research indicates that conceptual relationships, even within the first moments of viewing time, play a role in picture processing, it was hypothesized that conceptual relationships would influence the potency of a mask embedded in a serial presentation of pictures. Given the importance of global information in picture viewing, it was predicted that if subjects were made to expect to see a series of pictures of an announced category, the presence of an incongruous item would disrupt processing in much the same way that the presence of an incongruous item in a scene influences processing. In the research design of the present experiment, global information was incorporated into the relatively artificial methodology of Potter (1975, 1976) and Intraub (1980) by informing the subjects at the beginning of the trial as to the category of objects they should expect to see. Thus, in

the present experiment, a person derived an anticipation of the conceptual category of objects he was about to see, was then shown a series of the objects, into which was introduced a non-conceptually related item. The question was whether the items immediately preceding or following this item would be recalled less accurately than items in the equivalent position in a control group with no mask.

It was predicted that masks would be remembered with greater accuracy than equivalent control items, and that items adjacent to masks would be remembered less frequently than control items in equivalent positions. The reasoning behind this lies with Friedman's (1979) notion of frames. According to Friedman, a verbalization can evoke a frame, an organization about anticipated objects in a scene, based on previous experience. An object which violates the expectation--in the present situation the mask--requires additional processing resources, making it more recognizable subsequently. At the same time, the unexpected object in the series would deprive adjacent items of processing resources, thus diminishing later recognition of these objects.

Effects on Masks

The prediction that the masks would be remembered more accurately than control items was partially upheld. These findings provide some support for the hypothesis

that increased resource allocation needed for "analysis" rather than "detection" will cause the item in question to be recognized later with greater accuracy. However, greater memory for masks could also be explained in terms of "stimulus isolation" or what has come to be called the Von Restorff effect. In a classic study, Von Restorff (1933) found positive effects on recall for an item in a series that had been made perceptually distinct (see Hilgard and Bower, 1966, for discussion). This experiment and later experiments (Von Restorff and Kohler, 1935) demonstrated the effect of isolating the stimuli either physically or cognitively. It was found that if one item in a visually presented list of nonsense syllables was painted red, or printed differently, or if the item were a number rather than a nonsense syllable, the memory for the item was enhanced. Other support for the increased memory for stimuli isolated in a cognitive dimension is given by Kimble and Dufort (1955) who presented trials of 15 highly meaningful words to subjects, with a low meaningful word at the seventh position. Relative to control, the low meaningful words were remembered with fewer errors. The logic invoked by the authors to explain the results are somewhat opposite that described in the Introduction. Kimble and Dufort argue that meaningful words tend to cause multiple, competing associations that interfere with the overt emission of the correct response.

However, it has been argued in the Introduction that the mask requires more rather than less processing than other items because it has to be "analyzed". Presumably, the generation of multiple associations would require additional processing resources, and this is where the two explanations differ. However, Kimble and Dufort's explanation is less defensible if we take it to its logical extreme, which is that low meaningful lists would be remembered more accurately than high meaningful lists. An explanation in terms of frame theory would posit low meaningful lists as more difficult to remember, since there would be few associations between items, and therefore more of a need for analysis, which depletes resources.

Kimble and Dufort have not, of course, provided the only explanation of the Von Restorff effect. Other explanations, for example Green's (1955) "surprise" hypothesis emphasize considerations of attention which give it certain similarities with frame theory. Thus, it is not necessary to invoke Friedman's theory to explain better memory for masks in the present experiment. Other explanations might be made, but they all perhaps could be reduced to Friedman's notion of frames, and her concomittant ideas of data analysis and detection.

Items Adjacent to Masks

The prediction that items immediately preceding or following masks would be recognized less frequently received

partial support. In view of the partial evidence of increased memory for the masks, indicating extra resources had been used for the processing of these incongruous items, it is suggested that the items adjacent to the mask were deprived of resources needed for consolidation in memory. But though four of six a-priori comparisons were in accord with the original prediction, two comparisons were in accord with the original prediction, two comparisons did not show significance. Both of these comparisons which were not consistent with the other four comparisons occurred when the mask was in position 5.

No completely satisfactory reason arises to explain this discrepency. If the mask in position five were not "doing its job", that is, drawing away resources through analysis, then it could be argued that adjacent items were getting their share of resources. But as has been indicated, mask in position five was remembered at a rate which approached significance. Nor can we assume that pictures adjacent to the mask in the fifth position had, inherent in them, characteristics which would make them more likely to consolidate, under masking circumstances, than any other of Snodgras and Vanderwart's (1980) line drawings. In other words, there is no reason to assume that the pictures next to the mask in position five had some originally higher baseline rate of recognition. These same pictures, when occurring in other positions in

other experimental manipulations, were recognized at about the same frequency as they were in the experimental condition next to the mask. Neither does it appear that the control values for positions four and six were abnormally low. In other words the high recognition rate in position four before a mask is not due to an idiosyncratic control mean. When measured against the fourth item when the mask was in position six (a non-critical item which would not be directly affected by the mask), the fourth item in Mask Five still is recognized at a relatively elevated level. The same holds true for the sixth item in Mask Five when compared to the sixth item in Mask Four.

