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THE EFFECTS OF FORM CLASS, IMAGERY LEVEL AND COMPREHENSION UPON CUED AND FREE RECALL WITHIN A SENTENCE CONTEXT

by

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A THESIS

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled The Effects of Form Class, Imagery Level and Comprehension Upon Cued and Free Recall Within a Sentence Context

submitted by Lily Oddie

in partial fulfilment of the requirements for the degree of Master of Education.

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Date April 18, 1975

ABSTRACT

The validity of Paivio's dual encoding model and the relationship between imagery and comprehension processes within a sentence context were investigated by examining, (i) the effects of systematic multiple cueing of each word in a sentence by the remaining members of the sentence, (ii) the facilitatory/inhibitory effect of imagery on sentence recall by manipulating the imagery level of each word in the sentence, (iii) the effect of (ii) upon encoding processes as manifested in whole or partial free recall of the sentences, (iv) the relationship between additive imagery as determined by summing the individual values of component words in the sentence and by global ratings of the sentence as a whole, (v) the relationship between imagery and comprehension sentence ratings and its effect on free recall performance.

Total imagery of multiple contextual cues did not strongly predict cued recall, or produce a facilitative effect on free recall. Additive imagery levels of whole sentences correlated highly with free recall. These results were interpreted as being compatible with the pre-eminence of verbal sequential processing in cued recall and imaginal processing in free recall.

Results in the cued recall paradigm showed that when the to-be-recalled word was low imagery, form class produced no significant effect, although the object-noun was recalled more often than the verb or the adjective. In high imagery to-be-recalled words, object nouns were recalled significantly more than verbs or adjectives which were not significantly different from each other. An imagery effect across

context and form class suggested that the imagery level of the to-be-recalled word is more important than the additive imagery level of context cueing words. Form class of the to-be-recalled word was also more important than context imagery, with nounness per se more salient than either the verb or adjective.

The rank ordering of sentence types as determined by free recall performance indicated that verbs were not as critical for encoding and retrieving sentences as a priori predictions of noun, verb, adjective suggested. However, a main effect of form class across all sentence types did confirm this overall ordering pattern.

Correlations of additive imagery, global imagery, comprehension, and free recall were highly significant, and supportive of the assumption that global imagery is the sum of the individual levels of sentence components in regard to effect upon free recall. These results support the validity of Paivio's original imagery ratings, and the extended use by contemporary researchers of global sentence ratings. The prepotency of either imagery or comprehension was not indicated, suggesting a complex interactive relationship, not amenable to further investigation given the restrictions of the present study.

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CHAPTER I

INTRODUCTION

Overview

Paivio (1969, 1971, 1974) states that imagery and verbal processes have functional significance through differential meaning and mediation processes in perception, verbal learning, memory, and language. The purpose of the present study was to extend the "conceptual-peg" hypothesis (imagery), and the "associative probability or contiguity hypothesis" (verbal processes) from the traditional paired-associate paradigm to sentence learning.

Simple active sentences of the type "The (Subj-Noun) (Verb) the (Adj) (Obj-Noun)" were presented to subjects in six sets of eight sentences. Immediately after each set of sentences was presented for study, part of each sentence (one word missing) was presented. The subject's task was to recall the missing word. Feedback was given after each sentence. Word order within sentences remained constant, but the choice of the to-be-recalled word was randomized. Upon completion of cued recall of each set of sentences, the subject was asked to recall the sentence or any part thereof. The subject was then asked to rate the sentences on a seven-point scale for both imagery and comprehension. Six measures were of interest: (i) the salience of the multiple-stimulus cues on the retrieval of the response term (ii) the utilization and/or existence of compound complex sentence images or other functional image units (iii) the prepotency of the imaginal and verbal coding processes as revealed by response profiles in sentences which varied systematically in the degree to which individual words were abstract or

concrete (iv) the mathemagenic effect of cued recall on sentence learning (v) the mathemagenic effect of systematic variation of the imagery attribute on sentence learning (vi) the relationship between imagery and comprehension and the prepotency of either process on the performance measure of free recall.

This chapter begins with an introduction to A. Paivio and his associates as an influential North American force in the resurgence of theoretical and empirical concern with imagery over the past twenty years. Paivio's dual-encoding model of memory, together with the "conceptual peg" hypothesis, which is central to the model, are presented. A brief literature review outlines central issues and the direction of past and ongoing research. The chapter closes with a restatement of the general purpose of the study.

Introduction to Paivio

Paivio and his associates have been active in imagery research since 1956, and have focussed attention on the importance of imagery as a potent variable in the verbal-learning laboratory. Paivio questions the classic behavioristic argument that imagery is subjective and inferential, whereas words are objective and manageable. He states that the interests of contemporary psychologists have not remained at the empirical level, and quotes Deese (1965): "We study associations in order to make inferences about the nature of human thought....The whole of the current concern is with the associative properties of explicit verbal behavior as a model for the implicit verbal process of thought" (p.4). These verbal mediation processes are no less inferential than imaginal processes. The immediate problem, according to Paivio, is to clarify the function of both postulated processes. The usefulness of postulating either con-

struct, or both, depends on the adequacy of the defining operations and the research procedures used to test properties theoretically attributed to them. Paivio believes that images have functional significance in behavior, and that this functional significance is empirically demonstrated in contemporary studies of meaning and mediation processes in perception, verbal learning, memory and language (cf. Paivio, 1971).

Paivio's model of imaginal and verbal processes is presented in summary form, followed by a brief review of empirical findings. Studies relevant to this present study will be amplified.

A Dual-Encoding Model of Memory - Paivio (1969, 1971, 1974)

Paivio states that there are two principal coding systems in memory. These two codes, linguistic and semantic, are independent and interrelated or interconnected. Two processes underly the meaning of encoded information: one process utilizes verbal representations derived from interassociative relations between words or word units, and the second process utilizes imaginal representations of words or units. Performance differences for different types of stimulus materials can be attributed to the relative availability of the two memory codes. Both codes can be functional in tasks involving retention of item information. Thus the probability of remembering an item is a direct function of the availability of one or both codes. Memory increases directly with the number of alternative memory codes available for an item. In the case of the meaning attribute of concreteness, for example, the increase in the number of items remembered as one goes from abstract to concrete words to pictures would be interpreted as reflecting the differential availability of concrete imagery as a supplementary or additional coding system, since the availability of the verbal

code does not increase with concreteness. In sequential memory tasks, however, performance should be related to the availability of the verbal code. The fundamental assumption is that the two processes underlying performance are both independent and additive in the sense that storage or encoding in one process does not affect encoding in the other process and information from both codes can be used to determine recall. That is, the information contained in relatively concrete materials may be encoded in both systems at input, either directly, or through transformational links or interconnections. At retrieval, information is available through the activation of either or both systems. Utilization of the two systems presumably is dependent on cue restrictions and task demands.

Paivio's main concern is with cognitive processes that directly serve a symbolic representational function. Imaginal and verbal processes, as alternate coding systems or modes of symbolic representation, are developmentally linked to experience with concrete objects and events as well as with language. Paivio views the relative differences between the two systems as: (i) visual imagery may be considered a spatially and operationally parallel processing system, while verbal processing may be considered sequential; (ii) visual imagery and verbal processing can be viewed as differentially occupying opposite points on the static-dynamic continuum, with highly abstract material being encoded by th static verbal system, and highly concrete material by the dynamic imaginal system; (iii) visual and verbal processes occupy different positions on the concrete-abstract dimension of meaning attribute and stimulus-response functions.

A rigid dichotomy of the two symbolic modes is not suggested. In fact, the interaction or overlap of processes is critical to the

theory. Utilization of one code rather than the other depends on the relative efficiency of that code in a given situation. The theory does not exclude the possibility of the existence of other representational modes. It is not intended to be a complete theory of memory but is concerned instead with the functional roles of imaginal and verbal processes as memory codes. Paivio (1971) stresses the need for factual information to test the implications of the dual-coding model at this stage of ongoing research:

> The theoretical interpretations require elaboration, particularly in regard to the role of memory mechanisms operating during storage, retention, and retrieval of information in memory. It remains to be determined whether the findings and the dual-coding hypothesis can be incorporated into contemporary memory models without severe modifications in the latter. The postulated capacity of the image system for processing and storing spatial information also needs systematic investigation in relation to... various ...kinds of memory tasks. (p.243)

While much of Paivio's earlier research was concerned with traditional verbal learning paradigms, and specifically paired-associate learning, he has also extended imagery research into the area of meaningful phrases, sentence learning, and connected discourse. Although not as systematically well demonstrated empirically as earlier research, Paivio (1971) contends that his dual coding model can be extended into the memory and language domain, where the individual units at input are no longer single words, or paired-associates, but meaningful groupings of words. The implicit assumption is that encoding operations with these

larger units are the same as with smaller associative or linguistic units. Paivio 4) addresses this issue of generality by citing contemporary empirical evidence ranging from perceptual-psychophysical paradigms to the actual use of language (sentences, connected discourse) which he claims supports the assumptions of his dual-coding model. In this review, Paivio emphasizes another assumption which emerges as test material and the test situation more closely approximates meaningful discourse: there is a probability factor associated with both imaginal and verbal responses, which depends on variability and contextual determination of referential relations and of semantic processing in general (knowledge of the world and knowledge of language, as emphasized by Olson, 1970; Bransford & Johnson, 1973; Anderson & Ortony, 1974).

Levels of Meaning

Paivio (1971) proposes an approach to meaning in which images and words are regarded as major psychological reactions to objects and verbal stimuli. These reactions are the substance of an analysis involving three hypothetical levels of meaning (a) representational (b) referential (c) associative. Representational meaning implies that a mental representation or code (image or word) corresponding to an object or verbal stimulus has been stored and is available for further processing. Referential meaning implies an association between imaginal and verbal representations corresponding to the same referent, so that the object can evoke its verbal label and the label can arouse the object image. Associative meaning refers to chains or clusters of associations involving words, images, or both.

Of empirical significance is the fact that response profiles from various verbal-learning paradigms can be analysed in terms of

utilization of either the imaginal or verbal codes through the heirarchy of meaning levels. Factor-analytic studies of meaning attributes of the individual word reveal that concreteness and imagery correlate, (i.e., that they are largely uni-dimensional) (Paivio, 1968; Paivio, Yuille & Madigan, 1968). Imagery-concreteness is the most consistent and potent single predictor of performance in paired-associate, free recall, and recognition tasks. Frequency as a meaning attribute is inconsistent across tasks. However, it has been shown to interact in a complex manner in certain paired-associate learning tasks, recognition and verbal discrimination learning. Meaningfulness, as defined by the production method of Noble (1952), shows weak effects across paradigms.

The Conceptual Peg Hypothesis

The dual-coding model is concerned with two symbolic coding systems and their effectiveness in representing and retrieving input information. Theories which attempt to explain the distinctive functional properties of these systems are therefore of importance to the model. The conceptual-peg hypothesis is a theory about the functional properties of the imaginal system, while the associative probability or contiguity hypothesis is a theory about the functional properties of the verbal coding system.

An initial attempt to conceptualize associative learning in terms of imagery with emphasis on the role of stimulus meaning and the nature of the transformations that might be involved between information input and retrieval or recall output, was expressed in terms of the "conceptual-peg" hypothesis. The hypothesis was introduced by Lambert & Paivio (1956) and Paivio (1963) and has been modified and extended in light of empirical

findings in various paradigms (Paivio, 1971). Briefly, the hypothesis is that high-imagery or concrete stimulus terms function as efficient stimulus "pegs" from which associates can be hung and retrieved by means of mediating images. Underlying the hypothesis is the assumption that imagery-concreteness are meaning attributes; that the differential effect of these attributes on the stimulus and response terms in, for example, a paired-associate task, is a reliable predictor of recall performance; and that the performance interaction between meaning attributes and stimulus-response terms reflects the prepotency of either the imaginal or verbal coding process.

Related Research

Paired-Associate Experiments:

The conceptual-peg hypothesis interprets the facilitating effect of concreteness in terms of organized conceptual units. This implies that concreteness of the stimulus term is crucial, since it is the stimulus that on recall trials must reinstate (conceptually or symbolically) the organized stimulus-response unit experienced during their paired presentation. The clear functional distinction between stimulus and response members in a paired-associate task makes it ideal for studying the conceptual peg hypothesis. One member of the pair is explicitly designated as the stimulus in the sense that it functions as a retrieval cue for the to-be-recalled response term during a test trial. The nominal stimulus is thus the functional stimulus.

Most of the work related to the conceptual-peg hypothesis has been concerned with noun-adjective (N-A), noun-noun (N-N), and meaningful phrases. Paivio (1971) recognizes the need to extend the research to

include other word classes.

