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Unitary And Sequential Processing In The Recall Of Phrases

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UNITARY AND SEQUENTIAL PROCESSES IN THE RECALL OF PHRASES

by

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ABSTRACT

The theoretical and experimental work reported was concerned with how subjects remember the verbal information contained in meaningful adjective-noun phrases. It was hypothesized that concrete phrases, such as "round temple", are represented in memory as unitary images, while abstract phrases, such as "absolute truth", are represented as sequential verbal strings. Lists of 40 phrases, of which there were ten concrete, ten abstract, and twenty of mixed concreteness, were presented to groups of about 20 subjects in each experimental condition. In a cued recall condition, the subjects were given either the nouns or the adjectives from the list as cues, and were asked to produce the missing words. In a partial recall task, the subjects were asked to recall only the nouns or the adjectives from the list, while in a whole recall task, they were asked to recall as much of the list as they could. Additionally, the nouns and the adjectives from the lists were presented separately to subjects for free recall.

Since concrete phrases are assumed to arouse unitary images, it was predicted that subjects would recall the same proportion of words in free, partial, and whole recall,

despite the fact that the latter two conditions involve the presentation of twice as many words as the former. It was found that subjects recalled 41% of the words presented in each condition. With abstract phrases, however, the representation in memory is assumed to be sequential, so that a phrase would require twice as much storage space as a word. Consequently, subjects should recall the same number of words in free, partial, and whole recall, or proportionately half as many in the latter two tasks as in the former. The subjects recalled 23% of the words in free recall, but only 13% and 11% of the words in partial and whole recall, respectively, supporting the predictions.

The other findings can be summarized briefly. In whole recall, subjects recalled about an equal number of nouns and adjectives from the concrete and abstract phrases, while noun recall exceeded adjective recall in phrases where the noun was the more concrete member, and conversely, in phrases where the adjective was the more concrete member, adjective recall exceeded noun recall. All phrases, however, tended to be recalled or omitted as whole phrases, not as isolated words. In the partial recall and cued recall tasks, the cued recall of nouns only exceeded their partial recall if both the adjective cue and the to-be-remembered noun were concrete. With adjectives as to-be-remembered material, however, cued recall exceeded partial recall when the noun

cue was concrete, regardless of the concreteness of the adjective. Generally, recall performance was best for words presented in concrete phrases, worst for words in abstract phrases, and intermediate for words in mixed phrases.

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INTRODUCTION

This dissertation presents a theoretical and experimental analysis of the roles of mental imagery and verbal processes in remembering verbal material. The initial section describes the theory; subsequent sections describe three experiments. Although the theoretical rationale was intended to be quite general in its applicability, the stimulus material actually used in the experiments consisted only of meaningful adjective-noun phrases in which each word was either high or low in its rated image-arousing capacity. There were thus four kinds of phrases used, namely concrete (e.g. "white horse"), abstract (e.g. "basic theory"), or one of two kinds of phrases with mixed concreteness (e.g. CA phrases such as "wild idea", or AC phrases such as "previous baby").

Since the theoretical rationale was intended to be general, four different memory paradigms were used in three experiments. The first experiment concerned recall of phrases as well as words, and used a whole recall paradigm,

in which subjects wrote down everything they could remember after they had been presented with a list of phrases. The second experiment concerned memory for nouns in three different conditions. First, the subjects were given the nouns alone, for free recall. Second, other subjects were presented with a list of phrases, and were asked to recall only the nouns (partial recall). Third, after presentation of a list of phrases, subjects were given the adjectives as cues and asked to write the nouns next to the adjectives with which they had appeared (cued recall). The third experiment concerned memory for adjectives in the same three conditions as in the second experiment. There were thus two general methods of presenting material, namely as single words or as phrases. Given phrases at presentation, three ways were used to assess the subjects' memory performance, namely whole, partial and cued recall.

Predictions of two kinds were made concerning the outcomes of the experiments. One class of predictions was derived directly from the theory presented below, and concerned differential performance in several memory tasks, including free, whole, partial, and cued recall. A second class of predictions consisted of generalizations based on prior research, and concerned differential performance

as a function of the image-arousing capacity, or concreteness of the stimuli, especially in the phrases with mixed concreteness. Since the latter predictions are considered in depth elsewhere (Paivio, 1971), the major theoretical focus of the dissertation is with respect to the former.

