VISUAL IMAGERY AND EYEBLINKING

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Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
December, 1973

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PREFACE

During the last two decades the study of visual imagery has regained its respectability as a cognitive process worthy of study by psychologists. This dissertation is concerned with compound visual images (visual images in which elements of visual information are symbolically represented in a spatially parallel manner). This dissertation is also concerned with the relationship between visual imagery and eyeblinking.

I would like to express my sincere appreciation to my major adviser, Dr. Robert J. Weber, who provided continuous valuable advice and encouragement during all phases of the two experiments reported in this dissertation.

In addition, I would like to thank Drs. Robert F. Stanners, Larry Hochhaus, Elliott A. Weiner and P. Larry Claypool for their advice on the design and analysis of the reported experiments. I would also like to thank Nancy Younger and Marilyn Mallue, two of Dr. Weber's research assistants, who performed the tedious tasks of measuring response times and counting eyeblinks.

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CHAPTER I

INTRODUCTION

The cognitive process of visual imagery consists of the symbolic representation of visual information in the absence of a correlated environmental event. This definition of visual imagery includes two important aspects. The first important aspect is that the visual information exists in the absence of the environmental event which produces analagous information during visual perception. The second important aspect of this definition is that the visual information may or may not be accompanied by the subjective experience of "seeing" this information (Paivio, 1971). There are currently many interesting questions concerning visual imagery, including the relationship between visual imagery and verbal processes (Paivio, 1971). This dissertation is an attempt to answer some of these questions concerning visual imagery.

Before beginning the literature review, a brief overview of the chapters of this dissertation will be presented. The introductory chapter of this dissertation will include four sections. In the first section the relevant literature on visual perception will be reviewed. The second section is a review of the relevant literature on visual imagery. The third section is a selected review of the literature concerned with eyeblinking to which visual imagery may be related. In the final section a statement of the research problems with which this dissertation is concerned will be presented.

In the second chapter, the first experiment of this dissertation will be presented. The first experiment is an attempt to answer the following question: What experimental variables might provide further evidence of the formation of compound visual images (visual images in which several elements of visual information are symbolically represented in a spatially parallel manner)?

In the third chapter, the second experiment of this dissertation will be presented. The second experiment is an attempt to answer the following question: What factors might control the formation of compound visual images?

The two experiments of this dissertation are also concerned with two other questions. Both experiments are concerned with the verbal control of visual imagery. That is, the results of these two experiments might provide additional evidence for the verbal control of visual imagery that has been reported by Weber, Kelley, and Little (1972). Both experiments are also concerned with the relationship between visual imagery and eyeblinking. That is, the results of these two experiments may indicate that eyeblinking is suppressed during visual imagery as it has been shown (Drew, 1951; Hall, 1946) to be during visual perception.

The fourth and final chapter presents an integrated discussion of the two experiments of this dissertation.

Visual Perception

As auditory and visual sensations interact with previously stored information in memory, auditory and visual perception result (Paivio, 1971). The auditory and visual sensation-perception systems differ on two important dimensions. The first important difference concerns the kind of environmental stimulation received by these two sensation-perception systems. The auditory sensation-perception system receives stimulation in the form of sound. The auditory sensation-perception system transduces the physical properties of sound into psychological information. The psychological information resulting from this transduction includes information concerning the loudness, pitch, timbre, and rhythm of the sound. The visual sensation-perception system receives stimulation in the form of light. The visual sensation-perception system transduces the physical properties of light into psychological information which includes information concerning the brightness, hue, saturation, movement, size and shape of the light.

The second important difference between these two sensation-perception systems concerns the manner in which these systems receive stimulation. The auditory sensation-perception system is specialized to function sequentially in receiving auditory stimulation whereas the visual sensation-perception system is specialized to function simultaneously in receiving visual stimulation (Paivio, 1971). This difference between these two sensation-perception systems is most obvious when linguistic stimulation is involved. It is extremely difficult to hear and understand two or more phonemes spoken simultaneously. The auditory sensation-perception system functions best in receiving linguistic stimulation when the phonemes are sequentially organized as demanded by the grammar of the language. However, it is relatively easy to see and understand two or more letters shown simultaneously. The visual sensation-perception system permits several elements, such as letters during reading, to be perceived at the same time.

The visual sensation-perception of linguistic stimulation is a cognitive process of particular importance in this dissertation. It is, therefore, necessary to review the experimental findings concerning this cognitive process. There are two studies which are especially relevant in regard to the visual sensation-perception of linguistic stimulation. Winnick and Kressel (1965) visually presented subjects with words which varied in frequency and in concreteness. These investigators determined the visual recognition threshold for these words which were tachistoscopically presented. Winnick and Kressel found that the recognition threshold for high frequency words was lower than the recognition threshold for low frequency words. The concreteness of the words had no effect on the recognition threshold of the words.

Another factor which has been shown to affect the visual recognition threshold of tachistoscopically presented words is the pronounceability of the words. Gibson, Bishop, Schiff, and Smith (1964) studied the effects of meaningfulness and pronounceability on the recognition threshold for trigrams. Gibson, et al. presented subjects with three types of trigrams. The three types were pronounceable trigrams (for example, MIB and BIF), meaningful trigrams (for example, IBM and FBI), and control trigrams which were neither pronounceable nor meaningful (for example, MBI and IFB). The recognition thresholds were lowest for the pronounceable trigrams and were highest for the control trigrams, with the recognition thresholds for the meaningful trigrams being intermediate.

The results of these two studies concerning the effects of the frequency and pronounceability of verbal items on the visual sensation-perception of those items will be important in interpreting the results of the second experiment of this dissertation.

Another finding from the area of visual perception which is relevant to this dissertation comes from some studies performed by Brooks. Brooks (1967) presented subjects a list of statements describing the spatial relationships of 8 digits in an imagined 4 x 4 matrix. These statements were presented to the subjects in two different manners. In the listening condition, the subjects heard the statements. In the listening and reading condition, the subjects heard the statements while concurrently reading the statements from index cards. Following the presentation of the statements, the subjects were asked to recall the statements verbatim. Brooks found that the subjects made more errors in the listening and reading condition than in the listening condition. When subjects were presented a list of nonsense statements in the two manners described above, Brooks found that the subjects made more errors in the listening condition than in the listening and reading condition.

In another study Brooks (1968) presented subjects with two types of information, spatial information (line diagrams) and verbal information (sentences). After the presentation phase of the experiment, Brooks had the subjects recall the presented information and signal that information by either speaking or pointing. The results showed that subjects were able to signal the recalled spatial information faster when a spoken output was used than when a spatially monitored output (pointing) was used. However, the subjects were able to signal the recalled verbal information faster when a spatially monitored output (pointing) was used than when a spoken output was used.

Brooks interprets the results of these two studies as follows. Verbal and spatial information are processed by two different systems. Verbal perception and thought comprise one system and spatial perception and imagery comprise the other system. Concurrent activity within a system results in more interference than does concurrent activity involving one component of each system. For example, visual perception interferes more with visual imagery than it does with verbal thought, as was found in Brooks' two studies.

Another visual perception study likewise indicates that visual perception can interfere with concurrent visual imagery. Atwood (1971) demonstrated the existence of visual imagery mediation in a verbal learning task by using visual perception to selectively interfere with visual imagery. Atwood auditorially presented subjects with one of two types of verbal material, abstract and concrete phrases. The abstract material included phrases such as "the theory of Freud is nonsense". The concrete material included phrases such as "nudist devouring a bird". One second after the presentation of these phrases the subjects performed one of two types of interfering tasks. The auditory interference task required the subjects to respond to an auditory stimulus. If the subjects heard "1", they were required to say "2". If the subjects heard "2", they were required to say "1". The visual interference task required the subjects to respond to a visual stimulus. If the subjects saw "1", they were to say "2". If the subjects saw "2", they were to say "1". The 35 successive phrases presented to each subject occurred 4-5 seconds apart. Immediately following the presentation phase of the experiment, each subject was given the first noun of each phrase presented to him or her. The subject was then required to respond with the last noun of each phrase. For example, if the subject was cued with the noun, "theory", the subject was to reply with the noun, "nonsense". The results of this experiment showed that auditory inferference resulted in fewer correct responses during recall of the abstract material than did visual interference. However, visual interference resulted in fewer correct responses during recall of the concrete material than did auditory interference.

Another demonstration of the interference which results when both visual perception and imagery are involved in a task is provided by Segal and Fusella (1969). In this study visual imagery was found to interfere with visual perception. Segal and Fusella had subjects perform a visual signal detection task under two different conditions. In one condition the subjects performed only the signal detection task. In the other condition, the subjects performed both the signal detection task and a visual imagery task. The results showed that the subjects' signal detection sensitivity (d') was lower in the visual perception and imagery condition than in the visual perception condition. These results indicate that concurrent visual imagery interferes with visual perception.

This concludes the section concerned with visual perception. Some of the studies presented in this section will aid in the understanding of the studies presented in the following section which is concerned with visual imagery.

Visual Imagery

This section presents a review of the relevant literature concerning visual imagery. This review will include the identification and description of the currently hypothesized functions of visual imagery and the experimental support for the existence of these functions. Visual imagery may serve two general functions; visual imagery may serve an arousal function and an informative function. Each of these two hypothesized general functions may be divided into more specific functions.

The hypothesized arousal function of visual imatery may be divided into two specific functions: (1) physiological arousal and (2) behavioral arousal. The hypothesized informative function of visual imagery may be divided into five specific functions involving visual information: (1) the symbolic representation of concrete information; (2) the symbolic representation of static and dynamic information; (3) the symbolic representation of incidental information; (4) the symbolic representation of novel information; and (5) the spatially parallel representation of information. Although these specific informative functions of visual imagery are conceptually distinct, these specific functions may overlap with one another. For example, a visual image could involve the spatially parallel representation of concrete information.

The current literature concerning these hypothesized functions of visual imagery will now be reviewed.

Arousal Functions of Visual Imagery

As stated above, the hypothesized arousal functions of visual imagery include: (1) physiological arousal and (2) behavioral arousal. The relevant literature concerning these two functions will be considered in succession.

(1) The research on the physiological arousal function of visual imagery has involved the recording of electroencephalographic activity and evoked potentials.

In regard to EEG-arousal, it has been found that almost any type of external stimulus suddenly presented to a subject showing the EEG alpha rhythm will result in alpha rhythm attenuation (Thompson, 1967). EEG-arousal, indicated by alpha rhythm attenuation, has been hypothesized to occur in response to visual images as well as to external stimulation. The evidence supporting this interesting hypothesis is, unfortunately, inconclusive (Paivio, 1971).

The initial research efforts in this area attempted to relate particular habitual modes of thought to particular EEG activity. For example, Short (1953) found that subjects classified as habitual visualizers showed frequent EEG alpha rhythm attenuation and regular breathing. Subjects classified as habitual verbalists showed a persistent EEG alpha rhythm and irregular breathing. In contrast to Short's findings are the experimental results obtained by Simpson, Paivio, and Rogers (1967). These investigators gave subjects an imagery test battery. On the basis of the subjects' responses to these tests, two groups of subjects were formed. One group scored high on visual imagery ability and the other group scored low on visual imagery ability. One variable in this experiment was, therefore, imagery type. The subjects were then given verbal problems (that is, problems which, presumably, required verbal symbolization for their solution) and visual problems (that is, problems which, presumably, required visual imagery for their solution). A second variable was, therefore, problem type. During and after the subjects' solution of these problems, their occipital EEG was recorded. A third variable in this experiment was, therefore, the condition during which the EEG was recorded; there was a task condition and a control condition. The results showed that the imagery type variable had no effect on the subjects' recorded EEG alpha rhythm. The interaction of the problem type variable and the condition variable was important. The task condition resulted in an attenuation of the recorded EEG alpha rhythm in relation to the control condition. However, this attentuation was greater with the verbal task than with the visual task.

The results of these two studies (that is, Short, 1953 and Simpson, et al., 1967) demonstrate that the evidence relating EEG attenuation to visual imagery is inconclusive. Short found EEG attenuation in habitual visualists but Simpson, et al. did not find EEG attenuation in subjects scoring high on a visual imagery test battery or in subjects performing a task requiring the use of visual imagery.

Turning from the recording of EEG activity to the recording of evoked-potentials, evidence relating imagery and evoked-potentials has been obtained by John (1967). John found that evoked-potentials differing in shape were obtained when different spatial forms (for example, circles and squares) were presented to subjects. Another finding of particular interest is that evoked-potentials differing in shape were obtained when subjects imagined different spatial forms such as circles and squares. John also found that the visual presentation of the words, "circle" and "square" produced different evoked-potentials, even with the words equated for area. This latter result may have been obtained because the different words aroused different associated visual images. That is, the word "circle" aroused a visual image of a circle and the word "square" aroused a visual image of a square. John's results certainly seem to open a promising avenue of research and, hopefully, future research will build upon this suggested relationship between imagery and evoked-potentials.

The behavioral arousal function of visual imagery has been experimentally investigated by Cautela and Wisocki (1969). These investigators had experimental and control subjects rate statements concerning elderly people. One week after this initial rating, the experimental subjects were twice asked to imagine their lives being saved by an elderly person. The experimental subjects were then instructed to practice this scene at home at least twice a day. Ten days later both the experimental and control subjects again rated the statements concerning elderly people. The experimental subjects showed a change in their ratings in a positive direction. That is, they indicated greater positive emotional arousal towards elderly persons as a result of the imagery instructions. The control group showed no change in their attitudes towards elderly people.

Cautela and Wisocki's study indicates that imagery may serve an emotional arousal function. However, it is possible that factors other than visual imagery produced their results. The experimental subjects may well have used visual imagery as they were instructed to do. But they also may have engaged in covert speech, either with or without the associated memory. Moreover the role of demand characteristics in the task is not clear. It would be desirable to demonstrate that imagery can serve an emotional arousal function in a more controlled situation.

An attempt at such a controlled demonstration was made by Weiner, Weber, and Concepcion (in press). Although the Weiner, et al. study did not produce the expected results in regard to the present issue, this study will be described because of its ingenuity and relevance to possible future research in this area.

Weiner, et al. had subjects engage in a circle drawing task, with the speed on the circle drawing task related to the amount of positive or negative emotionally arousing stories with which the subjects were presented after completing the circle drawing task. It was predicted that positive emotionally arousing stories would speed up performance on the circle drawing task, while negative emotionally arousing stories would slow down performance. The stories were presented in one of two ways. In the listening only condition the subjects heard the stories; in the listening and reading condition the subjects both heard and read the stories. If visual imagery can arouse emotions beyond the arousal produced by verbal processes, then the listening only condition should have more of an effect on the rate of circle drawing than the listening and reading condition, since reading should interfere with visual imagery (Brooks, 1967, 1968). The results showed that the listening/listening and reading variable did not produce the expected effect.

Although the Weiner, et al. study did not demonstrate arousal which could be directly attributed to visual imagery, this study does suggest a general approach which might prove valuable in regard to the hypothesized functional significance of visual imagery in arousal. Additional discussion on this matter will appear in the final chapter of this dissertation.

Informative Functions of Visual Imagery

As previously stated, the hypothesized informative functions of visual imagery include: (1) the symbolic representation of concrete information; (2) the symbolic representation of static and dynamic information; (3) the symbolic representation of incidental information; (4) the symbolic representation of novel information; and (5) the spatially parallel representation of information. The relevant literature for each of these hypothesized functions will be examined successively.

(1) Concerning the concrete information representation function of visual imagery, Paivio (1971) has proposed that visual imagery functions relatively better in symbolically representing concrete information (for example, the information present in a picture) than in symbolically

representing abstract information (for example, the information present in a concept such as truth). Paivio further proposed that verbal processes can function well in symbolically representing both concrete and abstract information. Verbal processes, however, function especially well in symbolically representing abstract information in relation to visual imagery. Paivio cites considerable evidence to support this hypothesized distinction between visual imagery and verbal processes. For example, Paivio (1966) presented subjects with concrete and abstract stimulus nouns and required the subjects to press a key whenever they formed an association in response to the stimulus nouns. The associations to-be-formed were of two types, visual images and verbal associates. Paivio found that the response latency to the concrete nouns was shorter than the response latency to the abstract nouns. However, this difference in response latency to the concrete and abstract stimulus nouns was greater in the visual image condition than in the verbal associate condition, as would be predicted by Paivio's hypothesized distinction between visual imagery and verbal processes.

Another type of experiment which Paivio cites in support of his hypothetical distinction between visual imagery and verbal processes involved paired-associate learning with different mediational sets. Paivio and Foth (1970) presented one group of subjects with a list of 30 concrete noun pairs and another group of subjects with a list of 30 abstract noun pairs. Both groups of subjects were required to use imagined mediators to learn 15 randomly chosen noun pairs and verbal mediators to learn the other 15 noun pairs. The results of this experiment showed that imagined mediation produced better recall of concrete pairs and verbal mediation produced better recall of abstract pairs. The results of this experiment, as did the results of the preceding experiment, support Paivio's hypothesized distinction between visual imagery and verbal processes.

Paired-associate experiments involving concrete word pairs and abstract word pairs, such as the one just described, usually show that the concrete word pairs are recalled better than the abstract word pairs (Paivio, 1971). The imagined features of words, therefore, appear to be important in the memory of those words. Words, however, include other features such as phonetic features in addition to imagined features. Nelson and Brooks (1973) provide evidence indicating that imagined features of words are processed independently of phonetic features. Nelson and Brooks had subjects engage in a paired-associate task which involved words as the stimulus items and either digits or nouns as the response items. The stimulus words had either identical first, medial, or last letters. The usual ordinal position effect was found; that is, identical letters in the initial position of the stimulus words produced the most disruption of learning, identical letters in the final position produced the next most disruption, and identical letters in the medial position produced the least disruption. The result of this experiment which is most interesting to the present discussion of visual imagery is that the ordinal position effect was obtained with both high and low imagery stimulus words, even when the responses were high imagery words and an interacting image instructional set was given. Nelson and Brooks conclude that the imagined features of words and the phonetic features of words can be independently processed.

(2) Concerning the static and dynamic information representation function of visual imagery, Paivio (1971) proposed that visual imagery

can symbolically represent unchanging static information (for example, the type of information presented in photographs) as well as changing dynamic information (for example, the type of information presented in motion pictures). Paivio also proposed that verbal processes can symbolically represent both static and dynamic information. Nouns and noun phrases can represent the unchanging static aspects of a situation whereas verbs and verb phases can represent the changing dynamic aspects of a situation.

Which of the two symbolic systems will be used to represent the static and dynamic aspects of a particular situation will depend upon other aspects of the situation. For example, when the information to be represented is concrete, then visual imagery may be the preferred symbolic system. However, when abstract information is to be represented, then verbal processes may be the preferred mode of thought.

In a recent experiment by Rohwer (1970) which was concerned with subjects' memory for static and dynamic information, visual imagery may have been the basis for the results obtained. Rohwer found that the paired-associate learning of nouns was easier when the noun pairs were connected by verbs (for example, "the shoe taps the chair") than when connected by prepositions (for example, "the shoe under the chair"), by conjunctions (for example, "the shoe and the chair"), or unconnected (for example, "shoe-chair"). These results may have been obtained because the visual imagery produced by the dynamic information present in the noun pairs connected by verbs was more memorable than the visual imagery produced by the static information present in the other noun pairs. This suggestion that visual imagery was responsible for the results could be easily evaluated by using this stimulus material in conjunction with the experimental method for producing selective interference developed by Atwood (1971) which was described in the preceding section on visual perception.