Adjective-Noun Paired-Associates

Lambert and Paivio (1956) reported a serial anticipation experiment concerned with the effect of word order on the sequential learning of groups of words. Each group consisted of a noun and three relevant, modifying adjectives. Two orders of presentation were used: noun followed by its three adjectives, or the three adjectives followed by the noun. The noun-adjective order (N-A) was significantly easier to learn than the adjective-noun (A-N) order. Results were interpreted in terms of the relatedness of group members. The relatedness is determined by the noun: relatedness is high when the noun appears early and low when the noun appears late. Adjectives are meaningfully associated with the noun concept, thus when the associations are forward (N-A) the adjectives are more easily learned. Paivio (1963) states that in terms of the foregoing experiment, nouns act as conceptual "pegs" from which their modifiers can be hung. Accordingly, concrete nouns should be more "solid" pegs (more effective stimuli) than abstract nouns. Because stimulus-response functions were complicated in the 1956 experiment by the use of serially learned lists, Paivio (1963) used a paired-associate paradigm. Two experiments were conducted with N-A pairs, with order of pairs and abstractness-concreteness varied. It was predicted that learning is superior with concrete nouns, and that this effect is greater on the stimulus side of pairs, where the noun's image-evoking capacity has its effect on response retrieval. The Lambert and Paivio (1956) finding was confirmed. Pairs with concrete nouns were recalled better than pairs with abstract nouns. The predicted interaction of noun-concreteness and A-N order was achieved with elementary school children (although the effect was slight), but not with university students. Thus the prediction that abstract nouns have a

greater effect on the stimulus side was not supported. Kusyszyn and Paivio (1966) considered the contribution of interword transition probability to the word-order effect. Word order, transition probability, and noun abstractness were varied systematically. The effect of each variable was highly significant and relatively independent, recall being better for pairs in the N-A rather than A-N order, with concrete rather than abstract nouns, and of high rather than low transition probability. The results further supported the hypothesis that nouns are superior to adjectives as conceptual pegs.

The superiority of the N-A order of presentation can also be interpreted simply as a special case of the differential facilitating effect of concreteness or imagery value on the stimulus side of the pairs. This formulation differs from the conceptual peg hypothesis as it was applied to N-A pairs in that the emphasis is now placed explicitly on the differential imagery value of nouns and adjectives, rather than on some possible grammatical difference between the words. It does not negate in any event the conclusion that words that are high in imagery-concreteness are extraordinarily effective as stimulus cues in associative learning.

Lockhart (1969) proposed a similar interpretation of the N-A order effect in terms of differential abstractness. This interpretation also denied the importance of form class per se. His interpretation was supported in a study concerned with retrieval asymmetry (the relative effectiveness of stimulus and response members as retrieval cues in N-A pairs). However, Lockhart did not directly test the effect of adjective imagery in the order effect.

Yuille, Paivio, and Lambert (1969) investigated the role of adjective imagery in the order effect. The experiment involved A-N order, noun imagery, adjective imagery, and language (English and

French) as variables. Superior learning occurred for pairs in the N-A order, and for pairs containing high-imagery nouns. In addition, adjective imagery had a significant positive effect. Interactions showed that the imagery level of both adjectives and nouns had a greater effect with the words in the stimulus rather than the response position in the pairs, which is consistent with the conceptual-peg hypothesis. Interaction of noun and adjective imagery showed that the former had the greater effect. However, this effect was partly due to a more restricted range of imagery variation in adjective imagery. A triple interaction of noun imagery, adjective imagery and order indicated that the largest effect of imagery was obtained for noun imagery when pairs were in the N-A order and the response adjectives were high in imagery. This is consistent with the imagery hypothesis in that learning is easiest when both members are high imagery and when the stimulus member is a noun. Recall suffers particularly when the stimulus noun has a low imagery level. The effect of adjective imagery showed a reversal in that A-N pairs were recalled easier if the adjective member was high on imagery and the noun was low on imagery.

Phillipchalk and Begg (1971) showed that adjective imagery and noun imagery have similar effects when differences in the range of imagery variation are reduced. The to-be-learned items included high and low imagery nouns and adjectives associated with nonsense syllables embedded in sentence fragments of the type, "The QOF blister" and "The rusty QOF". Sentence fragments were shown successively, then frames were presented with the nonsense syllables missing. The subjects were required to fill in the blanks. Thus the nouns and adjectives functioned as stimuli for the recall of the associated syllable. Concreteness of both nouns and

adjectives strongly facilitated associative recall. The effects of noun and adjective imagery were approximately equal, as evidenced by the non-significant interaction of form class and concreteness. Nouns were better cues than adjectives, but non-significantly. In a recognition test, subjects chose appropriate CVCs from a list and inserted them in blanks. Results again showed a strong positive effect of concreteness, and the form class effect and concreteness by form-class interaction were significant.

The results of the above experiments suggests that stimulus imagery has a strong effect on associative recall whether varied within nouns or adjectives, and that any differential effect of imagery could be largely due to differences in the range of imagery variation. Form class may have some residual effect not attributable to imagery as evidenced by the recognition results. The results strengthen one conclusion: words that are high in imagery-concreteness are extraordinarily effective as stimulus cues in associative learning. In this regard, the metaphorical conceptual-peg hypothesis has been supported without exception.

Noun-Noun Paired-Associates

Apart from any differential imagery value of A-N pairs, another feature that might limit the generalization and inferences from the data is that the word sequences or pairs used in the early experiments (Lambert & Paivio, 1956; Paivio, 1963; Kusyszyn & Paivio, 1966) involved relatively strong direct associative connections. These may have obscured any mediational effects attributable to imagery. The conceptual-peg hypothesis was therefore tested further in a series of experiments involving unrelated N-N pairs, with concrete-abstractness varied.

The theoretical argument differs in one respect from that involved in the A-N situation, although the general mediating function attributed

to imagery remains the same. An A-N pair comprises a single conceptual unit in which the adjective specifies some attribute of the noun concept, whereas an unrelated noun pair comprises two conceptual units. If imagery is to function effectively as a mediator of the N-N association, it must consist of a compound image incorporating the representations evoked by each word individually. Such encoding of stimulus and response terms into a compound image presumably occurs during the study trial. To be effective in prompting response recall, the compound image must be re-aroused by the stimulus member alone during the recall trial. The image-evoking capacity of the pair member that serves as the stimulus is thus critical during the recall trial, since it also affects the ease with which the appropriate verbal response can be retrieved from the mediating image. The analysis thus assumes a complex sequence of encoding during both study and recall trials, and a further decoding process during recall in order to reproduce the response.

In general, N-N experiments have yielded the following results: concrete-concrete phrases are recalled better than concrete-abstract phrases, which are recalled better than abstract-concrete phrases. Abstract-abstract phrases have the lowest recall (Paivio & Olver, 1964; Paivio, 1965).

Symmetry-Asymmetry

The conceptual-peg hypothesis is essentially a retrieval theory, a high-imagery item being especially effective as a retrieval cue for a to-be-remembered associate. The concreteness of the nominal response is assumed to be relatively less important during the recall stage, but the formation and storage of the compound mediating image during the study stage presumably depends equally on the concreteness of both members.

of the pair. This distinction has important implications when the paired-associate learning procedure is modified (i.e. when the nominal response member is presented as the retrieval cue in a test of backward association). Such a procedure combined with variation in item concreteness provides an opportunity to evaluate one of the important theoretical distinctions between imaginal and verbal processes in relation to associative learning, namely their differential functional capacity for spatially parallel and sequential information processing. The traditional associationistic view is that the associative process is directed, with the direction corresponding to the directionality of the original experience involving two events. Empirical findings of better forward recall have led to the theoretical implication that separate forward and backward associative bonds are simultaneously formed and that forward bonds are stronger (Ekstrand, 1966).

Asch and Ebenholtz (1962) proposed the hypothesis of associative symmetry, which maintains that "when an association is formed between two distinct terms, a and b, it is established simultaneously and with equal strength between b and a". Unidirectional or asymmetrical associations are an artifact of differential availability of items (practice in one direction).

The asymmetry-symmetry issue is unresolved, and empirical data show evidence for both views (Houston, 1964; Asch & Lindner, 1963; Battig & Koppenaal, 1965).

Paivio (1971) hypothesizes that associative directionality relates to semantic attributes of stimuli--most particularly imagery-concreteness and the inferred underlying imaginal and verbal symbolic processes. To the extent that associations involve visual imagery, they will be symmetrical; to the extent that they involve the verbal symbolic system (or auditory-motor processes generally) they will tend to be directed, with the degree

of directional asymmetry depending on the relative asymmetry of associative experience involving two or more events. Since the availability of imagery presumably varies directly with item concreteness, it follows that the more concrete the pair of items, the more likely it is that they will be associated symmetrically. Conversely, the more abstract and devoid of imagery they are the more likely it is that the association will be unidirectional.

In considering the effects of imagery-concreteness on associative directionality, one must distinguish between effects attributable to the differential potency of concrete and abstract words as retrieval cues, and directional asymmetry or symmetry.

Lockhart (1969) carried out three experiments in which the subjects were given one study-test trial with A-N pairs. The pairs were presented in either A-N or N-A order, and either member of a pair could serve as the cue for recall. If associations are symmetrical, recall should be independent of the word given as the cue for recall. Recall was found to be independent of the word given as cue for concrete pairs, but superior when cued by the noun. Asymmetrical recall was attributable to the relative abstractness of adjectives in A-N pairs, an effect which was confirmed by the symmetry effect with abstract A-N pairs. Lockhart concluded that concrete A-N pairs are associatively linked in such a fashion that the concrete noun provides more cues for the retrieval of the adjective than vice versa. He suggested that mediating imagery could provide a plausible account of the asymmetry effect and the error data. This essentially supports the conceptual-peg hypothesis. The adjective-abstract nouns symmetry does not support the asymmetrical verbal processing theory, although instructions may have encouraged rehearsal in both directions.

Yarmey and O'Neill (1969) ran multiple trials, on N-N pairs, concrete-abstract, and abstract-concrete, forward and backward recall. The crucial comparison was between concrete-abstract pairs and abstract-concrete pairs, for which predictions from item availability and conceptual-peg hypotheses differ. Concrete-abstract pairs were somewhat superior to abstract-concrete during forward learning, and the turned-over abstract-concrete pairs were clearly superior in backward learning. The Lockhart and Yarmey and O'Neill experiments thus demonstrate retrieval asymmetries related to noun imagery-concreteness in A-N or N-A experiments regardless of the directionality of the test.

Noun pairs of concrete-concrete and abstract-abstract combinations were also included in the Yarmey and O'Neill experiments, and a comparison of error scores during backward learning showed that transfer from forward to backward association was stronger for concrete than for abstract noun pairs. That is, asymmetry was greater for the latter as predicted from the associative directionality hypothesis which related symmetry-asymmetry differences to the relative availability of imagery as an associative mediator.

Paivio (1971) cautions that any theoretical analysis of associative directionality needs to take into account the meaning attributes of individual items (p. 285). The relative effects of meaningfulness and imagery, have not been explored as systematically in relation to associative directionality as they have in relation to standard paired-associate learning.

This latter comment by Paivio is relevant to this study. We are specifically concerned with the effect of systematic variation of imagery-concreteness of individual words in a sentence on memorial processes, as well as effects of multiple-cueing of individual words on memory. This

implies that the meaningfulness (comprehension) and imagery of a sentence are some function of the total sum of individual word attributes. Thus function may be a summative property of both codes, although Paivio does not specifically extend his dual coding hypothesis to other meaning attributes. It is of interest therefore to determine what effect symmetry-asymmetry has in connected discourse.

Meaningful Phrases

A logical step following paired-associate manipulations of concreteness and word order, and which more closely approximates the English language, is an examination of recall patterns of meaningful phrases. Because the present study is an extension of the work of Begg (1972) a detailed review of his study is in order.

Begg (1972) presents experimental reasons for explaining imaginal facilitation of memory performance by an organizational hypothesis. The basic assumption is that images aroused by discrete verbal stimuli can be combined into complex images. The complex images are assumed to be functionally unitary, integrated memory structures. Functional units are defined by Tulving (1968) as those that are handled as single units by the memory system. The sets of elements in the units tend to be remembered or forgotten together as wholes. Integrated images are images in which the components interact to form conceptual units, or meaningful figures. Integrated images are functional units, although other kinds of functional units exist as well. If one assumes that meaningful phrases are represented as units, and that concrete phrases arouse integrated images while abstract phrases are represented as verbal strings, then predictions on experimental outcomes can be made. Two hypotheses regarding integration should be noted: integrated images

reduce memory load relative to non-integrated storage of the same stimuli. If the subject retrieves one part of the compound image, the other part can be retrieved with a high probability. Thus cueing recall should help redintegration with concrete phrases. With abstract phrases, however, the cues would be contiguity cues, so that a similar facilitation would not be expected.

Begg (1972) Experiment 1, tested predictions based on the hypothesis that integrated images facilitate chunking. Concrete and abstract nouns were factorially paired to form meaningful phrases, while other lists were formed using only the nouns or the adjectives. The lists were presented to subjects who were subsequently asked for free written recall. Specific predictions for homogeneous phrases were confirmed by the results. That is, the decrement in proportionate recall of abstract words was greater than the decrement in proportionate recall of concrete words due to a nominal doubling of the list, with total presentation time held constant. Proportionate recall of words in abstract phrases was half as high as for the words alone, while there was no difference between the two conditions in concrete phrases. No predictions were made for heteregenous phrases. Results in heteregenous phrase conditions showed that concrete words and abstract nouns were recalled better alone than in phrases, while for abstract adjectives, the two tasks did not differ. Begg believes that it is possible the concrete nouns in abstract-concrete pairs were such good redintegrative cues that recall was enhanced. Recall of concrete-concrete phrases exceeded abstract-abstract phrases, with concrete-abstract and abstract phrases intermediate in recall. An analysis of recall symmetry was performed on each of the four phrase-types. In the homogeneous phrase condition recall was symmetrical. In the heterogeneous condition, the more concrete member was more often recalled than its abstract counterpart.

