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The Influence of Set On the Discriminability of Letters

by

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ABSTRACT

Four experiments were carried out to examine the effect of set on the discriminability of letters and words.

Arrays were used containing two words and two nonwords, in which each word was identical in lettering to a nonword except for one letter. Word and nonword positions varied randomly for each card as did critical letter positions within words which distinguished each word from its matching nonword.

In Experiment I, providing subjects with a semantic cue significantly improved accuracy in identifying words and distinguishing word and nonword positions as compared to a no precue group. Providing Ss with a syntactic cue did not improve ability to identify words over that in a group receiving no precue.

The group receiving a semantic precue in Experiment I scored significantly greater than chance in locating word positions (independent of word identity) while the syntactic group did not score significantly different from chance and the no precue group scored significantly less than chance.

To examine whether a memory factor was operative, Experiment II was performed and required Ss only to read the words and locate word positions (not to identify words). Experiment III de-emphasized the reading aspect of the task by instructing Ss to locate nonword positions by discriminating words from nonwords.

In Experiments II and III, groups with minimal precue information improved to the level of accuracy of the semantic group.

The hypothesis that identifying words and locating their positions may be two distinct processes is discussed, as well as the implications of position performance for a response bias model of reading.

Experiment IV examined the effect of semantic cues on reaction time for identification of sentences and scrambled sentences. A significant interaction occurred between cues and sentence type.

The hypothesis that semantic cues induce subjects to process larger perceptual units and that the efficiency of such a strategy varies with sentence type is discussed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

The first three experiments presented in this thesis examine the hypothesis that Ss provided with a semantic cue are better able to structure visual material, that is, are better able to discriminate between visually similar words and nonwords than are Ss provided with minimal or no precue information. Experiment IV examines the hypothesis that Ss provided with a semantic cue process larger perceptual units than do Ss who are not cued.

It is useful to examine the early history of reading research, because conflicting perspectives existing in more recent models of reading originate in some earlier findings.

Early History of Reading Research

> "Early studies of reading often developed directly out of issues concerning the fundamental nature of attention. Some of the questions that psychologists then pursued were these: Why does the attention span vary as the presentations change from numbers, to letters, to words, or to sentences? What are the effects of context and set on attention, and through what mechanism do these operate in reading?" (Blumenthal, 1970, p. 144).

Javal (1878-79) reported that the reader's eye moves across the written page in an erratic fashion, sometimes advancing by long jumps, sometimes making regressive or backward movements, while Erdmann and Dodge (1898) computed the speed of the eye's movement from one reading fixation to the next and found it to be so rapid that no perception could take place during these movements.

It appeared from these studies that the written page did not provide stimulus information in any direct, pre-arranged fashion. Reading seemed to involve an active, creative contribution from the reader. Erdmann and Dodge (1898) demonstrated that words could be perceived at distances from the eye too great to permit perception of isolated letters. At even greater distances, sentences could be read while isolated words were not readable. Huey employed sentences with deleted words, to demonstrate the creative contribution of the organism to the reading process. When presented with such sentences for brief intervals, subjects reported seeing complete sentences (Blumenthal, 1970). Huey revealed most succinctly his conceptualization of the reading process in his statement: "The reading process had long seemed to me to mirror the processes of thinking." (Huey, 1968, p. xli).

The studies of Dearborn are relevant to current response bias models of reading concerning the influence of the structure of language upon the reading process. "Dearborn (1906) found that connectives, relative pronouns, auxiliary verbs and other 'non-substantives' require the most and longest fixations. These are the high-frequency words, so that the longer fixation on them is not a matter of unfamiliarity" (Blumenthal, 1970, p. 159).

The reader's fixation pattern then appeared to be a reflection of his attempts to comprehend grammatical structure and not to be solely determined by stimulus parameters such as word frequency.

Buswell (1920) studied the variations in eye-voice span during oral reading. The eye-voice span is the distance, measured in words, that the eye is ahead of the voice. Eye movements were recorded in Buswell's studies, while the subjects read aloud. "Buswell suggested that the function of the eye-voice span was to allow the mind to grasp and interpret a large meaning unit before it was necessary for the voice to express it. Cattell (1889) thought that the reading units could be words, phrases, or even sentences because he found that subjects could recognize tachistoscopically presented individual words, phrases, or even short sentences just as easily as they could recognize one letter. (Levin and Kaplan, 1970, p. 121).

Theorists held opposing views concerning the emphasis that should be given to peripheral factors in the reading process. Dodge and Dearborn held that peripheral retinal stimulation affords 'premonitions' of coming words and phrases.

Wundt (1900) "deemphasized the optical fixation point, duration times, and span of vision. Instead, he believed that the span of 'attention' must be understood and that this need not necessarily coincide with retinal stimulation, nor with the extent of peripheral vision" (Blumenthal, 1970, p. 158).

Contemporary models of the reading process reflect these same opposing emphases. Research emphasizes either the cognitive framework of the reader or, in contrast, the visual analysis of the text.

Contemporary Analyses of the Reading Process

Pattern Recognition Models

Recent developments in reading research include feature analytic models of the reading process. Distinctive features are conceptualized as being an inherent aspect of the written word. Gibson holds that "perceptual learning involves the learning of distinctive features and higher-order invariants, learning progressing actively toward the most economical features and structure" (Gibson, 1971, p. 351). Gibson has merged a model of reading with a general model of perceptual learning. She states: "Words are perceived by detecting their distinctive features" (Gibson, 1971, p. 354). She postulates three types of word features: graphological, phonological, and semantic. Graphological features are inferred on the basis of the classes of letters which are confused with one another. Gibson, Osser, Schiff and Smith (1963) obtained a confusion matrix for the twenty-six Roman capitals based on the errors of a group of four-year-old children. Errors were analyzed in terms of intuitively derived features such as verticality, curvature, etc. More recent studies (Gibson, Schapiro and Yonas, 1968) have led to the formulation of confusion matrices for adults as well as children.

Gibson, Pick, Osser and Hammond (1962) investigated the phonological features of words by presenting subjects with pronounceable and unpronounceable pseudo-words. When these letter strings were presented tachistoscopically in mixed order, subjects invariably read the pronounceable version more accurately than the unpronounceable one. Gibson suggests that not only phonological features, but also distinctive orthographic structure may account for the more accurate performance with the pronounceable pseudowords. That phonological features are not the sole factor producing the effect is evidenced by the fact that deaf subjects also showed superior performance with pronounceable strings (Gibson, Schurcliff, and Yonas, 1970).

Gibson, Bishop, Schiff and Smith (1964) attempted to separate pronounceability and semantic reference and to compare their effects. Trigrams were prepared which were either rated high in pronounceability (MIB), or in referential meaning (IBM), or in neither (MBI). In one experiment, they were presented tachistoscopically and recognition thresholds were obtained. Pronounceability very effectively facilitated accurate perception of the trigram. Meaning helped little. In another study, the same items were presented for two seconds each and twenty-four hours later, recall was tested. This time meaning facilitated recall far more than did pronounceability.

Gibson suggests that phonological features, such as pronounceability, are a primary factor in short-term memory. While the term "pronounceable trigram" is used to describe the stimuli which produced superior performance in this study, Gibson suggests in more recent articles that such effects are to be interpreted in terms of the reader's sensitivity to the rules of orthography. "The term 'pronounceable' now seems misleading to me. I believe the difference between the two types of words (pronounceable and unpronounceable pseudo-words) can be accounted for by spelling patterns" (Gibson, 1970, p. 140).

Feature analytic approaches to the study of reading have attempted to explicate the early finding of Cattell (1885) that words may be read at the same exposure durations as letters. The proposed mechanisms accounting for this effect de-emphasize the role of meaning.

Smith (1969) presented subjects with low-contrast projections of letter sequences -- high and low-redundancy words and nonwords. Mean contrast levels at which letters were first identified correctly, indicated no tendency for words to be identified as wholes. Smith reasoned that if word identification is based on familiarity with the total configuration, more simultaneous identification of all three letters would be expected in words and high redundancy sequences than in nonwords and low-redundancy sequences. There were, however, no significant differences among conditions in the number of responses which were correct simultaneous triplet identifications.

Further, Smith found that only after identification of two letters was it easier to identify a low-redundancy word than a high-redundancy nonword. The importance of sequential information is then evident. Errors in letter identification were found to cluster into relatively few "confusion types". Smith concludes that the reader's use of featural dependencies across letters may account for the more rapid perception of words as compared to isolated letters.

Other studies which emphasize the reader's knowledge of the featural aspects of the stimulus include the experiments of Baron and Thurston (1973). Baron and Thurston found that it is easier to decide which of two letters was presented tachistoscopically if the critical letter appears in a pronounceable nonword rather than in an unpronounceable nonword. The authors suggest that meaning is not the critical factor in the word superiority effect. Rather, the reader's knowledge of the spelling regularities of the language, these authors suggest, may be the determining factor producing the effect. In one experiment, subjects were presented with chemical formulae written correctly, for example, NaCl and incorrectly, ClNa. The group of subjects who were chemists perceived the correctly written formulas more rapidly than the incorrectly written formulas as revealed by a matching task. The experimenters controlled for practice effects by arranging stimuli such that any improvement due to practice would operate in a direction opposite to that predicted on the basis of the subject's knowledge of spelling regularities. Thus a group of non-chemists performed more efficiently with backward chemical formulae as was predicted by the practice effect. The authors of this series of studies suggest that the chemical formulae are "pure convention and convey no meaning in themselves" and that the experiment demonstrates the importance of the reader's knowledge of spelling regularities in producing the word superiority effect. Baron and Thurston contend that such knowledge plays a role also in the processes of normal reading (Baron and Thurston, 1973).