(3) Sheehan and Neisser (1969) suggest that visual imagery may function in the representation of incidental information. In one experimental condition Sheehan and Neisser presented subjects with visual designs which the subjects had to remember and later reproduce. These designs were ostensibly the principle information presented in the experiment. In another experimental condition subjects were presented with other visual designs which the subjects had to immediately reproduce using 4 Kohs blocks. These designs were presented as incidental information, as an exercise in problem solving rather than as the initial presentation of information which the subjects would later have to recall. The subjects upon recalling both types of designs were asked to rate the vividness of their imagery. The results showed that the subjects rated their imagery as being much more vivid in the recall of the incidental information than in the recall of the principal information. On the basis of these results, Sheehan and Neisser suggest that visual imagery may be important in the recall of incidental information.

Sheehan and Neisser note, however, that other factors besides the principal-incidental factor could account for these results. The visual designs used in the two conditions of the experiment were of different types and it may have been this difference, or other factors, which produced the results of this experiment. Although this experiment has some methodological weaknesses, it is nonetheless valuable in suggesting another function which visual imagery may serve. This hypothesized function of visual imagery certainly deserves additional investigation.

(4) Visual imagery may also be important in creativity; that is, visual imagery may function in the representation of novel information. This section will be relatively short because psychologists know little about creativity in general (Morgan and King, 1971) and very little about creativity and visual imagery in particular (Paivio, 1971).

The relationship between creativity and visual imagery has been studied by Schmeidler (1965). Schmeidler used a variant of Galton's famous breakfast-table questionnaire to measure visual imagery and a subset of the Barron Independence of Judgment Scale to measure creativity. Schmeidler presented these two questionnaires to over three hundred college student subjects. She found a low correlation between the scores on the two questionnaires.

If research scientists are considered creative individuals, then Roe's (1951) study of the use of imagery among research scientists is relevant at this point. Roe studied the working habits of sixty-four scientists from several fields. She interviewed and gave several tests (for example, the Rorschach) to these scientists. Her results showed that a predominant number of biologists and experimental physicists used visual imagery whereas a predominant number of psychologists, anthropologists, and theoretical physicists used verbal symbolization as their major mode of thought.

Visual imagery, therefore, appears to be related to creativity, especially in some individuals such as biologists. A recent example of visual models used by chemists is the representation of the DNA molecule as a double helix structure. Another example of a visual model is Hebb's three-dimensional neural latticework representation of cell assemblies (Paivio, 1971).

Visual imagery also appears to be related to creativity during dreaming in some individuals. For example, the famous organic chemist Friedrick Kekulé, is reported to have formed the concept of the benezene ring as a closed structure, a most revolutionary concept, during a dream in which a snake bit its own tail (Paivio, 1971). The visual imagery in dreams can also apparently foster literary creativity. Bram Stoker, who wrote Dracula, is reported (Hill and Williams, 1965) to have conceived Dracula during a dream. The conception of the monster in Frankenstein by Mary Shelley is also reported (Hill and Williams, 1965) to have occurred during a dream. Robert Stevenson, it is reported (Diamond, 1967), initially experienced some of the scenes of A Strange Case of Dr. Jekyll and Mr. Hyde during a dream.

It appears from the evidence cited in this section that visual imagery may serve a creative function. Paivio (1971) proposes that both visual imagery and verbal processes are involved in creativity. Paivio suggests that the initial discovery in the creative process frequently involves visual iamgery whereas the later formalization in the creative process usually involves verbal processes.

Although measured creativity is independent of measured intelligence above the average level of intelligence (Lindgren and Bryne, 1971), creativity is conceptually related to intelligence in that both creativity and intelligence are personality traits involving cognitive processes. Therefore the relationship between intelligence and visual imagery can be considered in this section. In studying the relationship between intelligence and visual imagery, Brower (1947) found no relationship between college students' rating of the intensity of their visual imagery and their scores on the Otis Intelligence Test.

Although there is no correlation between rated visual imagery and intelligence, visual imagery can be valuable in certain intellectual activities. For example, imagery has been shown to be involved in subjects' solutions of three-term series problems. The two following studies provide the basis for this statement. A description of a three-term series problem is provided in the review of the second study.

Huttenlocher and Strauss (1968) presented subjects with two immobile blocks and a third mobile block. The subjects were then told to place the third block above or below the other two blocks. In the statement instructing the subjects where to place the third block, the third block was either the grammatical subject or object of the statement (for example, "Block three should be on top of block one" or Block one should be under block three"). The subjects took longer to place the third block and made more errors in placing the third block when the reference to the mobile block was the grammatical object of the instructional statement.

Huttenlocher (1968) presented subjects with three-term series problems. A three-term series problem involves the experimenter presenting the subject two statements (for example, "Tom is taller than Sam" and "John is shorter than Sam"). Following the presentation of these two statements the experimenter asks the subject a question (for example, "Who is the tallest"). The response measures in three-term series problems are response latency and error rate. Huttenlocher reasoned that the above results with actual objects should also be found in three-term series problems if subjects use imagery in the solution of three-term series problems. She, therefore, presented subjects with three-term series problems in which the third term was either the grammatical subject or the grammatical object of the second statement. The results showed that when the third term was the grammatical object of the second statement the subjects took longer to solve the problem than when the third term was the grammatical subject of the second statement.

Since the same factor affected the actual objects problems and the three-term series problems in the same manner, this is evidence that imagery was involved in the solution of the three-term series problems. This evidence in conjunction with the subjects' introspective reports of imagery during their solution of the three-term series problems provide converging operations which validate the hypothesis that imagery is important in the solution of three-term series problems.

(5) The fifth and final hypothesized informative function of visual imatery involves the spatially parallel representation of information. Paivio (1971) and Weber, Kelley, and Little (1972) propose that the visual imagery system can permit the spatially parallel or simultaneous representation of visual information. That is, the visual imagery system, as the visual perception system, may allow more than one element of visual information to be symbolically represented at the same time. Paivio further proposes that verbal processes permit only the sequential representation of verbal information. That is, the verbal processing system may allow only one element of linguistic information to be symbolically represented at a time.

Evidence supporting the hypothesized distinction between visual imagery and verbal processes on the parallel-sequential dimension has been provided by Weber and his associates. Weber and Bach (1969) found that visual imagery can be a slower information processing system than verbal processes. Weber and Bach had one group of subjects visually imagine the typewritten letters of the alphabet as if the letters were appearing one at a time on a movie screen. Another group of subjects convertly spoke the letters of the alphabet one at a time. The results of this experiment showed the rate of processing in the visual imagery condition (about 2.5 letters/sec) to be slower than the rate of processing in the covert speech condition (about 6.5 letters/sec). This experiment was replicated with similar results by Weber and Castleman (1970).

In an experiment incorporating the methodological improvements suggested Weber and Castleman (1970), Weber and Kelley (1972) found that processing visual and acoutstic propreties of letters proceeded at about the same rate when a long serial list such as the alphabet is processed. In the visual property condition subjects visually imagined the individual letters of the alphabet in lower case typewritten form and classified each letter on the basis of its spatial property (for example, the letter, "a", would be classified as vertically small whereas the letter, "b", would be classified as vertically large). In the acoustic property condition subjects acoustically imagined the individual letters of the alphabet and classified each letter on the basis of its acoustic property (for example, the letter, "a", would be classified as not possessing a long ē sound whereas the letter, "b", would be classified as possessing the long ē sound). In both the visual and acoustic imagery conditions the subjects overtly signalled their classification of the individual alphabetic letters by either a spoken response or a written response. The results showed the rate of visual imagery did not differ from the rate of acoustic imagery. The results did show, however, that the response rate in the written condition was faster than in the spoken condition for both visual and acoustic imagery. This result was interpreted as meaning that there was verbal control over the sequencing between individual letters in both the visual and the acoustic imagery conditions. That is, the subjects, apparently, covertly spoke the name of each letter in order to retrieve the visual or the acoustic representation of the letter.

In another similar experiment Weber, Kelley, and Headley (1973, Experiment 2) had subjects classify the visual or acoustic properties of single letters rather than the twenty-six letters of the alphabet. The results of this experiment showed that the overall response rate in the visual imagery condition did not differ from the overall response rate in the acoustic imagery condition.

The preceding research of Weber and his colleagues may be summarized at this point. Depending upon the particular task requirements, the rate of information processing in the visual imagery system is slower than or euqal to the rate of comparable information processing in the verbal processing system. This conclusion applies to single letters and to long serial lists such as the alphabet. However, if visual imagery has the potential for the spatially parallel representation of visual information whereas verbal processes operate under a sequential constraint, then visual imagery should be faster than analogous verbal activity provided that the prevailing conditions permit the potential spatially parallel representation capability of the visual imagery system to be realized.

An attempt to demonstrate this potential spatially parallel representation capability of visual imagery was made by Weber, Kelley, and Little (1972). Weber, et al. presented subjects with alphabetic lists and word lists. The subjects had to visually imagine the spatial properties of the individual letters of the alphabet in one condition and four letter words in another condition. The subjects overtly signalled the spatial properties of the individual letters using either a spoken response or a written response. It was hypothesized that the response time per letter for words would be faster than the response time per letter for the alphabet because the four letters of a word could be visually imagined as a spatially parallel unit whereas this capability for spatially parallel representation would be exceeded in the alphabet condition. The results showed that the response rate was faster for words than for the alphabet, as was predicted. The results also showed that written responding was faster than spoken responding but only in the alphabet condition. This latter result was again interpreted to mean that the sequencing between visual images was under verbal control in the alphabet condition. In the word condition the verbal control for sequencing was not necessary because of the apparent limited capability of the visual imagery system for the spatially parallel representation of visual information.

Further research (Weber, Kelley, and Headley, 1973, Experiment 1) contributes additional support to the hypothesis that visual imagery can function in the spatially parallel representation of visual information. Weber, Kelley, and Headley presented subjects with five letter words and had the subjects respond to either the spatial or acoustic properties of the individual letters of the imagined representations of these words. The subjects responded faster to the spatial properties than to the acoustic properties, as would be predicted from the hypothesis of a limited capability for spatially parallel representation in the visual imagery system.

Weber and Harnish (1973, Experiment 1) also obtained evidence for a limited capability for spatially parallel representation in visual imagery. Weber and Harnish presented subjects with three and five letter words. In the visual image condition, the words were verbally presented to the subjects and the subjects were required to form visual images of the words. In the visual percept condition, the words were visually presented to the subjects. Following the presentation of a word, the subjects were presented a probe digit which instructed them to respond to the spatial property of the i-th letter of the word. The results showed that there was no difference between the visual image and visual percept conditions. This result was interpreted as indicating a limited capability for spatially parallel representation in visual imagery. The basis for this interpretation lies in the recognized capability for spatially parallel representation in the visual perception system.

This concludes the review of the relevant literature on visual imagery. This literature review presented the evidence supporting the currently hypothesized functions of visual imagery. There are two general functions, an arousal function and an informative function, which visual imagery is currently hypothesized to serve. Each of these two general functions can be divided into more specific functions. At this point it is possible to ask how well did the available research support these hypothesized functions of the visual imagery system.

In regard to the hypothesized arousal function of visual imagery, first the evidence for physiological arousal will be considered, then the evidence for behavioral arousal. Concerning physiological arousal, the evidence pertaining to arousal as measured by electroencephalographic activity is inconclusive because conflicting results have been obtained in this area. Undoubtedly this area will be occasionally investigated in the future as it has been in the past. It can only be hoped that this future research will resolve the issue of whether visual imagery is accompanied by EEG alpha rhythm attenuation. The evidence pertaining to physiological arousal as measured by evoked potentials is suggestive. There is, to date, only one study (John, 1967) in this area. Hopefully, future research will replicate and extend the initial findings in this area concerned with the relationship between visual imagery and evoked potentials.

Concerning behavioral arousal, the evidence pertaining to arousal as measured by attitude scales or rates of operant responses is, at best, suggestive. Future research, hopefully, will involve more analytical techniques for a fuller investigation of the relationship between visual imagery and behavioral arousal.

In regard to the hypothesized informative function of visual imagery the evidence for the specific informative functions will be considered succession. The proposed capability of visual imagery to symbolically represent concrete information better than abstract information has received considerable experimental support (Paivio, 1971). The proposed capability of visual imagery to symbolically represent static and dynamic information has not received comparable experimental support. The proposed capability of the visual imagery system to symbolically represent concrete information is much better established as an actual capability than is the proposed capability of the visual imagery system to symbolically represent static and dynamic information. The proposed capabilities of the visual imagery system to symbolically represent incidental information and novel information exist, unfortunately, only as proposed capabilities. Hopefully, future research will provide sound experimental evidence in regard to these possibilities. The proposed capability of the visual imagery system for the spatially parallel representation of visual information has received experimental support in the case of visual imagery for verbal material (Weber, Kelley, and Little, 1972; Weber, Kelley, and Headley, 1973; and Weber and Harnish, 1973).

The next section of this introductory chapter concerns eyeblinking, which may be related to visual imagery.

Eyeblinking

Eyeblinking may be related to visual imagery. The purpose of this section is to present a selected review of the relevant literature on eyeblinking. The following section, which is concerned with the research problems to which this dissertation is addressed, will present a discussion of the hypothesized relationship between eyeblinking and visual imagery.

Eyeblinking may be influenced by several factors. Eyeblinking may be the result of reflex activity such as occurs when some small alien object is caught between the eyelid and the cornea. Eyeblinking, however, may also be a voluntary act. For example, eyeblinking or winking may occur when one individual wishes to communicate friendship to another individual. Cognitive and motivational-emotional factors can also influence eyeblinking. These cognitive and motivational-emotional factors are the most interesting in the context of this dissertation. The literature review of this section will begin with the cognitive factors which affect eyeblinking. Following the discussion of cognitive factors will be the discussion of motivational-emotional factors which influence eyeblinking.

Cognitive Factors Influencing Eyeblinking

The relationship between certain cognitive processes and oculomotor activity has been investigated by Antrobus, Antrobus, and Singer (1964). These investigators found that the amount of oculomotor activity in general and eyeblinking in particular was greater when subjects were instructed to engage in active thinking than when subjects were instructed to engage in relaxed thinking. In the active thought condition subjects were instructed "to make their thoughts race as fast as possible". In the relaxed thought condition subjects were instructed "to let their thought drift lazily". Another result of this study was that the amount of both eye movement and eyeblinks was greater when subjects were instructed to suppress, rather than to generate, "an important, secret wish" which the subjects did not have to reveal to the experimenter. A final result of this study is that the amount of both eye movements and eyeblinks was greater when subjects were instructed to engage in visual imagery involving movement (for example, a tennis match) than when subjects were instructed to engage in visual imagery involving no movement (for example, a piece of fruit on a table). Antrobus, et al. interpret these results as meaning that as the rate of change in cognitive content increases, as in active thought, wish suppression, and visual imagery involving movement, the amount of associated oculomotor activity similarly increases.

The rate of change in cognitive content may then be one cognitive factor which influences eyeblinking. Another cognitive factor which has been shown to affect eyeblinking is the difficulty of the cognitive task. Clites (1935) had subjects perform nonvisual tasks which varied in difficulty. Subjects performed mental multiplication and recited the alphabet in both a forward and a backward direction. Presumedly, the multiplication task was the most difficult, the backward recitation task was less difficult and the forward recitation task was the least difficult. Clites computed the eyeblink rate during a control period prior to the various tasks and during performance of the tasks. The results showed that both the mental multiplication task and the alphabet recitation tasks produced increased eyeblinking in comparison to the control period. The multiplication task produced the greatest increase, the backward recitation task produced a lesser increase and the forward recitation task produced the least increase. These results are interpretable as showing that as the difficulty of a nonvisual task increases the rate of eyeblinking also increases.

The effect of task difficulty on eyeblinking has also been investigated using visual tasks. Drew (1951) measured the rate of eyeblinking while subjects performed a visual tracking task and while subjects drove a car. In the visual tracking task subjects, using remote controls, had to guide a pencil over a path which was partially straight and partially oscillating from side to side. In the car driving task subjects drove in both heavy traffic and on an open road. Drew found that the subjects' eyeblink rates were considerably higher when they were tracking over a straight path and when driving on an open road than when they were tracking over an oscillating path and when driving in heavy traffic.

McPherson (1943) also investigated the effect on task difficulty on eyeblinking. McPherson had subjects count rows of dots, read print, detect airplane silhouettes on a screen, and plot graphs. The subjects' eyeblinking was monitored during these tasks. The results showed the counting task reduced the average eyeblink rate by 58%, the detection of silhouettes task reduced the average eyeblink rate by 52%, the reading task reduced the average eyeblink rate from 37% to 42% depending upon the amount of illumination and the plotting task reduced the average eyeblink rate by 21%. McPherson concluded from these results that the rate of eyeblinking is inversely associated with the difficulty of visual tasks.

In the two studies just cited, Drew (1951) and McPherson (1943) have found that the rate of eyeblinking is inversely associated with the difficulty of visual tasks. However, Clites (1935) found that the rate of eyeblinking is directly associated with the difficulty of nonvisual tasks. A similar pattern of results was obtained by Telford and Thompson (1933). These investigators found that reading decreased the rate of eyeblinking and mental arithmetic increased the rate of eyeblinking in relation to the rate of eyeblinking shown by subjects engaged in normal conversation. The following interpretation is suggested to account for these different results produced from different tasks. In general, as the level of task difficulty increases there is a corresponding increase in the rate of eyeblinking. However, if the task requires visual perception in order to perform the task, then the effects of task difficulty are negated by the requirement for visual perception. In visual tasks, increased task difficulty results in decreased eyeblinking because of the increased necessity for accurate visual perception which is incompatible with increased eyeblinking.

This interpretation is supported by the finding (Hall, 1945) that subjects when reading tend to blink at the end of sentences and at the end of pages where blinking is least disruptive.

It is possible, therefore, to conclude that visual perception involves a decrease in eyeblinking. The question concerning the relationship between visual imagery and eyeblinking is one of the research problems with which this dissertation is concerned. Further discussion of the relationship between visual imagery and eyeblinking will be presented in the following section. The review of the relevant literature on eyeblinking will now focus on motivational-emotional factors influencing eyeblinking.

Motivational-Emotional Factors Influencing Eyeblinking

Meyer (1953) developed a response interaction theory to account for the effects of muscular tension on responses, both unlearned and learned. Meyer proposed that the eyeblink rate can be used as an index of the degree of generalized muscular tension. The rationale for this proposal involves anatomical considerations. The motor structures responsible for the eyeblink are bordered on one side by the large structures responsible for movement of the face and tongue and on the other side by the large structures responsible for movement of the hand. Because the face, tongue, and hand are involved in so many different responses and because neural activity in one area irradiates to surrounding areas, most responses are accompanied by eyeblinking. Meyer, Bahrick, and Fitts (1953) provide evidence in support of Meyer's theory. Meyer, et al. state that an increased incentive to perform a task produces generalized muscular tension in the subject performing the task. From this statement of fact, Meyer, et al. predict that increased incentive should produce increased eyeblinking. In order to test this prediction Meyers, et al. had subjects perform a visual pursuit task. During the inter-trial intervals, the subjects' frequency of eyeblinking was recorded. The prediction was that an increased incentive (money) should produce increased eyeblinking during the inter-trial intervals. The reason eyeblinks were counted during the inter-trial intervals rather than during the trials is because the subjects must suppress eyeblinking during the visual task in order to perform the task satisfactorily. The subjects need not suppress eyeblinking during the inter-trial intervals. Therefore, the subjects' eyeblinks were recorded during the inter-trial intervals. Meyer, et al. found that the introduction of an increased incentive produced an increase in the eyeblink rate during the inter-trial intervals.