As a test for functional unity of phrases, measures of association were calculated. Recall of phrases tended to be all-or-none. Phrases, then, have functionally unitary memory representation insofar as recall of one member is typically associated with recall of the other member.

The purpose of Experiment II was to compare recall of the nouns from the phrases with or without adjectives as cues in order to examine the hypothesis that concrete phrases are more redintegrative than abstract phrases. A further hypothesis was that pairs must be integrated before they can be redintegrated. The prediction that cued recall of nouns exceeds noncued recall of the same nouns in concrete pairs but not in abstract pairs is made solely on the basis of the theoretical properties of integrated images, inasmuch as both phrases are functionally unitary. The same A-N phrases were presented to groups. One group was then asked to recall only the nouns, while the other group was given a list of the adjectives as cues and instructed to recall the nouns. The predictions were that cued recall of nouns exceeds noncued recall of the same nouns only in the concrete-concrete phrases. Results indicated that both noun and adjective concreteness were positively related to noun recall, and interacted with the type of task. The two types of concreteness interacted with each other since the performance level for the concrete-concrete phrases exceeded the mixed phrases more than the latter exceeded the abstract-abstract phrases. Cued recall exceeded noncued recall only in concrete-concrete phrases as predicted.

The conclusions for concrete-concrete and abstract-abstract phrases are in line with the original hypothesis. Recall of nouns remembered imaginally is invariant over a nominal doubling of list length of the type used here. Cueing recall of part of an integrated image with another part of the same image facilitates recall while cueing recall of a verbal

unit with another part of the unit does not.

Experiment III was identical to Experiment II except adjectives rather than nouns were recalled. Results indicated more concrete than abstract adjectives were recalled, and more adjectives presented with concrete than abstract nouns were recalled. The two types of concreteness interacted with each other since again the concrete-concrete phrases differed from the mixed phrases by more than the latter exceeded the abstract-abstract phrases. Concreteness had larger effects in cued than noncued recall. However cued recall exceeded noncued recall in both concrete-concrete and abstract-concrete phrases.

In summarizing adjective recall over tasks and phrase types, it is clear that the major conclusions for nouns generalize to adjectives. The pattern of data characterizing concrete phrases can be called an integrated pattern, and the pattern characterizing abstract phrases a sequential pattern. Concrete-abstract phrases thus follow a sequential pattern regardless of which word is to be recalled, while abstract-concrete phrases followed an integrated pattern for adjective recall but a sequential one for noun recall.

Begg (1972) states that the relationship between the results of the present investigations and the results of other investigations using A-N phrases is difficult to draw since earlier investigators (Lockhart, 1969; Yuille, Paivio & Lambert, 1969) examined the cueing effectiveness of the two words within a pair without a control condition in which no cue was presented. However, the general conceptions underlying the research are seen as being quite similar.

The research on meaningful phrases illustrates the prepotency of the verbal system in abstract and mixed phrases in both cued recall and

total recall and using either adjective or noun cues. The facilitating effects of the imaginal process were restricted to concrete-concrete phrases. The questions of interest in extending Begg's work to sentence learning are firstly, whether meaningful or connected discourse depends more on the verbal system or the imaginal system, and secondly to what extent is this dependency a function of imagery-concreteness and cued recall.

Sentence Learning

This study is not concerned with the cuing effects of a single stimulus on a single response, but with multiple cues on recall of a response term, both cues and response terms originally being viewed in the context of a meaningful sentence. It is also concerned with the mathemagenic effect of cues in a free-recall situation. A selected review of the sentence-learning literature follows to assess the direction of sentence research and to relate this study and further studies to this trend. A further consideration of this review and study is to attempt to extend the dual-process coding model into the area of sentence learning.

Sachs (1967) made an empirical distinction between memory for the linguistic aspects of a sentence and memory for the gist of message meaning given by the sentence. Using a recognition paradigm and concrete items, Sachs demonstrated that while detection of both lexical and semantic changes was high immediately following sentence presentation, wording and grammatical changes were poorly detected following intervening syllables. Meaning changes were still well detected following this intervening activity. Sachs argues that memory for the lexical structure of sentences is rapidly forgotten, and for later sentence recall the wording is generated or reconstructed from the semantic repre-

sentation held in memory.

Wanner (1968) replicated Sachs' study with modifications. When he instructed his subjects to attend to the individual words as well as to the meaning, presumably forcing subjects to rely more on the verbal code than on non-verbal processes such as imagery, recognition for changes in meaning decreased, whereas recognition for changes in wording increased. Thus differential findings may depend upon whether subjects are asked to attend to individual words or meaning of sentences which would lead to differential arousal of verbal and nonverbal symbolic systems in sentence recall.

Begg and Paivio (1969) demonstrated that the degree of concreteness of the sentence message caused differential reliance on lexical as opposed to semantic forms of representation. Using a detection procedure, they operationalised lexical changes as synonym substitutions (which result in wording but not semantic change) and semantic changes as subject-object reversals (maintaining the original sentence words but changing the meaning). They found that for concrete sentences detection was better for semantic than lexical changes, while for abstract sentences the reverse was true with lexical changes more easier to detect than semantic.

Brent (1969) approaches the study of sentence memory from an organizational point of view directly relevant and supportive of Begg's (1972) hypothesis of organization in meaningful phrases. Brent states that chunking is on the basis of linguistic units rather than isolated words and that a subject will utilize the largest linguistic unit that he can. He hypothesized that the sequence of items within each unit are learned virtually immediately, while relations between units are learned slowly. Analysing his data by serial position error curves,

he found the curve scalloped in appearance, with a relatively large number of errors on the first item of each linguistic unit and relatively few errors on the remaining items of each unit. Working with sentences, paragraph or anomalous sentence levels, Brent found more scalloping with natural sentence units. In the case of paragraphs he found integration of lower-order units over time. These findings are consistent with the general organization approach to memory as proposed by Mandler (1968) and Tulving (1968). Brent suggests that the unit of memory is the unitary idea or meaning aroused by the discrete verbal elements in a sentence and not the verbal elements themselves.

Paivio and Yuille (1969) varied level of organization of passages (lists, anomalous sentences, connected discourse) as well as concreteness. Results showed that more words were recalled as concreteness increased. Concreteness, organization, and trials interacted in such a manner that recall was facilitated by syntactic order on the second trial of anomalous sentences, but only when the content of the passage was highly concrete. Connected discourse was of course recalled significantly better than anomalous or list material.

Anderson and Hidde (1971) had their subjects rate either the pronunciability or the image-evoking value of thirty sentences, then unexpectedly asked them to recall the verb and object of each sentence given the subject as a retrieval cue. The subjects who rated imagery recalled over three times that of the pronunciation group. Errors tended to be predominantly synonym intrusions in the case of the imagery group but not the pronunciation group. These data suggest clearly that imagery facilitates recall through a reconstructive process, which sometimes results in decoding errors, whereas pronunciation subjects recalled verbatim and therefore avoided synonym errors but made more ommission errors because they had

not stored sentence meaning during input.

Paivio and Begg (1971) predicted that if imagery contributed to reading comprehension as Paivio's view of imagery-as-meaning and Bugelski's (1969, 1971) approach to reading suggests, then indices of comprehension and image arousal should be highly correlated. Indeed imagery should precede understanding in time. One of two experiments involved presentations of a series of relatively concrete sentences which varied in syntactical type under one of four instructional sets (reading, imaging, comprehending, or paraphrasing). A sentence was presented and the subject pressed a key when he had completed the required task. Correlations were computed between the mean latencies for individual sentences under each instructional set. The highest correlation was between imagery and comprehension, followed by comprehension with paraphrasing. In a second experiment, sentences that were either concrete or abstract were used. The subject pressed a button to expose the sentence, and released it as soon as he had an image or understood the sentence. Half of the subjects were given the imagery set and half were given the comprehension set. On the basis of the dual-coding model and previous empirical findings, one would expect an interaction between concreteness-abstractness and the image-versus-comprehension instructional variable. The meaning of abstract sentences, like that of abstract nouns or noun pairs is presumably tied more closely to the intraverbal context, and verbal associative reactions than to imagery. Abstract sentences therefore should arouse images only with difficulty and yet be readily understood on the basis of their intraverbal meaning. This distinction would be reflected in much longer latencies for imagery than for comprehension. On the other hand, the meaning of concrete sentences is closely tied to concrete referents and their psychological representations in the form of imagery, and this close relationship should be reflected in

relatively small differences between image and comprehension latencies. Results showed a significant interaction in accord with the prediction.

Begg (1971) investigated recognition memory for both meaning and wording of concrete sentences using a continuous recognition paradigm. Recognition memory was much better for meaning than wording. Meaning judgments were as accurate when the test sentence was a paraphrase as for the original sentence. Meaning and wording judgments were uncorrelated, which justifies the conclusion that memory for the meaning of concrete sentences is independent of memory for their wording and, more specifically, that the meaning is remembered as an image from which words are reconstructed at retrieval.

Another possible explanation of the difference in recognition for lexical and semantic changes for concrete and abstract sentences in the Begg and Paivio (1969) study may be that abstract sentences are simply more difficult to understand, and that subjects must analyse the sentence wording longer in order to abstract the message. Thus the greater reliance on the verbal code for abstract sentences may be related to comprehension, not to differences in the way in which abstract sentences are ultimately stored in memory. Paivio and Begg (1971) argue that the results of their Experiment II supports the dual encoding notion in that encoding differences cannot be attributed to comprehension differences. Using reaction time measures, they found that subjects took longer to form images of abstract than concrete sentences, but that there were no differences in latencies when the subjects were asked to indicate when they comprehended the abstract and concrete sentences.

Johnson, Bransford, Nyberg and Cleary (1972) also address themselves to the same problem of comprehension. Using Paivio and Begg's collection of abstract and concrete sentences used in the 1969 study,

they found that subjects rated the abstract sentences to be significantly harder to comprehend than the concrete sentences. They further found that subjects rated changes caused by subject-object reversals (the method used by Begg and Paivio (1969) to produce semantic changes) to be smaller semantic changes for abstract than for concrete sentences. The implication is that the test method causes larger and therefore more detectable semantic changes for concrete than abstract sentences. Thus comprehensibility of the material and the differential sensitivity of the testing method could both be contributing to the differences reported by Begg and Paivio (1969). Differential encoding of different types of material may be related to input processing requirements (comprehension) rather than to differential availability of verbal and imaginal codes for storage.

Klee and Eysenck (1973) investigated the relationship between comprehension and abstract-concreteness in sentences which varied in meaningfulness (meaningful vs. anomalous). Subjects were instructed to press one button if the sentence made sense and the other if it did not. Latencies were recorded. Visual and verbal interference conditions were also imposed by interposing a digit between each word in the sentence. Concrete sentences were more rapidly comprehended than abstract, and there was a significant interaction between type of interference and sentence concreteness. The advantage of concrete over abstract sentences within the verbal interference condition was considerably reduced under the visual interference condition, particularly for anomalous sentences. Klee and Eysenck conclude that the dual-coding hypothesis is supported by these results. They suggest that imagery should not be considered an epiphenomenon in comprehension but may precede understanding of concrete material. Further they state that the superiority in remembering concrete sentences over abstract involves the differential effect of two (further)

sets of variables: relationships between individual words or phrases, and large scale contextual variables.

To summarize, the experiments reviewed tend to support the view that nonverbal imagery is involved in the comprehension of concrete sentences. The relationship between imagery and comprehension remains a contentious issue. Nonetheless, Paivio suggests that organization and thus comprehension is facilitated by concreteness. Extending the conceptual-peg metaphor to sentences, Paivio (1971) states that the logical subject is the conceptual peg upon which the ease of image arousal and comprehension depends. This peg is more difficult to locate in passive than in active sentences; and is limited to relatively concrete sentences. Highly abstract sentences presumably arouse images only with difficulty, but they can be understood. Comprehension in this case would depend more on the intraverbal context itself and the linguistic and other associations evoked by that context, but the problem remains to be investigated (p. 448).

In apparent contradiction to what was predicted from the dual-coding model for lists of words, the model does not imply that high-imagery (concrete) sentences will necessarily be remembered better than low-imagery sentences. If concrete material tends to be coded in a nonverbal form, then it must be decoded back in order to generate the correct verbal output. The probability of decoding errors is high, especially in regard to such features of language as its grammatical form and precise wording. Imagery is regarded as potentially facilitative in the retrieval of items from memory and not in the retrieval of their sequential order. Therefore imagery may facilitate or hinder memory for language, depending on such factors as length of the to-be-remembered verbal units and the

features of the messages that are to be recalled. Imagery may enable one to retrieve the general theme of the message and perhaps most of its word units, but not necessarily its grammatical form.

Relative memory for the wording and meaning of sentences depends upon the retention interval, abstractness-concreteness of the sentence, and sets to attend to meaning or wording. Verbatim recall is favored by short retention intervals. With concrete sentences, meaning is well-retained over longer intervals whereas memory for wording fades rapidly. With abstract sentences, wording is sometimes well-retained, perhaps because the wording itself is essential to the meaning.