Gibson's position perhaps most clearly illustrates the difference between feature analytic models and a cognitive schema approach to reading. She states: "Meaning for an adult reader is embedded in the word. He doesn't begin by decoding it letter by letter; the concept symbolized by the word 'hits him'. It is specified for him in stimulus information" (Gibson, 1971, p. 357).

Response Bias Models

There is no clear-cut distinction between the feature analytic models of reading and those concerned with the role of inferential processes in reading. The implication of response bias models, as with feature analytic models, is that the reader "extracts" information from the written word. While the extraction of information from the page may appear to be the evident starting point in the reading process, this perspective will be examined further and compared to the proposed model in a later section. Models which emphasize the inferential processes of the reader need not necessarily be feature analytic models, yet the two types of models often occur in combination so as to provide a fuller account of the reading process.

The analysis and synthesis of features would appear to be a complex task which would place a heavy load upon the reader's limited channel capacity. This is held by theorists to be compensated for by the fact that the reader may infer large portions of the text on the basis of knowledge of the redundant structure of the language. As context increases, the reader is held to sample less and less visual information as inferential processes operate more efficiently with highly constrained text.

Tulving and Gold (1963) conceptualized tachistoscopic recognition of words in terms of the subject having to select a response from a previously learned set of alternatives. They conducted experiments in which the pre-exposural context was either relevant or irrelevant with a target word. For example, the sentence "The actress received praise for being an outstanding ...." is a congruous context for the target word "performer" but not for the word "collision". Thresholds for targets were found to be significantly lower when preceding context was relevant to the target word. Tulving and Gold suggest that Ss need not sample as much visual information when the preceding context is relevant as compared to the case when it is not relevant. Tulving and Gold's interpretation suggests that Ss may recognize words with minimal visual information if provided with relevant context.

"Rouse and Verinis (1962) presented Ss with one word to fixate and a second word was flashed on in the same place at increasing durations. The associate relatedness of the two words was varied. The results showed that the recognition time of the associated test words was less than for non-associated words. The results were attributed to 'a general associative set which activated a larger number of associates enabling Ss to guess the flashed word with only a partial perception'" (Paivio, 1971, p. 125). Similar results and interpretation in terms of "partial perceptions" are given in a study by Samuels (1969).

The feature analytic models and the response bias models of reading both emphasize pattern recognition in that clues concerning context and meaning are derived mostly from an analysis of the stimulus information.

Cognitive Schema Models

Cognitive schema models differ from the pattern recognition models, discussed previously, in that they stress that meaning may not simply be the result of stimulus processing, but that meaning may play a role in the perceptibility and structuring of stimuli themselves.

In the field of speech perception, Savin and Bever (1970) have demonstrated that the analysis of spoken material is not always from bottom-to-top, that is phoneme identification was found to be subsequent to the perception of larger phonological units.

So, too, in reading a general grasp of meaning appears to influence the structuring of smaller units such as words within a phrase. "The fluent reader extracts meaning from a sequence of words before identifying any particular ones...Meaning precedes word identification" (Smith, 1971, p. 195). Evidence for this is found in the eye-voice span studies.

It has been demonstrated that the eye-voice span (EVS) extends significantly more often to the end of meaningful phrase boundaries than to non-meaningful points. The size of the EVS varies not so much with the number of words in a line as with meaningfulness. A comparison made between EVS on unstructured word lists and sentences revealed significant differences. The mean span on unstructured lists was 2.19 words and for sentences the mean span was 3.91 words. The latter finding comes from a study with second and fourth graders (Levin and Kaplan, 1970).

A frequent type of error made by both fluent readers and children during oral reading is that of semantic confusion. If Ss err in reading the passage containing the words "He said that I should..." they are far more likely to say "He told me that I should..." rather than something like "He sent that I should ..." although "sent" is a far more likely visual confusion than is "told me". Smith contends that the explanation for this type of frequent error is that "the reader is attending to the meaning of the passage and not to the identity of individual words ... Speakers who have their talks written in advance know how frequently they diverge from the literal text without straying significantly from the meaning" (Smith, 1971, p. 197).

Weber (1970) demonstrated that the degree of attention given to grammaticality or context may bear an inverse relationship to the degree of attention given the graphic information itself. Weber developed an index of "graphic similarity between words" based on the number of letters the two words had in common, the number of pairs of letters in the same order shared by the two words, etc. She found that children who made errors by substituting words which did <u>not</u> form grammatically acceptable sentences, made substitutions which were graphically similar to the actual word on the page (the mean graphic similarity score was higher for ungrammatical errors than it was for grammatical errors).

Thus a lessened degree of attention to grammatical context coincided with a closer inspection of the visual aspects of the word. The errors involving disregard of preceding grammatical context were few (10%).

Weber's study provides insight into adult reading in that it suggests that inspection of the stimulus in terms of its graphic characteristics may not always precede and determine the extent of grammatical and meaningful information the reader receives from the text.

Meaning rather than graphic characteristics alone may determine how S structures the written word. Kolers (1972) demonstrated that semantics may play a primary role in the segmentation of words from one another. He found that at short durations Ss cannot recognize two temporally extended words. The critical variable was not spatial separation because single words were recognized in a triangular array dispersed over four degrees of visual angle, single temporal columns of words were readily perceived as were single word arrays which virtually eliminated the reading habit.

When presented with the array in Figure I, Ss were more often able to record the first word (temper) but not the second (height). When recording letters from the second word, Ss were more accurate in reporting later pairs of letters than earlier pairs. "Apparently, the semantic processing that requires putting a bound on the first three pairs of letters interfered with the perception of the subsequent letters" (Kolers, 1972, p. 122). Semantic factors appear, as demonstrated in Kolers' (1972) study, to be a determining factor in the actual perceptual structuring of the stimulus material.

The experiments discussed in this section have raised the problem of what is the relationship between semantics and the actual visual configuration on the page? While Gibson suggests that meaning is extracted from the visual information, Kolers contends that the

T . E

M . P

E . R

H . E

I . G

H . T

Figure 1: Stimulus Array from Kolers' (1972) Study, p. 120

skilled reader "operates on the semantic or logical relations of the text he is reading, even to the point of disregarding, in a certain sense, the actual printed text" (Kolers, 1970, p. 109).

Kolers supports his viewpoint in part with a study involving the reading of bilingual connected discourse (Kolers, 1966). French-English bilinguals read passages such as : "His horse, followed by deux bassets, faisait la terre résonner under its even tread..."

Ss were tested for their comprehension of the bilingual passages as compared to their understanding of similar passages in French only or in English only. With the same time available, subjects were able to understand mixed passages as well as they could unilingual ones. Kolers contends that if the readers had had to make all the words in the mixed passage conform to a single language before they could understand them, they would have had less time to work out the meaning of a mixed passage than of a unilingual one; and having less time, their comprehension would have been poorer. Since comprehension was not reduced in the bilingual passage condition, Kolers concludes that the readers perceived the words directly in terms of their meanings. Further, when Ss were instructed to read the bilingual text aloud, certain translation errors and distortions of syntax occurred. For example, Ss might say "door" when "porte" was printed. Ss corrected the syntax of the printed text; for example, the phrase "made resound the earth" was read as "made the earth resound." These deviations from the printed word went unnoticed by the subjects.

While Kolers suggests that the reader directly perceives meaning, the problem arises that "semantic features are in one way critically different from visual or acoustic features -- they do not have immediate physical referents" (Smith, 1971, p. 190).

How does the reader come to perceive meaning from the written page? Kolers states: "How little and what the precise dependence of reading is upon the visual array are something of a mystery at this time" (Kolers, 1968, p. xxv). Following is a proposed model, which attempts to offer a certain perspective for approaching the problem of the relationship between reading for meaning and the more purely visual analysis of the written page.

Proposed Model

It is the view presented in this thesis that semantic, syntactic and graphological features are not stimuli "picked up" in the initial stage of reading a word or a phrase, but rather that these features are the end products of an already completed perceptual process termed "reading". This model suggests that the visual configuration on the page is not structured; that there are no inherent semantic, graphological and syntactic features, but rather that these are imposed upon the inkmarks on the page as the result of ongoing thinking processes.

This view differs from the feature analytic models which postulate distinctive features as a "given" -- an aspect of a structured stimulus. According to Oatley, N.S. Sutherland postulates that "the detection of lines and edges is followed by sequences of logical operations which generate structural descriptions of the pattern." (Oatley, 1972, p. 92). But this view raises the problem as to how the reader comes to select a particular stored description to fit the pattern unless he is already aware of the line relationships displayed.

There is experimental evidence which suggests that the unity of words, as a visual configuration, is not an inherent aspect of the stimulus but that it is the product of a creative perceptual process.

Haber (1965) found that when Ss had prior knowledge of the stimulus word, the word percept was formed gradually. Ss were reporting about their ability to perceive the stimulus and the results indicated a progression from the perception of parts of letters to the perception of whole letters and then words. In reading, however, one does not have such complete advance knowledge of the stimulus material.