Another possibility is that the fourth and sixth items in Mask Five showed increased retention precisely because they were located next to a mask. Rundus (1971) presented subjects with lists of words printed in black, into which were intruded words printed in red. He found that the main effect of introducing a distinctive item into a free recall list thus appears to be (a) an increase in recall probability for the distinctive item, (b) a decrease in overall performance on the list, and (c) an enhancement of items presented adjacent to the distinctive item. Mask Five was the only group of trials which exhibited the enhancement of items presented adjacent to the distinctive

item, and the reason for this is uncertain. It is certain, however, that in consideration of Rundus' findings, the suppression of memory for adjacent items in Mask Four and Mask Six is all the more noteworthy, since one might have expected that memory for these critical items would have been, if anything, enhanced. A possible explanation for suppression rather than enhancement in Mask Four and Mask Six is that when an unusual item in a series is only physically distinct--when for example it is red rather than black--resource deprivation does not occur in the same way as in a conceptually coherent sequence into which a non-conceptually related item is placed. Still, of course, this does not explain why Mask Five produced different data than Mask Four and Mask Six.

Serial Position Effects

Murdock and Walker (1969) found a serial position effect for both visually and auditorily presented lists. However, as shown in Figure 1, all mask conditions as well as the control trials had a recency effect, but no primacy effect. A similar finding was reported by Potter and Levy (1969) who found a strong recency effect, but a lower than average recall for the first item in picture sequences.

The discrepancy which seems to exist may be explained in terms of a modality effect. When speaking of the

serial position effect for memory of spoken words, Atkinson and Shiffrin's (1968) buffer model is often cited. The primacy effect is theorized to be due to the fact that early items in the list enter an empty "buffer" which can hold several items which are rehearsed until pushed out of the buffer by a succeeding item. The extra rehearsals of the item facilitates consolidation in memory. However, iconic storage, as opposed to echoic storage (the auditory sensory register), may have characteristics which terminate the rehearsal of initially presented items when new ones are presented. In echoic storage, for example, it may be possible to retain more than a single item, whereas in the icon this does not occur, since each succeeding item instantly erases the one before it (see Klatzky, 1975 for discussion). Early items in a visually presented list may not be rehearsed more than later ones. At fast rates rapid erasure may preclude a primacy effect in the data.

The lack of a primacy effect and the presence of a recency effect also seems to indicate that, in a series of pictures, backward masking is more effective than forward masking. In the present experiment the last item in a given sequence seems to have been little affected by the presence of an item before it, although it is impossible to say how much greater masking would have been if there had been no picture at all in position seven.

On the other hand, items in the beginning of the list were remembered very poorly. Evidently they did not much profit from the absence of a preceding item--the lack of forward masking did not much increase recognition accuracy. In future experimentation, it might be useful to determine the extent, under conditions of no masking at all, of memory for the last item. It might happen that the last item would be remembered even more accurately were there no item placed before it. An experiment might consist of presenting six items, then a blank space of equivalent time, and then the target. Such an experiment might clarify the role of forward masking in rapidly presented sequences of pictures.

Overall, the results of the experiment underscore the importance of conceptual factors in a viewing situation where they have not otherwise been extensively explored, namely the viewing of lists of conceptually related objects. The experiment approximated real world viewing situations by (1) instantiating a frame early in the viewing process, (2) presenting pictures for a period of time about the same as the period of time the eye would normally focus on various images and (3) having subjects view series of pictures which had some coherent theme to them. The study was a success to the extent that it showed that conceptual factors influence the amount of masking which occurs in a sequential presentation of pictures.

Whether or not a viewed item is expected or unexpected has implications for its own processing, and for the processing of temporally close images. Not only were two out of three masks remembered with greater frequency than would otherwise have been expected, but the items adjacent to the masks, in four of six cases, had their recognition accuracy significantly reduced.

The conception of the experiment, therefore, seems sound, but needs to be further refined. Several improvements might be incorporated into the methodology, should a similar experiment ever be performed. First, it is vital to make sure that no serial position in any experimental group contains a preponderance of pictures which have visual characteristics making them either especially recognizable, or somehow immune to masking. A pretest of stimuli, to determine their baseline rates of recognition by subjects when their category is known beforehand is advisable. By announcing the category, and then showing the picture for an appropriately short period of time (e.g., 188 msec), one could better insure that experimental results are not artifacts of the stimuli used. It would also be helpful to see how the stimuli are affected by forward and backward masking. Certain idiosyncracies of stimuli in a masking situation, which would otherwise confound the data, might be detected.