The manipulation of meaning attributes of individual words within sentences, analyses of relationships between words and/or units, and effects on memory for meaning as compared to wording of sentences of mediation instructions, rate of presentation, etc., have not been investigated systematically as yet. As such it is difficult to generalize or extend the findings of verbal-learning experiments to language production, comprehension, or memory processes. The functional significance or role of the symbolic processes in language is no doubt qualitatively different from the well-documented traditional verbal-learning paradigms.

The Present Study - General Considerations

The development of research on the dual-coding model has not followed one of the directions suggested by the Begg (1972) study -- a more molecular analysis of the individual components of sentence meaning and the way in which they operate (additively or interactively). If in fact, the effects of imagery upon encoding are considerably more complex within meaningful phrases than within paired-associates, it

seems advisable to pursue a more molecular approach to the study of imaginal and verbal encoding within a sentence context.

The broad purpose of this study is to investigate the validity of the dual-coding model within a sentence context at a more molecular level than earlier research reviewed above by examining (i) the effects of systematic multiple cueing of each word in a sentence by the remaining members of the sentence, (ii) the facilitatory/inhibitory effect of imagery-concreteness on sentence recall by systematically varying the imagery level of each word in the sentence, (iii) the effects of (ii) upon encoding processes as manifested in whole or partial free recall of sentences.

A secondary consideration of this study is to explicate the relation between imagery, comprehension, and the free recall of sentences. The equivocal nature of the sentence research cited above raises doubts as to the explanatory adequacy of the construct of imagery (the picture metaphor). It appears that this construct may well need further reduction if in fact it is confounded with comprehension. This study will utilize a rating instrument to examine the imagery-comprehension issue. The molecular methodology of summing individual values of component words in a sentence, referred to as additive imagery hereafter, will be compared with the rating of sentences as wholes. This latter comparison questions the validity of the extensive use of global ratings in earlier research. It should be noted that the operation of additive imagery as defined here is not to be confused with the notion of additivity as contained in Paivio's assumption of independence in the dual-encoding model (cf. Paivio, 1971).

CHAPTER II

METHOD

Materials

Simple active sentences were used of the type "The (Subject-Noun) (Verb) the (Adjective) (Object-Noun)". The imagery-concreteness level of the major parts of speech, with the exception of the subject-noun, were systematically varied while Thorndike-Lorge (1944) frequency was held as low as possible. The eight sentence types are shown in Table 1. There were twelve examples of each type (see Appendix A). The sentences were constructed from the ratings of Paivio, Yuille and Madigan (1968) and supplementary ratings provided by J.C. Yuille. Selection of the words was computerized (see Appendix E). The range of imagery levels for each of the major parts of speech used are shown in Table 2. The total imagery levels for parts of speech used for the twelve examples of each of the eight sentence types are also shown in appendix A. Words were chosen according to imagery level, frequency level, part of speech, and number of items requested. The imagery level of the subject-noun in the above sentences was held constant to keep the dimensions of the present study practicable due to the limited availability of imagery ratings. Manipulating subject-noun imagery doubles the number of sentences required. The present sentences will be used again with appropriate changes in subject-noun imagery in a future study. The total imagery levels shown within the eight sentence types in appendix A are summarized in appendix B for ease of comparison.

Study Lists

The total number of sentences in the sentence pool was ninety-six.

TABLE I

Imagery Levels for Words in Eight Sentence Types

Sentence Type	Subject-Noun	Verb	Adjective	Object-Noun
1	HI	HI	HI	HI
2	HI	LO	LO	LO
3	HI	HI	HI	LO
4	HI	HI	LO	HI
5	HI	HI	LO	LO
6	HI	LO	HI	HI
7	HI	LO	LO	HI
8	HI	LO	HI	LO

TABLE 2

Range of Mean Imagery Levels for Words Across Sentence Types

Part of Speech	Imagery	Range	Mean
Subject-Noun	High	5.50-7.00	5.93
	Low	not used	
Object-Noun	High	5.50-7.00	5.85
	Low	0-3.00	2.58
Verb	High	3.70-7.00	4.32
	Low	0-3.60	2.80
Adjective	High	4.30-7.00	4.75
	Low	0-3.10	2.57

Twelve sentences were generated for each of the eight sentence types (see Table 1). Half of these sentences for each sentence type were randomly assigned to either the high or low imagery condition. The designation of the condition names (high or low) was a function of the imagery level of the to-be-recalled word in the cued recall portion of the test situation. The high imagery condition was always required to recall a high imagery word. The low imagery condition was always required to recall a low imagery word (except in the case of the subject-noun which was held constant at high-imagery). All parts of speech (subject-noun, verb, adjective, object-noun) were cued for recall in each condition. Each time a to-be-recalled part of speech was tested, the low imagery condition had to recall a low imagery word (except in the case of the subject-noun), and the high-imagery condition had to recall a high-imagery word. For example, in sentences where the adjective was the word to be recalled, the low imagery condition would recall a low imagery adjective and the high imagery condition would recall a high imagery adjective.

There were 48 sentences randomly assigned to each condition. In the high-imagery condition, a high-imagery subject-noun would be the to-be-recalled word in the cued recall test on twelve occasions. The verb, adjective, and object-noun were also cued for recall twelve times. In the low-imagery condition, a low imagery verb, adjective, and object-noun, were each cued for recall twelve times. The subject-noun was also cued for recall twelve times, but the imagery level of that word was always high.

Subjects were randomly assigned to either the high or low imagery condition. Each subject received 48 sentences. None of these sentences

nor any of the words within the sentences were duplicates. None of the sentences used in the high imagery condition were duplicates of the sentences used in the low imagery condition.

The sentences were presented for study in sets of eight. Each subject therefore saw six sets of study sentences. Each set contained one representative sentence from each of the eight sentence types. The assignment of particular exemplars of sentence types to sets was random. In the cued recall test, the subject-noun, verb, adjective, and object-noun were each omitted twice within each set of sentences. That is, subjects were cued for recall (by the remaining components of the sentence) twice for each of the four form classes.

Cued Recall

After each set of eight study sentences were presented, the set was re-presented, with one word of each sentence missing. The subject's task was to recall the missing word. Word order within sentences remained constant, but the choice of the to-be-recalled word was systematically varied within sentence types (see appendix C for a sample). The determination of the to-be-recalled word was made by sampling without replacement within each set of sentences. The study sentence was shown again following each response.

Free Recall

Upon completion of the cued recall task for each set, subjects were asked to free recall the sentences from the set.

Ratings

After the six sets had been tested for free recall, the sentences were re-presented in four random orders, and subjects were asked to rate the sentences on a seven-point scale, first for imagery and again for

comprehension. This technique was a modification of Paivio et al. (1968), and is illustrated in appendix F.

Procedure

Sentences were presented by carousel AV 900 projector. Instruction and test booklets contained a set of instructions describing the above sequence of study and recall operations. Study sentences were presented for 8 seconds. Sentence cues appeared for 5 seconds. The study sentences were presented again for 5 seconds, immediately following the cued recall interval. Three minutes were allowed for free recall. To prepare subjects for the experimental procedure a practice set of sentences followed by cued and free recall, was presented before the experiment proper began.

Ratings for imagery and comprehension were unpaced. Imagery ratings for the entire 48 sentences were presented first, followed by comprehension ratings. Study sentences and the two rating scales appeared on typed sheets in the test booklet given to each subject. Appendix D illustrates the rating instruction sheets for imagery and comprehension.

The subjects were tested individually and read the instruction sheet silently as the experimenter read it aloud. Any questions arising from the instructions were answered. The familiarization and experimental sets followed. During cued recall the experimenter recorded the responses. Free recall responses were recorded by the subject in the booklet provided. This cycle occurred six times with different sentences in each set. The above procedure was administered to both experimental groups.

Modifications of this procedure were made for the control groups.

Groups 3 and 4 were the no cue control groups. These subjects were presented with the study lists and then asked to free recall after each presentation set. They did not receive the cued recall test. Groups 5 and 6 were the no study control groups. These subjects were presented with the cued recall sets, and then asked to free recall after each cued recall test. They did not receive the initial study sets.

In summary, the experimental groups received study sets, followed by cued recall and free recall. The no cue control groups received the study sets, followed by free recall. The no study control groups received the cued recall sets, and were asked to free recall.

All subjects completed the rating sheets for both imagery and comprehension.

Subjects

The subjects were 80 unpaid volunteers from courses in Educational Psychology at the University of Alberta.

Design

A 2 x 3 x 4 factorial design was employed. The factors were (a) imagery level of the to-be-recalled word (low and high), (b) part of speech (form class) of the to-be-recalled word (verb, adjective, object-noun), (c) sentence type (HH, HL, LL, LH - these combinations refer to the imagery levels of the two remaining words of interest when one has been designated for recall.

There were three groups within each condition. Groups 1 and 2 were the experimental groups (Group 1, low imagery condition; Group 2, high imagery condition). Groups 3 and 4 were the control groups, no cue (Group 3, low imagery, no cue; Group 4, high imagery, no cue). Groups 5 and 6 were the control groups, no study (Group 5, low imagery,

no study; Group 6, high imagery, no study). There were 20 subjects in each of the experimental groups, and ten subjects in each of the four control groups.

Predictions

Based on the assumption that, in absolute terms, nouns are recalled better than verbs, which are recalled better than adjectives, several predictions were made. Since the subject-noun was held constant at the high-imagery level in this study, cued recall was hypothesized to be a function of the imagery level and form class of the two remaining cueing words relative to that of the to-be-recalled word. This applied to both high and low imagery to-be-recalled words. The predictions of the outcomes of comparisons for each dependent variable (verb, adjective, object-noun) are shown in Table 3. The rank order predictions for the cued recall task within imagery levels and form classes are shown in Table 4. The rank order predictions for all combinations of verb, adjective and object-noun for the cued recall of subject nouns are shown in Table 5. This pattern was expected to hold for sentence recall also.

While no predictions could be made with confidence, due to lack of normative data, the literature reviewed by Paivio (1971) indicates that differences should occur in recall of high and low imagery words because of their ability to function as part of a compound complex image. This functional difference should be more evident in the free recall task where there are fewer constraints imposed by the task.

Cued recall of the subject and object nouns, verbs and adjectives was correlated with free recall of the same form class (partial recall) as well as total free recall. This was expected to indicate a possible

TABLE 3

Contrasts of Mean Percent Cued Recall of
Verbs, Adjectives and Object Nouns of High and Low Imagery
within Sentence Contexts

Dependent Variable	Sentence Contexts (1) HH	(2) LH	(3) HL	(4) LL	Prediction
Verb	HHH-80	HLH-53	HHL-27	HLL-40	H > L
	LHH-47*	LLH-33	LHL-20	LLL-40	
Adjective	HHH-60	LHH-73	HHL-40	LHL-57	H > L
	HLH-47	LLH-33*	HLL-33	LLL-23*	
Obj-Noun	HHH-93	LHH-87	HLH-53	LLH-70	H > L
	HHL-57*	LHL-37*	HLL-33*	LLL-40*	

* Significant using Tukey method ($.95q2$, 696)

Note: The sentence patterns represent variations of Verb, Adjective, Obj-Noun, with Subj-Noun held constant at High Imagery. The components represent Verb, Adjective, and Object-Noun respectively.

In comparison Type #1, the comparisons are between sentences in which the to-be-recalled word (the dependent variable) is either Low or High imagery, and the cuing words are High Imagery. For example, when the Obj-Noun is the to-be-recalled word, the crucial comparison is between the high and low imagery of the object-noun, which has been cued by a high imagery verb and adjective. The prediction is H > L. In the same type of comparison, with an adjective as the dependent variable, the crucial comparison is between High and Low adjectives, and the prediction is again H > L.

TABLE 4

Rank Order Predictions for Cued Recall Within Imagery Levels of To-Be-Recalled Form Classes

Word to be Recalled	Cued Pairing	Words not to be recalled	
		Low Imagery Level	High Imagery Level
Verb	A-N	HH > LH > HL > LL	HH > LH > HL > LL
Adjective	V-N	HH > LH > HL > LL	HH > LH > HL > LL
Obj-Noun	V-A	HH > HL > LH > LL	HH > HL > LH > LL

TABLE 5

Rank Order Predictions for Cued Recall of Subject Noun and Results

Mean Percent Recall	Subj-Noun Rank Order		Words Not Recalled Imagery Level		
	Predicted	Actual	Verb	Adjective	Obj-Noun
59.5	1*	4	H	H	H
59	2	5	H	L	H
69	3	1	L	H	H
41	4	7	H	H	L
64	5	2	L	L	H
60	6	3	H	L	L
58	7	6	L	H	L
38	8	8	L	L	L

Note: *This same pattern is expected to hold for sentence recall.

mathemagenic effect of cueing. Mean differences in recall between the experimental and control groups was also expected to bear on this question.

A correlation matrix for constructed or a priori imagery, rated imagery, rated comprehension, and free recall across the eight sentence types was expected to explicate both the relationship between the global ratings used in earlier research and additive imagery (the sum of the individual imagery levels of sentence components), and also the relationship between imagery and comprehension ratings as a possible indication of the prepotency of either on free recall performance.

A comparison of rank order of means across sentence types for constructed imagery, rated imagery, rated comprehension, was expected to reflect the generalizability of the ordering of recall of form class generally obtained by Paivio (1971).