Furthermore, reading appears to be too rapid a process to depend on a letter by letter analysis (Kolers and Katzman, 1966). The problem thus arises as to how the reader perceives the written page without the gaps which are the necessary consequence of such fragmentary stimulus input. It is proposed that the reader perceives the written page as complete because the "stimulus" in reading is a construction utilizing not simply stimulus input, but also conceptual output. A response bias model of reading leaves unanswered the question as to how the reader perceives the written page as complete without complete stimulus information. The proposed model suggests that the reader's semantic hypotheses about word and phrase meaning play a role in creating a complete percept. Such a view is reminiscent of Huey's statement:

> "In reading, the deficient picture is filled in, retouched, by the mind, and the page is thus made to present the familiar appearance of completeness in its details which we suppose to exist in the actual page. The defective retinal picture, taken in connection with all the other clews available to consciousness ... means such a page, and we project this meaning outward, just as we fill in mentally the gap in the visual field left by the blind spot."
>
> (Huey, 1968, p. 67-68)

Huey (1968) demonstrated that Ss could read, quite efficiently, text with the lower half of the lines obscured, eliminating such critical distinctive features as descenders. Huey also pointed out that the reader can efficiently process text in various fonts. This presents certain difficulties for a feature analytic model of the reading process which would conceptualize the reader as abstracting certain orthographic regularities from the text.

If the reader is viewed as himself structuring the input, this would account for his ability to read text in various fonts.

Kolers and Katzman (1966) found that in presenting the letters of a familiar word serially, letters must appear for more than one-quarter of a second in order for correct identification to occur. If normal reading occurred as a serial scan, its maximal rate would be between three to four letters per second; since English contains words of about five to six letters in length, the reading rate would be thirty to forty-two words per minute. College readers average at a rate of 300 words per minute, thus it is clear one is not engaged in a serial scan. The reader appears to be processing larger semantic units (as evidenced also by eye-voice span studies). The model proposed in this thesis suggests that the discriminability of letters in words and phrases depends on the ability to formulate semantic hypotheses about the meaning of those words and phrases. Semantic hypotheses concerning the visual material are, however, not viewed as a passive response to an already structured stimulus.

The proposed model is contrary to a model of "reading as externally guided thinking" (Neisser, 1966, p. 136). Neisser's view seems to imply that thinking during reading is a response to an external visual stimulus. The proposed model suggests that thinking is an active internal process (during reading) rather than directly a response to an external visual stimulus. It is suggested that reading occurs when the reader entertains a semantic hypothesis necessary to comprehend the passage. Without a semantic hypothesis, it is proposed, the reader ceases to read but instead merely recognizes visual designs and responds with the knowledge that he is viewing a familiar pattern much as one would respond when presented with a familiar geometric pattern. Evidence exists which suggests a functional difference between words as visual configurations and words as semantic units. "Shulman (1971) had subjects scan a list of words for targets defined either structurally (such as words containing the letter A) or semantically (such as words denoting living things). After the scanning task, Ss were given an unexpected test of recognition memory. Performance in the semantically defined target conditions was superior to that in the structurally defined condition; although scanning time per word was approximately equivalent in most cases" (Craik and Lockhart, 1972, p. 677-678). It may be that the semantically defined condition induced Ss to process the material more completely. Such a view of different levels of processing and evidence for it is presented by Craik and Lockhart (1972). Neisser and Beller (1965) presented subjects with a visual search task in which Ss were to search for a proper name. On a subsequent recognition test S did not perform significantly better than chance in determining which of sixteen words read to him had occurred on the list he had just finished scanning. Thus subjects had located the target and rejected non-targets but had not processed the non-targets "deeply" enough to allow recognition in the subsequent test.

Neisser (1966) reports that Ss searching for targets in a multiple target task occasionally reported that they stopped without knowing which of the several targets was actually present. Neisser contends that searching for targets in a visual search task may well involve preattentive processing.

Processing a word primarily as a visual configuration does not seem, as evidenced by Neisser's 1965 study, to lead to storage of the word; at least in visual search tasks.

In reading, one appears to attend to the sense of the passage rather than the actual visual configuration. Kolers (1970) demonstrated that in reading aloud transformed text (for example, lines rotated in three dimensional space) subjects' substitution errors were semantically and syntactically consistent with the antecedent text in 90 to 100 per cent of the cases. When the substitution was grammatically acceptable, the reader usually left it uncorrected. "The reader was more sensitive to the grammatical relations of what he was reading than to the printed words themselves" (Kolers, 1970, p. 105).

Posner (1969) presents a model of pattern recognition involving levels of processing. Posner suggests that the visual process is an isolable subsystem of letter processing in the adult, to be distinguished from other subsystems (name of the letter). Posner has demonstrated that it is possible to manipulate visual and name codes independently. The time for matching identical letters (for instance, A A) is faster than for letters of the opposite case (A a). Moreover, the times to make physical matches are systematically affected by visual factors such as the visual similarity of the forms, while name matches are affected primarily by factors related to letter name, such as the number of letter names held in the short-term store (Posner, Lewis and Conrad, 1971). Physical matches are unaffected by name level information (it takes no longer to say "different" to letters which have the same name, for instance A, a (Posner, Lewis and Conrad, 1971).

In one study, target letters were embedded in a visually similar context. Probe letters were then presented. When S was to respond "same" if the probe and target letters were physically identical, the visually similar context of the target letters slowed reaction times. No such slowing effect occurred for name matches (Posner, 1969). It appears then that treating the stimulus as a purely visual configuration resulted in greater interference from the visually confusable context.

The present model proposes that groups receiving minimal pre-cue information are operating with primarily a visual code. It was predicted that these Ss should be hindered more greatly by the visually confusable context than groups provided with a semantic hypothesis, just as Ss in Posner's experiments, employing a visual code, were hampered by a visually confusable context more greatly than Ss operating with a name code.

Present Investigations

The present investigation (experiments I, II and III) examines the effects of set on the discriminability of letters and attempts to demonstrate that providing S with a semantic hypothesis allows him to structure the visual material, thus leading to better discrimination.

Response bias factors are controlled by randomly varying the position of words and visually similar nonwords within the array. S then has no basis for inferring the position of the words. By examining the relationship between ability to locate word positions and ability to identify words, some insight into inferential processes may be gained.

Context in this series of experiments is created by providing subjects in the semantic group with a topic related to the topic of the two word phrases they are to identify, and by providing the syntactic group with the information that the two words form a sentence. Context is then viewed as an aspect of the thinking process rather than as an external stimulus variable.

A fourth experiment was undertaken in order to examine whether a semantic set induces Ss to process larger perceptual units.

It is hypothesized that the no precue groups in experiments I to III are responding to the visual stimulus purely in terms of the visual pattern it represents. The semantically cued groups, on the other hand, are engaged in a process which parallels, to a certain extent, normal reading -- that is, structuring visual material in terms of semantic hypotheses.

EXPERIMENT I

Method

Subjects and Design

Ss were 78 university students enrolled in introductory psychology. Twenty-six Ss were assigned to three treatment groups.

The conditions were: 1) no precue group in which Ss were not provided with any precue information before stimulus presentation; 2) a syntactic group in which Ss were told that the two words formed a sentence; 3) a semantic group in which Ss were told that the two words formed a sentence concerning a certain topic, such as, for example, "astronomy".

Apparatus

A Cambridge, two-channel tachistoscope was used. Brightness of the fields was approximately 5 foot lamberts and the field angle was 15° by 9°. The tachistoscope presented a flash to a lighted field. The stimulus display appeared 38 centimeters from the subjects' eyes and was controlled by S using a handswitch.

Cards were 4 inches by 6 inches, with letters typed in blue ink 3 millimeters high; all letters were in capitals. The visual angle subtended by each letter vertically was .4°. The visual angle subtended horizontally by the practice and experimental stimulus phrases was approximately 7°. A fixation card with a cross was used.

Nine cards were used to acquaint Ss with the tachistoscope, and to determine the exposure duration for each subject. The first three cards contained a single familiar word used to familiarize S with the tachistoscope. The remaining six cards each contained two words and two nonwords, with nonwords in varying positions relative to the words. These six cards were used to determine exposure durations to be used with each S.

Words were selected from the most frequent range of the Thorndike-Lorge Wordbook (1944). An example of a card used to determine threshold is: TASTE TASTA THIS THIO.

Each word is identical in lettering to a nonword, except for one letter.

In addition, twelve practice cards were presented with one of the instructional sets. The cards are of the same type as the threshold cards, described above. An example of a practice card is as follows: STARS STARP SHINE SHINA. The positions of the words and nonwords varied randomly from card to card, as did the position of the critical letter within the words.

The twenty-four experimental cards also contain two words and two nonwords as described above. Words for the experimental cards were selected from the intermediate frequency range of the Thorndike-Lorge Wordbook.

Procedure:

Each S was tested individually. Exposure durations for each subject were determined using the ascending (modified) method of limits. S was required to read completely the two words on the threshold card and to correctly place strokes to mark the position of the two nonwords relative to the two words. The median time required for a totally correct response with the six threshold cards determined the exposure duration for each subject.

Ss in all treatment groups received the same threshold cards and no instructional set was given. The threshold cards were followed by the twelve practice cards. Ss in all treatment groups received the same practice and the same experimental cards.

Ss in all treatment groups were informed that each card contained two words and two nonwords. Ss were not told anything concerning lettering. The only difference between groups is in terms of instructional set given verbally before presentation of the practice and experimental cards. The no precue group received no prior information, the syntactic precue group was told that the two words formed a sentence and the semantic precue group was told that the two words formed a sentence concerning a certain topic. In the semantic group the topic "astronomy" would then be given verbally before presentation of STARS STARP SHINE SHINA.

Ss in all groups were to respond by writing down the words and placing two strokes to represent nonword positions, for example, STARS ____ SHINE _____.

Subjects received one trial for each practice and experimental card.

All instructions were pre-recorded and presented on a tape recorder.

Results and Discussion

An analysis of variance was performed with exposure times and revealed no significant differences between the three treatment groups ($F=.078$, d.f. 2,75).