Another factor, besides incentive, which is related to generalized muscular tension is anxiety. Therefore anxiety should produce an increase in eyeblinking as does increased incentive. Research findings from two different areas are relevant to this suggested relationship between anxiety and eyeblinking. Experimental evidence from studies of eyeblink conditioning and from studies of threat will be considered.

In regard to eyeblink conditioning, Taylor (1951) conditioned eyeblinks in two groups of subjects. The subjects in one group had previously scored high on a manifest anxiety inventory whereas the subjects in the other group had previously socred low on the inventory. Since anxiety is related to increased muscular activity the subjects scoring high on manifest anxiety should exhibit more conditioned eyeblinks because of the strategic location of the cortical motor structures responsible for eyeblinking. Taylor found that the anxious group of subjects exhibited more conditioned eyeblinks than did the non-anxious group of subjects.

Similar support for Meyer's theory is provided by the findings of Hilgard, Jones, and Kaplan (1951). Hilgard, et al. gave subjects an anxiety inventory and had the subjects participate in an eyeblink conditioning experiment. In the experimental phase of this study, the subjects were conditioned to blink in response to a light. Following this simple conditioning was a conditioned discrimination task in which the subjects were to discriminate between two lights. One light was always accompanied by a puff of air whereas the other light was never followed by the unconditioned stimulus. The subjects who had scored high on the anxiety inventory showed more difficulty on the conditioned discrimination task. This result would be expected from Meyer's theory which proposes that increased muscular tension, such as occurs in anxious subjects, results in increased eyeblinking.

Studies concerned with threat also support the suggested relationship between anxiety and eyeblinking. Ponder and Kennedy (1972) monitored the blinking of witnesses in a law court. They found that the witnesses increased their blink rate when being cross-examined. The increased blink rate can be very plausibly explained as the result of the witnesses' experiencing increased threat upon being cross-examined.

In another study of threat and eyeblinking, Appel, McCarron, and Manning (1968) formed two groups of subjects based upon the subjects' initial rate of eyeblinking. One group of subjects had an initial high blink rate whereas the other group had an initial low blink rate. These two groups of subjects were exposed to a high threat situation and a low threat situation. The subjects in this experiment were highschool counselors who were attending a Couseling and Guidance Institute. In the high threat situation the counselors were placed in a role playing situation. Each counselor was exposed to "an irrate and hostile 'mother' portrayed by a trained actor" for ten minutes. This counseling session with the "mother" of a highschool boy took place "in a large unfamiliar professional television studio" where the session was recorded for later evaluation by the staff at the Institute and by the counselor's peers. In the low threat situation, each counselor was informally interviewed by a familiar Institute staff member in his familiar office for five minutes. The results of this experiment showed an important interaction between the blink rate variable and the threat condition variable. During the low threat situation the subjects with an initial high blink rate showed a significant decrease in eyeblinking in relation to the high threat situation. During the low threat situation the subjects with an initial low blink rate showed no change in eyeblinking in relation to the high threat situation.

On the basis of the eyeblink conditioning studies and the threat studies it appears that increased anxiety, as well as increased incentive, results in increased eyeblinking. Another factor which has been shown to affect the blink rate is hypnosis. Weitzenhoffer (1969) gave subjects a slightly modified version of the Stanford Scale of Hypnotic Susceptibility. Following this, the subjects were hypnotized. The subjects' blink rates were determined in their pre-hypnotic and hypnotic states. Weitzenhoffer found that the subjects who had scored six or more on the Stanford Scale showed a decrease in their blink rate while hypnotized. The subjects who had scored five or less on the Stanford Scale were, presumably, not hypnotized and did not show a change in their blink rate following the hypnotic induction.

One of the current problems in research on hypnosis is to find an objective indicator that the hypnotic state of consciousness and behavior, as opposed to the normal state of consciousness and behavior, truly exists. Weitzenhoffer's study is, therefore, an important step in establishing the validity of the hypnotic state. Further discussion of this topic will appear in the final chapter of this dissertation.

Research Problems

The research problems with which this dissertation is concerned will be presented in this section. There are essentially two research problems of concern in this dissertation. The two problems will be discussed successively. The first research problem concerns an informative function of the visual imagery system. As discussed in a previous section, the visual imagery system appears to have a limited capacity for the spatially parallel or simultaneous representation of visual information. There are two interesting questions which can be raised in regard to this limited capacity for the spatially parallel representation of visual information. The first question is: What experimental variables might provide further evidence of the formation of compound visual images (visual images in which several elements of visual information are symbolically represented in a spatially parallel manner)? The second question is: What factors might control the formation of compound visual images?

In order to attempt to answer the two questions which constitute the first research problem, the present study uses the method of studying visual imagery developed by Weber and Castleman (1970). That is, the present study involves visual imagery for verbal material. Weber and Castleman noted that the individual lower case typewritten letters of the alphabet can be divided into two classes based on the vertical size of the letters. The first class, large letters, include "b", "d", "f", "g", etc. and the second class, small letters, includes "a", "c", "e", "i", etc. By having subjects visually imagine verbal material and overtly signal the vertical size of the individual letters, there is greater assurance that the subjects are, in fact, visually imagining the verbal material. This is, in general, the method used to study visual imagery in this dissertation.

In the first experiment the question of what experimental variables might provide further evidence of the formation of compound visual images is dealt with as follows. Subjects are presented stimulus words which vary in length (4 versus 8 letters) and are required to form visual images of these words. The subjects are also required to scan their visual images in either a forward direction (left to right) or a backward direction (right to left) and to signal the vertical size of the individual letters. If the difference in response rate (letters/sec) between forward scanning and backward scanning is less with 4 letter words than with 8 letter words (that is, if the interaction of the word length and scan direction factors is significant) then this can be interpreted as demonstrating a limited capacity for the spatially parallel representation of visual information in the visual imagery system. Another variable manipulated in the first experiment is the position of the syllabic break in the stimulus words. This aspect of the experiment may yield information concerning the relationship between visual imagery for words and verbal processes. A final variable manipulated is the type of representation (perceptual versus imaginal) of the stimulus words. This aspect of the experiment will assist in the interpretation of the experiment.

In the second experiment the question of what factors might control the formation of compound visual images is dealt with as follows. Subjects are presented stimulus items which vary in frequency of occurrence and in degree of pronounceability and are required to form visual images of these items. The subjects are also required to scan their visual images from left to right and to signal the vertical size of the individual letters. If these two variables, frequency of occurrence and degree of pronounceability, significantly affect response time, then these factors apparently influence the formation of compound images.

These two experiments are also concerned with the verbal control of visual imagery. Weber, Kelley, and Little (1972) have reported evidence for the verbal control of the visual imagery process. The two experiments of this dissertation may identify some of the variables (for example, word length and degree of pronounceability) which affect the translation of a verbal representation into a compound visual image representation.

The second research problem of concern in this dissertation involves a hypothesized relationship between visual imagery and eyeblinking. This hypothesis states that the blink rate will be suppressed during visual imagery. This hypothesis follows from the finding that the blink rate is suppressed during visual perception (Drew, 1951; Hall, 1946). The blink rate is suppressed during visual perception because eyeblinking erases or interferes with visual percepts. The blink rate may also be suppressed during visual imagery because eyeblinking erases or interferes with visual images. Alternatively, the blink rate may be suppressed during visual imagery because visual imagery is similar to visual perception and the habits acquired during visual perception generalize to visual imagery without serving any significant function. These are, therefore, two independent reasons for expecting the hypothesized suppression of the blink rate during visual imagery.

In order to evaluate this hypothesis concerning visual imagery and eyeblinking, eyeblinking is monitored during the two experiments of this dissertation. Although these two experiments can serve to evaluate the hypothesis concerning blink rate suppression during visual imagery, the two experiments cannot serve to identify which of the two above reasons is responsible for the hypothesized blink rate suppression. At this time, it is desired only to empirically determine if suppression of the blink rate during visual imagery does, in fact, occur.

This section concludes the introductory chapter of this dissertation. In the next two chapters the two experiments of this dissertation are described. These two chapters are followed by a final chapter in which an integrated discussion of the two experiments is presented.

CHAPTER II

EXPERIMENT 1

The first experiment to be reported is concerned with two questions. The first question is: What experimental variables might provide further evidence of the formation of compound visual images? The second question is: What is the relationship between visual imagery and eyeblinking?

Concerning the first question, in this experiment subjects are presented stimulus words which vary in length (4 versus 8 letters). The subjects are instructed to form visual images of these words, to scan their visual images in either a forward direction (left to right) or a backward direction (right to left), and to signal the vertical size of the individual letters which are imagined in lower case form. If the difference in response time (sec/letter) between forward scanning and backward scanning is significantly less with 4 letter words than with 8 letter words, then this interaction can be interpreted as demonstrating a limited capacity for the spatially parallel representation of visual information in the visual imagery system. This interpretation is based on the following reasoning: If the visual imagery system has a limited capacity for the spatially parallel representation of visual information, then 8 letter words might exceed this limited capacity and require verbal sequencing between the component images; this verbal sequencing would be more difficult with backward scanning than with forward scanning, resulting in the scan direction by word length interaction. Another variable manipulated in this experiment is the position of the syllabic break in the stimulus words. This variable may yield information concerning the relationship between visual imagery for words and verbal processes. Still another variable manipulated is the type of representation (perceptual versus imaginal) of the stimulus words. This variable should yield information which will assist in the interpretation of the experiment. For example, if the difference in response time between forward and backward scanning is significantly less in the percept conditions than in the image conditions, then this would indicate that backward scanning, per se, is not the basis of the scanning direction effect in the image conditions.

Concerning the second question raised above, in this experiment the subjects' eyeblinks will be recorded during the trials and during the inter-trial intervals. If visual imagery suppresses eyeblinking, as was hypothesized in the introductory chapter, the subjects' blink rate should be slower during the imagery trials than during the inter-trial intervals.

Method

Subjects

The subjects used in this experiment were 40 Oklahoma State University undergraduates who participated for extra credit in an introductory psychology course. The subjects were native speakers of English who could read without glasses or contact lens.

Experimental Design

There are five independent variables which are factorially varied in this experiment. The first independent variable, the position of the syllabic break in the stimulus words, has 4 levels. There are stimulus words without a syllabic break (for example, "love" and "straight"), stimulus words with the syllabic break in an initial position (for example, "able" and "although"), stimulus words with the syllabic break in a medial position (for example, "into" and "handsome"), and stimulus words with the syllabic break in a final position (for example, "body" and "friendly"). Note that "initial" does not necessarily mean after the first letter; it means early in the word, before the middle. Likewise, "final" does not necessarily mean before the last letter; it means late in the word, after the middle. The second independent variable, the length of the stimulus words, has 2 levels. There are 4 letter stimulus words and 8 letter stimulus words. The stimulus words used in this experiment appear in Appendix A. The third independent variable, the direction of scanning the stimulus words, has 2 levels. There are forward scan conditions and backward scan conditions. The fourth independent variable, the type of representation of the stimulus words, has 2 levels. There are perceptual representation conditions and imaginal representation conditions. The fifth and final independent variable, the interval during which eyeblinks are recorded, has 2 levels. There is the trial interval and the inter-trial interval.

There are four dependent variables which are examined in this experiment. The first dependent variable is response time. Response time is defined as the time per letter that results from classifying <u>every</u> letter in a stimulus word (that is, the elapsed time from the onset of a stimulus word to the onset of the last classification response divided by the number of letters in the stimulus word). The second dependent variable is response latency. Response latency is defined as the elapsed time from the onset of a stimulus word to the onset of the first classification response. The third dependent variable is the number of classification errors made in response to a stimulus word. The fourth dependent variable is blink rate.

The above information concerning experimental design can be integrated at this point. The part of the experiment concerned with the experimental variables which might provide further evidence of the formation of compound visual images involves a 4 x 2 x 2 x 2 factorial design. The first factor is the position of syllabic break variable. The second factor is the word length variable. The third factor is the scan direction variable. The fourth factor is the representation type variable. There are repeated measures on the first two factors. There are 10 Ss for each between subject condition which results in a total of 40 Ss. Response time, response latency, and number of errors are the dependent measures associated with this design.

The part of the experiment concerned with the relationship between visual imagery and eyeblinking involves a 2 x 4 x 2 x 2 x 2 factorial design. The first factor is the eyeblink recording interval variable. The second factor is the position of syllabic break variable. The third factor is the word length variable. The fourth factor is the scan direction variable. The fifth factor is the representation type variable. There are repeated measures on the first three factors. There are 10 Ss for each between subject condition which again results in 40 Ss. Blink rate is the dependent variable associated with this design.

Procedure

An IBM Executive typewriter was used to type the stimulus items and the diazochrome method was used to reproduce the stimulus items into transparencies. The transparencies were mounted in 35-mm. slide holders. The slides were back projected onto a viewing screen by a Kodak Carousel projector. Another Kodak Carousel projector was used to provide continued illumination of the viewing screen.

At the beginning of the experiment the S sat at a table and placed his head on the headrest fastened to the table. The S's head was approximately 34 cm. from the viewing screen. The S initiated each trial by depressing a foot switch with his or her right foot. The depression of the foot switch produced two events. (1) A slide was projected onto the viewing screen to a height of approximately 1.6 cm. In the image conditions a slide with a stimulus word in upper case letters on it, remained on the screen for .5 sec. and in the percept conditions a slide with a stimulus word in lower case letters on it, remained on the screen for 10 sec. The presentation of a slide was controlled by a Lafayette tachistoscope and a Lafayette 4-bank timer. (2) Two Harvard Apparatus marker modules recorded the onset of a trial on a Harvard Apparatus 10-speed chart mover. In the image conditions, following the presentation of a stimulus item in upper case letters, the S was to visually imagine the stimulus item in lower case letters. In the percept conditions, the S visually perceived the stimulus item in lower case letters. In both conditions the S was to overtly signal the vertical size of the individual letters of the stimulus item by using two micro-switches fastened to the table in front of him. One micro-switch was designated with a small sign for small sign for small letters and the other for large letters.

The small/large designation of the two micro-switches was counterbalanced across *Ss*. The two micro-switches were connected to the two Harvard Apparatus marker modules which resulted in the *S*'s classification responses being recorded on the chart mover. The *S*'s classification responses were distinguishable from the onset of a trial. A classification response activated only one marker module; the onset of a trial activated both marker modules. When the *S* finished responding to a stimulus item, he or she said "Finished". Upon hearing this signal the *E* positioned the next slide to be presented with a remote control switch. The *E* then said "OK" which informed the *S* to begin the next trial when ready.

During the experiment the *S*'s eyeblinks were recorded with a Biometrics eye movement monitor used in conjunction with a Harvard Apparatus recorder module and chart mover. Before the first trial the eye movement monitor was calibrated. During the calibration the *S* was asked (1) to move his or her eyes left and right and (2) to blink his or her eyes. When eye movements could be easily distinguished from eyeblinks the calibration was complete.

This procedure made it possible to record the *Ss*' response times, response latencies, errors, and eyeblinks with the Harvard Apparatus chart mover and the associated equipment.

The instructions to the *Ss* in this experiment appear in Appendix B. The *Ss* were given 40 practice trials involving 10 4-letter words and 10 8-letter words presented twice. Following the practice trials, the *Ss* were given 40 test trials involving 5 of each of the 8 types of stimulus items (4 positions of syllabic break x 2 word lengths = 8 types of stimulus items). Each *S* received a different random order of the 40 test items.

Results

The results of the four different response measures used in this experiment will be considered successively. Concerning the response time measure, the *Ss*' mean response time for the 5 trials in each condition of the experiment was calculated. The *Ss*' means for each condition may be found in Table XXI in Appendix C. These means were the units used in a 4 x 2 x 2 x 2 AOV of the response time data. The means and standard errors of the *Ss*' mean response times are presented in Table I. Figure 1 presents the response time data, averaged over the four levels of the syllabic break position factor which was not a significant factor. Table II presents the AOV results for the response time data. An examination of Table I, Figure 1, and Table II reveals the following: the position of syllabic break factor did not have a significant main effect (F (3.108) = 1.23, $P > .05$); however, the position of syllabic break by word length interaction was significant (F (3,108) = 4.30, $P < .05$). The word length factor also did not have a significant main effect (F (1,36) = 3.75, $P > .05$); however, the word length by scan direction interaction was significant (F (1,36) = 12.27, $P < .01$); the word length by representation type interaction was significant (F (1,36) = 25.54, $P < .01$), and the word length by scan direction by representation type interaction was significant (F (1,36) = 16.41, $P < .01$). The scan direction factor had a significant main effect (F (1,36) = 18.83, $P < .01$) and the representation type factor had a significant main effect (F (1,36) = 62.10, $P < .01$). Also the scan direction by representation type interaction was significant (F (1,36) = 17.93, $P < .01$).