CHAPTER III

RESULTS AND DISCUSSION

Cued Recall - Free Recall

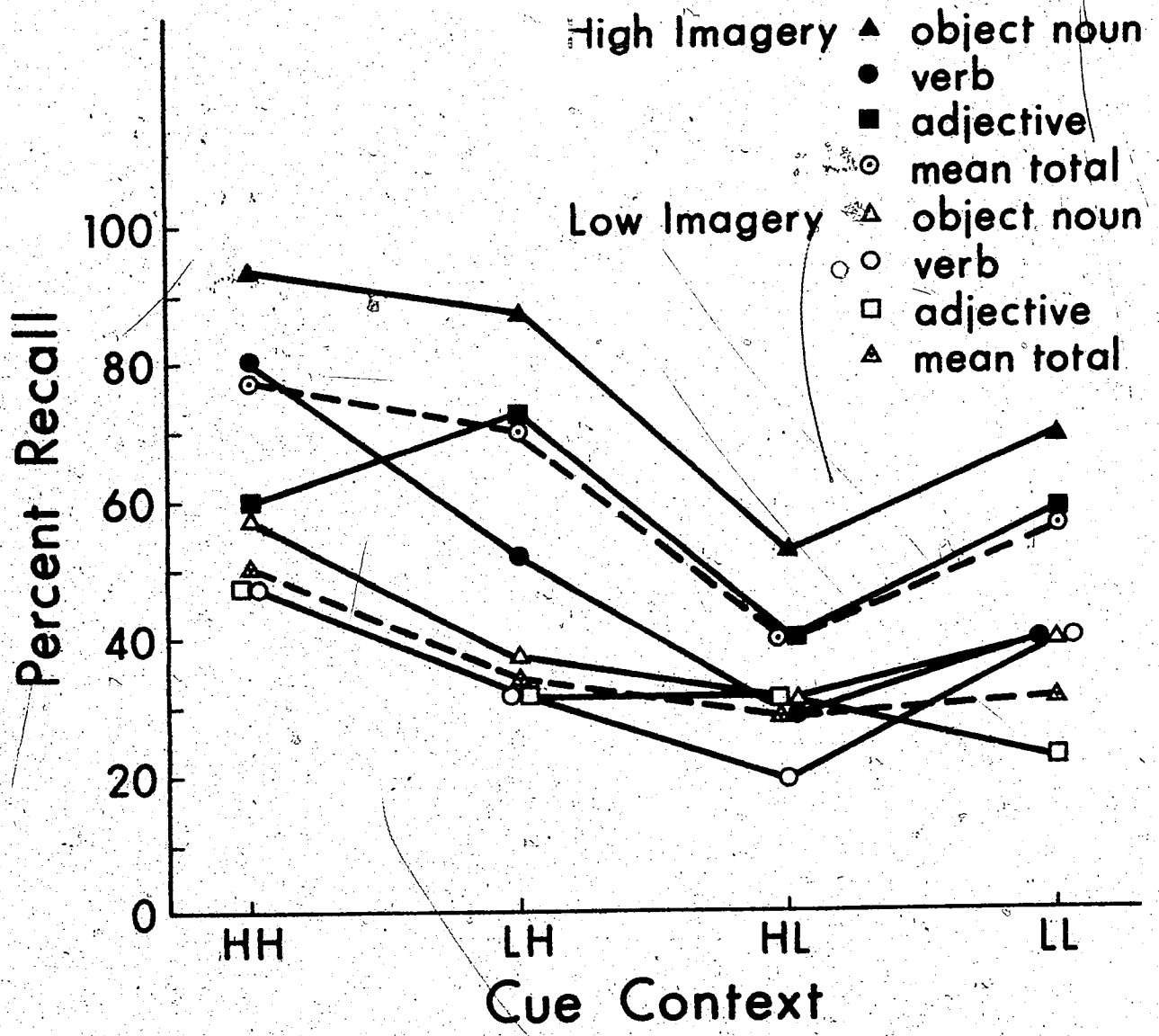
Figure 1 shows the cued recall of verbs, adjectives and object-nouns for low and high imagery levels and cue context in terms of imagery levels of the two cueing words. All subject-nouns in the sentences remained at a constant high imagery level.

A context x imagery level x form class analysis of variance was performed on the cued recall data for verb, adjective and object noun recall to determine whether an interaction had occurred. Because of the random sampling without replacement in the allocation of sentence types to subjects some cells in the design contained only thirty entries. The numbers in other cells were reduced to this figure by random omission in order to equate cells to maximize the chance of detecting a meaningful interaction. There were significant main effects for context F (3,696) = 12.69, $p < .001$; imagery level F (1,696) = 47.95, $p < .001$ and form class F (2,696) = 8.06, $p < .001$. There were no significant interactions, although the interactions for context and imagery level, F (3,696) = 2.38, $p < .07$, and for imagery level and form class, F (2,696) = 2.52, $p < .08$ approached significance.

The cue context means across form class ranked as HH(64%), LH(53%), LL(45%), HL(34%). The following were significant using the Tukey method of comparison HH-LL, HH-HL, LH-HL ($.95\ q\ 4,696$). High imagery words were recalled significantly more than low imagery words as shown in the above analysis of variance.

Object-nouns were recalled significantly more than verbs or

Figure 1 Cued Recall of Verbs, Adjectives and Object-Nouns for Low and High Imagery Levels (Experimental Groups) and Cue Context in Terms of Imagery Levels of the Two Cueing Words


High Imagery
object noun
verb
adjective
mean total
Low Imagery
object noun
verb
adjective
mean total
Percent Recall
100
80
60
40
20
0
HH
LH
HL
LL
Cue Context

adjectives (objects 59%, verbs 43%, adjectives 46%), which were not significantly different in terms of recall. The Tukey method was also employed here (.95 q 3,696).

Table 6 presents the cell means for the three way analysis of variance cited earlier. For low imagery cued recalled words, the context rank order across form class was HH, LH=LL, HL. Recall for the HH context was significantly greater than the HL context. There were no significant differences between adjacent ranks (Tukey comparisons .95 q 4,696). For high imagery cued recalled words, the context rank order was HH, LH, LL, HL. There were no significant differences between adjacent ranks. However, HH recall was significantly greater than LL or HL recall, and LH was significantly greater than HL recall (Tukey .95 q 4,696).

Inspection of Table 6 shows that when the to-be-recalled word is low imagery, form class produces no significant effect ($\bar{X}$ verb = 35%, $\bar{X}$ adjective = 34%, $\bar{X}$ object noun = 42%). For the high imagery to-be-recalled words, object nouns were recalled significantly more than adjectives or verbs which were not significantly different ($\bar{X}$ verb = 50% $\bar{X}$ adjective = 57%, $\bar{X}$ object noun = 76%). The Tukey method was used to compare the above means (.95 q 3,696). The trend for superior object noun recall is common to both imagery levels, however a higher imagery level enhances the effect. The range of the mean cued recall scores for the four contexts across form class for high imagery words is 79%-40% while the low imagery to-be-recalled words is 50%-29%. This along with the significant imagery effect suggests that the imagery level of the to-be-recalled word is more important than the additive imagery level of the context cueing words.

TABLE 6

Percent Recall for Cell Means of
Context x Imagery x Form Class Analysis of Variance

Imagery Level	Form Class	Context LL	HL	LH	HH	$\bar{X}$ Total
Low	V	40	20	33	47	35
	A	23	33	33	47	34
	O	40	33	37	57	42
High	V	40	27	53	80	50
	A	57	40	73	60	57
	O	70	53	87	93	76
$\bar{X}$ Total		45	34	53	64	

Note: V=Verb
A=Adjective
O=Obj-Noun

Table 3 contains the results of the comparisons made between the same context but different imagery levels of the to-be-recalled word for verbs, adjectives and object nouns. One contrast of verbs was significant. A high imagery adjective and object noun in the cueing context produced significantly greater recall of high imagery verbs over low imagery verbs. Two adjective context comparisons were significant. A low imagery verb and high imagery object noun or a low imagery verb and a low imagery object noun produced significantly better recall of high imagery adjectives over low imagery adjectives. A high imagery object noun was recalled significantly more than a low imagery object noun across all four cue contexts.

The irregularity of the effect of context cueing upon recall of adjectives and verbs is consistent with the view that as form classes they are not as salient as nouns. This supports the contention that form class of the to-be-recalled word is more important than context imagery. However, in all cases except one, high imagery words were recalled more than low imagery words. The explanation may lie in the fact that all context cues included a high imagery subject noun. According to the "conceptual peg" hypothesis the subject nouns should be the best cues for recall of the object nouns. The data supports this for all contexts when the object noun is high imagery.

If a sentence forms a compound image it is reasonable to expect that the subject and object components in combination should be better cues to recall than other components. Therefore, verb and adjective recall should be greater than subject noun or object noun recall. The present results are contrary to this hypothesis, with object nouns being recalled significantly better than verbs or adjectives when the

to-be-recalled word was high, and better but not significantly different when the to-be-recalled word was low imagery level. Form class of the to-be-recalled word as well as its imagery level appears to be more important than a conceptual peg. Nounness and imagery per se of the to-be-recalled word seem to be the most important influences upon cued recall.

The variability of context cue effects for recall of verbs and adjectives suggests that the extrapolation of the "conceptual peg" hypothesis to sentences with the companion notion of a compound image does not completely account for the cued recall data. It seems that sequential processing or contiguity may be more important to the recall of these two form classes. Another possible explanation for these data is the failure to obtain a large enough difference in the contrasting imagery levels for adjectives (see Table 2) when the sentences were constructed for this study. This resulted from the limited imagery ratings available. Nevertheless, seven of the twelve contrasts were significant in the predicted direction.

Table 5 shows the cued subject noun recall for the eight contextual conditions with predicted and actual rank order. The rank order correlation between predicted and actual order was $r_s = .39$. Interpretation is difficult except to point out that the HHL and LLL cue contexts were significantly lower than the other cue contexts. The sixth ranked context (LHL) approached significance over the seventh ranked context (HHL) $t(65) = 1.32$ $p < .10$, which was not significantly different from the eighth ranked context (LLL). These data also indicate the inability of the total imagery level of contextual cues to predict recall well in this paradigm.

The cued recall results suggest that contextual cues are not necessarily used in a total additive way in terms of compound imagery level. The situation is too confusing to warrant a firm conclusion. However, there is a tendency for the HHH context to produce the best recall with the HHL context producing the poorest recall for verbs, adjectives and object-nouns for both low and high imagery levels of the to-be-recalled word.

Table 7 shows the effect of contrasting the imagery level of one word in each of the four basic contextual cue patterns for cued subject noun recall.

Increases in subject recall occur in seven out of twelve comparisons when the imagery level of a particular form class is increased. Four comparisons were significant: those in the LL context were uniformly significant for all form classes; significant increases in subject recall also occurred when object nouns in the HH context were increased in imagery. These results do not support the predicted additive imagery cueing effect.

An increase in object noun imagery was expected to produce the greatest increase in cued subject noun recall because of backward cueing if the subject and object form the basis of the sentence image. However, this was significant in only two of the four basic contexts (HH, LH). An overall decrease in cued recall occurred in the HL context. In the LH and HH contexts cued recall decreased for verbs.

The cued recall data are compatible with a dual coding hypothesis in that the "conceptual peg" hypothesis or contextual imagery levels is able to only partially account for the results. There is some suggestion that verbal sequential encoding may also be involved.

TABLE 7

Mean Percent of Subject-Noun Cued Recall for Contextual Form Class Contrasts

	Context (Common Imagery Level)			
Form Class	LL	HL	LH	HH
Verb	HLL-60*	HHL-41	HLH-59	HHH-59.5
	LLL-38	LHL-58	LLH-64	LHH-69
Adjective	LHL-58	HHL-41	LHH-69	HHH-59.5
	LLL-38*	HLL-60	LLH-64	HLH-59
Object-Noun	LLL-38	HLH-59	LHH-69	HHH-59.5
	LLH-64*	HLL-60	LHL-58	HHL-41*