The number of words correctly identified was scored for each treatment group. Mistakes in noun number, for example, making a singular form plural or vice versa, were not counted as errors, but any other deviation from the printed word, for example, changes in the tense of a verb, were scored as errors.

An analysis of variance for randomized groups revealed a significant difference between groups in terms of number of words correctly identified independent of position ($F=17.79$, d.f. 2,75, $p < .01$).

To evaluate the contribution of each treatment group to this overall difference, Newman-Keuls Multiple Comparisons were performed.

TABLE I

Means (Variances) for Identifying Words Correctly

Experiment I

SEMANTIC CUE	SYNTACTIC CUE	NO PRECUE
31.230	22.346	21.923
(37.45)	(29.81)	(53.58)

TABLE II

Analysis of Variance

Word Identification: Experiment I

SOURCE	DF	SS	MS	F
Between	2	1436.485	718.242	17.80*
Within	75	3026.338	40.351	
Total		4462.820		

*$p < .01$

TABLE III

Means (Variances) for Identifying Both Words Correctly and at the same time Positioning Both Words Correctly in the Array: Experiment I

SEMANTIC CUE	SYNTACTIC CUE	NO PRECUE
4.231	2.269	1.615
(6.105)	(2.525)	(1.686)

TABLE IV

Analysis of Variance

Word Identity Plus Position Correct: Experiment I

SOURCE	DF	SS	MS	F
Between	2	96.333	48.1665	14.008*
Within	75	257.884	3.4384	
Total		354.217		

*$p < .01$

The mean number of words correctly identified was significantly different in the semantic and no precue groups ($p < .01$) and in the semantic and syntactic groups ($p < .01$). There was no significant difference between the syntactic and no precue groups.

Totally correct responses were defined in terms of identifying both words on the card correctly and placing both words in the correct positions relative to the nonwords. An analysis of variance for randomized groups revealed significant differences in mean number of totally correct responses between groups ($F=14.01$, d.f. 2,75, $p. < .01$).

A Newman-Keuls Multiple Comparisons test was performed and revealed significant differences between the semantic and no precue groups ($p < .01$) and the semantic and syntactic groups ($p < .01$). No significant difference was found between the syntactic and no precue groups.

Scores in terms of number of words identified correctly in all three treatment groups were grouped according to thresholds. These fell into the following groups: 30 milliseconds, 40, 50, 60, and over 60 milliseconds. An analysis of variance for randomized groups was performed on the word identification scores grouped according to exposure duration. The results revealed a significant difference between the five exposure duration levels in terms of mean number of words correctly identified ($F=3.25$, d.f. 4,71, $p. < .05$).

To examine which exposure duration levels contributed most greatly to this overall difference in word identification, a Newman-

Keuls Multiple Comparisons test was performed. The results of this test revealed significant differences in word identification a) between subjects whose threshold level was 30 milliseconds and subjects whose threshold was 60 milliseconds ($p < .05$) and b) between subjects whose threshold level was 30 milliseconds and subjects whose threshold level was over 60 milliseconds. The mean word identification scores in the groups whose threshold was 60 milliseconds and over 60 milliseconds were 10 points lower than the mean word identification score in the 30 millisecond group. This finding will be discussed in the general discussion of this thesis.

There were no significant differences between the syntactic and no precue groups in terms of the number of words identified correctly independent from position, nor in terms of totally correct responses.

There was also no significant difference between the no precue and syntactic group in terms of number of sentence responses, independent of word identity correct ($t=1.37$, d.f. 50).

The syntactic group subjects did, however, respond significantly more often with blanks (trials on which subjects reported that they saw no words) than did the no precue subjects ($t=2.4$, d.f. 50, $p < .05$). There was no difference between the semantic group subjects and the no precue group in terms of numbers of blanks ($t=.8$, d.f. 50).

It may be that the emphasis on reading sentences in the syntactic group's instructions produced a set to deal with larger units such as the entire two-word phrase rather than with isolated word units and such a strategy may have produced more interference between the words and visually similar nonwords in the syntactic group than in the no precue group.

The semantically cued subjects identified significantly more words correctly than did the no precue and syntactic group subjects. The semantic group also scored significantly higher than the other two groups in terms of totally correct responses. Thus, having identified the word, semantic group subjects were also more likely to place it in the correct word position. Since word and nonword positions varied randomly from card to card, semantic subjects could not infer word positions.

The point may be raised that the semantic cues facilitated only Ss' ability to position words and not their ability to identify them. However, since the cues did not provide Ss with information concerning the position of the words but only with clues as to word identity, the facilitating effect of the cues on word location performance seems to have been mediated by the influence of the cues on Ss' ability to identify the words.

The finding that semantic cues facilitate the ability of Ss to identify words as well as to position words in the array is consistent with the proposed model which suggests that semantic cues aid subjects in structuring word percepts.

Yet the number of totally correct responses was low, even in the semantic group compared to that for word identity alone. Inability to scan the field (mean exposure duration was 48 milliseconds, allowing not more than one fixation) may account for the less accurate performance in locating word positions. It may be necessary to fixate a word several times, each time in a slightly different context, in order to segment it from other material.

Experiment I may have presented S with two qualitatively different tasks: a) reading for meaning (word identification) and b) pattern recognition (identifying word position). The latter may be a more purely visual skill.

EXPERIMENTS II and III

Experiment II was designed in order to examine the effect of memory load on word location performance. Memory load was reduced by allowing Ss to identify word positions simply by placing two W's in the appropriate spaces rather than by writing the words that had occurred on the card, as had been the case in experiment I. Nonword positions were, as in experiment I, to be indicated by two strokes. Although Ss were instructed to specify word positions with a W, they were nevertheless instructed to "read" the words on the card (silently).

Experiment III replicates experiment II except for the fact that the spatial aspects of the task were stressed more emphatically in experiment III than in experiment II. This was accomplished by instructing Ss "to distinguish the nonwords from the words" and to "locate" the "position" of the "nonwords". This differs from experiment II in which Ss were instructed to "read" the words.

A further difference in experiment III as compared to experiment II is that the precue instructions for the semantic and syntactic groups were de-emphasized in experiment III. This was accomplished by mentioning the precue information only once at the termination of the task instructions rather than at the beginning with repetition, as in experiment II.

The results and discussion sections for experiments II and III are combined as the findings can more meaningfully be discussed as a whole.

Experiments II and III attempt to gain some insight into how subjects' ability to acquire word position information is related to their ability to read for meaning.

Method

Subjects and Design

In experiment II subjects were 45 university students enrolled in introductory psychology. Fifteen subjects were randomly assigned to three treatment groups: a) no precue group; b) a semantic precue group; c) a syntactic group. As in experiment I, the semantic precue group was told that the two words formed a sentence and was given a topic related to that sentence. The syntactic group was informed only that the two words formed a sentence.

In experiment III subjects were 33 university students enrolled in introductory psychology. These students were assigned to three treatment groups (the no precue, the syntactic precue and the semantic precue group) with 11 students in each group. The treatment groups were the same as those described in experiment II.

Apparatus

The apparatus was identical to that used in experiment I.

Procedure

Each S was tested individually. Exposure duration for each subject was determined by using the ascending (modified) method of limits.

Ss were required to indicate the two words on the threshold cards by writing two W's to represent word positions and two strokes to represent nonword positions. The median time required for an accurate response with the six threshold cards was used to determine the exposure duration for each S.

Ss in all groups were presented with the same threshold cards. No instructional set was given with threshold cards.

The six threshold cards were followed by twelve practice cards and 24 experimental cards. Ss in all groups received the same practice and experimental cards.

The practice and experimental cards were accompanied by the set instructions: a) no precue; b) semantic precue or c) syntactic precue.

All subjects were informed that each card contained two words and two nonwords, but were not told anything concerning lettering.

Ss in all groups were to respond by writing two W's in the word positions and two strokes in the position of the nonwords.

Experiment III involved the same procedure in determining thresholds and presenting practice and experimental cards as in experiment II. The only difference from experiment II is that Ss were no longer told to "read" the words and specify their positions with a W (as in experiment II) but were instead told to "locate" nonword positions, specifying these positions with an N. By replacing the word "read" with "locate" and by emphasis on the detection of nonword positions, the reading for meaning aspect of the task was diminished. A further difference from experiment II is that precue information in the semantic and syntactic groups was mentioned once at the end of the task instructions rather than at the beginning, with repetition for emphasis, as had been the case in experiment II.

Results and Discussion

Experiments II and III involved Ss in locating word positions without actually identifying the words (by marking word positions with a W, etc.). Data from experiment I were re-analyzed in terms of the number of times Ss placed both word responses in the correct word positions irrespective of whether or not the word identity was correct. This re-analysis served to make the data from experiment I more comparable with that of experiments II and III.

Accuracy in locating word positions in experiment I was significantly better than chance in the semantic group ($t=3.31$, d.f. 25, $p < .01$); significantly less than chance in the no precue group ($t=2.3$, d.f. 25, $p < .05$) and did not differ significantly from chance in the syntactic group ($t=1.6$, d.f. 25).