TABLE I

MEAN RESPONSE TIME (SEC/LETTER) AND STANDARD ERRORS FOR EACH CONDITION OF EXPERIMENT I

		4 Letter Words				8 Letter Words			
		Position of Syllabic Break				Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Image	Mean	.59	.68	.62	.67	.64	.59	.65	.65
	S.E.	.10	.19	.11	.12	.20	.14	.19	.20
Backward Image	Mean	.94	.95	.91	.95	1.18	1.05	1.18	1.17
	S.E.	.23	.19	.24	.21	.32	.30	.34	.28
Forward Percept	Mean	.47	.49	.48	.49	.44	.45	.45	.43
	S.E.	.08	.05	.08	.04	.05	.05	.03	.04
Backward Percept	Mean	.51	.50	.49	.48	.44	.42	.46	.44
	S.E.	.11	.09	.09	.09	.07	.07	.08	.10

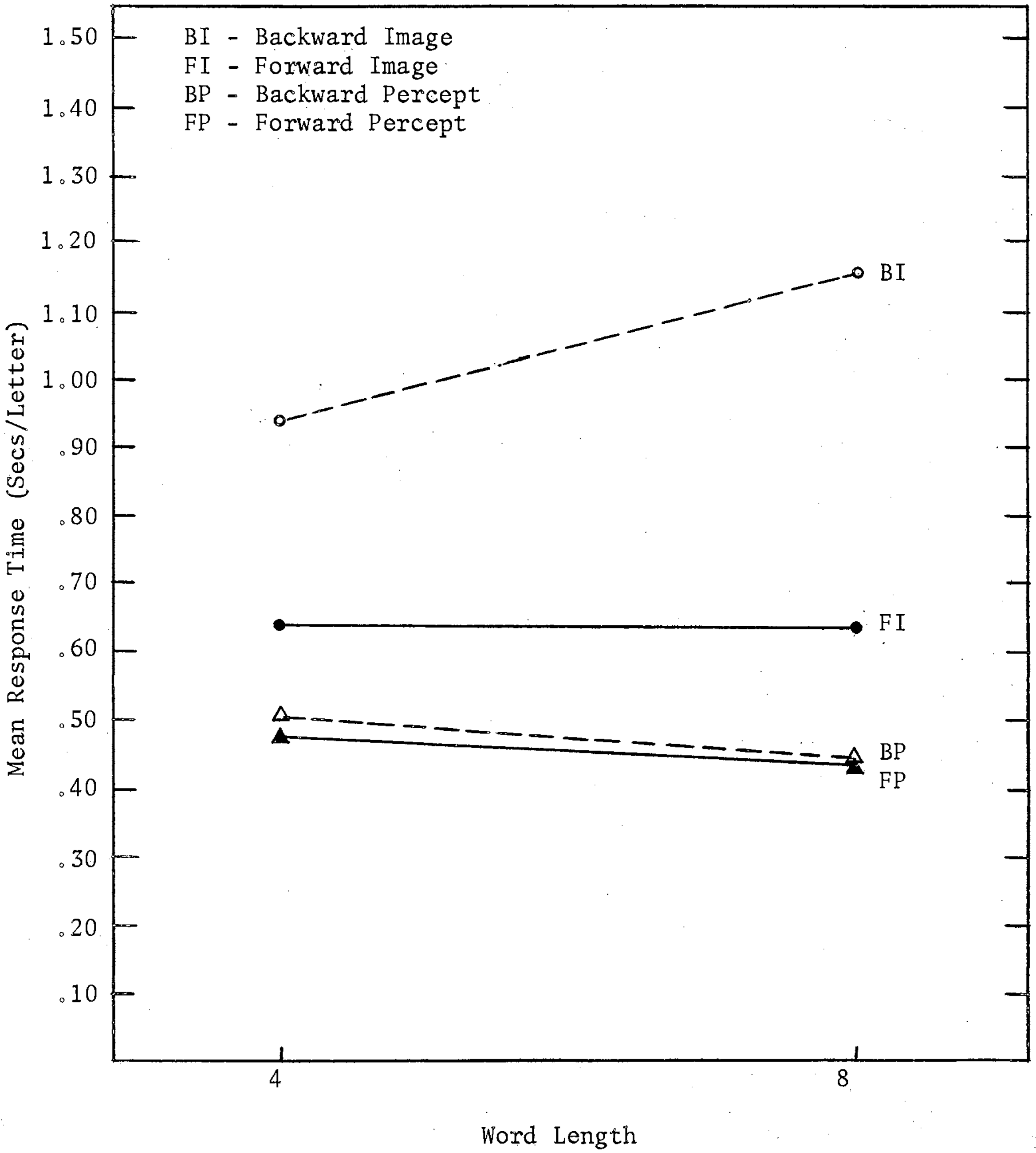

Figure 1. Experiment 1 - Response Time as a Function of Word Length, With Image-Percept Representation and Forward-Backward Scan as the Parameters

TABLE II

AOV OF THE RESPONSE TIME DATA OF EXPERIMENT 1

Source of Variation	S.S.	D.F.	M.S.	*F*
Within *Ss*				
A (position of syllabic break)	.01947	3	.00649	1.23
AC	.02996	3	.00999	1.90
AD	.02301	3	.00767	1.46
ACD	.00674	3	.00225	.43
A x *Ss* within groups (error term)	.56899	108	.00527	
B (word length)	.06384	1	.06384	3.75
BC	.20910	1	.20910	12.27**
BD	.43512	1	.43512	25.54**
BCD	.27966	1	.27966	16.41**
B x *Ss* within groups (error term)	.61333	36	.01704	
AB	.09152	3	.03051	4.30*
ABC	.01572	3	.00524	.74
ABD	.05072	3	.01691	2.39
ABCD	.00188	3	.00063	.09
AB x *Ss* within groups (error term)	.76537	108	.00709	
Between *Ss*				
C (scan direction)	3.39900	1	3.39900	18.84**
D (representation type)	11.20502	1	11.20502	62.10**
CD	3.23610	1	3.23610	17.93**
Ss within groups (error term)	6.49582	36	.18044	

*P < .05.

**P < .01.

Concerning the response latency data, a similar pattern of results was found. The Ss' mean response latency for the 5 trials for each condition was calculated. The Ss' means for each condition may be found in Table XXII in Appendix C. These means were the units used in a 4 x 2 x 2 x 2 AOV of the response latency data. The means and standard errors of the Ss' mean response latencies are presented in Table III. Figure 2 presents the response latency data, averaged over the four levels of the syllabic break position factor which was not a significant factor. Table IV presents presents the AOV results for the response latency data. Table III, Figure 2, and Table IV reveal the following: the position of syllabic break factor did not have a significant main effect ($F(3,108) = 1.06$, $P > .05$) nor were any interactions involving this factor significant. The word length factor did have a significant main effect ($F(1,36) = 18.93$, $P < .01$); the word length by representation type interaction was significant ($F(1,36) = 12.51$, $P < .01$). The scan direction factor had a significant main effect ($F(1,36) = 15.26$, $P < .01$) and the representation type factor had a significant main effect ($F(1,36) = 74.23$, $P < .01$). Also the scan direction by representation type interaction was significant ($F(1,36 = 16.12$, $P < .01$).

It should be noted at this point that the response time and latency analyses were based on correct responses only.

Concerning the error data, a somewhat similar pattern of results was found as was found with the response time data. The Ss' total number of errors for the 5 trials of each condition was calculated. The Ss' total number of errors out of 5 possible errors for each condition may be found in Table XXIII in Appendix C. These totals were the units used in a 4 x 2 x 2 x 2 AOV of the error data. The means and standard deviations

TABLE III

MEAN RESPONSE LATENCY (SECS) AND STANDARD ERRORS FOR EACH CONDITION OF EXPERIMENT 1

		4 Letter Words				8 Letter Words			
		Position of Syllabic Break				Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Image	Mean	1.28	1.24	1.35	1.34	1.49	1.43	1.63	1.51
	S.E.	.04	.08	.12	.02	.14	.06	.33	.13
Backward Image	Mean	2.02	1.89	1.87	2.22	2.30	2.29	2.20	2.30
	S.E.	.20	.14	.20	.22	.86	.31	.52	.31
Forward Percept	Mean	.98	.93	1.01	.99	1.08	.99	.96	.95
	S.E.	.02	.01	.06	.02	.03	.04	.03	.01
Backward Percept	Mean	.94	.98	.93	.99	.95	.96	1.08	.98
	S.E.	.03	.02	.06	.02	.02	.05	.22	.05

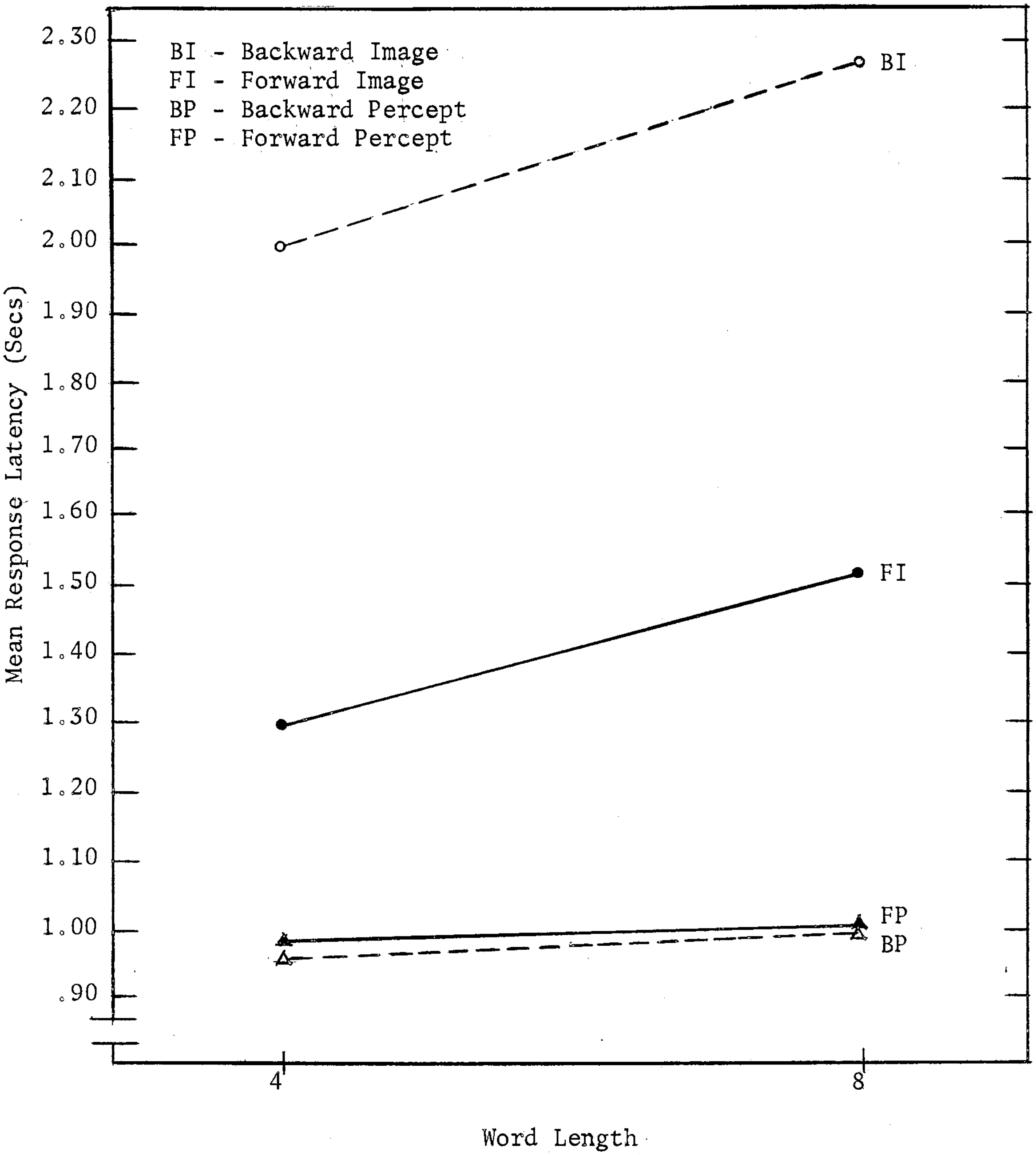

Figure 2. Experiment 1 - Response Latency as a Function of Word Length, With Image-Percept Representation and Forward-Backward Scan as the Parameters

TABLE IV

AOV OF THE RESPONSE LATENCY DATA OF EXPERIMENT 1

Source of Variation	S.S.	D.F.	M.S.	F
Within Ss				
A (position of syllabic break)	.20512	3	.06837	1.06
AC	.21912	3	.07304	1.13
AD	.15912	3	.05304	.82
ACD	.33512	3	.11171	1.73
A x Ss within groups (error term)	6.95894	108	.06443	
B (word length)	1.43112	1	1.43112	18.93**
BC	.02813	1	.02813	.37
BD	.94612	1	.94612	12.51**
BCD	.01012	1	.01012	.13
B x Ss within groups (error term)	2.72197	36	.07561	
AB	.19512	3	.06504	1.44
ABC	.07612	3	.02537	.56
ABD	.05013	3	.01671	.37
ABCD	.17312	3	.05771	1.28
AB x Ss within groups (error term)	4.87788	108	.04517	
Between Ss				
C (scan direction)	10.29611	1	10.29611	15.26**
D (representation type)	50.08600	1	50.08600	74.23**
CD	10.87810	1	10.87810	16.12**
Ss within groups (error term)	24.28095	36	.67477	

$^*P < .05$.

$^{**}P < .01$.

of the Ss' total number of errors out of the 5 possible errors are presented in Table V. Figure 3 presents the error data, averaged over the four levels of the syllabic break position factor which was not a significant factor. Table VI presents the AOV results for the error data. Table V, Figure 3, and Table VI reveal the following: the position of the syllabic break factor did not have a significant main effect ($F(3,108) = 2.10$, $P > .05$) nor were any interactions involving this factor significant. The word length factor did have a significant main effect ($F(1,36) = 29.23$, $P < .01$); the word length by representation type interaction was significant ($F(1,36) = 14.39$, $P < .01$). The representation type factor had a significant main effect ($F(1,36) = 12.92$, $P < .01$).

Concerning the eyeblink data, the Ss' mean blink rate for the 5 trials and inter-trial intervals for each condition were calculated. The Ss' mean blink rate for each condition may be found in Table XXIV in Appendix C. The rates were used in a 2 x 4 x 2 x 2 x 2 AOV of the eye blink data. The means and standard errors for the Ss' mean blink rate are presented in Table VII. Table VIII presents the AOV results for the eyeblink data. An examination of Table VII and Table VIII reveals the following: the eyeblink recording interval factor had a significant main effect ($F(1,36) = 40.32$, $P < .01$). There were no other significant main or interaction effects.

Further discussion of the results of Experiment 1 will be postponed until the final chapter. In the final chapter there is a combined discussion of Experiments 1 and 2.

TABLE V

MEAN NUMBER OF ERRORS AND STANDARD DEVIATIONS FOR EACH CONDITION OF EXPERIMENT 1

		4 Letter Words				8 Letter Words			
		Position of Syllabic Break				Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Image	Mean	.40	.60	.40	.30	1.20	1.00	2.00	1.00
	S.E.	.84	1.04	.64	.21	1.36	.80	1.40	1.20
Backward Image	Mean	.20	.50	.30	.40	2.10	1.70	2.00	1.80
	S.E.	.16	.45	.21	.44	3.29	1.21	2.80	2.16
Forward Percept	Mean	.30	.40	.40	.20	.00	.50	.80	.20
	S.E.	.21	.44	.44	.16	.00	.45	.56	.16
Backward Percept	Mean	.00	.10	.20	.10	.90	.20	.30	.50
	S.E.	.00	.09	.16	.09	1.29	.16	.41	.45

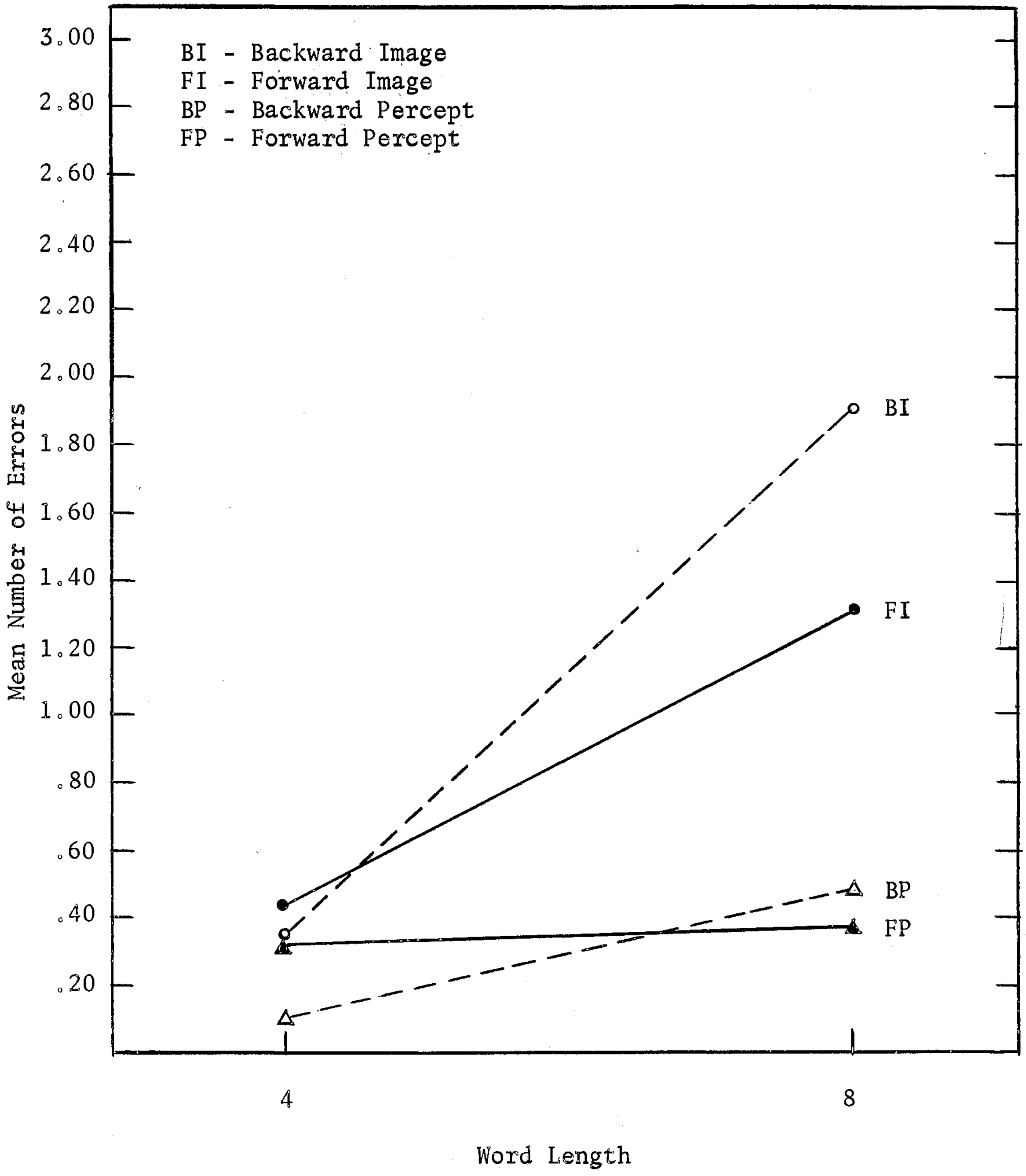

Figure 3. Experiment 1 - Number of Errors as a Function of Word Length, With Image-Percept Representation and Forward-Backward Scan as the Parameters

TABLE VI

AOV OF THE ERROR DATA OF EXPERIMENT 1

Source of Variation	S.S.	D.F.	M.S.	F
Within Ss				
A (position of syllabic break)	2.46250	3	.82083	2.10
AC	3.62500	3	1.20833	3.09
AD	.17500	3	.05833	.15
ACD	.76250	3	.25417	.65
A x Ss within groups (error term)	42.22500	108	.30907	
B (word length)	40.61249	1	40.61249	29.23**
BC	5.00000	1	5.00000	3.60
BD	20.00000	1	20.00000	14.39**
BCD	.61250	1	.61250	.94
B x Ss within groups (error term)	50.02500	36	1.38958	
AB	2.91250	3	.97083	2.69
ABC	3.97500	3	1.32500	3.67
ABD	1.37500	3	.45833	1.27
ABCD	.51250	3	.17083	.47
AB x Ss within groups (error term)	38.97500	108	.36088	
Between Ss				
C (scan direction)	.80000	1	.80000	.28
D (representation type)	36.45000	1	36.45000	12.92**
CD	2.11250	1	2.11250	.75
Ss within groups (error term)	101.57499	36	2.82153	

*P < .05.