Another improvement in the procedure which would

make a similar experiment more valid would be to more fully create proper visual relationships between the items. Ideally, the presentation of pictures should mimic the way images from a well formed scene fall on the retina as natural saccadic viewing occurs. According to Biederman (1980), there are five attributes to a well formed scene: (1) support--the fact that most objects rest on something (2) interposition--an opaque object will occlude the contours of an object behind it (3) probability--certain objects are likely to be seen with other objects (4) position--objects in a given scene are likely to be seen in some positions and unlikely to be seen in others and (5) size--objects have certain size relationships. In this experiment most of these attributes were violated. The objects did not appear to rest on anything, there was no positioning of objects in a probable way (all appeared on the same place on the screen), and objects presented were not drawn to a consistent scale. Whether or not condition 2 (interposition) was met is also questionable. Since the objects were presented alone, one really cannot say whether they were opaque or not; however, the very fact that they were presented alone is inconsistent with naturalistic viewing. The only relationship consistent with real world viewing was probability, and even this was sometimes not well realized. For example, though animals are conceptually

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related, there are very few places (except for a zoo) where one might expect to see a horse, a bear, an alligator, or a giraffe. Nor does one normally see a plane, a locomotive, a baby carriage, or a truck together. In the future, it might be advantageous to arrange, mix, and alter the size of stimuli with the ultimate view of creating more realistic viewing circumstances.

Another methodological consideration which should be taken into account in future experimentation is that the presence of masks in the experimental group may reduce, to some extent, the rate of recognition for non-mask items in the recognition phase of the task. The mask itself tends to be recognized with very high frequency. Since the recognition task is one in which subjects have to choose 8 items from a total of 16 alternatives, the high recognition rate for any single item reduces the probability that they will be reported as recognized. The high frequency of mask recall may thus serve to depress the recognition rate for other items in Mask Four, Mask Five and Mask Six. The same thing is not occurring in the control condition, which may therefore have higher recognition values for positions other than that which corresponds to the mask condition in other trials. Adjustments for this factor might be made by altering, during control trials, the number of response alternatives, or perhaps by placing a "floating" mask within the control group.

APPENDIX A

CATEGORIES AND EXEMPLARS

CATEGORIES AND EXEMPLARS

ANIMALS: bear, camel, cow, deer, dog, donkey, elephant, fox, frog, giraffe, goat, gorilla, horse, kangaroo, leopard, lion, monkey, mouse, pig, rabbit, raccoon, rhinocerous, sheep, skunk, squirrel, tiger, turtle, zebra, ant, caterpillar, lobster, spider, seahorse.

KITCHEN UTENSILS: bowl, cup, fork, frying pan, glass, kettle, knife, pot, refrigerator, rolling pin, spoon, stove, toaster.

ARTICLES OF FURNITURE: bed, chair, couch, desk, dresser, lamp, record player, stool, table, television, vase, rocking chair, clock, ashtray, piano.

HUMAN BODY PARTS: arm, ear, eye, finger, foot, hair, hand, heart, leg, lips, nose, thumb, toe.

FRUIT: apple, banana, cherry, grapes, lemon, orange, peach, pear, pineapple, strawberry, tomato, watermelon.

VEGETABLES: artichoke, asparagus, carrot, celery, corn, lettuce, mushroom, onion, peanut, pea, pepper, potato, pumpkin.

CARPENTER'S TOOLS: ax, chisel, hammer, knife, ladder, nail, nut, pencil, pliers, ruler, saw, screwdriver, wrench.

CLOTHES: belt, blouse, cap, coat, dress, glove, hat, jacket, pants, shirt, shoe, skirt, sock, sweater, tie, vest, watch.

THINGS THAT FLY: chicken, duck, eagle, osterich, owl, peacock, rooster, airplane, balloon, helicopter, bee, butterfly, fly, grasshopper, beetle.

VEHICLES: airplane, balloon, bicycle, bus, car, helicopter, horse, motorcycle, roller skate, sled, train, truck, wagon, carriage, sailboat.

APPENDIX B

SAMPLE ANSWER SHEET

DIRECTIONS: Before each trial, the experimenter will announce what most of the objects in the trial are (for example, "dogs"). Each trial will then be presented on the screen, at the focussing dot. After the trial is presented, you will be shown a slide, and you should try and remember which items on the slide were in the trial. If you think a particular item on the slide was in the trial, write down the number below the item on your answer sheet. If you cannot remember what you saw on the trial, guess, so that all 8 spaces on your answer sheet are filled.

If you have any questions, ask. Remember, before each trial look at the dot on the screen. This is where the pictures will be shown. Also, remember to guess on those items you do not remember. All spaces on your answer sheet should be filled up.

SAMPLES

1 -- -- -- -- -- -- -- --
2 -- -- -- -- -- -- -- --
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