TABLE V

Means (Variances) for Locating Both Word Positions Correctly
(Disregarding Word Identity)

	SEMANTIC CUE	SYNTACTIC CUE	NO PRECUE
Experiment I	6.230	3.4230	3.269
	(11.304)	(3.37)	(2.604)
Experiment II	6.6	6.6	5.93
	(6.685)	(4.542)	(3.638)

TABLE VI

Analysis of Variance

Correct Word Positions Only: Experiment II

SOURCE	DF	SS	MS	F
Between	2	4.44	2.22	.448
Within	42	208.133	4.956	
Total		212.577		

TABLE VII

Analysis of Variance

Correct Word Positions Only

No Precue Groups in Experiments I and II

SOURCE	DF	SS	MS	F
Between	1	67.5122	67.5122	22.688*
Within	39	116.0487	2.9756	
Total		183.5609		

*p $<$ .01

Semantic Groups in Experiments I and II

SOURCE	DF	SS	MS	F
Between	1	1.2968	1.2968	.1344
Within	39	376.215	2.9756	
Total		377.5121		

Syntactic Groups in Experiments I and II

SOURCE	DF	SS	MS	F
Between	1	96.0050	96.005	25.3078*
Within	39	147.9461	3.793	
Total		243.9512		

*p $<$ .01

In experiment II there were no significant differences between the semantic, syntactic and no precue groups in terms of ability to locate word positions. ($F=.45$, d.f. 2,42). In experiment II, the mean number of correct word locations in the no precue and syntactic groups reached the level achieved by the semantic group.

An analysis of variance for randomized groups comparing the syntactic group in experiment I with the syntactic group in experiment II revealed that the difference in syntactic performance between experiments was significant ($F=25.30$, d.f. 1,39, $p < .01$). The semantic groups in experiments I and II did not differ significantly.

An analysis of variance for randomized groups comparing no precue performance in experiments I and II revealed a significant difference ($F=22.68$, d.f. 1,39, $p < .01$).

In experiment II there were no significant differences between the semantic, syntactic and no precue groups in terms of ability to locate word positions. This finding is quite contrary to the large differences between groups found in experiment I in terms of number of words identified and in terms of number of words correctly identified which were also correctly positioned.

The syntactic and no precue groups performed at a level comparable to the semantic group when the task does not involve identifying words but merely recognizing word positions. Since these groups can attain the same accuracy as the semantic group on this measure, with only minimal or no precue information, the semantic group's superior performance in experiment I appears not to be due to inferential processes, at least as far as the measure of locating word positions is concerned.

Recognizing word positions appears to rely more heavily on purely visual skill, as a de-emphasis on reading for meaning produced a significant improvement in the syntactic and no precue groups. In experiment III, which further de-emphasized reading for meaning, the no precue group located more word positions accurately as compared to the no precue group in experiment II, although the difference was not significant.

It appears then, that locating words and nonwords is more accurately performed when reading for meaning is de-emphasized and pattern discrimination is emphasized. Groups without precue information can perform this task as accurately as groups with semantic precue information (experiments II and III), even though they are less accurate in identifying words, as shown in experiment I. It may be that detecting word position is not a part of normal reading.

There may have been some conflict between reading for meaning and identifying word positions as suggested by the improvement in syntactic and no precue group performance in ability to locate word positions when Ss were no longer required to identify words.

Why are no precue groups and syntactic groups deficient in identifying words in experiment I? A response bias model such as suggested by Tulving and Gold (1963) presents the hypothesis that Ss without precue information must sample more visual information thus leading to poorer performance with brief tachistoscopic displays.

TABLE VIII

Means (Variances) for Correct Word Positions

	SEMANTIC CUE	SYNTACTIC CUE	NO PRECUE
Experiment II	6.60	6.60	5.93
	(6.685)	(4.542)	(3.638)
Experiment III	7.27	6.55	7.73
	(3.22)	(7.87)	(6.82)

TABLE IX

Analysis of Variance

Correct Word Positions:
No Precue Group in Experiment II
and No Precue Group in Experiment III

SOURCE	DF	SS	MS	F
Between	1	20.423	20.423	4.115*
Within	24	119.115	4.963	
Total		139.538		

*Approaching significance at $p < .05$

In experiments II and III it was demonstrated that Ss in the no precue groups and syntactic groups can locate word and nonword positions as accurately as can semantic group Ss, that is, these Ss process the visual material as "deeply" as do semantic group Ss. Only with quite complete visual processing could Ss position a visually similar word and nonword (for instance, PRAISE PRAISF).

Yet, in experiment I it is the syntactic and no precue groups which appear to process less visual information, not the semantic group, as would be predicted by a response bias model. This is evidenced by the fact that semantic group Ss were superior in locating word positions (performing a fine discrimination) in experiment I to the no precue and syntactic groups. It appears then that semantic group Ss do not rely on minimal visual information in experiment I as would be predicted if Ss in the semantic group relied on inferential processes to identify words.

Accuracy in locating word and nonword positions did not exceed approximately 25 per cent correct even when memory load is reduced, as in experiments II and III. Although the material was highly visually confusable, on the basis of a response bias model one would hypothesize that Ss would be quite sensitive to familiar and unfamiliar letter sequences. It is noteworthy then that words did not appear as a more distinct percept for Ss than nonwords, allowing Ss to pinpoint word positions. Pillsbury (1897) found that in reading incorrectly spelled words, subjects would often be most certain of letters not actually on the slide. In the present experiments (I, II and III) Ss may have read nonwords as words, that is, they may have restructured the faulty letter to be consistent within a word framework.

Accurate identification of words did not lead to accurate positioning of the words in the array. Posner (1969) has shown that Ss can proceed from the visual form of a letter to the classification "letter" without activating the letter name. A similar process may occur in distinguishing words from nonwords. Identifying words as words may not involve identification of the word name. It may be relevant to examine to what degree words and nonwords must be visually dissimilar, in order to discriminate between them.

A study by Hochberg, Levin and Frail (1966) suggested that advanced readers process larger perceptual units than less advanced readers. Using similar techniques, experiment IV attempts to examine if semantic group Ss are similar to advanced readers in that they process larger perceptual units. If semantically cued Ss do process larger perceptual units, then this may account for the facilitating effect of the semantic cues on Ss' ability to identify more word positions than Ss not receiving semantic cues in experiment I.

Hochberg, Levin and Frail (1966) presented short stories prepared in two typographical versions to second and fifth graders. In one version, normal spaces between words were present. In another version, the spaces between all the words were filled by a meaningless symbol, producing an unbroken line of type. Second graders were little influenced by the absence of interword spaces, while fifth graders were strongly hampered in their oral reading by the doctored texts. "The younger children are reading the text word for word so that the lack of spaces does not hamper their relevant processing units. Older children, who are apparently forming units that are larger than a single word, are unable to use these higher order units when interword spaces are not available" (Levin and Kaplan, 1970, p. 119).

In experiment IV Ss were presented with sentences and scrambled sentences in which interword spaces were filled with two X's. If a semantic cue induces S to process larger perceptual units, a cued group should show longer reaction time for silent reading of sentences than would a noncued group (for instance, the X's, eliminating interword spaces, should hinder cued readers more than noncued if the processing unit of cued readers is larger than a single word).

EXPERIMENT IV

Method

Subjects and Design

Ss were 32 university students enrolled in introductory psychology. Sixteen students were assigned to two treatment groups. The conditions were: 1) a cued group in which Ss were presented with 12 cued sentences and 12 uncued scrambled sentences; 2) a noncued group in which Ss received 12 uncued sentences and 12 uncued scrambled sentences.

Apparatus

A two-channel Cambridge tachistoscope was used as described in experiment I. The stimulus display was controlled by S using a handswitch. The S pressed a button operating a timer on a reaction time device (Hunter Decade Interval Timer, Model 111C) and simultaneously displaying the stimulus card. Releasing the button, terminated the stimulus display and stopped the timer.

Cards were 4 inches by 6 inches with words in capital letters 3 millimetres high. Each letter subtended a visual angle vertically of .4°. The stimulus sentences and scrambled sentences subtended a visual angle horizontally of 7° - 8°. Six practice cards were used with scrambled sentences and nonscrambled sentences. Twenty-four experimental cards, twelve containing scrambled sentences and twelve containing non-scrambled sentences, were employed. Interword spaces on all cards were filled by two X's, for example, XXPLANXXAHEADXX.

The words were selected from the intermediate frequency range of the Thorndike and Lorge Wordbook (1944) and ranged from 4-7 letters in length. Sentence length was 2 - 4 words.

Procedure

Each S was tested individually. The six practice cards were presented with appropriate set instructions (cue or no cue), followed by the 24 experimental cards accompanied by set instructions. Ss in both groups were informed that the cards contained sentences or scrambled sentences (the sentences and scrambled sentences were presented in random order). Ss in all groups were also informed that the spaces between words were filled with two X's.

Groups differed only in that the cued group was given a topic cue for cards containing non-scrambled sentences, while the non-cued group was not given a topic cue for sentences.

Neither cued, nor non-cued groups were given topics prior to presentation of scrambled sentences.

Ss were to respond by releasing the response button immediately after having read (silently) the entire card well enough to identify all the words. Ss then wrote exactly what they had seen on the card -- that is, Ss wrote the words in the order that they had appeared on the card.

Results and Discussion

The dependent variable in the following analyses is reaction time. Bartlett's test indicated heterogeneity of variance between cued and noncued groups (B' of 8.72 with three degrees of freedom [$p < .05$]). A log transformation was performed. Bartlett's test applied to the transformed reaction time data yielded a B' of 1.98 with three degrees of freedom; indicating that the logarithmic transformation had successfully eliminated the heterogeneity of variance.

A one-way analysis of variance for repeated measure with two levels of sentence type and two levels of groups revealed a significant sentence type effect (F=129.06, d.f. 1,30, $p < .01$), and a significant sentence type X group interaction (F=4.56, d.f. 1,30, $p < .05$).