**P < .01.

TABLE VII

MEAN BLINK RATE (BLINKS/SEC) AND STANDARD ERRORS FOR EACH CONDITION OF EXPERIMENT 1

		Position of Syllabic Break							
		O		I		M		F	
		Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial
		4 Letter Words							
Forward Image	Mean	.13	.22	.15	.21	.15	.27	.10	.20
	S.E.	.20	.20	.18	.19	.14	.24	.22	.15
Backward Image	Mean	.13	.33	.10	.29	.12	.34	.12	.34
	S.E.	.18	.41	.14	.41	.18	.43	.19	.38
Forward Percept	Mean	.04	.22	.04	.25	.05	.25	.06	.23
	S.E.	.07	.12	.09	.15	.08	.12	.08	.14
Backward Percept	Mean	.04	.16	.03	.19	.02	.16	.03	.14
	S.E.	.09	.10	.10	.17	.06	.14	.05	.08
		8 Letter Words							
Forward Image	Mean	.11	.25	.15	.32	.13	.24	.12	.25
	S.E.	.15	.20	.18	.24	.14	.27	.17	.26
Backward Image	Mean	.07	.17	.16	.31	.09	.25	.18	.39
	S.E.	.10	.19	.24	.37	.16	.37	.30	.42
Forward Percept	Mean	.03	.30	.04	.29	.07	.22	.02	.26
	S.E.	.05	.17	.05	.18	.09	.08	.04	.16
Backward Percept	Mean	.03	.14	.02	.15	.04	.14	.02	.20
	S.E.	.04	.08	.05	.11	.06	.10	.04	.12

TABLE VIII

AOV OF THE EYEBLINK DATA OF EXPERIMENT 1

Source of Variation	S.S.	D.F.	M.S.	F
Within Ss				
A (interval)	4.10079	1	4.10079	40.32**
AD	.00147	1	.00147	.01
AE	.01991	1	.01991	.20
ADE	.19286	1	.19286	1.90
A x Ss within groups (error term)	3.66142	36	.10171	
B (position of syllabic break)	.04324	3	.01441	1.07
BD	.07019	3	.02340	1.74
BE	.03035	3	.01012	.75
BDE	.04340	3	.01447	1.08
B x Ss within groups (error term)	1.44997	108	.01343	
C (word length)	.00032	1	.00032	.02
CD	.02244	1	.02244	1.62
CE	.00079	1	.00079	.06
CDE	.00252	1	.00252	.18
C x Ss within groups (error term)	.50003	36	.01389	
AB	.01208	3	.00403	.51
ABD	.01653	3	.00551	.70
ABE	.01183	3	.00394	.50
ABDE	.00071	3	.00024	.03
AB x Ss within groups (error term)	.85271	108	.00790	
AC	.00166	1	.00166	.13
ACD	.04573	1	.04573	3.45
ACE	.00347	1	.00347	.26
ACDE	.00969	1	.00969	.73
AC x Ss within groups (error term)	.47787	36	.01327	
BC	.09802	3	.03267	2.74
BCD	.06214	3	.02071	1.74
BCE	.08462	3	.02821	2.37
BCDE	.01394	3	.00465	.39
BC x Ss within groups (error term)	1.28635	108	.01191	
ABC	.03166	3	.01055	1.53
ABCD	.02537	3	.00846	1.23
ABCE	.01750	3	.00583	.84
ABCDE	.00090	3	.00030	.04
ABC x Ss within groups (error term)	.74470	108	.00690	
Between Ss				
D (scan direction)	.03645	1	.03645	.09
E (representation type)	.97110	1	.97110	2.34
DE	.24531	1	.24531	.59
Ss within groups (error term)	14.96457	36	.41568	

*p < .05.

**p < .01.

CHAPTER III

EXPERIMENT 2

The second experiment to be reported is also concerned with two questions. The first question is: What factors might control the formation of compound visual images? The second question, once again, is: What is the relationship between visual imagery and eyeblinking?

Since this dissertation is concerned with visual imagery for verbal material, there are two factors which could possibly control the formation of compound visual images. These factors are the frequency of occurrence of the verbal material and the degree of pronounceability of the verbal material.

In this experiment subjects will be presented with stimulus items which differ in frequency of occurrence and degree of pronounceability. The subjects' task is to visually imagine the letters of the stimulus items as lower case typewritten letters and to overtly signal the vertical size of these letters as was done in Experiment 1. If frequency of occurrence and degree of pronounceability control the formation of compound visual images, then stimulus items which are more frequent and more pronounceable should produce quicker and more accurate responses.

The relationship between visual imagery and eyeblinking is also examined in this experiment. The subjects' eyeblinks will be recorded during the imagery trials and during the inter-trial intervals. If visual imagery suppresses eyeblinking, then the subjects' blink rate should be slower during the imagery trials than during the inter-trial intervals.

Method

Subjects

The subjects used in this experiment were 12 Oklahoma State University undergraduates who were paid $1.50 for their participation. The subjects were native speakers of English who could read without glasses or contact lens.

Experimental Design

There are three independent variables which are factorially varied in this experiment. The first independent variable, the frequency of occurrence of the stimulus items, has two levels. There are stimulus items with a high frequency of occurrence (HF) and stimulus items with a low frequency of occurrence (LF). The second independent variable, the degree of pronounceability of the stimulus items, also has two levels. There are stimulus items with a high degree of pronounceability (HPr) and stimulus items with a low degree of pronounceability (LPr). These two independent variables, when factorially varied, produce four types of stimulus items: HF/HPr stimulus items (for example, "this"); LF/HPr stimulus items (for example, "thas"); HF/LPr stimulus items (for example, "abcd"; and LF/LPr stimulus items (for example, "thrs"). The HF/HPr stimulus items were one syllable four letter words with a Thorndike-Lorge (1944) frequency of AA and a Mayzner-Tresselt (1965) frequency of 1 or above. The LF/HPr stimulus items were obtained by replacing the vowel in the HF/HPr stimulus items with another vowel so that a non-word resulted (for example, "this" - "thas"). The LF/HPr stimulus items had a Mayzner-Tresselt frequency of zero. The LF/LPr stimulus items were obtained by replacing the vowel in the HF/HPr stimulus items with a consonant so that a non-word resulted (for example, "this - "thrs"). The LF/LPr stimulus items also had a Mayzner-Tresselt frequency of zero. The HF/LPr stimulus items involved a different type of frequency. These stimulus items were four letter strings from the alphabet (for example, "abcd") which probably have a relatively high frequency of occurrence and a low degree of pronounceability. The notion here is that such stimulus items will have high frequencies of occurrence since any use of a dictionary, phone book, or library card catalog is based on such strings. Nonetheless, this is merely a plausible argument and it is emphasized that a different type of frequency may be involved with the HF/LPr stimulus items. The stimulus items which were used in this experiment appear in Appendix A. The third independent variable, the interval during which eyeblinks are recorded, also has two levels. There is the trial interval and the inter-trial interval.

There are four dependent variables which are examined in this experiment. The first dependent variable is response time. Response time is defined as the time lapse between the onset of a stimulus item and the S's final response to the stimulus. The second dependent variable is response latency. Response latency is defined as the time lapse between the onset of a stimulus item and the S's first response to the stimulus. The third dependent variable is the number of classification errors made in response to the stimulus. The fourth dependent variable is blink rate.

The above information concerning experimental design can be integrated at this point. The part of the experiment concerned with the factors which might control the formation of compound visual images involves a 2 x 2 factorial design. The first factor is the frequency variable. The second factor is the pronounceability variable. There are repeated measures on both factors; that is, all 12 Ss serve in all four conditions. Response time, response latency, and number of errors are the dependent measures associated with this design.

The part of the experiment concerned with the relationship between visual imagery and eyeblinking involves a 2 x 2 x 2 factorial design. The first factor is the eyeblink recording interval variable. The second factor is the frequency variable. The third factor is the pronounceability variable. There are repeated measures on all factors; that is, all 12 Ss serve in all eight conditions. Blink rate is the dependent variable associated with this design.

Procedure

The procedure used in this experiment is identical to the procedure used in the imagery conditions of Experiment 1. The instructions to the Ss in this experiment appear in Appendix B. The Ss were given 40 practice trials involving 5 of each of the four types of stimulus items presented twice. Following the practice trials, the Ss were given 60 test trials involving 15 of each of the 4 types of stimulus items. Each S received a different random order of the 60 test items.

Results

The four response measures used in this experiment will be examined in succession. Concerning the response time measure, the Ss' mean response time for the 15 trials in each condition of the experiment was calculated. The Ss' means for each condition may be found in Table XVII in Appendix C. These means were the units used in a 2 x 2 AOV of the response time data. The means and standard errors for the 12 Ss' means are presented in Table IX. The response time data is presented graphically in Figure 4. Table X presents the AOV results for the response time data. An examination of Table IX, Figure 4, and Table X reveals the following: the frequency factor did not have a significant effect on response time ($F = 1.78$, $P > .05$); the pronounceability factor did, however, have a significant effect on response time ($F = 33.38$, $P < .01$). These main effects must, however, be qualified because there was a significant frequency by pronounceability interaction ($F = 10.45$, $P < .05$). The basis for this significant interaction lies in the Ss' responses in the HF/LPr condition. The Ss in the HF/LPr condition took relatively longer to complete the imagery task than did the Ss in the other conditions.

TABLE IX

MEAN RESPONSE TIME (SECS) AND STANDARD ERRORS FOR EACH CONDITION OF EXPERIMENT 2

	HF		LF	
	Mean	S.E.	Mean	S.E.
HPr	3.04	(.56)	3.08	(.64)
LPr	3.53	(.70)	3.32	(.76)

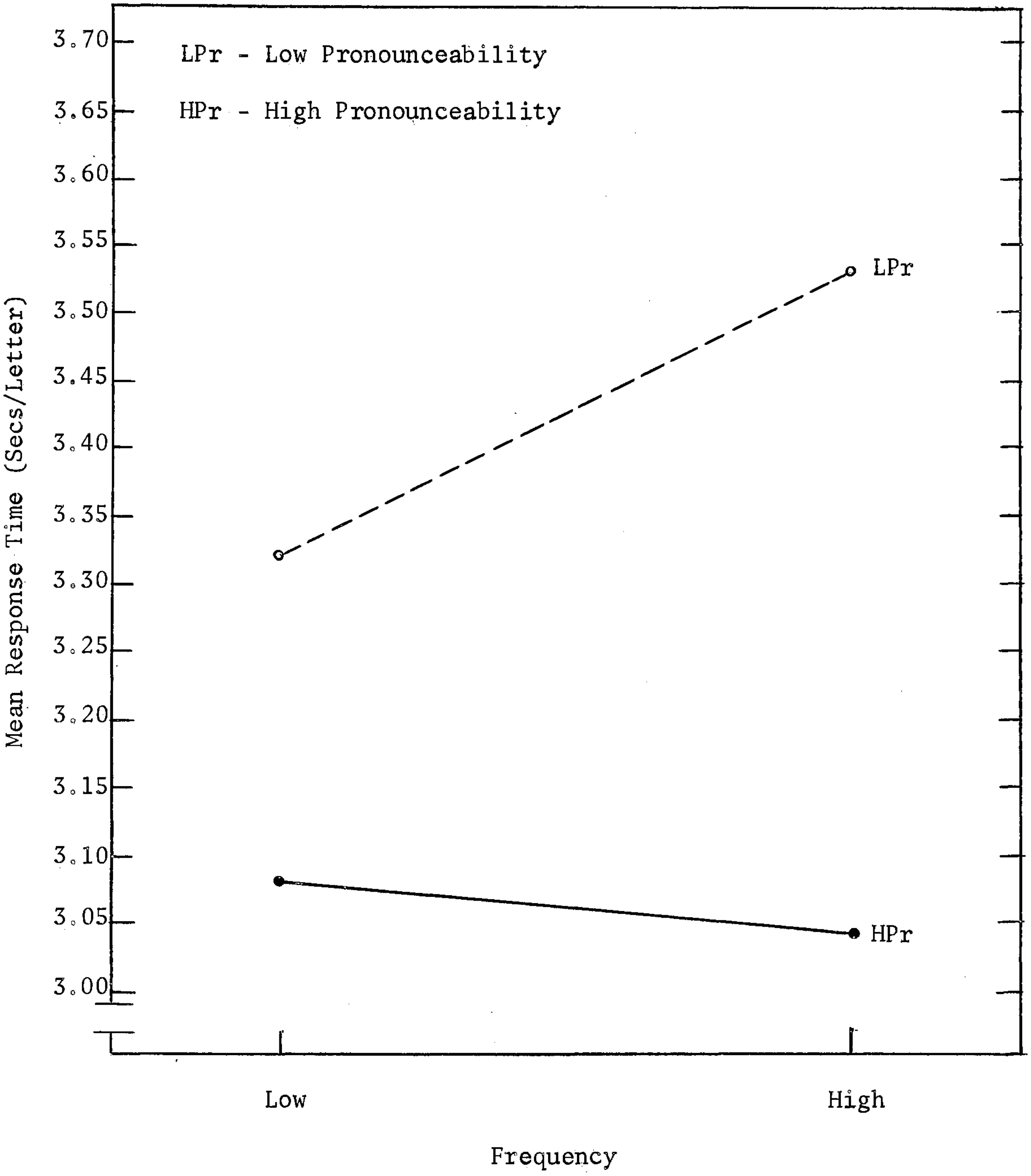

Figure 4. Experiment 2 - Response Time as a Function of Frequency of Occurrence, With Pronounceability as the Parameter

TABLE X

AOV OF THE RESPONSE TIME DATA OF EXPERIMENT 2

Source of Variation	S.S.	D.F.	M.S.	*F*
A (frequency)	.10083	1	.10083	1.78
AS (error term)	.62417	11	.05674	
B (pronounceability)	1.61333	1	1.61333	33.38**
BS (error term)	.53167	11	.04833	
AB	.18750	1	.18750	10.45*
ABS (error term)	.19750	11	.01795	

*P < .05.

**P < .01.

Concerning the response latency measure, the *Ss*' mean response latency for the 15 trials in each condition of the experiment was calculated. The *Ss*' means for each condition may be found in Table XVIII in Appendix C. These means were used in a 2 x 2 AOV of the response latency data. The means and standard errors for the 12 *Ss*' means are presented in Table XI. Figure 5 presents the response latency data graphically. The AOV results for the response latency data are presented in Table XII. A similar pattern of results occurred with the response latency data as occurred with the response time data. The frequency factor did not have a significant effect ($F = 2.59$, $P > .05$); the pronounceability factor did have a significant effect on response latency ($F = 48.09$, $P < .01$). The frequency-pronounceability interaction was not significant with the response latency data ($F = 3.00$, $P > .05$). However, an interaction pattern similar to the significant interaction found with the response time data occurred.

TABLE XI

MEAN RESPONSE LATENCY (SECS) AND STANDARD ERRORS FOR EACH CONDITION OF EXPERIMENT 2

	HF		LF	
	Mean	S.E.	Mean	S.E.
HPr	1.62	(.41)	1.60	(.40)
LPr	1.88	(.42)	1.76	(.45)

TABLE XII

AOV OF RESPONSE LATENCY DATA OF EXPERIMENT 2

Source of Variation	S.S.	D.F.	M.S.	F
A (frequency)	.05333	1	.05333	2.59
AS (error term)	.22667	11	.02061	
B (pronounceability)	.52083	1	.52083	48.09**
BS (error term)	.11917	11	.01083	
AB	.03000	1	.03000	3.00
ABS (error term)	.11000	11	.01000	

*$P < .05$.

**$P < .01$.

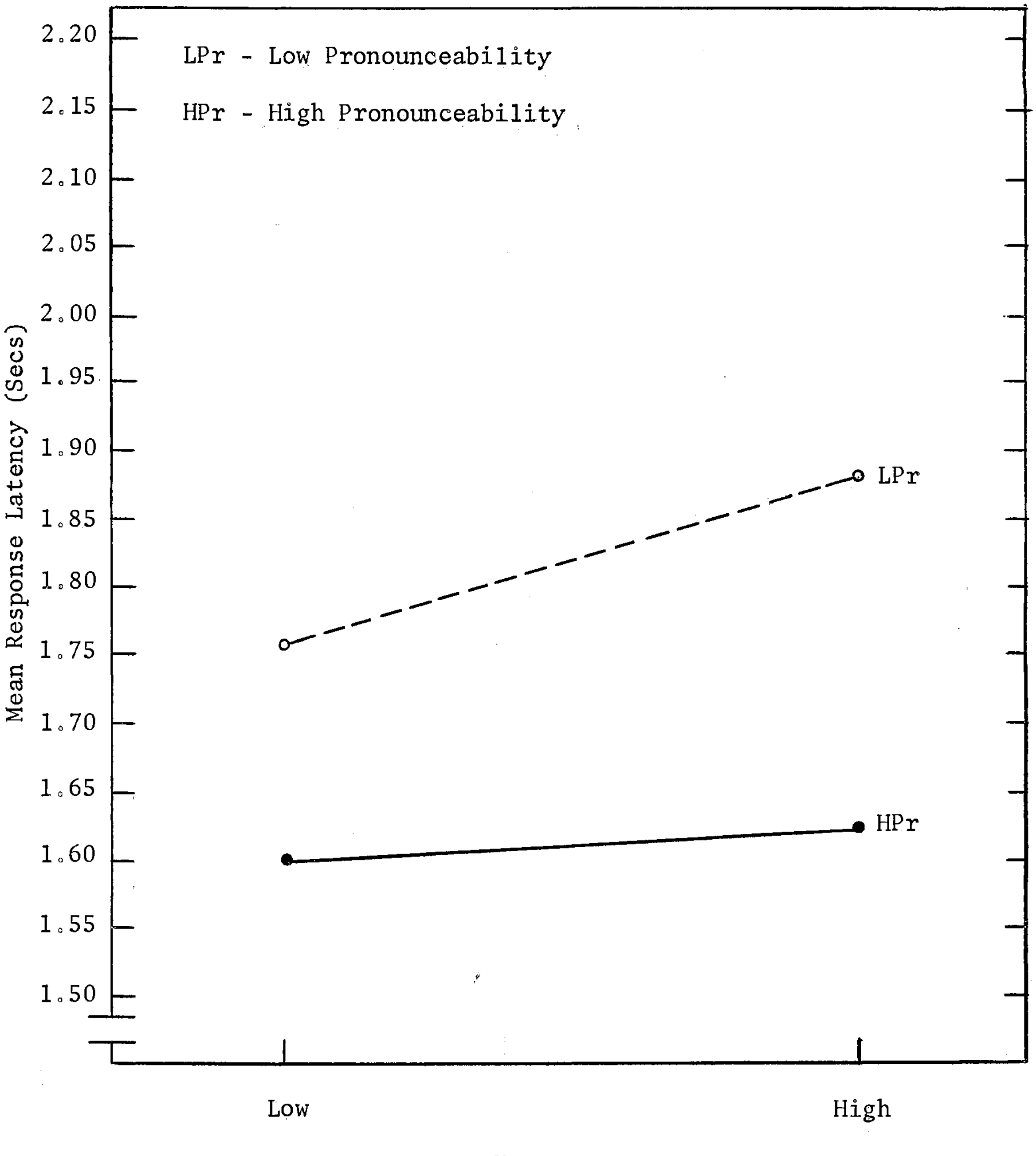

Figure 5. Experiment 2 - Response Latency as a Function of Frequency of Occurrence, With Pronounceability as the Parameter

As in Experiment 1, the response time and latency analyses were based on correct responses only.

The Ss' total number of errors for the 15 trials in each condition was also calculated. The Ss' total number of errors out of 15 possible errors for each condition may be found in Table XIX in Appendix C. These values were used in a 2 x 2 AOV of the error data. The means and standard deviations for the 12 Ss' total number of errors out of the 15 possible errors are presented in Table XIII. Figure 6 presents the error data graphically. The AOV results for the error data are presented in Table XIV. Once again, a similar pattern of results occurred with the error data as occurred with the response time data. The frequency factor did not have a significant effect ($F = .10$, $P > .05$) and the pronounceability factor did have a significant effect ($F = 12.48$, $P < .05$). The frequency by pronounceability interaction was not significant with the error data ($F = .71$, $P > .05$). However, once again, an interaction pattern similar to the significant interaction found with the response time data occurred.