* t-test significant at $p < .05$

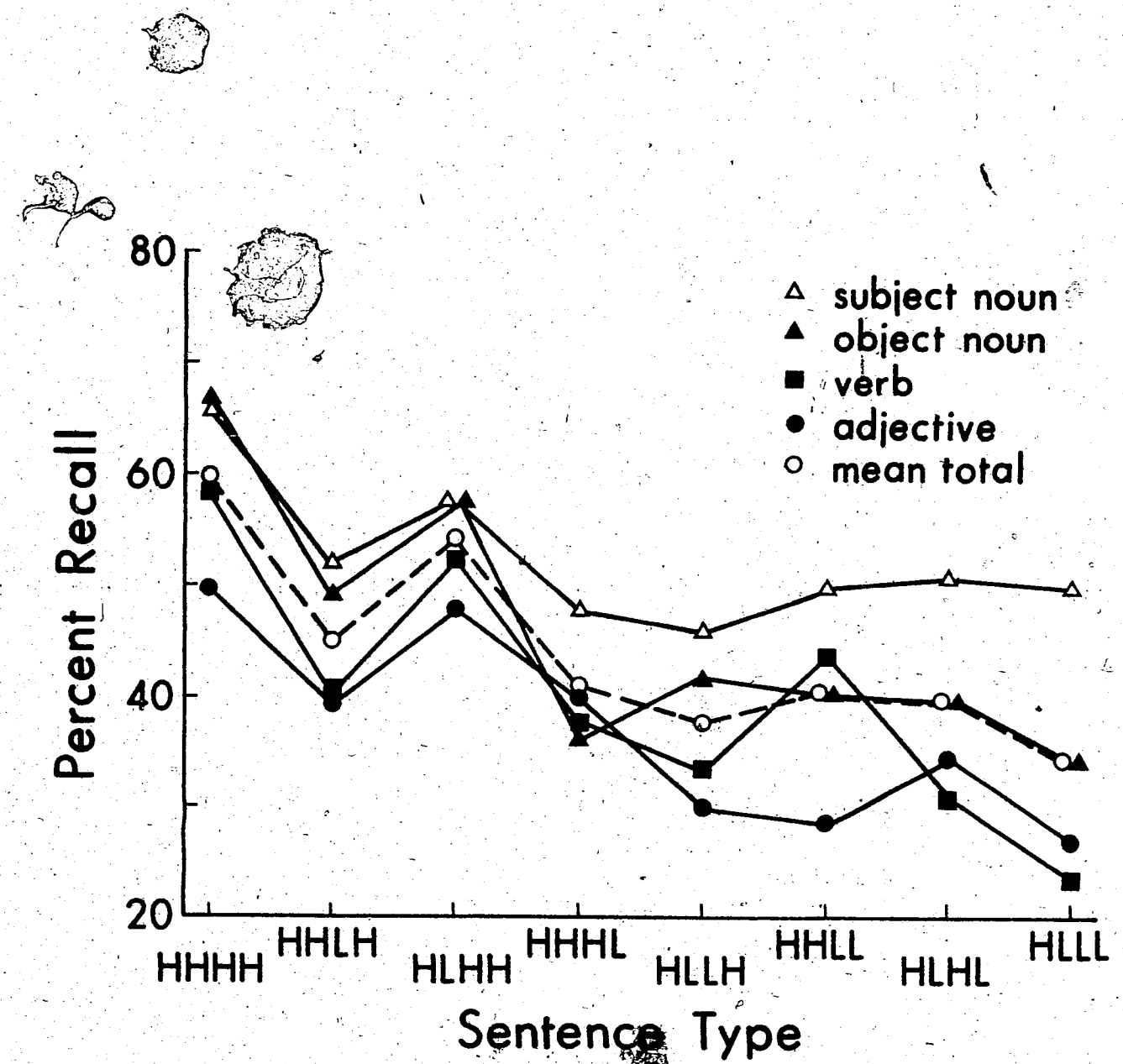
Figure 2 shows the total and partial (for each form class) free recall scores for the eight sentence types. The predicted rank order is shown along the abscissa. The rank order correlation between predicted and actual rank was $r_s = .91$, $p < .001$. The first two sentence types in rank order were not significantly different. However, they were significantly greater than the third sentence type. (HHH - HHLH, $t(478)=3.83$, $p < .001$; HLHH - HHLH, $t(478)=2.30$, $p < .025$).

From the third rank order down the differences in mean total free recall were not significant. These results along with the correlation of $r_s = .91$ between predicted and actual rank suggests a fragile effect due to imagery manipulations. This fragility may partially explain the irregularity of the cued recall results. The clear superiority of the HHHH and HLHH sentence types suggest the potency of maximal imagery as well as the possibility that verbs were not as critical for encoding and retrieval of sentences as was assumed a priori.

For partial free recall, subject nouns ($\bar{X}$ = 52%) were recalled significantly more than object nouns ($\bar{X}$ = 46%) t (3818) = 4.20, $p < .001$; which were recalled significantly better than verbs ($\bar{X}$ = 40%) t (3818) = 3.31, $p < .001$, which were recalled significantly better than adjectives ($\bar{X}$ = 37%) t (3818) = 2.029, $p < .025$.

The discrimination between the form class means for free recall confirms the initial prediction. This contrasts with the general lack of discrimination between verb and adjective cued recall discussed earlier. The additive imagery level of the sentence types correlates highly with their free recall. The critical difference between the two recall paradigms is the subject's freedom to rely upon his subjective organization in free recall or attempt to make use of available

Figure 2 Total and Partial Free Recall of Sentence Types (Sentence Component Order = Subject, Verb, Adjective, Object) - Experimental Groups


80
60
40
20
Percent Recall
subject noun
object noun
verb
adjective
mean total
HHHH
HHLH
HLHH
HHHL
HLLH
HHLL
HLHL
HLLL
Sentence Type

contextual cues in cued recall. The free recall data suggest that the imagery attribute largely accounts for the degree of recall. The high positive correlation between additive sentence imagery and free recall suggests that even for low imagery sentences imagery is a consistent and potent predictor of performance. However, it must be remembered that the key word in all sentences from an imagery theory point of view (subject noun) was always high imagery. Consequently, a clearer interpretation of these data may be possible if the study is repeated using low-imagery subject nouns.

Table 8 shows the mean percent recall of form class of the control groups for cued and free recall. Groups 3 and 4 were combined as were groups 5 and 6 due to a lack of significant differences. It is apparent that study of the sentence or cued recall affect later free recall equally. The failure of the no study, cued recall group to exceed the study, no cued recall group in terms of total free recall suggests that cued recall does not have a mathemagenic effect. For the no study cued group, subjects actually saw the sentence once with a word missing and then in total during feedback. Perhaps the preoccupation with a particular word restricted learning of the whole sentence. The greater free recall of the subject noun in the study, no cue group supports this contention. In this essentially free recall situation, the subject noun appears to have emerged as the key word in the sentence (conceptual peg). Otherwise the pattern of results for free recall of respective form classes for all groups is quite similar.

The failure of cued recall to produce a mathemagenic effect upon subsequent free recall may be a result of the nature of the

TABLE 8

Mean Percent Cued and Free Recall for Experimental and Control Groups

	S	V	A	O	(Total SVAO)	S	V	A	O	(Total SVAO)
Experimental Groups	53	43	46	59	49	52	40	37	46	44
Control No Study, Cue Groups	2	4	5	1	3	35	30	25	32	30
Control Study, No Cue Groups	-	-	-	-	-	47	26	21	31	31

Note: S = subject-noun, V = verb, A = adjective, O = object-noun

encoding process(es) involved in cued recall. It seems that associative processes relating to contiguous context are more likely to be involved than apprehension of the semantic context of the sentences. Begg's (1972) results with mixed imagery phrases support this conjecture. Watts and Anderson (1971) also found that "name questions" inserted in a passage produced poorer performance by subjects than a control group who received no questions on a later test involving application of knowledge contained in the passage. Although other studies have demonstrated the mathemagenic effect of questions in text (e.g. Rothkopf & Bisbicos, 1967), the nature of the question and the terminal task affect the outcome. As in the Watts and Anderson study, subjects in this study were constrained by task demands which focussed attention upon individual words rather than sentence meaning. During feedback the subjects may have focussed attention upon the to-be-recalled word and thus did not profit from a second exposure to the complete sentence. A suggestion for resolution of this issue may lie in an analysis of the error data. Cued recall in this study may have neither facilitated nor inhibited later free recall. The two paradigms appear to have been approached as independent tasks.

Table [illegible] shows the correlations of cued recall for subject noun, verb, adjective, and object noun with their later free recall and total free recall of the sentences in which they occurred across all sentence types for experimental subjects. The correlation of cued recall with partial or total free recall is quite similar for subject nouns, adjectives and object nouns. However, correlations for verbs are noticeably lower. This suggests that the verb, as a basis for sentence [illegible]ning, had little effect on recall performance, and that the function of the verb in this study was elaborative.

TABLE 9

ation of Mean Cued Recall with Partial and Total
ree Recall Within Sentences for each Form Class

	Cued-Partial Free	Cued-Total Free
Subject	.24	.30
Verb	.10	.12
Adjective	.30	.29
Object	.24	.25

The failure of cued recall to facilitate later free recall more than simple study of the sentence is also reflected in the rather meagre correlations shown in Table 9. Results indicate that cued recall of all form classes did not strongly predict later free recall of the same word or the whole sentence. These findings suggest the possibility of an inhibiting effect of cued recall upon later free recall similar to that discussed by Rundus (1973) in regard to cueing in a free recall list.

Imagery-Comprehension Ratings

Table 10 shows the means of (1) constructed or a priori additive imagery sentence ratings, representing a summing of imagery values over the four sentence components (Subj-Verb-Adj-Obj); (2) post hoc imagery ratings on a seven-point scale where 7 represents the highest possible rating; (3) post hoc seven-point scale comprehension ratings; (4) recall of number of words out of a possible four during free recall as a function of the eight sentence types. Table 11 presents the correlation matrix for constructed or a priori imagery, rated imagery, rated comprehension, and free recall across the eight sentence types.

There were no differences in rank order across sentence types for constructed imagery, rated imagery, rated comprehension, and free recall. Partial free recall results confirm the ordering of recall of form class generally obtained by Paivio (cf. Paivio, 1971).

Results support the assumption that global imagery is the sum of the individual imagery levels of the sentence components in regard to effect upon free recall. This supports the validity of the extensive use of global ratings in earlier research. The results also support the validity of Paivio's and Yuille's original imagery ratings.

TABLE 10

Mean Imagery, Comprehension and Recall Scores Across Sentence Types

Sentence Type (SVAO)*	Constructed Imagery	Rated Imagery	Rated Comprehension	Free Recall
1 HHHH	21.36	6.17	6.73	2.40
2 HLLL	12.97	2.65	5.45	1.32
3 HHHL	17.46	4.63	6.20	1.65
4 HHLH	18.39	5.45	6.49	1.81
5 HHLL	15.32	3.83	5.53	1.61
6 HLHH	19.68	5.96	6.71	2.16
7 HLLH	17.48	4.73	5.95	1.50
8 HLHL	16.28	4.04	6.18	1.58
Mean	17.37	4.68	6.18	1.75
Standard Deviation	2.59	1.18	.49	.36

* Subject, verb, adjective, object word order: H is high imagery L is low imagery.

TABLE 11

Correlation of Additive Imagery, Global Imagery, Comprehension and Free Recall of Sentences Across Sentence Types

	1. Constructed Imagery	2. Rated Imagery	3. Rated Comprehension	4. Free Recall
1		.98	.92	.91
2			.93	.89
3				.86

The prepotency of either comprehension or imagery is not indicated by these results. It is apparent that both measures of imagery and comprehension were good predictors of free recall. The results suggest that rated comprehension may have been just as good a predictor of free recall as rated imagery. The operational definitions of imagery and comprehension (i.e. rated measures) do not permit resolution of a possible causal relationship between these two variables over all possible paradigms or measures. The high correlations found in this present study are constrained by the rating operation used. Nor does the high correlation of imagery and comprehension answer the question of which is prepotent.

CHAPTER IV

GENERAL DISCUSSION

The predictions made in this study were based upon the assumption of the differential importance of form class as well as the additive effect of imagery in sentence learning and recall. The cued recall do not support an additive imagery model of encoding and retrieval in the form of compound sentence images. The form class and imagery of the to-be-recalled word seemed to be most important.

The predicted superiority of nouns as cues was confirmed by the high object-noun recall. This supports the notion that the subject-noun is the "conceptual peg" of a sentence image, i.e. that the object-noun was retrieved as an integrated associate of the subject-noun. The apparent failure of object nouns to produce superior verb or adjective recall suggests that these form classes are not a central part of a compound sentence image. The fact that an increase in object-noun imagery produced better subject-noun cued recall for two out of four contexts (HH, LL - verb-adjective imagery) suggests, however, that these form classes do have an influence upon processing of the nouns in the sentence. The superiority of the HHH context for cued recall of all form classes supported the hypothesis of an integrated sentence image. The failure of the additive imagery model to predict cued recall results for mixed imagery level contexts is similar to Begg's (1972) results with mixed phrases.

The unstable pattern of results for adjective and verb cued recall as well as their failure to differ significantly within contexts when either was low or high imagery, point to possibilities such as

form class per se or contiguity as factors in this paradigm. The pattern of facilitative cue contexts, when a high imagery level is contrasted with a low imagery level of the to-be-recalled word, suggests the importance of contiguity.

In the case of the verb, the high imagery verb was recalled significantly better when both adjective and object were high imagery. For adjectives, high imagery words were recalled significantly better than low imagery words when the adjacent verb is low imagery in the facilitating contexts. The pattern of contextual cueing in subject noun recall also failed to support an additive imagery model of sentence learning and recall.

The low level of cued recall of verbs and their lower correlation with later free recall than other form classes in this study is compatible with the contention that despite the importance of the verb in surface structure, it has no direct representation in the encoded memorial abstraction referred to as an "image" by Reid (1974). Several authors cited by Reid maintain that the verb has the important function of bringing other words (nouns) in a sentence into a relationship which subsumes the verb. The verb tends to lose its independent identity by becoming attached to nouns.

The lower recall of verbs and adjectives in this study is also compatible with the view that they are only represented indirectly in relation to nouns in cognitive representations (images). This might explain why form class appears to have a greater influence upon cued recall with object nouns being better cues than verbs or adjectives regardless of imagery level. This appears to be an area where the "conceptual peg" hypothesis has difficulty within a sentence context.

The almost complete confirmation of predictions within the free recall situation strongly supported the additive model. Not only did free recall of sentence types generally confirm predictions but the significantly different rank ordered recall of form classes (subject, object, verb, adjective) confirmed a priori assumptions about the salience of these classes.