There was no significant difference in reaction time between

TABLE X

Means (Variances) of Reaction Time in
Identifying Sentences and Scrambled Sentences: Experiment IV

GROUPS	NOT SCRAMBLED	SCRAMBLED
Cued	1.6309	2.3662
	(.3504)	(.7309)
Not Cued	1.6714	2.2166
	(.1558)	(.5574)

TABLE XI

Means (Variances) of Logarithmic Transformations
of Reaction Times: Experiment IV

GROUPS	NOT SCRAMBLED	SCRAMBLED
Cued	.1723	.3351
	(.0164)	(.0173)
Not Cued	.1933	.3046
	(.0094)	(.0212)

TABLE XII

Analysis of Variance

Mean Log Reaction Time in
Identifying Sentences and Scrambled Sentences
as a Function of Cue: Experiment IV

SOURCE	DF	SS	MS	F
Cued vs. non-cued groups	1	.000	.000	.012
Error	30	.896	.030	
Sentence type (scrambled vs non-scrambled)	1	.301	.301	129.059**
Sentence type X Groups	1	.011	.011	4.556*
Error	30	.070	.002	

** $p < .01$

* $p < .05$

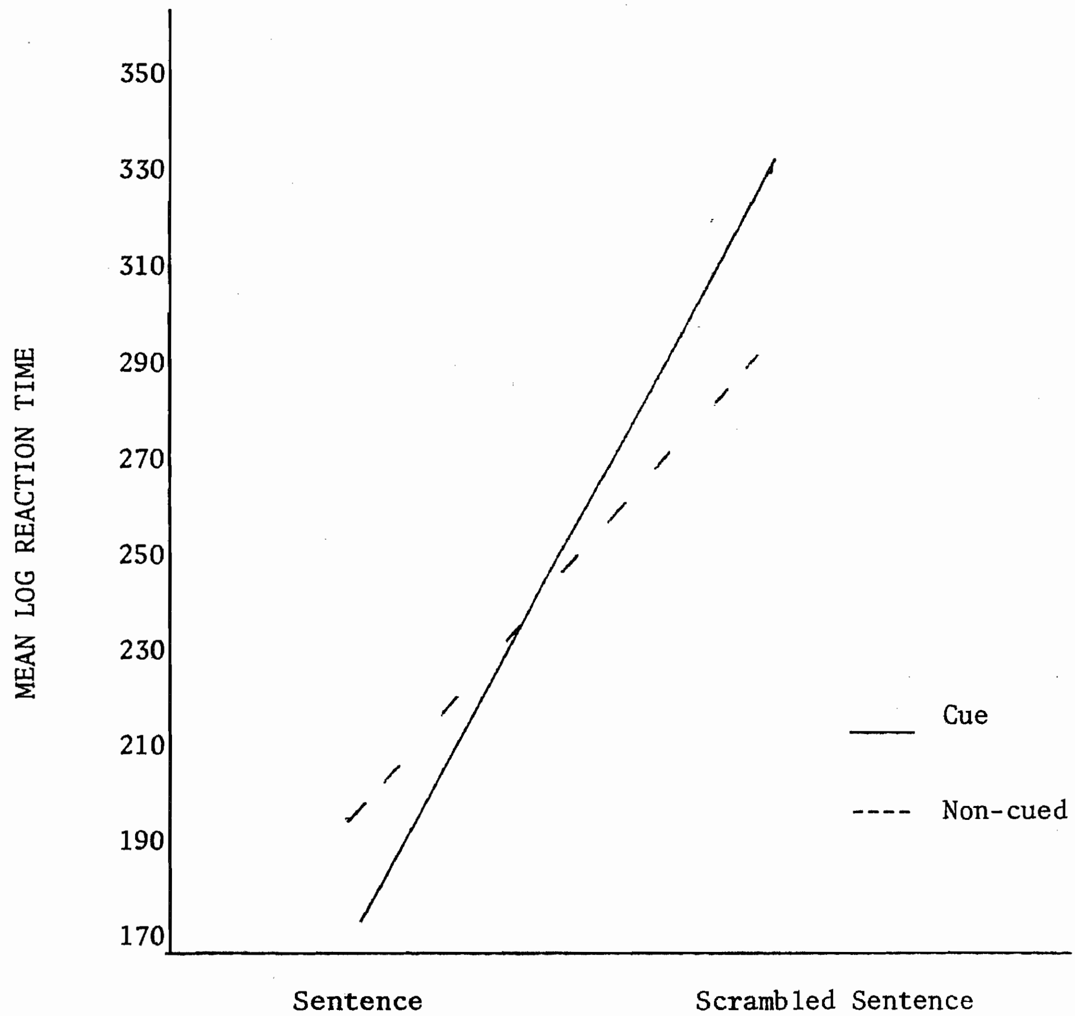

Figure 2: Mean Reaction Time With Sentences and Scrambled Sentences As a Function of Set (Cue vs. No-Cue): Experiment IV

the cued and noncued groups with sentences (t=.52, d.f. 30), nor with scrambled sentences (t=.62, d.f. 30).

It can be seen from figure 2 that the cued group's mean reaction time with sentences was faster than that of the noncued group's, while the cued group's reaction time with scrambled sentences was slower than that of the non-cued group, resulting in the interaction of cue and sentence type.

The faster reaction time with sentences in the cued group than in the noncued group may be due to the fact that cued Ss process larger perceptual units. The carry-over of such a strategy (processing larger units) to the reading of scrambled sentences may have been inefficient when reading unrelated words. This carry-over effect then may have produced the slower reaction time with scrambled sentences in the cued group as compared to the noncued group.

It had been predicted that cuing would induce Ss to process larger perceptual units and that X's filling in interword spaces would therefore more greatly hinder the cued group than the noncued group.

The cued group did not, however, perform significantly more slowly with sentences than the noncued group. This may have been due to the fact that the X's filling interword spaces were not an adequate source of interference. Ss may have read sentences as "figure", grouping the X's as background noise. In Hochberg's study, the interfering symbol was made by superimposing an X on an a and c, each typed at half pressure, so that the resulting contrast of the characters together was roughly that of the surrounding letters (Hochberg, Levin and Frail, 1970). The symbol described in the study by Hochberg, Levin and Frail (1970) might have been a more effective interfering symbol in experiment IV. Replication of experiment IV with the interfering symbol utilized in the Hochberg, Levin and Frail (1970) study may produce slower reaction time with sentences in the cued group as compared to the noncued group. This finding would be consistent with the view that cuing induces Ss to process larger perceptual units, thus making the absence of interword spaces a greater source of interference in the cued group than in the non-cued group.

GENERAL DISCUSSION

The experiments presented in this thesis were directed toward an examination of the influence of set on visual processing.

Experiment I provided evidence consistent with a cognitive schema model of reading, such as the proposed model.

In experiment I, semantically cued Ss were significantly better in identifying words and in locating word positions (discriminating between visually similar words and nonwords) than were syntactic and no precue Ss.

Since semantic group Ss located word positions more accurately than Ss in the no precue and syntactic groups, Ss in the semantic group processed the visual material more completely than did Ss in the other two groups. This latter finding is inconsistent with response bias models which state that a reader, provided with context, processes less visual material than does a reader not provided with context.

Experiments II and III which attempted to eliminate the word identification aspect of the task, produced significant changes in performance in the syntactic and no precue groups (greater accuracy in locating word positions). Ss in the no precue and syntactic groups are as accurate in locating word positions (in experiments II and III) as was the semantic group in all three experiments.

The no precue and syntactic Ss are deficient in ability to read for meaning (identify words in experiment I), yet Ss in these groups appear to be able to locate word positions as accurately as semantic Ss when the task eliminates reading for meaning and requires a more purely visual analysis (detecting word-like visual configurations). Since no precue and syntactic groups are as efficient in locating word positions (experiments II and III) and are yet deficient in word identification (experiment I), it seems that Ss do not perform the task in experiment I by first locating word positions and then extracting the visual information necessary to perceive them. If the latter were the case, the no precue and syntactic group should have been able to identify as many words as did the semantic group in experiment I, and to locate as many word positions.

The following finding concerning the relationship between exposure duration levels and mean number of words identified may provide some insight into how the efficiency of the reader's visual processing relates to his ability to formulate hypotheses about the material (for instance hypotheses about the identity of words).

In experiment I, it was found that Ss whose threshold was 30 milliseconds had significantly higher mean word identification scores than Ss whose threshold was 60 milliseconds or over 60 milliseconds. Thus, although exposure durations had been varied for each S according to his individual threshold level, so as to compensate for individual differences in time needed to register and encode visual material, Ss in the 30 millisecond group continued to identify significantly more words than Ss whose exposure duration was 60 milliseconds or over 60 milliseconds. Processing at lower thresholds may mean that Ss in the 30 millisecond group may have a more efficient nervous system than Ss in the 60 millisecond group. The fact that the differences between Ss with a 30 millisecond and a 60 millisecond threshold persisted when time to process material was adjusted to individual requirements, suggests that the superiority of Ss whose threshold is 30 milliseconds is not due simply to their ability to process visual material more rapidly. Ss at the 30 millisecond threshold level may be able to formulate hypotheses more rapidly than do Ss at the 60 millisecond level. The following provides evidence that faster readers may formulate hypotheses more rapidly. Morton (1964) found that faster readers have longer eye-voice spans than do slower readers. Furthermore, faster readers read to the end of phrase boundaries more often than do slow readers; "the EVS of the faster readers appears to be more adaptable to the structure or content of the reading material" (Levin and Kaplan, 1970, p. 124).

Poor readers read word for word and are less able to scan meaningful units.