TABLE XIII

MEAN NUMBER OF ERRORS AND STANDARD DEVIATIONS FOR EACH CONDITION OF EXPERIMENT 2

	HF		LF	
	Mean	S.E.	Mean	S.E.
HPr	.33	(.65)	.42	(.67)
LPr	1.58	(1.24)	1.33	(.78)

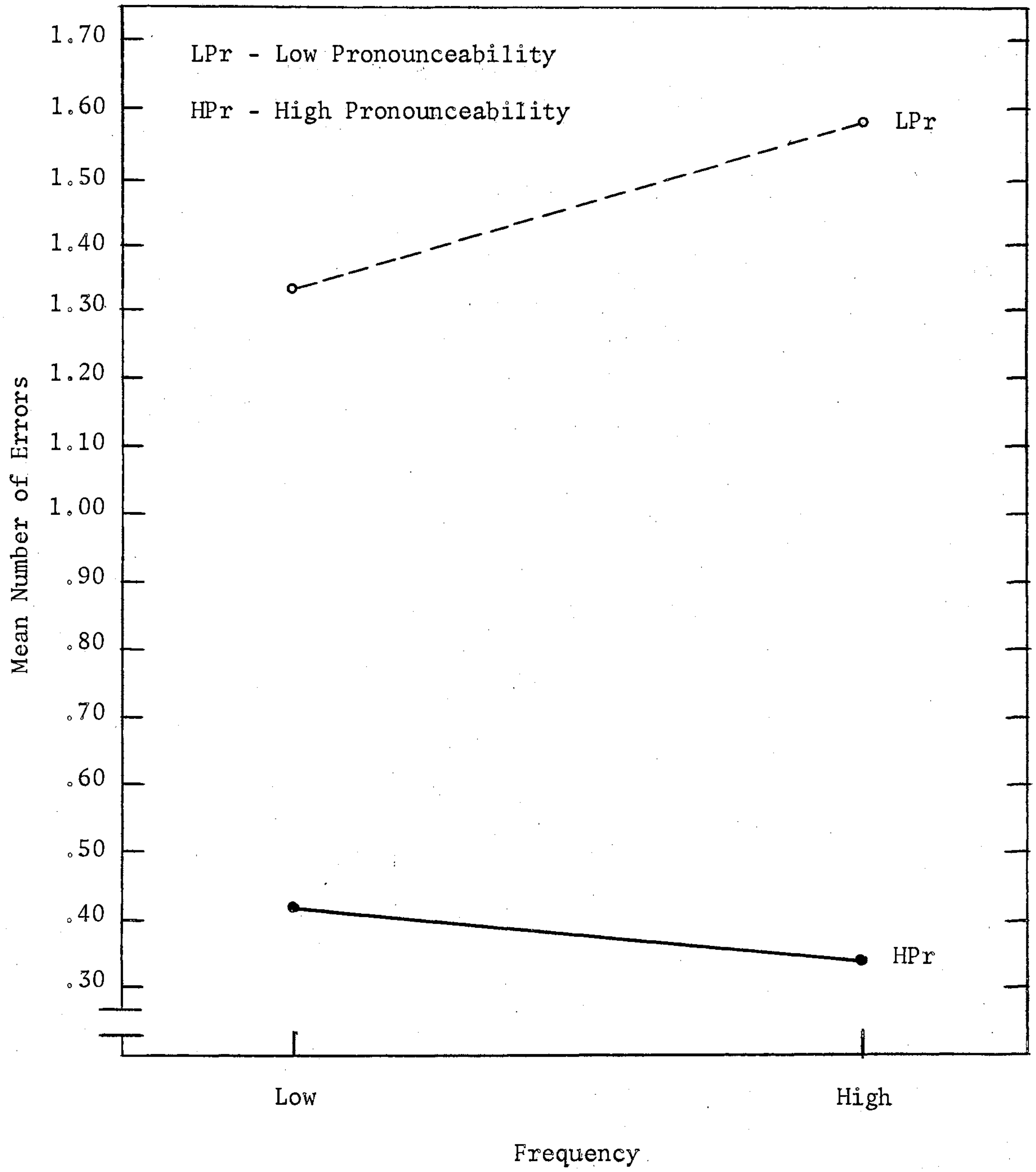

Figure 6. Experiment 2 - Number of Errors as a Function of Frequency of Occurrence, With Pronounceability as the Parameter

TABLE XIV

AOV OF THE ERROR DATA OF EXPERIMENT

Source of Variation	S.S.	D.F.	M.S.	*F*
A (frequency)	.08333		.08333	.10
AS (error term)	9.41667		.85606	
B (pronounceability)	14.08333		14.08333	12.48**
BS (error term)	12.41667		1.12879	
AB	.03333		.03333	.71
ABS (error term)	5.16667		.46970	

*$p < .05$.

**$p < .01$.

The *Ss'* mean blink rate for the 15 trials and 15 inter-trial intervals was also calculated. The *Ss'* mean blink rate for each condition may be found in Table XX in Appendix C. These rates were used in a 2 x 2 x 2 AOV of the eyeblink data. The means and standard errors for the 12 *Ss'* mean blink rates appear in Table XV. The AOV results for the eyeblink data are presented in Table XVI. An examination of Table VI and Table VII reveals that the eyeblink recording interval factor was not significant ($F = 1.73$, $P > .05$) nor were any of the other main effects or any of the interaction effects.

TABLE XV

MEAN BLINK RATE (BLINKS/SEC) AND STANDARD ERRORS FOR EACH CONDITION OF EXPERIMENT 2

	HF				LF			
	Trial		Inter-trial		Trial		Inter-trial	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
HPr	.11	(.18)	.19	(.18)	.12	(.18)	.17	(.15)
LPr	.13	(.22)	.17	(.15)	.13	(.22)	.19	(.16)

TABLE XVI

AOV OF THE EYEBLINK DATA OF EXPERIMENT 2

Source of Variation	S.S.	D.F.	M.S.	F
A (interval)	.07426	1	.07426	1.73
AS (error term)	.47195	11	.04290	
B (frequency)	.00001	1	.00001	.01
BS (error term)	.00780	11	.00071	
C (pronounceability)	.00271	1	.00271	.03
CS (error term)	.01975	11	.00180	
AB	.00008	1	.00008	1.51
ABS (error term)	.02953	11	.00268	
AC	.00175	1	.00175	.57
ACS (error term)	.03371	11	.00306	
BC	.00193	1	.00193	1.50
BCS (error term)	.01424	11	.00129	
ABC	.00271	1	.00271	1.87
ABCS (error term)	.01595	11	.00145	

*P < .05.

**P < .01.

Further discussion of the results of Experiment 2 will be postponed until the final chapter. In the final chapter there is an integrated discussion of both Experiment 1 and Experiment 2.

CHAPTER IV

DISCUSSION

This dissertation has been concerned with two major issues. The first issue concerned an informative function of visual imagery. More specifically, the issue concerned the formation of compound visual images. The second issue concerns the relationship between visual imagery and eyeblinking. This discussion chapter will contain three sections. In the first section the issue concerning the formation of compound visual images will be discussed. In the second section the issue concerning the relationship between visual imagery and eyeblinking will be considered. The third section presents suggestions for future research in the area of visual imagery.

Compound Visual Images

The results of the two experiments of this dissertation provide additional evidence of the formation of compound visual images in the visual imagery system. The following discussion consists of a detailed examination and interpretation of the results of Experiments 1 and 2. The discussion of Experiments 1 and 2 will be based for the most part on the response time data. The response latency and the error data both appear to follow a pattern similar to the response time data and, therefore, do no usually provide unique information. Unless there is a clear reference to the response latency or the error data, the discussion will be concerned with the response time data.

In Experiment 1 the following significant results were found. The position of syllabic break by word length interaction was significant. The main effect of the scan direction factor was significant; it took significantly less time to respond to stimulus words in a forward direction than in a backward direction. The main effect of the representation type factor was also significant; it took significantly less time to respond to stimulus words when the stimulus words were perceptually available than when the stimulus words were visually imagined. These main effects, however, must be qualified because of several two way in interactions. The scan direction by representation type interaction was significant; the difference in response rate between forward and backward scanning was greater in the image conditions than in the percept conditions. The scan direction by word length interaction was also significant; the difference in response time between forward and backward scanning was greater with 8-letter words than with 4-letter words. The representation type by word length interaction was also significant; the difference in response rate between the image conditions and the percept conditions was greater with 8-letter words than with 4-letter words. The two way interaction effects, however, must also be qualified because of a significant three way interaction. The scan direction by representation type by word length interaction was significant and is, perhaps, the most important finding in Experiment 1. This significant three way interaction indicates that the difference in response rate between forward and backward scanning was greater when 8-letter words were visually imagined than when 4-letter words were visually imagined or when 4- or 8-letter words were perceptually available. This result appears to indicate that the visual imagery system has a limited capacity for forming compound visual images. That is, the visual imagery system apparently has a limited capacity for the spatially parallel representation of visual information such as the individual letters of words. Because this capacity is limited, sequencing between the compound visual images is necessary. In the visual percept conditions, any necessary sequencing is accomplished by eye movement. The sequencing in the visual percept condition can be accomplished almost as quickly with backward scanning as with forward scanning, regardless of word length. However, in the visual image conditions the necessary sequencing may be accomplished with verbal processes such as covertly speaking the name of the next letter or syllable in order to retrieve the visual image of that letter or syllable (Weber and Kelley, 1972; Weber, Kelley, and Little, 1972). The sequencing in the visual image condition must be accomplished less quickly with backward scanning than with forward scanning, especially with 8-letter words which present more sequencing problems than 4-letter words do.

Because it is less difficult to spell the letters or name the syllabes of a word in a forward direction than in a backward direction, because this sequencing mechanism probably must be used to sequence between compound visual images but not visual percepts, and because 4-letter words present fewer sequencing problems than do 8-letter words the three way scan direction by representation type by word length interaction was significant. Because 4-letter visually imagined words were responded to more quickly than 8-letter visually imagined words this provides further evidence of the formation of compound visual images in the visual imagery system. One property of a word which determines whether the individual letters can be represented in a compound visual image is, apparently, its size or length. Another property important in this regard was identified in Experiment 2.

In Experiment 2 the following significant results were found. The main effect of the frequency factor was not significant. The main effect of the pronounceability factor was, however, significant; it took significantly less time to respond to items rated high on pronounceability than items rated low on pronounceability. The interaction of these two factors was also significant.

This significant two way interaction indicates that the items rated high on pronounceability were responded to more quickly than the items rates low on pronounceability; however, this difference in response time was greater with high frequency items than with low frequency items. The response times to the HF/LPr items (for example, "abcd") are probably the basis on this interaction. The response times to these items were longer than the response times to the three other types of items. Why should this be? The answer to this question is twofold. First, the HF/LPr items probably do not rate as high on the frequency dimension as was initially thought. These items, while frequently experienced when individuals search through dictionaries, telephone books, or library catalog cards, are probably not as frequently experienced as the other items rated high on the frequency dimension (that is, words such as "this"). Second, the HF/LPr items may have rated even lower on the pronounceability dimension than the other items rated low on this dimension (that is, non-words such as "thrs"). A non-word such as "thrs" may be encoded as "'thrs' with a 'r' in place of an 'i'" by subjects. A non-word such as "thrs" may, therefore, be more pronounceable than a non-word such as "abcd" because "thrs" is closer to being a word than is "abcd". These two reasons, a lower than expected frequency and pronounceability for the HF/LPr items, are suggested to account for the response times to the HF/LPr items and the resulting significant interaction between the frequency and pronounceability factors.

The most important finding of Experiment 2 is, therefore, the significant effect which the pronounceability of the stimulus items had on the response time to those items. The following explanation is suggested to account for this effect. Both the frequency (Winnick and Kressel, 1965) and pronounceability factors (Gibson, Bishop, Schiff, and Smith, 1964) probably affected the initial recognition of the stimulus items. Once recognized the subjects engaged in either (1) pronouncing the name of the stimulus item, if the item rated high on pronounceability, in order to retrieve a compound visual image consisting of the lower case spatial forms of the individual letters of the stimulus item or (2) spelling the stimulus item, if the item rated low on pronounceability, in order to retrieve a succession of visual images consisting of the lower case spatial forms of the individual letters of the stimulus items. The formation of compound visual images with the HPr stimulus items reduced the necessary response time in relation to the formation of successive visual images with the LPr stimulus items.

If the above explanation is correct, then the HPr conditions should produce fewer errors than the LPr conditions because compound visual images would not require sequencing between the component visual images as would successive visual images. When sequencing is required as with LPr items, then there is an increased probability of errors, both of commission and omission, occurring. This is exactly what was found: the HPr conditions resulted in fewer errors than did the LPr conditions.

In summary, the results of both Experiments 1 and 2 indicate that compound visual images may be formed in the visual imagery system. Experiment 1 indicates that the size of the word to be visually imagined is important in the formation of a compound visual image of the word. Experiment 2 indicates that the pronounceability of the word to be visually imagined is important in the formation of a compound visual image of the word.

Visual Imagery and Eyeblinking

Concerning the relationship between visual imagery and eyeblinking, in the first experiment the subjects' blink rate was significantly lower during the trials than during the inter-trial intervals. However, during the second experiment the subjects' blink rate during the trials tended to be lower but was not significantly so during the imagery trials than during the inter-trial intervals. The following discussion provides a detailed examination and an interpretation of these results.

In Experiment 1 the blink rate was significantly suppressed during the trials in relation to the inter-trial intervals. However a more important finding was that the eyeblink recording interval factor did not significantly interact with any other factors. More specifically, the eyeblink recording interval by representation type interaction was not significant. The fact that this interaction was not significant indicates that both visual imagery and visual perception suppressed the subjects' blink rate. If the visual perception conditions had been responsible for producing the significant main effect of the eyeblink recording interval factor whereas the visual imagery conditions were not involved in producing the significant main effect, then the eyeblink recording interval by representation type interaction would have been significant. Since this interaction was not significant, it is possible to conclude that visual imagery, as well as visual perception, significantly suppressed eyeblinking in Experiment 1.

In Experiment 2 the blink rate tended to be suppressed during the imagery trials in relation to inter-trial intervals but was not significantly suppressed. Why is there this discrepancy between the results of Experiments 1 and 2? The answer to this question lies in the following considerations. Experiment 2 was actually the first experiment to be conducted. In Experiment 2 the criterion for considering a recorded ocular movement as an eyeblink was based on the amplitude of the recorded ocular movement. During the calibration of the eye movement recording equipment, it appeared that recorded eyeblinks differed from recorded eye movements not only in appearance but also in amplitude. Since an eyeblink criterion based on amplitude seemed to be the more objective approach, this was the eyeblink criterion established for Experiment 2. However, this criterion was probably too conservative. If the less conservative eyeblink criterion based on appearance had been used in Experiment 2, then the suppression of the blink rate during the imagery trials in relation to the inter-trial intervals might have been significant rather than only suggestive. In Experiment 1 the criterion for considering a recorded ocular movement as an eyeblink was based on the appearance of the recorded ocular movement. This was believed to be a more reasonable approach based on the outcome of Experiment 2.

In both Experiments 1 and 2, the two individuals who scored the eyeblink data reported very little difficulty in determining which recorded ocular movements were eyeblinks and which were eye movements. This difference in eyeblink criteria is the suggested explanation for the discrepancy between Experiments 1 and 2.

The results of Experiment 1 and perhaps Experiment 2 can be interpreted as follows: visual imagery as well as visual perception apparently can suppress eyeblinking. In visual perception eyeblinking temporarily erases or interferes with visual percepts and eyeblinking is, therefore, suppressed. In visual imagery eyeblinking may temporarily erase or interfere with visual images and, therefore, be suppressed. Alternatively, eyeblinking may be suppressed during visual imagery without serving any significant function. It may be suppressed during visual imagery because visual imagery is similar to visual perception and the ocular habits associated with visual perception generalize to visual imagery. Regardless of which explanation may be correct, visual imagery does appear to suppress eyeblinking.

Future Research

As discussed in the introductory chapter, one of the proposed functions of visual imagery is to arouse the individual. The experimental evidence supporting this arousal function is, at present, sometimes contradictory and sometimes inconclusive. This research problem might, possibly, be profitably approached in the following manner. In order to demonstrate the arousal function of visual imagery the technique of selective interference as used by Weiner, Weber, and Concepcion (1973) might be combined with a different response measure, penile tumescence. The technique of selective interference permits the arousal function of visual imagery to be measured independently from the arousal function of verbal processes. Penile tumescence, which can be measured with a mercury filled silicon strain gauge, has proven to be a useful response measure in research on dreaming, a cognitive activity usually involving visual imagery. If subjects are presented sexual arousing stimulus material (for example, passages from Lady Chatterley's Lover by D. H. Lawerence) and if the subjects show greater penile tumescence when required to listen to this material than when required to listen and read this material, then it would be possible to conclude that visual imagery has some capacity to arouse the individual which is independent of the capacity of verbal processes to arouse the individual.

Future research in the area of visual imagery may also be important in validating the existence of a hypnotic state of consciousness and behavior. There are currently two views of hypnosis (Hilgard, 1971). In the skeptical view hypnotized individuals are believed to be in a normal state which is influenced by factors which usually affect behavior. In the credulous view hypnotized individuals are believed to be in an altered state. Although factors which usually affect behavior such as increased motivation and role playing have an important influence during hypnosis (Orne, 1959), the credulous view maintains that there is still a difference between the normal state of an individual and his or her hypnotic state. One such difference which has been suggested (Orne, 1959) is the decreased ability of the hypnotized individual to distinguish fantasy from reality. This suggestion could possibly be evaluated as follows. There would be two groups of subjects, a group of hypnotized subjects and a group of non-hypnotized subjects. On each trial both groups would be asked to visually imagine a single alphabetic letter of a particular size in a particular location on a viewing screen in front of the subject. On some trials a corresponding alphabetic letter would be faintly presented on the viewing screen. On other trials the corresponding alphabetic letter would not be presented on the viewing screen. On each trial the subjects would be asked if an alphabetic letter had appeared on the screen. The visual percept present trials would serve to establish some response set in the subjects for reporting experiencing visual perceptions. The visual percept absent trials would serve to evaluate the hypothesis that hypnotized individuals confuse images and perceptions more so than non-hypnotized individuals. If on the visual percept absent trials the hypnotized subjects see significantly more actual letters than the non-hypnotized subjects, then this could be interpreted as supporting the hypothesis that hypnotized individuals confuse fantasy and reality more so than non-hypnotized individuals. If this hypothesis were supported, then this evidence, as the decreased blink rate during hypnosis (Weitzenhoffer, 1969), would provide objective support for the existence of a hypnotic state of consciousness and behavior.

BIBLIOGRAPHY

Antrobus, J. S., Antrobus, J. S., and Singer, J. L. "Eye Movements Accompanying Daydreaming, Visual Imagery, and Thought Suppression." *Journal of Abnormal and Social Psychology*, Vol. 69 (1964), 244-252.

Appel, V. H., McCarron, L. T., and Manning, B. A. "Eyeblink rate: Behavioral Index of Threat? *Journal of Counseling Psychology*, Vol. 15 (1968), 153-157.

Atwood, G. "An Experimental Study of Visual Imagination and Memory." *Cognitive Psychology*, Vol. 2 (1971), 290-299.

Brooks, L. R. "The Suppression of Visualization by Reading." *Quarterly Journal of Experimental Psychology*, Vol. 19 (1967), 289-299.

Brooks, L. R. "Spatial and Verbal Components of the Act of Recall." *Canadian Journal of Psychology*, Vol. 22 (1968), 348-368.