The contrast of results from different paradigms suggests caution in extrapolating imaginal type theories of encoding and retrieval to all situations. It seems likely that the subject encodes and retrieves information differently in the two paradigms. If he wishes he can use any one or combination of the three context cue words. When they vary in imagery level the result for cued recall can be critical. The superior recall in the HHH context supports this contention as does the variability of results using other contexts. This is where the cued paradigm used in this study is fundamentally different to the conventional paired-associate paradigm. Unlike the usual situation, the choice of cue is not necessarily a contiguous word. However, there is some reason to suspect contiguous recall. As was the case in Begg's (1972) study the data for the two paradigms suggest a dual encoding model. The lack of correlation between the imagery of contextual cues and cued recall suggested the possibility of verbal encoding while the high correlation of sentence imagery and free recall supported the presence of imaginal encoding. The extent to which additive contextual imagery was able to predict free recall suggests that imagery is a good predictor of recall, even with relatively abstract sentences, and that imaginal encoding may be prepotent. However, the effect of having high imagery subject nouns in all sentence types may explain this.

There seems little doubt that imagery facilitated recall in this study. However its modus operandum may be quite difficult to determine in a cued sentence recall context. Nor is it clear from this study whether verbal sequential processing is completely adequate as an alternative to imaginal processing within the cued recall paradigm employed here. Indeed, as Paivio (1971) states, the dual-coding model does not rule out the possibility of other important coding mechanisms. Use of low imagery subject nouns in modifications of the sentences used in this study may clarify this issue.

The high correlations between imagery and comprehension and free recall in this study do not explicate the prepotency of either process, due in large measure to the constraints of the rating operation used, and the specificity of the design to those sentences which employ a high-imagery subject noun.

Keeping these restrictions in mind, however, an interesting area of speculation presents itself when one examines the variance of means across sentence types for rated imagery and rated comprehension. Several interpretations are offered. The standard deviation (SD) of the comprehension ratings is not as great as the SD of the imagery ratings (.49 and 1.18 respectively). This suggests that comprehension may not have varied sufficiently to justify the conclusion that a high degree of association holds between these two variables throughout their range. The findings may be relative to the range used here: that is, while the sentences were constructed to represent a full useage of imagery range, they were not constructed to represent a full useage of comprehensibility (i.e. from non-comprehensible to completely comprehensible). All sentences in fact were comprehensible. However, if differences between

sentences in terms of comprehension were small then imagery may have been responsible for the observed differences in free recall. The problem of how small is small and how large is large in terms of comprehension differences remains an empirical question unanswered by this study. One explanation of the difference in variance is that imagery may be the common contributing factor, as reflected by the similar pattern in rank ordering of responses, and the magnitude of the difference reflects the contribution of abstractness. This would support the dual encoding model which would predict that comprehension ratings for mixed stimulus materials should be higher than imagery ratings inasmuch as the comprehension process receives input from both imaginal and verbal processes.

Another possible explanation for the rank order similarity between imagery and comprehension is that the conceptual peg metaphor may apply to both ease of imagery arousal and comprehension, inasmuch as the subject noun in all sentences was a high imagery word. If a low imagery word was substituted as the subject-noun, this rank ordering similarity may not result.

A third possibility is that comprehension rating is not as valid an index of comprehension as, for example, asking the subject to produce another sentence extending the meaning of the sentence or asking him to paraphrase the meaning. A levels-of-processing approach to comprehension (Craik & Lockhart, 1972; Mistler-Lachman, 1974) would state that the more active the orienting task demanded of the learner with respect to stimulus input information, the deeper the level of processing required to complete such a task, and the easier it is to make an objective assessment of

whether or not the subject correctly comprehended the stimulus material. In this study, imagery ratings were validated against a priori additive imagery values. Comprehension ratings were not validated by another comprehension measure. It is possible that the measure of comprehension used was relatively shallow and resulted in an inflated response measure.

The experimental procedure may also have inadvertently contributed to the higher response measure on comprehension, in that comprehension ratings always appeared after the imagery ratings, resulting in a possible repetition or familiarity effect confounded with comprehension. The results obtained suggest that there is an overlap between comprehension and imagery which makes it difficult to extricate the prepotency of either process. There appears to be a need to explore the extent to which any one (or a combination) of the alternative explanations described above affects the comprehension-imagery relationship found in this study.

A fruitful approach to further research may be the application of a levels-of-processing approach to both comprehension and imaginal materials in order to assess the effect of systematic manipulation of each. Using orientation tasks such as, imagery or comprehension ratings, imagery production or verbal extension, on a common dependent variable like free recall, would seem to be appropriate.

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Appendix A

Constructed Sentences by Sentence Type, Part of Speech, and Imagery Values

Sentence Type #1 - Subj=HI, Verb=HI, Adj=HI, Obj=HI (HHHH)

1. The monk crushed the wet daffodil.
2. The singer bent the polished hairpin.
3. The porter slapped the angry man.
4. The runner stole the colorful balloon.
5. The granny sewed the bulky apron.
6. The nymph married the rebellious sultan.
7. The hostage baked the sour cabbage
8. The acrobat rode the ugly bison.
9. The doorman robbed the affectionate hermit.
10. The quarterback sketched the muscular blacksmith.
11. The infant destroyed the valuable decoration.
12. The fireplace illumined the gloomy cellar.

Sentence Type #1 - HHHH
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	6.40	4.47	5.31	6.47	22.65
2	6.17	4.53	4.66	6.13	21.49
3	5.50	4.77	4.94	6.67	21.88
4	5.63	4.38	5.00	6.13	21.14
5	5.63	4.75	4.50	5.88	20.76
6	5.63	5.91	4.56	5.57	21.67
7	5.57	4.97	4.66	5.75	20.95
8	6.53	4.91	5.06	5.56	22.06
9	6.40	4.59	4.41	5.56	20.96
10	5.81	4.41	5.94	6.17	22.33
11	6.33	3.75	4.03	5.37	19.48
12	6.83	3.66	4.22	6.27	20.98
Total	72.43	55.10	57.29	71.53	256.35

Appendix A (continued):

Sentence Type #2 - Subj=HI, Verb=LO, Adj=LO, Obj=LO (HLLL)

1. The amour constituted a punishable impropriety.
2. The builder modified the unpopular surtax.
3. The serf altered the basic pestle.
4. The musician identified the significant attribute.
5. The admiral resumed the exacting tenure.
6. The butler acknowledged the accurate disclosure.
7. The hamlet nullified the prior outcome.
8. The monarch ousted the unfair arbiter.
9. The instructor transformed the preliminary function.
10. The pianist fulfilled the comprehensive criterion.
11. The baron obtained the annual franchise.
12. The chorus aroused the eccentric magnate.

Sentence Type #2 - HLLL
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	5.50	1.66	2.50	[illegible]	11.53
2	5.70	2.16	2.56	[illegible]	12.05
3	5.50	2.28	2.09	[illegible]	11.96
4	6.13	2.31	1.97	[illegible]	12.71
5	6.20	2.31	2.41	[illegible]	12.70
6	5.59	2.38	2.53	2.17	12.67
7	5.87	2.22	2.13	2.40	12.62
8	6.20	2.66	2.00	2.33	13.19
9	5.70	2.53	1.88	2.19	12.30
10	6.43	2.41	2.19	1.83	12.86
11	5.10	2.03	3.50	2.90	13.53
12	5.16	3.44	2.97	3.72	15.29
Total	69.08	30.57	28.73	27.31	155.69

Appendix A (continued):

Sentence Type #3 - Subj=HI, Verb=HI, Adj=HI, Obj=LO (HHHL)

1. The interview excited the lonely unbeliever.
2. The choir sang a joyful sequel.
3. The cigar burned the mournful burgher.
4. The photograph prejudiced the emotional explanation.
5. The mermaid chanted the musical inducement.
6. The juggler entertained a sexual hankering.
7. The guardhouse discouraged the wild discord.
8. The headlight furnished a shadowy unreality.
9. The waltz upset the proud patron.
10. The bandit whimpered a nervous supplication.
11. The evangelist drank the yellow essence.
12. The friar practiced the ancient computation.

Sentence Type #3 - HHHL
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	5.03	3.84	4.31	2.60	15.78
2	5.69	4.66	4.69	2.09	17.13
3	6.80	5.59	4.72	2.69	19.80
4	6.43	3.78	4.44	2.90	17.55
5	6.00	4.34	4.41	2.93	17.68
6	6.33	3.91	5.09	2.23	17.56
7	5.80	3.72	5.13	2.69	17.34
8	6.43	4.66	4.31	2.10	17.50
9	5.83	4.28	4.37	2.80	17.28
10	5.28	4.47	4.31	3.44	17.50
11	4.97	5.22	5.97	2.38	18.54
12	4.88	3.69	4.41	2.84	15.82
Total	69.47	52.16	56.16	31.69	209.48

Appendix A (continued):

Sentence Type #4 - Subj=HI, Verb=HI, Adj=LO, Obj=HI (HHLH)

1. The beggar pillaged the available storeroom.
2. The bacteria invaded the apparent victim.
3. The thicket surrounded the outlandish infirmary.
4. The pebble shattered the essential flask.
5. The graduation drew impetuous gaiety.
6. The lantern pierced the alternative passageway.
7. The mammal killed the tremulous fowl.
8. The lice startled the noisy glutton.
9. The avalanche missed the verdant hillside.
10. The fox chased the flighty bunny.
11. The wench tasted the mild whiskey.
12. The brute tortured the insolent comrade.

Sentence Type #4 - HHLH
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	6.40	3.72	2.28	5.87	18.27
2	5.33	3.88	2.03	5.07	16.31
3	5.60	4.00	2.88	5.63	18.11
4	5.63	4.47	2.06	6.50	18.66
5	6.03	4.19	2.84	5.63	18.69
6	6.06	4.72	2.06	5.53	18.37
7	6.00	5.00	2.78	5.86	19.64
8	5.57	3.88	1.38	5.77	16.60
9	6.27	4.13	2.94	6.30	19.64
10	6	3.81	3.07	6.13	19.74
11	5.30	3.78	2.97	5.78	17.83
12	5.1	4.97	3.09	5.57	18.80
Total	70.09	50.55	30.38	69.64	220.66

Appendix A (continued):

Sentence Type #5 - Subj=HI, Verb=HI, Adj=LO, Obj=LO (HHLL)

1. The banker cheered the impartial functionary.
2. The goblet hurt the modest abbess.
3. The attendant devoured the available hyssop.
4. The scissors depressed the normal encephalon.
5. The missile stopped the deliberate debacle.
6. The leopard won adequate mastery.
7. The appliance decorated the versatile unit.
8. The drunkard bought the outlandish item.
9. The lecturer furnished the candid advice.
10. The ambassador opened the mediocre emporium.
11. The candidate abandoned the important legislation.
12. The priest screamed the idealistic blessing.

Sentence Type #5 - HHLL
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	6.03	4.06	2.31	1.77	14.17
2	6.03	4.28	3.00	2.97	16.28
3	5.03	3.69	2.28	1.34	12.34
4	6.19	4.22	2.31	2.17	14.89
5	6.33	3.75	3.00	2.10	15.15
6	5.75	4.00	2.06	2.77	14.58
7	5.73	4.25	2.81	2.87	15.66
8	5.38	3.78	2.88	3.67	15.71
9	5.70	4.66	2.95	3.13	16.43
10	5.70	3.88	2.75	2.93	15.26
11	4.67	3.69	3.00	3.72	15.08
12	6.53	5.13	3.31	3.33	18.30
Total	69.07	49.36	32.65	32.77	183.85

Appendix A (continued):

Sentence Type #6 - Subj=HI, Verb=LO, Adj=HI, Obj=HI (HLHH)

1. The alcohol improved the rich cuisine.
2. The spire flattered the rural landscape.
3. The dove examined the brilliant caterpillar.
4. The summit overlooked the majestic edifice.
5. The kerosene revealed the black hardwood.
6. The spinach replaced the cold macaroni.
7. The reptile searched the muddy jungle.
8. The bagpipe originated the thin shriek.
9. The mosquito annoyed the pretty warbler.
10. The horsehair strengthened the gaudy wigwam.
11. The fisherman broke the heavy fibre.
12. The donor exhibited the immense cottage.

Sentence Type #6 - HLHH
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	6.47	2.56	4.53	5.57	19.13
2	5.57	3.33	4.66	6.43	19.99
3	6.53	3.00	4.63	6.57	20.73
4	5.63	2.75	4.34	4.70	17.42
5	5.77	3.06	6.09	5.57	20.49
6	6.47	2.59	4.78	6.47	20.31
7	6.00	3.74	5.32	5.75	20.81
8	6.43	2.56	4.72	5.73	19.44
9	6.53	3.56	4.81	5.57	20.47
10	5.67	3.00	4.34	6.23	19.24
11	6.50	3.50	4.91	4.22	19.13
12	4.81	3.44	4.22	6.50	18.97
Total	72.38	37.09	57.35	69.31	236.13

Appendix A (continued):

Sentence Type #7 - Subj=HI, Verb=LO, Adj=LO, Obj=HI (HLLH)

1. The tweezers exposed an acceptable skull.
2. The morgue preserved the critical corpse.
3. The medallion signified proficient gymnastics.
4. The nursery recommended the additional vaccination.
5. The tempest prefaced the rampant hurricane.
6. The racketeer inspired the presentable portrait.
7. The orchestra vacated the noisy basement.
8. The revolver provoked absolute turmoil.
9. The amplifier discriminated the precise trumpet.
10. The sermon condemned the spiteful busybody.
11. The instrument survived the wasteful destruction.
12. The garment endured the excessive foam.