The finding that fast readers process meaningful phrase units, suggests that they are able to formulate hypotheses about the relation between words more readily than do slow readers.

Experiment IV attempted to demonstrate that Ss provided with a semantic set process larger perceptual units than do non-cued Ss.

The results revealed a significant interaction between cues and sentence type. However, in experiment IV, effects produced by the cue may have been partially masked by effects produced by the absence of interword spaces. The absence of interword spaces in the sentences may have induced Ss to treat sentences more as isolated word units than as a larger semantic unit, thus reducing the tendency to process larger perceptual units and reducing the possible carry-over of such a strategy to the reading of scrambled sentences. Replication of experiment IV, with interword spaces present, would allow cued Ss to process larger perceptual units when reading sentences.

If it were found that cued Ss were significantly slower in reading scrambled sentences or word lists than was the noncued group, this finding would then be consistent with the view that cued Ss carry over a sentence reading strategy to the reading of unrelated words when this is no longer efficient (that is cued Ss process larger perceptual units when reading unrelated words).

Semantic set may have improved word identification scores in experiment I by inducing Ss to process larger perceptual units. Reading larger perceptual units has been found by researchers to be associated with good reading as defined in terms of standardized reading tests (Buswell, 1920) and as defined in terms of fast reading (Levin and Kaplan, 1970).

Processing larger perceptual units as indicated, for example, by longer eye-voice span, may be due to factors other than simply the degree of constraint within the text. This view differs from that of Levin and Kaplan who state: "Constraints allow the decoder to anticipate, predict or formulate hypotheses about what comes next" (Levin and Kaplan, 1970, p. 130). The proposed model suggests that the reader's ability to conceptually link words independent of the constraints within the text, is also a factor in the degree to which he can process larger perceptual units.

Indirect support for the hypothesis that cued Ss process larger perceptual units than noncued Ss is found in experiment I as semantically cued Ss are better able to position words within the array. Ability to process a larger perceptual unit would lead to increased accuracy in locating a line of words and nonwords relative to one another. The smaller the portion of the line perceived, the more difficult it would be to locate the position of any word or nonword relative to the other words and nonwords.

To test directly whether set affects the size of the perceptual unit, it may be relevant to examine whether set can affect the size of the EVS (induce longer EVS).

The proposed model differs from the model of Levin and Kaplan, who also view the reader as formulating hypotheses, in that the proposed model suggests that Ss structure visual material in terms of semantic hypotheses. Levin and Kaplan, in contrast, view the reader as checking his hypotheses against an already structured text. The experiments I, II and III attempted to demonstrate that Ss with a semantic cue perform more accurately in discriminating visually similar words and nonwords because they have a basis for forming a percept. Experiment IV attempted to provide support for the view that cues induce Ss to process larger perceptual units and that the size of the perceptual unit is not simply a function of the constraints within the text.

A suggestion which would perhaps further extend the analysis of the effect of semantic set on subjects' ability to structure visual material would be to present subjects with stimuli consisting of two-word phrases with letters run together and four superfluous additional letters. For example, RAPRAISEQPUPILSF.

Ss would be told that cards contain two-word phrases plus four superfluous letters somewhere on the card.

Semantically cued Ss should, according to the proposed model, be better able to identify the two-word phrase "PRAISE PUPILS" and to disregard the superfluous letters R, A, Q and F than would no pre-cue or syntactic Ss. This experiment may provide some support for the view that semantically cued Ss do not partially perceive words (for instance, perceive relevant clusters of letters) and infer the rest, because Ss would need to be able to disregard the superfluous letters in order to view the relevant letter clusters in the words. The positions of the four superfluous letters would be varied randomly to include all letter positions on the card. Thus response bias models would need to explain why semantic Ss were not distracted by the superfluous letters.

SUMMARY AND CONCLUSIONS

The present research consists of four experiments designed to assess the influence of set on visual processing.

The results of experiment I indicated that a semantic cue could improve accuracy in identifying words and word positions. Semantic group Ss were shown to process more visual information than the no precue or syntactic groups because they were better able to locate word positions (better able to discriminate visually similar words and nonwords the position of which varied randomly from card to card).

Experiments II and III demonstrated that no precue and syntactic groups can locate words as accurately as the semantic group when no longer required to identify words. This indicated that identifying words as words may be an independent process from identifying word names; for while the no precue and syntactic groups were as accurate in locating word positions (experiment II and III), they are less accurate in specifying word identity (experiment I). Since accuracy in locating word positions in the syntactic and no precue groups is significantly lower in experiment I than in experiments II and III, there may have been some conflict between reading for meaning and locating word positions in experiment I in the syntactic and no precue groups.

Experiment IV attempted to provide some support for the hypothesis that a semantic cue induces Ss to process larger perceptual units than noncued Ss. A significant interaction between the cue and sentence type was found. However, there were no significant differences in reading time with sentences or scrambled sentences between the groups. Further experiments were suggested in order to examine the mechanism underlying the interaction of cue and sentence type.

Experiments I, II and III seem to provide support for the view that semantic set facilitates the ability of Ss to form word percepts.

Further research may be directed toward a study of the mechanisms by which set facilitates word identifications, for example, an examination of the effect of set on the size of the perceptual unit employed by the reader.

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APPENDIX A

TABLE XIII

Means (Variances), Exposure Times: Experiment I

SEMANTIC PRECUE	SYNTACTIC PRECUE	NO PRECUE
48.077 (168.154)	48.077 (304.2)	50 (752)

TABLE XIV

Analysis of Variance

Exposure Times for All Three Treatment Groups: Experiment I

SOURCE	DF	SS	MS	F
Between	2	64.103	32.05	.078
Within	75	30607.692	408.01	
Total		30671.794		

TABLE XV

Means (Variances), Number of Words Identified According to Exposure Duration: Experiment I

EXPOSURE DURATION (milliseconds)	WORDS IDENTIFIED	
30	30.5	(38.12)
40	24.57	(52.53)
50	26.35	(68.99)
60	21.77	(50.36)
(over 60)	21.78	(46.69)

TABLE XVI

Analysis of Variance

Word Identification According to Exposure Duration

SOURCE	DF	SS	MS	F
Between	4	683.4	170.8	3.249*
Within	71	3733.0	52.58	
Total		4416		

* $p < .05$ approaching $p < .01$

TABLE XVII

Word Positions Correct, Syntactic Group:

Experiments II and III

SOURCE	DF	SS	MS	F
Between	1	.1888	.1888	.003
Within	24	142.327	5.93	
Total		142.346		

Word Positions Correct, Semantic Group:

Experiments II and III

SOURCE	DF	SS	MS	F
Between	1	2.872	2.872	.548
Within	24	125.781	5.241	
Total		128.654		

APPENDIX B

Familiarization with Single Word Stimuli: Experiments I, II and III

When you place your face right up against the goggles in front of you, you will see a card with a cross on it. Look at the cross each time, as this will help you to fixate your eyes. When you press the button to your right, the card with the cross will be removed automatically, and the card with the word will come on. You are to read the word completely and accurately and write it down. You have only one attempt to read the word on each card.

Threshold Instructions: Experiment I

You are going to be shown a series of card each containing two words and two nonwords. Your task is to try and read both the words as accurately as possible and to write them down. I will be showing you each of these cards several times. Each time then, write down both words, even though you may not be sure of your answer. In addition, you are required to place a stroke in the position of the two nonwords. You must complete each answer by writing down two words and by placing two strokes in the position of the two nonwords.

After each trial wait until I tell you to begin again.

No Precue Instructions: Experiment I

You are going to be shown a series of cards each containing two words and two nonwords. Your task is to try and read both the words as accurately as possible and to write them down. You are allowed only one attempt at each card. You must write down both words, even though you may not be sure of your answer. Each time then, write down both words. In addition, you are required to place a stroke in the position of the two nonwords. You must complete each answer by writing down the two words and placing two strokes in the position of the two nonwords.

Semantic Precue Instructions: Experiment I

You are going to be shown a series of cards containing two words and two nonwords. The two words form a sentence concerning a certain subject. For each card I will give you a topic which is related to what the sentence is about. Your task is to read the two-word sentence as accurately as possible, and write it down. You are allowed only one attempt at each card. You must write down the entire two-word sentence, even though you may not be sure of your answer. Each time then, write down the two-word sentence, keeping in mind the topic I have given you, which is related to the topic of the sentence. In addition, you are required to place a stroke in the position of the two nonwords. You must complete each answer by writing down the two-word sentence and placing strokes to represent the position of the two nonwords.

Syntactic Precue Instructions: Experiment I

You are going to be shown a series of cards each containing two words and two nonwords. The two words form a sentence. Your task is to read the sentence as accurately as possible and write it down. You are allowed only one attempt at each card. You must write down the entire two-word sentence, even though you may not be sure of your answer. Each time, then, write down the two-word sentence. In addition, you are required to place a stroke in the position of the two nonwords. You must complete each answer by writing down both the words in the sentence and by placing two strokes to represent the positions of the two nonwords.

Threshold Instructions: Experiment II

You are going to be shown a series of cards on which two words and two nonwords are written, horizontally, in the centre of the card. Your task is to try and read both the words accurately. You need not write down the words, but you are to place a W in the position of the two words and place two strokes in the position of the nonwords. After each trial, be sure to write two W's in the position where the two words occurred and two strokes in the position where the two nonwords occurred. You must complete each answer by writing the two W's to identify word positions, and two strokes, to identify nonword positions, even though you may not be sure of your answer. I will be showing you each of these cards several times. After you write each answer, wait until I tell you to begin again.