Brower, D. "The Experimental Study of Imagery: I. The Relation of Imagery to Intelligence." *The Journal of General Psychology*, Vol. 36 (1947), 229-231.

Cautela, J. R., and Wisocki, P. A. "The Use of Imagery in the Modification of Attitudes Toward the Elderly: A Preliminary Report." *The Journal of Psychology*, Vol. 73 (1969), 193-199.

Clites, M. S. "Certain Somatic Activities in Relation to Successful and Unsuccessful Problem Solving." *Journal of Experimental Psychology*, Vol. 18 (1935), 708-724.

Diamond, E. "The Interpretation of Dreams." *New York Times Magazine*, February 12, 1967.

Drew, G. C. "Variations in Reflex Blink Rate During Visual-Motor Tasks." *Quarterly Journal of Experimental Psychology*, Vol. 3 (1951), 73-87.

Gibson, E. J., Bishop, C. H., Schiff, W., and Smith, J. "Comparison of Meaningfulness and Pronounceability as Grouping Principles in the Perception and Retention of Verbal Material." *Journal of Experimental Psychology*, Vol. 67 (1964), 173-182.

Hall, A. "The Origin and Purposes of Blinking." *The British Journal of Ophthalmology*, Vol. 29 (1945), 445-467.

Hilgard, E. R., Jones, L. V., and Kaplan, S. S. "Conditioned Discrimination as Related to Anxiety." Journal of Experimental Psychology, Vol. 42 (1951), 94-99.

Hill, D., and Williams, P. The Supernatural. New York: Hawthorn Books, 1965.

Huttenlocher, J. "Constructing Spatial Images: A Strategy in Reasoning." Psychological Review, Vol. 75 (1968), 550-560.

Huttenlocher, J., and Strauss, S. "Comprehension and a Statement's Relation to the Situation it Describes." Journal of Verbal Learning and Verbal Behavior, Vol. 7 (1968), 527-530.

John, E. R. Mechanisms of Memory. New York: Academic Press, 1967.

Lindgren, H. C., and Bryne, D. Psychology: An Introduction to a Behavioral Science. New York: John Wiley and Sons, Inc., 1971.

Mayzner, M. S., Tresselt, M. E., and Wolin, B. R. "Tables of Tetragram Frequency Counts for Various Word Length and Letter Position Combinations." Psychonomic Monograph Supplements, Vol. 1 (1965), 79-143.

McPherson, S. J. "The Effectiveness of Lighting - Its Numerical Assessment by Methods Based on Blinking Rates." Illuminating Engineering, Vol. 38 (1943), 520-522.

Meyer, D. R. "On the Interaction of Simultaneous Responses." Psychological Bulletin, Vol. 50 (1953), 204-220.

Meyer, D. R., Bahrick, H. P., and Fitts, P. M. "Incentive, Anxiety, and the Human Blink Rate." Journal of Experimental Psychology, Vol. 45 (1953), 183-187.

Morgan, C. T., and King, R. A. Introduction to Psychology. New York: McGraw-Hill Book Company, 1971.

Nelson, D. L., and Brooks, D. H. "Independence of Phonetic and Imaginal Features." Journal of Experimental Psychology, Vol. 97 (1973), 1-7.

Paivio, A. "Latency of Verbal Associations and Imagery to Noun Stimuli as a Function of Abstractness and Generality." Canadian Journal of Psychology, Vol. 20 (1966), 378-387.

Paivio, A. Imagery and Verbal Processes. New York: Holt, Rinehart, and Winston, Inc., 1971.

Paivio, A., and Foth, D. "Imaginal and Verbal Mediation and Noun Concreteness in Paired-Associate Learning: The Elusive Interaction." Journal of Verbal Learning and Verbal Behavior, Vol. 9 (1970), 384-390.

Ponder, E., and Kennedy, W. P. "On the Act of Blinking." Quarterly Journal of Experimental Physiology, Vol. 18 (1927), 89-110.

Roe, A. "A Study of Imagery in Research Scientists." Journal of Personality, Vol. 19 (1951), 459-470.

Rohwer, W. D., Jr. "Images and Pictures in Children's Learning: Research Results and Educational Implications." Psychological Bulletin, Vol. 73 (1970), 393-402.

Schmeidler, G. R. "Visual Imagery Correlated to a Measure of Creativity." Journal of Consulting Psychology, Vol. 29 (1965), 78-80.

Segal, S. J., and Fusella, V. "Effects of Imagining on Signal-to-Noise Ratio, With Varying Signal Conditions." British Journal of Psychology, Vol. 60 (1969), 459-464.

Sheehan, P. W., and Neisser, U. "Some Variables Affecting the Vividness of Imagery in Recall." British Journal of Psychology, Vol. 60 (1969), 71-80.

Short, P. L. "The Objective Study of Mental Imagery." British Journal of Psychology, Vol. 44 (1953), 38-51.

Simpson, H. M., Paivio, A., and Rogers, T. B. "Occipital Alpha Activity of High and Low Visual Imagers During Problem Solving." Psychonomic Science, Vol. 8 (1967), 49-50.

Taylor, J. A. "The Relationship of Anxiety to the Conditioned Eyelid Response." Journal of Experimental Psychology, Vol 41 (1951), 81-92.

Telford, C. W., and Thompson, N. "Some Factors Influencing Voluntary and Reflex Eyelid Responses." Journal of Experimental Psychology, Vol. 16 (1933), 524-539.

Thompson, R. F. Foundations of Physiological Psychology. New York: Harper and Row, Publishers, 1967.

Thorndike, E. L., and Lorge, I. The Teachers Word Book of 30,000 Words. New York: Columbia University Press, 1944.

Weber, R. J., and Bach, M. "Visual and Speech Imagery." British Journal of Psychology, Vol. 60 (1969), 199-202.

Weber, R. J., and Castleman, J. "The Time it Takes to Imagine." Perception and Psychophysics, Vol. 8 (1970), 165-168.

Weber, R. J., and Harnish, R. W. "Visual Imagery for Words: The Hebb Test." (Unpublished Manuscript, Oklahoma State University, 1973).

Weber, R. J., and Kelley, J. "Aspects of Visual and Acoustic Imagery." Psychonomic Science, Vol. 27 (1972), 121-122.

Weber, R. J., Kelley, J., and Headley, D. "Visual and Acoustic Imagery for Letters and Words." (Unpublished Manuscript, Oklahoma State University, 1973).

Weber, R. J., Kelley, J., and Little, S. "Is Visual Image Sequencing Under Verbal Control?" *Journal of Experimental Psychology*, Vol. 96 (1972), 354-362.

Weiner, E., Weber, R., and Concepcion, P. "Emotive Aspects of Visual Imagery." *Journal of Clinical Psychology*, in press.

Weitzenhoffer, A. M. "Eyeblink Rate and Hypnosis: Preliminary Findings." *Perceptual and Motor Skills*, Vol. 28 (1969), 671-676.

Winnick, W. A., and Kressel, K. "Tachistoscopic Recognition Thresholds, Paired-Associate Learning, and Immediate Recall as a Function of Abstractness-Concreteness and Word Frequency." *Journal of Experimental Psychology*, Vol. 70 (1965), 163-168.

APPENDIX A

STIMULUS ITEMS USED IN EXPERIMENTS 1 AND 2

Experiment 1

The following are the practice items used in Experiment 1:

4 Letter Words		8 Letter Words	
lion	only	advances	accounts
upon	also	entrance	improved
bury	busy	conclude	arranged
shoe	mule	practice	creature
thin	gate	daughter	contract.

The following are the test items used in Experiment 1:

4 Letter Words		8 Letter Words	
cake	army	breathed	congress
ring	baby	branched	crossing
face	hero	searched	distance
love	into	straight	handsome
star	lady	thoughts	darkness
able	body	although	friendly
away	copy	approach	grounded
evil	easy	exchange	knighted
obey	many	observer	scratchy
open	pity	instance	strongly.

Experiment 2

The following are the practice items used in Experiment 2:

HF/HPr	LF/HPr	LF/LPr	HF/LPr
ship	shup	shnp	cdef
know	knaw	knrw	defg
till	tull	tcll	higk
when	whan	whvn	mnop
with	weth	wsth	tuvw.

The following are the test items used in Experiment 2:

HF/HPr	LF/HPr	LF/LPr	HF/LPr
back	beck	bmck	abcd
beds	bods	bwds	bcde
call	cill	crll	efgh
find	fand	fmnd	fghi
from	fram	frvm	ijkl
hand	hond	hwnd	jklm
just	jist	jxst	klmn
king	kong	kzng	lmno
less	luss	lcss	opqr
long	lang	lmng	pqrs
most	mest	mnst	qrst
them	thom	thcm	rstu
this	thas	thrs	vwxy
what	whut	whwt	wxyz
will	woll	wxll	ghij.

APPENDIX B

INSTRUCTIONS TO <u>S</u>s IN EXPERIMENTS 1 AND 2

Experiment 1

Forward Percept Condition

This experiment is concerned with individuals' visual perception of the alphabetic letters of words. Before beginning the experiment I'd like to familiarize you with the words which will be used in this experiment. Would you please spell aloud the words which I speak to you? (Spelling Familiarization Test)

I'll now continue with the instructions.

The lower case typewritten letters of the English alphabet can be divided into two classes based on the vertical size of the alphabetic letters. That is, some of the alphabetic letters are vertically small and some of the alphabetic letters are vertically large. (Illustration)

In the experiment which follows you will be shown various words on the viewing screen in front of you. These words will be presented in lower case letters. (Illustration) Your task will be to signal the vertical size of the individual letters of a word using the switches in front of you. One switch is for small letters, as indicated, and the other switch is for large letters, as indicated.

In signalling the vertical size of the individual letters of a word you should start with the initial left-hand letter and proceed to the final right-hand letter. For example, with the word, "tall", you would respond to the vertical size of the individual letters in the following fashion: large, small, large, large.

Do you have any questions at this point?

The visual presentation of the words will be initiated by you. Nearby your right foot you will find a button which when briefly depressed by your right foot will visually present a word on the viewing screen in front of you. All that is required to operate this button is a light tap with your right foot. Please do not step on the button in too rough a manner and don't hold it down.

When you finish responding to the vertical size of the individual letters of a word you are to say "Finished". Upon hearing this signal I will respond "OK". Anytime after I respond "OK" and you are ready for another word you should lightly tap the foot button in order to visually present yourself the next word. When you have finished responding say "Finished" and I will reply "OK". We will continue in this manner throughout the experiment.

Do you have any questions at this point?

In responding to the vertical size of the individual letters of a word you should respond as quickly as possible without making any mistakes.

During the experiment you will wear these special glasses which will monitor the movement of your eyes. During the experiment you should always be looking at the viewing screen in front of you and you should try to move your head as little as possible. The headrest will help keep your head stationary. Would you now put on these special glasses? I'll adjust them so that they are reasonably comfortable.

Any questions before we begin the experiment? We will have several practice trials before we have the test trials. Remember to respond as quickly and as accurately as possible. Please tell me whenever a blank slide appears. You may start as soon as I say "OK".

This concludes the experiment. Please do not discuss your participation in the experiment with any friends who might participate so that everyone will start out equally unfamiliar with the experimental task.

Thank you for your time and cooperation.

Backward Percept Condition

This experiment is concerned with individuals' visual perception of the alphabetic letters of words. Before beginning the experiment I'd like to familiarize you with the words which will be used in this experiment. Would you please spell aloud the words which I speak to you? (Spelling Familiarization Test)

I'll now continue with the instructions.

The lower case typewritten letters of the English alphabet can be divided into two classes based on the vertical size of the alphabetic letters. That is, some of the alphabetic letters are vertically small and some of the alphabetic letters are vertically large. (Illustration)

In the experiment which follows you will be shown various words on the viewing screen in front of you. These words will be presented in lower case letters. (Illustration) Your task will be to signal the vertical size of the individual letters of a word using the switches in front of you. One switch is for small letters, as indicated, and the other switch is for large letters, as indicated.

In signalling the vertical size of the individual letters of a word you should start with the initial right-hand letter and proceed to the final left-hand letter. For example, with the word, "tall", you would respond to the vertical size of the individual letters in the following fashion: large, large, small, large.

Do you have any questions at this point?

The visual presentation of the words will be initiated by you. Nearby your right foot you will find a button which when briefly depressed by your right foot will visually present a word on the viewing screen in front of you. All that is required to operate this button is a light tap with your right foot. Please do not step on the button in too rough a manner and don't hold it down.

When you finish responding to the vertical size of the individual letters of a word you are to say "Finished". Upon hearing this signal I will respond "OK". Anytime after I respond "OK" and you are ready for another word you should lightly tap the foot button in order to visually present yourself the next word. When you have finished responding say "Finished" and I will reply "OK". We will continue in this manner throughout the experiment.

Do you have any questions at this point?

In responding to the vertical size of the individual letters of a word you should respond as quickly as possible without making any mistakes.

During the experiment you will wear these special glasses which will monitor the movement of your eyes. During the experiment you s-ould always be looking at the viewing screen in front of you and you should try to move your head as little as possible. The headrest will help keep your head stationary. Would you now put on these special glasses? I'll adjust them so that they are reasonably comfortable.

Any questions before we begin the experiment? We will have several practice trials before we have the test trials. Remember to respond as quickly and as accurately as possible. Please tell me whenever a blank slide appears. You may start as soon as I say "OK".

This concludes the experiment. Please do not discuss your participation in the experiment with any friends who might participate so that everyone will start out equally unfamiliar with the experimental task.

Thank you for your time and cooperation.

Forward Image Condition

This experiment is concerned with individuals' visual memory of the alphabetic letter of words. Before beginning the experiment I'd like to familiarize you with the words which will be used in this experiment. Would you please spell aloud the words which I speak to you? (Spelling Familiarization Test)

I'll now continue with the instructions.

The lower case typewritten letters of the English alphabet can be divided into two classes based on the vertical size of the alphabetic letters. That is, some of the alphabetic letters are vertically small and some of the alphabetic letters are vertically large (Illustration)

In the experiment which follows you will be visually shown various words on the viewing screen in front of you. These words will be briefly presented in upper case letters. Your task will be to visually imagine these words, that is, form a mental picture of these words, as they would appear in lower case typewritten form. (Illustration)

From your mental images of these words you will signal the vertical size of the individual letters of a word using the switches in front of you. One switch is for small letters, as indicated, and the other switch is for large letters, as indicated.

In signalling the vertical size of the individual letters in your mental image of a word you should start with the initial left-hand letter and proceed to the final right-hand letter. For example, with the word, "tall", you would respond to the vertical size of the individual letters in the following fashion: large, small, large, large.

Do you have any questions at this point?

The visual presentation of the words will be initiated by you. Nearby your right foot you will find a button which when briefly depressed by your right foot will visually present a word on the viewing screen in front of you. All that is required to operate this button is a light tap with your right foot. Please do not step on the button in too rough a manner and don't hold it down.

When you finish responding to the vertical size of the individual letters in your mental image of a word you are to say "Finished". Upon hearing this signal I will respond "OK". Anytime after I respond "OK" and you are ready for another word you should lightly tap the foot button in order to visually present yourself the next word. When you have finished responding say "Finished" and I will reply "OK". We will continue in this manner throughout the experiment.

Do you have any questions at this point?

In responding to the vertical size of the individual letters in your mental image of a word you should respond as quickly as possible without making any mistakes.

During the experiment you will wear these special glasses which will monitor the movement of your eyes. During the experiment you should always be looking at the viewing screen in front of you and you should try to move your head as little as possible. The headrest will help keep your head stationary. Would you now put on these special glasses? I'll adjust them so that they are reasonably comfortable.

Any questions before we begin the experiment? We will have several practice trials before we have the test trials. Remember to respond as quickly and as accurately as possible. Please tell me whenever a blank slide appears. You may start as soon as I say "OK".

This concludes the experiment. Please do not discuss your participation in the experiment with any friends who might participate so that everyone will start out equally unfamiliar with the experimental task.

Thank you for your time and cooperation.

Backward Image Condition

This experiment is concerned with individuals' visual memory of the alphabetic letters of words. Before beginning the experiment I'd like to familiarize you with the words which will be used in this experiment. Would you please spell aloud the words which I speak to you? (Spelling Familiarization

Test)

I'll now continue with the instructions.

The lower case typewritten letters of the English alphabet can be divided into two classes based on the vertical size of the alphabetic letters. That is, some of the alphabetic letters are vertically small and some of the alphabetic letters are vertically large. (Illustration)

In the experiment which follows you will be visually shown various words on the viewing screen in front of you. These words will be briefly presented in upper case letters. Your task will be to visually imagine these words, that is, form a mental picture of these words, as they would appear in lower case typewritten form. (Illustration)

From you mental images of these words you will signal the vertical size of the individual letters of a word using the switches in front of you. One switch is for small letters, as indicated, and the other switch is for large letters, as indicated.

In signalling the vertical size of the individual letters in your mental image of a word you should start with the initial right-hand letter and proceed to the final left-hand letter. For example, with the word, "tall", you would respond to the vertical size of the individual letters in the following fashion: large, large, small, large.

Do you have any questions at this point?

The visual presentation of the words will be initiated by you. Nearby your right foot you will find a button which when briefly depressed by your right foot will visually present a word on the viewing screen in front of you. All that is required to operate this button is a light tap with your right foot. Please do not step on the button in too rough a manner and don't hold it down.

When you finish responding to the vertical size of the individual letters in your mental image of a word you are to say "Finished". Upon hearing this signal I will respond "OK". Anytime after I respond "OK" and you are ready for another word you should lightly tap the foot button in order to visually present yourself the next word. When you have finished responding say "Finished" and I will reply "OK". We will continue in this manner throughout the experiment.

Do you have any questions at this point?

In responding to the vertical size of the individual letters in your mental image of a word you should respond as quickly as possible without making any mistakes.

During the experiment you will wear these special glasses which will monitor the movement of your eyes. During the experiment you should always be looking at the viewing screen in front of you and you should try to move your head as little as possible. The headrest will help keep your head stationary. Would you now put on these special glasses? I'll adjust them so that they are reasonably comfortable.

Any questions before we begin the experiment? We will have several practice trials before we have the test trials. Remember to respond as quickly and as accurately as possible.

Please tell me whenever a blank slide appears. You may start as soon as I say "OK".

This concludes the experiment. Please do not discuss your participation in the experiment with any friends you might participate so that everyone will start out equally unfamiliar with the experimental task.

Thank you for your time and cooperation.

Experiment 2

This experiment is concerned with individuals' visual memory of alphabetic letters.

The lower case typewritten letters of the English alphabet can be divided into two classes based on the vertical size of the alphabetic letters. That is, some of the alphabetic letters are vertically small and some of the alphabetic letters are vertically large. (Illustration)

In the experiment which follows you will be visually shown various strings of alphabetic letters on the viewing screen in front of you. These letter strings will be briefly presented in upper case letters. Your task will be to visually imagine these letter strings, that is, form a mental picture of these letter strings, as they would appear in lower case typewritten form. (Illustration)

From your mental images of these letter strings you will signal the vertical size of the individual letters of a letter string using the switches in front of you. One switch is for small letters, as indicated, and the other switch is for large letters, as indicated.

In signalling the vertical size of the individual letters in your mental image of a letter string you should start with the initial left-hand letter and proceed to the final right-hand letter. For example, with the letter string, "tall", you would respond to the vertical size of the individual letters in the following fashion: large, small, large, large.

Do you have any questions at this point?