Sentence Type #7 - HLLH
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	6.57	3.06	2.31	6.47	18.41
2	6.03	3.59	2.53	6.50	18.65
3	5.87	2.44	3.06	5.83	17.20
4	6.10	2.47	2.50	5.97	17.04
5	5.63	2.69	2.94	6.33	17.59
6	5.07	3.09	3.00	5.87	17.03
7	6.77	3.16	1.38	6.03	17.34
8	6.70	3.16	2.06	4.13	16.05
9	5.80	2.94	2.78	6.60	18.12
10	5.53	3.28	2.91	5.17	16.89
11	5.67	3.38	2.69	5.27	17.01
12	5.83	2.81	3.41	6.33	18.38
Total	71.57	36.07	31.57	70.50	209.71

Appendix A (continued):

Sentence Type #8 - Subj=HI, Verb=LO, Adj=HI, Obj=LO (HLHL)

1. The timepiece guaranteed an orderly rating.
2. The metropolis survived the bitter adversity.
3. Daybreak preceded the affectionate clemency.
4. The galaxy complicated the strong assumption.
5. The slush provided a rough hint.
6. The slippers influenced the dancing ability.
7. The profile indicated a strong intellect.
8. The rainbow signified a beautiful aberration.
9. The glacier created a frigid vista.
10. The bouquet signified loving forethought.
11. The accordion provided the musical context.
12. The frog vacated the muddy formation.

Sentence Type #8 - HLHL
Imagery Values as a function of
Part of Speech and Sentences

Sentence Number	Subject	Verb	Adjective	Object	Total
1	6.10	2.69	4.31	2.60	15.70
2	5.97	3.38	4.19	2.80	16.34
3	6.13	2.16	4.66	2.90	15.85
4	6.00	2.88	4.56	1.91	15.35
5	6.27	2.00	4.77	2.57	15.61
6	6.40	2.16	5.53	2.67	16.76
7	5.97	1.78	4.56	2.93	15.24
8	6.38	2.44	5.38	2.27	16.47
9	6.07	3.13	4.59	2.75	16.54
10	6.77	3.06	5.00	2.57	17.40
11	6.50	2.00	4.41	2.13	15.04
12	6.73	3.16	5.32	3.87	19.08
Total	75.29	30.84	57.28	31.97	195.38

Appendix B

Summary Sheet
Imagery Ratings - Parts of Speech
(Total loadings over twelve sentences)

Sentence Type	Subj-Noun High	Verb High	Verb Low	Adjective High	Adjective Low	Obj-Noun High	Obj-Noun Low	Total Sentence Loading
1	72.43	55.10		57.29		71.53		256.35
2	69.08		30.57		28.73		27.31	155.69
3	69.47	52.16		56.16			31.69	209.48
4	70.09	50.55			30.38	69.64		220.66
5	69.07	49.36			32.65		32.77	183.85
6	72.38		37.09	57.35		69.31		236.13
7	71.57		36.07		31.57	70.50		209.71
8	75.29		30.84	57.28			31.97	195.38
Totals	569.38	207.17	134.57	228.08	123.33	280.98	123.74	1,667.25
$\bar{X}$ Imagery Rating/Word	5.93	4.32	2.80	4.75	2.57	5.85	2.58	
$\bar{X}$ Imagery Rating/Set of 8 Sentences								138.93

Appendix C

Sample Sentence Set High Imagery Level Group (Each cued response is a high imagery word)

Presentation Order	Sentence	Sentence Type	Cued Response
1	The banker cheered the impartial functionary.	5	Verb
2	The monk crushed the wet daffodil.	1	Obj-Noun
3	The timepiece guaranteed an orderly rating.	8	Adj
4	The amour constituted a punishable impropriety.	2	Subj-Noun
5	The tweezers exposed an acceptable skull.	7	Obj-Noun
6	The interview excited the lonely unbeliever.	3	Adj
7	The alcohol improved the rich cuisine.	6	Subj-Noun
8	The beggar pillaged the available storeroom.	4	Verb

Appendix D

General Instructions
Experimental Groups

A number of sentences will appear on the screen one at a time. Your task is to read them through in preparation for two simple memory tests which follow.

To make sure that you have understood the meaning of the sentence, you will be allowed eight seconds to read each sentence. After eight seconds has elapsed, the next sentence will automatically appear.

When a set of eight sentences has been shown, a dashed line will appear on the screen. The dashed line will be followed by a number to indicate that the first test is about to begin. Each sentence in the set you have just seen will again be presented on the screen. However, this time one of the words will be missing. Your task is to recall (out loud) this word within a time limit. At the end of this time limit, the complete sentence will appear on the screen. The next sentence will then appear, and you will again be asked to recall the missing word. This procedure will continue until the entire set of eight sentences has been presented. At the end of this test, a dashed line will again appear on the screen. This will indicate that Test #2 is about to begin.

Test #2 requires you to recall, in any order, the sentences you have just seen in this set, or any part of the sentences. Your answers should be written in the test booklet in front of you. At the end of approximately three minutes, your experimenter will tell you to stop writing. You should then turn to the next blank sheet of your booklet.

You will then have completed set #1. This procedure will be repeated a total of six times for this experimental task.

Appendix D (continued):

Prior to this experimental task, we will conduct a preliminary trial, so that you will be familiarized with the procedure. Please use the booklet in front of you for this familiarization trial.

Are there any questions?

Appendix D (continued):

General Instructions
Control Groups
Non-cued - Free Recall

A number of sentences will appear on the screen one at a time. Your task is to read them through in preparation for a simple memory test which will follow.

To make sure that you have understood the meaning of the sentence, you will be allowed eight seconds to read each sentence. After eight seconds has elapsed, the next sentence will automatically appear.

When a set of eight sentences has been shown, a dashed line will appear on the screen. The dashed line will be followed by a number to indicate that the memory test will follow.

This test requires you to rec l, in any order, the sentences you have just seen in this set, or any part of the sentences. Your answers should be written in the test booklet in front of you. At the end of approximately three minutes, your experimenter will tell you to stop writing. You should then turn to the next blank sheet of your booklet.

You will then have completed set #1. This procedure will be repeated a total of six times for this experimental task.

Prior to this experimental task, we will conduct a preliminary trial, so that you will be familiarized with the procedure. Please use the booklet in front of you for this familiarization trial.

Are there any questions?

Appendix D (continued):

General Instructions
Control Groups
No Study - Cued Recall/Free Recall

A number of sentences will appear on the screen one at a time. Each sentence will be presented in two forms. The sentence will first be presented with one of the words missing. You are asked to guess (out loud) this word if at all possible. At the end of five seconds, the complete sentence will appear on the screen. The next sentence will then appear, and you will again be asked to guess the missing word. This procedure will continue until the entire set of eight sentences has been presented. At the end of this set a dashed line will appear on the screen. This will indicate that a simple memory test will follow.

This test requires you to recall, in any order, the sentences you have just seen in this set, or any part of the sentences. Your answers should be written in the test booklet in front of you. At the end of approximately three minutes, your experimenter will tell you to stop writing. You should then turn to the next blank sheet of your booklet.

You will then have completed set #1. This procedure will be repeated a total of six times for this experimental task.

Prior to this experimental task, we will conduct a preliminary trial, so that you will be familiarized with the procedure. Please use the booklet in front of you for this familiarization trial.

Are there any questions?

Appendix E

Compilation of Stimulus Materials - Imagery and Frequency Levels

The combined word lists of Paivio, Yuille, and Madigan (1968) and supplementary word ratings provided by Yuille (1971) placed restrictions on the selection of low frequency words in this study. Imagery levels (high or low) were strictly controlled.

Selection of words was computerized. Words were chosen according to imagery level, frequency level, part of speech, and number of items requested. Although only 48 words from each part of speech and imagery level were needed, the composition of meaningful sentences dictated that approximately 100 words be called out for verbs and adjectives. Because the subject-noun was restricted to high imagery, 96 words were required, and approximately 200 nouns were called up for the high imagery level to cover both the subject-noun and object-noun requirements.

To illustrate the computer programme, the sort for nouns of low imagery and low frequency will be described. The initial sort (#1) was conducted on nouns falling within the imagery level of 0-.50, and within the frequency level of 0-10. If the criterion number of words was not reached in this sort, a new sort (#2) was conducted with parameters of imagery changed to 0-1.10, and frequency level 0-15. The decision to proceed to another level of frequency or imagery with every additional sort was made for each attribute independently. That is, if a given frequency level was exhausted before the imagery level, the computer searched a new frequency group but remained at the same imagery level until it was exhausted. Sorting continued in this fashion until the

Appendix E (continued):

criterion number of words was reached. The final list of nouns was composed of the lowest levels of imagery and frequency possible. The imagery levels which were searched in order to reach the criterion number of words are listed in Table 2.

As noted, imagery level (high or low) was rigorously controlled. It was not possible to maintain strict adherence to the low-frequency requirement. Table A shows the percentage of words that reached Thorndike-Lorge high frequency levels of A or AA in the final sorts, and in the final choice of words to be used as stimulus materials for this study. Frequency was controlled across nouns, and for low-imagery adjectives. Percentage of verbs and high-imagery adjectives for the stimulus materials did not exceed the percentage of words in the final sort which contained A or AA frequency words.

Table [illegible] indicates that certain sentence types, in order to be meani[illegible]d the use of a relatively higher-frequency word than [illegible] example, sentence type #5 (HHLL) required the use [illegible]r-frequency verb than did condition #7 (HLLH). [illegible] was further restricted to transitive verbs.

Appendix E (continued):

Table A

Percentage of Words Reaching Thorndike/Lorge A or AA Frequency Levels

	Final Sort		Stimulus Materials	
	High	Low	High	Low
Nouns	–	–	–	–
Verbs	45	29	40	22
Adjectives	46	0	40	0

Table B

Distribution of High-Frequency Words Across Imagery Levels and Sentence Types for Verbs and Adjectives (Nouns were controlled for frequency. Figures are out of a possible 12 sentences per type).

Sentence Type	Verb		Adjective	
	Low	High	Low	High
1	–	3	–	3
2	–	–	–	–
3	–	2	–	1
4	–	4	–	–
5	–	7	–	–
6	4	–	–	5
7	1	–	–	–
8	4	–	–	7

Appendix F

Sentence Ratings - Imagery Instructions

Sentences differ in their capacity to arouse mental images which convey the meaning of the words that comprise the sentence. Some sentences arouse a sensory experience, such as a mental picture or sound, very quickly and easily, whereas others may do so only with difficulty (i.e. after a long delay) or not at all. The purpose of this experiment is to rate the list of sentences you have just seen as to the ease or difficulty with which they arouse mental images. Any sentence which, in your estimation, arouses a mental image very quickly and easily should be given a high imagery rating: any sentence that arouses a mental image with difficulty or not at all should be given a low imagery rating.

Think of the sentence, "The boy ate the red apple". This sentence would probably arouse an image relatively easily and would be rated as high imagery. However the sentence "Logic solves many problems" would not arouse an image easily and would be rated as low imagery.

Your ratings will be made on a seven-point scale, where one is the low imagery end of the scale and seven is the high imagery end of the scale. Make your rating by putting a check mark over the number from 1 to 7 that best indicates your judgement of the ease or difficulty with which the sentence arouses an image. The sentences that arouse mental images most readily for you should be given a rating of 7; sentences that arouse images with the greatest difficulty or not at all should be rated 1; sentences that are intermediate in ease or difficulty with which they arouse an image should be rated between the two extremes. Feel free to use the entire range of numbers from 1 to 7. At the same time, don't be concerned about how often you use a particular number as long as it is your true judgment. Work fairly quickly but do not be careless in your ratings.

Appendix F (continued):

Sentence Ratings - Comprehension Instructions

Sentences differ in their capacity to be understood or comprehended. Comprehension is dependent on many factors, two of the more important of which are your past experience or general knowledge of the world, and your knowledge of the language.

The purpose of this experiment is to rate the list of sentences you have just seen on the ease or difficulty of your understanding what the speaker is trying to communicate to you, the reader. We would like you to rate the sentences on a seven-point scale, where one is the low comprehension end of the scale and seven is the high comprehension end of the scale. Make your rating by placing a check mark over the number from 1 to 7 that best indicates your judgement of the ease or difficulty of understanding the sentence. The sentences that are most easily comprehended should be given a rating of 7; sentences that you have great difficulty in comprehending or which you cannot comprehend at all should be rated 1. Sentences that are intermediate in ease or difficulty of comprehension should be rated appropriately between the two extremes. Feel free to use the entire range of numbers from 1 to 7. At the same time, don't be concerned about how often you use a particular number as long as it is a true judgment. Work fairly quickly but do not be careless in your ratings.

Please note that it is not necessary for you to agree with, or to make logical sense of, the sentence in order to understand what the speaker is trying to communicate to you. For example, the sentence "The green snow covered the roof of the house" may not make sense when compared to your past experience or knowledge of the world, but this artificiality does not prevent you from understanding the sentence.

Are there any questions?