No Precue Instructions: Experiment II

You are going to be shown a series of cards each containing two words and two nonwords as before. Your task is to try and read both the words as accurately as possible. You are allowed only one attempt at each card. You need not write down the words, but you are to write a W in the position of the two words and place a stroke in the position of the two nonwords. Even though you may not be sure of your answer, you must complete each answer by writing two W's in the position of the two words and placing two strokes in the position of the two nonwords. The two words may be separated by the two nonwords or may not be.

Semantic Precue Instructions: Experiment II

You are going to be shown a series of cards each containing two words and two nonwords as before. The two words form a sentence concerning a certain subject. For each card, I will give you a topic related to what the sentence is about. Your task is to read the two-word sentence, as accurately as possible, keeping in mind the topic I have given you. You are allowed only one attempt at each card. You need not write down the words, but you are to write a W in the position of the two words and place a stroke in the position of the two nonwords. Even though you may not be sure of your answer, you must complete each answer by writing down two W's that represent the position of the two words in the sentence and by placing two strokes in the position of the two nonwords. Each time that you write down your answer, keep in mind the topic I have given you which is related to the topic of the two-word sentence. The two words in the sentence may be separated by the two nonwords or may not be.

Syntactic Precue Instructions: Experiment II

You are going to be shown a series of cards each containing two words and two nonwords as before. The two words form a sentence. Your task is to read the two-word sentence as accurately as possible. You are allowed only one attempt at each card. You need not write down the words, but you are to write a W in the position of the two words and place a stroke in the position of the two nonwords. Even though you may not be sure of your answer, you must complete each answer by writing two W's to represent the position of the two words in the sentence and by placing two strokes to represent the position of the two nonwords.

The two words in the sentence may be separated by the two nonwords or may not be.

Threshold Instructions: Experiment III

You are going to be shown a series of cards on which two words and two nonwords are written horizontally in the centre of the card. You are to locate the position of the two nonwords. You are to write two N's to represent the position of the two nonwords on the card and two dashes to represent the position of the two words.

You must complete each answer by writing two N's to represent the nonword positions and two dashes to represent the word positions, even though you may not be sure of your answer.

I will show you each of these cards several times.

After you write down each answer, wait until I tell you to begin again.

No Precue Instructions: Experiment III

You are going to be shown a series of cards each containing two words and two nonwords. Your task is to distinguish the nonwords from the words, and to locate the position of the nonwords. After you have located the position of the two nonwords, you are to write two N's to represent the position of the two nonwords on the card, and two dashes to represent the position of the two words on the card. You are allowed only one attempt at each card. Even though you may not be sure of your answer, you must complete each answer by writing two N's to represent the position of the two nonwords on the card and by writing two dashes to represent the position of the two words on the card. Remember that the N's are to represent the nonword positions. Your task is to locate the position of the two nonwords.

Semantic Precue Instructions: Experiment III

You are going to be shown a series of cards each containing two words and two nonwords. Your task is to distinguish the nonwords from the words, and to locate the position of the nonwords. After you have located the position of the two nonwords, you are to write two N's to represent the position of the two nonwords on the card and two dashes to represent the position of the two words on the card. You are allowed only one attempt at each card. Even though you may not be sure of your answer, you must complete each answer by writing two N's to represent the position of the two nonwords on the card and two dashes to represent the position of the two words on the card. Remember that the N's are to represent the nonword positions.

The two words on the card form a sentence and for each card I will give you a topic related to what the sentence is about. Your task is to locate the position of the two nonwords.

Syntactic Precue Instructions: Experiment III

You are going to be shown a series of cards each containing two words and two nonwords. Your task is to distinguish the nonwords from the words and to locate the position of the nonwords. After you have located the position of the two nonwords, you are to write two

N's to represent the position of the two nonwords on the card and two dashes to represent the position of the two words on the card. You are allowed only one attempt at each card. Even though you may not be sure of your answer, you must complete each answer by writing two N's to represent the position of the two nonwords on the card and two dashes to represent the position of the two words on the card. Remember that the N's are to represent the nonword positions.

The two words on the card form a sentence. Your task is to locate the position of the two nonwords.

Noncued Group Instructions: Experiment IV

I am going to show you a series of cards, some of which contain sentences that make sense and some of which contain sentences with words in scrambled order. The spaces between the words, on all cards, are filled with two X's. When you press the button to your right, the card will come on. Keep your finger on the button in order to display the card and read the card to yourself silently. Read the card as accurately and as rapidly as possible. Do not release the button until you know what is written on the card and have read the entire card. Release the button immediately when you finish reading the entire card.

After you release the button, write down what you have read as accurately and as completely as possible. You have only one attempt to read each card. Remember not to release the button until you have read the entire card. Write down exactly what you read on the card. You need not unscramble the scrambled sentences.

Cued Group Instructions: Experiment IV

I am going to show you a series of cards, some of which contain sentences that make sense and some of which contain sentences in a scrambled order. The spaces between the words on all the cards are filled with two X's. For the cards containing sentences I will give you a topic related to what the sentence is about. You are to think of the topic as you try to read the sentence. When you press the button to your right, the card will come on. Keep your finger on the button in order to display the card and read the card to yourself silently. Read the card as accurately and as rapidly as possible. Do not release the button until you know what is written on the card and have read the entire card. Release the button immediately when you finish reading the entire card.

After you release the button, write down what you have read as accurately and as completely as possible.

Remember to think of the topic I give you, which is related to the subject of the sentence, when you are reading the cards with sentences on them.

Remember also not to release the button until you have read the entire card.

You have only one attempt at each card.

Write down exactly what you read on the card. You need not unscramble the scrambled sentences.

APPENDIX C

Stimuli for Experiments I, II, and III

Familiarization Cards:

TALK

GOLD

BIRD

Threshold Cards:

TASTE TASTA THIS THIO

STIN STIR SLOWLY SLOWLP

EOOLS FOOLS LAUGH LAUGB

WEEP SADLY VEEP SACLY

VRAP PARCELS WRAP BARCELS

PLAY RLAY NUSIC MUSIC

Practice Cards:	Semantic Group Cues:
STARS STARC SHINE SHINF	Astronomy
DOGS DOGC BAPK BARK	Puppies squeal
EIRES FIRES BURN PURN	Flames
CIRLS GIRLS SAMG SANG	Choir
HELP THEM HELR LHEM	Assist
NENS SPREAB NEWS SPREAD	Rumour
PRIFSTS PBAY PRIESTS PRAY	Religious Service
WORK HARD VORK HARB	Be Industrious
KCCEPT ACCEPT PEFEAT DEFEAT	Be a good sport
COOD GOOD WORK WORH	A job well done
BEGIN BEGIM HERF HERE	Start
PERFORM BEFORM MAGIC MAGID	Sleight of Hand

Experimental Cards for Experiments I, II, and III

Experimental Cards	Semantic Group Cues
BAKE BNEAD BREAD PAKE	Prepare supper
WEIGH WFIGH ORAMGES ORANGES	Price per pound
PEQUEST REQUEST AID ALD	help
PENT RENT CABIMS CABINS	Summer Resort
HIDE QUIETLY HIDF QUIETLP	Conceal
FLAMEC HROSE FLAMES AROSE	Fire
DASR PHEAD DASH AHEAD	Hurry Along
LIONS ROAR TIONS ROAP	Jungle sounds
PAUSF PAUSE PRIEFLY BRIEFLY	Take a coffee break
CLIMP CLIMB STAIRS STALRS	Use the steps
COWS CQWS BRAZE GRAZE	Animals in the pasture
AVOID AWOID DELAY DEIAY	Be prompt
POUR WINE BOUR WIME	Prepare liquor
GREEI GUESLS GREET GUESTS	Welcome them
OBEY OBEP PAPENTS PARENTS	Respect authority
DHEER CHEER LOUDLY IOUDLY	Yell
PERFUMF PERFUME SMEELS SMELLS	Sweet scent
SWIN SNIM FARTHER EARTHER	Skin dive
DISPLAY DISPRAY COURAGE COUPAGE	Be determined
BFG BEG MERCY MERCP	Plead
UTTER UTTEP CIGHS SIGHS	Moan
REW SEW DLOTH CLOTH	Mend
BELLS RANG PELLS RANB	Chimes Sounded
PRAISF PUPLLS PRAISE PUPILS	Encourage students

Stimuli for Experiment IV

Practice Cards	Sentence Cues for the Cued Group
PLAN AHEAD	Future
THE WON RACE WHO	______
PLAY THE GAME	Final's match
DOOR LIVE NEXT I	______
PICK A CARD	Magic trick
HE IS GONE	Leave

Experimental Cards	
LIGHT THE MATCH	Fire
DO NOT WORRY	Be calm
NET THE CAST	______
MONEY THE EARN	______
FOLLOW THIS ROUTE	Lead the way
TRUTH THE TELL	______
JOIN THE CLUB	Be a member
YOURSELF JUDGE FOR	______
BEST THE FOR HOPE	______
DRINK SOME BEER	Consume liquor
PAY ATTENTION	Listen to me
NOT DO AFRAID BE	______
HIS IS IT FAULT	______
IT IS A FUNNY STORY	Joke
CLOUDY THE WAS SKY	______
CLEVER THE IS IDEA	______
I RECALL THE EVENT	To remember

RULES THE OBEY	______
WE HAVE MET	Acquaintances
HE GAINED WEIGHT	Grow fat
HE LEARNS QUICKLY	Smart
CLOCK THE RANG ALARM	______
PARCEL THE BRING	______
I COOKED DINNER	Prepare supper

NOTE: All inter-word spaces were filled with two X's, for example:

XXPLANXXAHEADXX