The visual presentation of the letter strings will be initiated by you. Nearby your right foot you will find a button which when briefly depressed by your right foot will visually present a letter string on the viewing screen in front of you. All that is required to operate this button is a light tap with your right foot. Please do not step on the button in too rough a manner and don't hold it down.

When you finish responding to the vertical size of the individual letters in your mental image of a letter string you are to say "Finished". Upon hearing this signal I will respond "OK". Anytime after I respond "OK" and you are ready for another letter string you should lightly tap the foot button in order to visually present yourself the next letter string. When you have finished responding say "Finished" and I will reply "OK". We will continue in this manner throughout the experiment.

Do you have any questions at this point?

In responding to the vertical size of the individual letters in your mental image of a letter string you should respond as quickly as possible without making any mistakes.

During the experiment you will wear these special glasses which will monitor the movement of your eyes. During the experiment you should always be looking at the viewing screen in front of you and you should try to move your head as little as possible. The headrest will help keep your head stationary. Would you now put on these special glasses? I'll adjust them so that they are reasonably comfortable.

Any questions before we begin the experiment. We will have several test trials. Remember to respond as quickly and as accurately as possible. Please tell me whenever a blank slide appears. You may start as soon as I say "OK".

This concludes the experiment. Please do not discuss your participation in the experiment with any friends who might participate so that everyone will start out equally unfamiliar with the experimental task.

Thank you for your time and cooperation.

APPENDIX C

TABLES

TABLE XVII

MEAN RESPONSE TIME (SEC/LETTER) FOR EACH S FOR EACH CONDITION IN EXPERIMENT 1

Direction/ Representation	S	4 Letter Words				8 Letter Words			
		Position of Syllabic Break				Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Image	1	.70	.75	.73	.75	.80	.73	.93	.90
	2	.78	1.20	.83	.90	.90	.75	.85	.90
	3	.55	.65	.70	.58	.78	.63	.55	.65
	4	.45	.45	.45	.50	.38	.39	.44	.41
	5	.68	.68	.65	.78	.60	.70	.78	.70
	6	.60	.53	.55	.60	.60	.56	.70	.63
	7	.53	.58	.55	.65	.26	.29	.25	.26
	8	.53	.58	.50	.53	.51	.58	.54	.49
	9	.65	.65	.63	.75	.83	.71	.74	.78
	10	.48	.70	.65	.63	.78	.56	.73	.78
Backward Image	1	.93	.95	.98	.98	1.17	1.25	1.20	1.38
	2	1.20	1.25	1.23	1.05	1.63	1.39	1.88	1.63
	3	1.05	.90	1.25	1.00	1.34	1.34	1.31	1.16
	4	.55	.53	.50	.58	.71	.49	.61	.69
	5	1.43	1.20	1.15	1.38	1.33	1.49	1.18	1.43
	6	.90	.90	.80	.90	1.18	.83	1.43	.96
	7	.98	1.00	.95	1.05	1.03	1.08	1.18	1.14
	8	.75	.83	.68	.65	.99	.80	1.20	.86
	9	.85	1.05	.98	1.05	1.63	.95	1.11	1.41
	10	.80	.85	.75	.90	.75	.88	.95	1.03

TABLE XVII (Continued)

Direction/ Representation	S	4 Letter Words				8 Letter Words			
		Position of Syllabic Break				Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Percept	1	.48	.53	.50	.45	.43	.45	.50	.48
	2	.53	.55	.45	.50	.49	.48	.46	.45
	3	.50	.45	.50	.50	.48	.45	.46	.49
	4	.45	.48	.45	.50	.39	.40	.44	.40
	5	.50	.48	.45	.43	.50	.55	.49	.44
	6	.34	.43	.40	.45	.36	.36	.38	.38
	7	.40	.50	.48	.50	.45	.43	.43	.45
	8	.58	.58	.58	.55	.53	.50	.45	.46
	9	.58	.53	.63	.55	.45	.49	.45	.45
	10	.35	.40	.35	.43	.36	.39	.44	.35
Backward Percept	1	.65	.50	.58	.65	.55	.51	.55	.60
	2	.53	.50	.48	.45	.44	.45	.53	.40
	3	.43	.50	.45	.40	.43	.40	.46	.43
	4	.50	.50	.50	.48	.45	.41	.44	.43
	5	.60	.63	.65	.55	.51	.50	.55	.55
	6	.43	.40	.43	.40	.35	.35	.39	.36
	7	.40	.38	.43	.43	.36	.35	.35	.38
	8	.73	.60	.60	.63	.54	.55	.59	.60
	9	.40	.38	.33	.35	.35	.33	.38	.34
	10	.45	.48	.43	.50	.38	.39	.38	.36

TABLE XVIII

MEAN RESPONSE LATENCY (SECS) FOR EACH S FOR EACH CONDITION IN EXPERIMENT 1

Direction/ Representation	S	4 Letter Words Position of Syllabic Break				8 Letter Words Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Image	1	1.4	1.6	1.4	1.5	1.8	1.7	2.6	2.4
	2	1.7	1.4	2.3	1.4	2.3	1.4	2.2	1.7
	3	1.1	1.0	1.1	1.1	1.2	1.3	1.2	1.2
	4	1.1	.8	1.0	1.2	1.0	1.2	1.3	1.3
	5	1.4	1.2	1.4	1.5	1.5	1.4	1.8	1.5
	6	1.4	1.2	1.3	1.4	1.4	1.3	1.2	1.4
	7	1.1	1.1	1.1	1.4	1.2	1.0	1.1	1.2
	8	1.1	1.2	1.2	1.1	1.4	1.4	1.4	1.1
	9	1.3	1.1	1.3	1.3	1.2	1.6	1.0	1.5
	10	1.2	1.8	1.4	1.5	1.9	1.5	2.5	1.8
Backward Image	1	2.0	2.1	1.8	2.6	2.3	3.2	2.2	2.0
	2	2.1	2.2	2.0	2.1	2.0	2.5	3.2	2.9
	3	2.4	1.7	2.4	2.3	1.7	2.0	2.5	2.1
	4	1.1	1.0	.9	1.2	1.2	1.1	1.3	1.3
	5	2.7	2.1	1.9	2.6	4.2	2.2	2.0	2.6
	6	2.1	1.9	1.8	2.2	2.0	1.9	1.7	1.8
	7	2.4	2.3	2.3	2.8	3.0	3.0	2.6	3.1
	8	1.4	1.5	1.3	1.6	2.2	2.2	2.1	2.0
	9	2.1	2.1	2.4	2.3	2.8	2.3	2.4	3.0
	10	1.9	2.0	1.9	2.5	1.6	2.5	2.0	2.2

TABLE XVIII (Continued)

Direction/ Representation	S	4 Letter Words				8 Letter Words			
		Position of Syllabic Break				Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Percept	1	.9	1.0	1.0	.9	1.0	.8	.9	.8
	2	1.0	1.0	.9	.9	1.2	1.0	.9	.9
	3	1.1	.9	1.0	.9	1.4	1.1	1.2	1.1
	4	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.1
	5	1.0	.9	1.0	1.0	1.0	1.2	.9	1.0
	6	1.0	.8	1.0	1.0	1.1	.8	1.0	.9
	7	.7	.8	.8	.8	.8	.7	.6	.8
	8	1.3	1.0	1.2	1.2	1.3	1.3	1.0	1.1
	9	1.0	1.1	1.6	1.2	1.1	1.1	.9	1.0
	10	.8	.8	.6	.9	.8	.8	1.0	.8
Backward Percept	1	1.3	1.1	1.1	1.2	1.2	1.1	1.0	1.5
	2	1.0	1.1	.9	1.0	.9	1.0	1.0	.9
	3	.9	1.0	.8	1.0	1.0	1.0	1.2	.9
	4	.9	1.0	.9	1.0	1.0	.9	1.0	1.0
	5	1.0	1.2	1.0	1.0	1.1	1.1	1.1	1.0
	6	.7	.7	.7	.7	.8	.7	.6	.8
	7	.8	.8	1.0	1.0	.8	1.0	.8	1.0
	8	1.2	1.1	1.5	1.1	1.1	1.4	2.4	1.2
	9	.8	.8	.6	.8	.7	.6	.8	.7
	10	.8	1.0	.8	1.1	.9	.8	.9	.8

TABLE XIX

NUMBER OF ERRORS FOR EACH S FOR EACH CONDITION IN EXPERIMENT 1

Direction/ Representation	S	4 Letter Words Position of Syllabic Break				8 Letter Words Position of Syllabic Break			
		O	I	M	F	O	I	M	F
Forward Image	1	0	0	0	0	1	0	1	0
	2	3	3	2	1	2	2	3	1
	3	1	0	0	1	4	2	4	3
	4	0	2	0	0	1	1	1	1
	5	0	0	0	0	1	0	0	0
	6	0	0	0	0	0	0	2	0
	7	0	0	0	0	1	1	1	1
	8	0	1	2	1	0	2	3	1
	9	0	0	0	0	0	0	2	0
	10	0	0	0	0	2	2	3	3
Backward Image	1	0	1	0	0	5	2	5	4
	2	0	1	0	0	4	3	2	3
	3	0	0	0	0	1	2	1	0
	4	1	0	0	1	0	3	2	1
	5	0	2	1	1	4	3	4	3
	6	0	0	0	0	1	1	1	1
	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	1	1	1	1
	9	1	0	1	0	1	0	0	1
	10	0	1	1	2	4	2	4	4

TABLE XIX (Continued)

Direction/ Representation	S	4 Letter Words Position of Syllabic Break O	I	M	F	8 Letter Words Position of Syllabic Break O	I	M	F
Forward Percept	1	0	2	1	0	0	0	1	1
	2	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	1	0
	4	0	0	0	0	0	1	0	1
	5	1	1	2	0	0	2	1	0
	6	0	0	0	0	0	0	1	0
	7	0	0	0	1	0	0	2	0
	8	0	0	0	1	0	0	0	0
	9	1	0	0	0	0	1	0	0
	10	1	1	1	0	0	1	2	0
Backward Percept	1	0	0	1	0	0	0	0	0
	2	0	0	0	0	1	0	0	2
	3	0	0	0	0	0	0	0	0
	4	0	0	0	0	1	0	0	0
	5	0	0	0	0	0	0	0	1
	6	0	0	1	0	4	0	2	0
	7	0	0	0	0	1	0	0	1
	8	0	0	0	0	1	1	1	0
	9	0	1	0	0	1	0	0	0
	10	0	0	0	1	0	1	0	1

TABLE XX

BLINK RATE (BLINKS/SEC) FOR EACH S FOR
EACH CONDITION IN EXPERIMENT I

Direction/ Representation	S	Position of Syllabic Break							
		O		I		M		F	
		Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial
		4 Letter Words							
Forward Image	1	.07	.08	.06	.22	.21	.39	.00	.23
	2	.00	.00	.00	.00	.00	.00	.00	.00
	3	.00	.00	.00	.00	.07	.05	.00	.00
	4	.54	.35	.56	.18	.44	.14	.50	.26
	5	.36	.06	.84	.00	.23	.00	.13	.04
	6	.00	.28	.09	.41	.09	.53	.16	.36
	7	.00	.27	.08	.22	.00	.26	.00	.20
	8	.37	.68	.21	.41	.32	.79	.12	.51
	9	.00	.22	.08	.10	.08	.23	.06	.17
	10	.00	.30	.00	.58	.08	.31	.00	.28
Backward Image	1	.16	.86	.26	.97	.19	.88	.20	.98
	2	.00	.00	.00	.06	.00	.04	.00	.00
	3	.29	.13	.16	.18	.28	.32	.10	.25
	4	.00	.06	.00	.00	.00	.00	.00	.27
	5	.59	1.30	.41	1.21	.60	1.38	.68	1.16
	6	.05	.16	.00	.05	.12	.00	.06	.08
	7	.10	.24	.00	.10	.05	.38	.09	.29
	8	.00	.00	.00	.00	.00	.05	.00	.00
	9	.00	.43	.00	.16	.00	.10	.00	.07
	10	.06	.12	.15	.19	.00	.22	.09	.27
Forward Percept	1	.10	.33	.00	.21	.13	.13	.11	.19
	2	.00	.11	.00	.16	.00	.16	.00	.07
	3	.00	.38	.11	.32	.00	.33	.10	.24
	4	.00	.17	.00	.27	.00	.32	.00	.28
	5	.00	.12	.00	.06	.00	.30	.00	.12
	6	.00	.10	.00	.12	.00	.10	.00	.14
	7	.00	.18	.00	.19	.21	.14	.00	.40
	8	.09	.47	.00	.42	.00	.36	.23	.55
	9	.21	.22	.28	.16	.16	.19	.18	.16
	10	.00	.15	.00	.59	.00	.49	.00	.19

TABLE XX (Continued)

Direction/ Representation	S	Position of Syllabic Break							
		O		I		M		F	
		Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial
Backward Percept	1	.30	.16	.32	.09	.21	.06	.15	.16
	2	.00	.25	.00	.18	.00	.25	.11	.26
	3	.11	.11	.00	.14	.00	.08	.00	.05
	4	.00	.07	.00	.07	.00	.09	.00	.05
	5	.00	.07	.00	.07	.00	.13	.00	.13
	6	.00	.80	.00	.27	.00	.53	.00	.28
	7	.00	.13	.00	.23	.00	.17	.00	.21
	8	.00	.27	.00	.20	.00	.19	.00	.12
	9	.00	.10	.00	.62	.00	.07	.00	.11
	10	.00	.09	.00	.00	.00	.07	.00	.06
				8 Letter Words					
Forward Image	1	.08	.45	.03	.35	.14	.05	.11	.25
	2	.00	.00	.00	.09	.00	.00	.00	.00
	3	.00	.00	.00	.09	.00	.00	.00	.00
	4	.33	.34	.43	.31	.28	.21	.29	.33
	5	.05	.00	.00	.06	.10	.07	.11	.04
	6	.17	.47	.27	.39	.18	.46	.08	.53
	7	.00	.28	.05	.29	.00	.35	.00	.07
	8	.43	.59	.50	.94	.47	.92	.51	.85
	9	.03	.11	.17	.33	.11	.09	.10	.21
	10	.00	.29	.00	.34	.00	.23	.00	.26
Backward Percept	1	.00	.00	.43	1.03	.00	.00	.45	1.36
	2	.00	.00	.00	.00	.00	.00	.00	.00
	3	.23	.20	.09	.26	.24	.29	.11	.18
	4	.03	.34	.00	.00	.00	.19	.05	.19
	5	.28	.53	.80	.98	.53	1.32	.96	.96
	6	.05	.00	.04	.06	.02	.11	.03	.06
	7	.05	.39	.07	.38	.02	.29	.00	.40
	8	.00	.00	.08	.00	.00	.00	.00	.07
	9	.00	.25	.00	.26	.00	.14	.00	.38
	10	.00	.00	.14	.18	.13	.21	.24	.24

TABLE XX (Continued)

Direction/ Representation	S	Position of Syllabic Break							
		O		I		M		F	
		Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial
Forward Percept	1	.00	.28	.00	.23	.06	.33	.00	.10
	2	.00	.11	.05	.08	.05	.13	.05	.09
	3	.05	.40	.05	.49	.07	.25	.00	.29
	4	.06	.23	.00	.24	.00	.19	.00	.23
	5	.00	.31	.00	.08	.06	.21	.00	.19
	6	.00	.12	.07	.13	.00	.16	.00	.09
	7	.00	.30	.00	.97	.00	.07	.00	.43
	8	.05	.73	.15	.66	.19	.29	.05	.48
	9	.17	.21	.13	.27	.27	.25	.11	.16
	10	.00	.31	.00	.31	.00	.29	.00	.55
Backward Percept	1	.14	.02	.14	.16	.09	.19	.13	.22
	2	.07	.15	.00	.18	.19	.02	.00	.30
	3	.00	.14	.00	.06	.05	.12	.00	.12
	4	.00	.10	.00	.06	.00	.07	.00	.09
	5	.00	.17	.00	.08	.00	.14	.00	.16
	6	.00	.28	.00	.42	.00	.35	.07	.48
	7	.00	.18	.00	.18	.00	.20	.00	.34
	8	.00	.15	.00	.21	.05	.21	.00	.18
	9	.00	.19	.08	.14	.00	.11	.00	.11
	10	.07	.02	.00	.02	.00	.00	.00	.05

TABLE XXI

MEAN RESPONSE TIME (SECS) FOR EACH S FOR EACH CONDITION IN EXPERIMENT 2

S	HF/HPr	LF/HPr	HF/LPr	LF/LPr
1	2.5	2.6	3.0	2.6
2	3.5	3.3	4.2	3.5
3	2.8	2.9	3.2	3.0
4	3.1	3.3	3.6	3.4
5	3.6	3.6	4.0	4.0
6	2.1	2.2	2.2	2.1
7	3.0	3.1	3.4	3.0
8	2.9	2.6	3.1	3.1
9	3.3	3.0	4.3	3.8
10	2.3	2.3	2.8	2.7
11	4.0	4.5	4.5	5.0
12	3.4	3.5	4.1	3.6

TABLE XXII

MEAN RESPONSE LATENCY (SECS) FOR EACH S FOR EACH CONDITION IN EXPERIMENT 2

S	HF/HPr	LF/HPr	HF/LPr	LF/LPr
1	1.5	1.4	1.8	1.6
2	2.0	1.6	2.1	1.8
3	1.5	1.6	1.8	1.6
4	1.7	1.8	1.9	1.9
5	1.7	1.9	2.0	2.0
6	1.0	1.0	1.1	1.0
7	1.3	1.4	1.5	1.4
8	1.5	1.3	1.7	1.6
9	1.9	1.8	2.4	2.0
10	1.1	1.1	1.4	1.4
11	2.5	2.5	2.5	2.8
12	1.7	1.8	2.3	2.0

TABLE XXIII

NUMBER OF ERRORS FOR EACH S FOR EACH CONDITION IN EXPERIMENT 2

S	HF/HPr	LF/HPr	HF/LPr	LF/LPr
1	0	0	2	1
2	0	2	0	0
3	0	0	2	1
4	1	1	2	2
5	1	1	1	1
6	0	0	0	1
7	2	0	2	1
8	0	0	3	1
9	0	1	0	2
10	0	0	1	3
11	0	0	4	2
12	0	0	2	1

TABLE XXIV

BLINK RATE (BLINKS/SEC) FOR EACH S FOR EACH CONDITION IN EXPERIMENT 2

S	HF/HPr		LF/HPr		HF/LPr		LF/LPr	
	Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial	Trial	Inter Trial
1	.03	.32	.03	.28	.00	.27	.00	.36
2	.00	.00	.00	.02	.00	.00	.00	.00
3	.17	.51	.21	.41	.31	.36	.27	.40
4	.00	.08	.04	.11	.02	.18	.00	.10
5	.37	.29	.35	.19	.37	.41	.50	.29
6	.54	.40	.55	.38	.67	.31	.63	.34
7	.00	.00	.00	.02	.00	.02	.00	.00
8	.00	.30	.03	.29	.00	.24	.00	.23
9	.00	.00	.00	.00	.00	.02	.00	.03
10	.00	.13	.00	.02	.00	.08	.00	.11
11	.00	.00	.00	.02	.00	.00	.00	.04
12	.22	.22	.17	.26	.21	.15	.19	.36

VITA

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Weber, R. J., Kelley, J., and Little, S. "Is Visual Image Sequencing Under Verbal Control?" *Journal of Experimental Psychology*, Vol. 96 (1972), 354-362.