The general theoretical framework that predicated the present investigation will now be described, in order to establish a basis for predicting memory performance.

THEORETICAL CONSIDERATIONS

This section includes a brief discussion of theoretical mechanisms of memory and forgetting, intended mainly as an introduction of some terminology, followed by a more detailed consideration of the postulates and implications of the present theory.

Some Issues in Theories of Memory

Although it is often difficult to find agreement between different theories of the memory process, there is one conceptual system that appears to be widely used. Melton (1963) proposed a tripartite system for describing the memory process, and in it he suggested that a successfully recalled item must have been acquired, stored and retrieved. For the moment, the terms will not be defined rigorously,

but will be used in their ordinary senses.

If a subject fails to produce a word with which he was presented earlier, what can one conclude? Forgetting could occur if the item was never stored, if it was lost from storage, or if it was stored but was not found. In order to simplify the possibilities, assume that words are always acquired or stored whenever the subjects are aware of what the task is about, the items are presented at an easily perceivable rate, and the subjects are motivated to perform well. The reasons for the assumption are twofold. First, regardless of how long a list of words is presented to subjects in a free recall task, retention of the last few words in the list is essentially perfect (e.g. Murdock, 1962). This suggests that the words are actually acquired and stored for at least a short time, and that some forgetting occurs as more words are presented.

Secondly, Mandler (e.g. Mandler & Dean, 1969) has developed a free recall technique in which performance is almost perfect. On the first trial, the subject is presented with one word, which he then recalls. On the second trial, he is presented with another word and the first one, and recalls them both. In a similar fashion, up to 25 words have been presented. When one word is presented on

each trial, performance is excellent, suggesting that acquisition is not really a problem. Given the simplification, forgetting can occur if an item is lost from storage, or if it is stored but is not retrieved. The two possible loci of forgetting will now be discussed.

If the primary cause of forgetting is assumed to be the loss of an item from storage, forgetting is said to be "trace-dependent", while if forgetting occurs because of failure to retrieve an item that is stored, forgetting is said to be "cue-dependent" (Tulving & Madigan, 1970). An alternative way to describe the possible loci of forgetting is to say that items lost from storage are not available for retrieval, while items that are stored but not found are available but not accessible (Tulving & Pearlstone, 1966). The availability-accessibility distinction can be made clear by an analogy with a bank: there is lots of money available, but one normally has access only to money in his own account. In recent years, there has been considerable controversy over whether forgetting is trace- or cue-dependent. Some theories of trace-dependent forgetting will be discussed below.

In theories that consider forgetting to be primarily a matter of losing information from storage, two main

mechanisms of loss are considered. First, the trace corresponding to an item can decay passively with time, until it is too weak to be retrieved (e.g. Bower, 1967a, b; Norman & Wickelgren, 1969; Wickelgren, 1970a, b). Secondly, incoming information could dislodge, bump out, or interfere with previously stored information (e.g. Bernbach, 1970a, b; Keppel, 1968). Alternatively, both processes could occur simultaneously (Reitman, 1970), decay could be a case of interference from "silent" information (Sperling & Speelman, 1970), or no decision is made (Norman & Rumelhart, 1970). The theories have been classified here on the basis of the relative emphasis placed on decay or interference as causes of forgetting. The one feature shared by the theories is that the major reason posited for forgetting is that an item has been lost from storage, to the operational extent that the trace of the item is too weak to exceed the criterion for retrieval. That is, the theories assume that items not recalled are not available for retrieval.

On the other hand, Tulving (e.g. 1968; see also Greeno, 1970) has argued that forgetting occurs because the items are not accessible. That is, cues for retrieving the items have been lost. Several lines of evidence have been used to support the idea of cue-dependent forgetting. First,

Penfield (1954) offered suggestive evidence that some events, of which the subject has not been conscious for some years, can be recalled with great clarity (if of doubtful veracity) after appropriate brain stimulation, at least if the patient is epileptic with focus in the temporal lobe. Penfield concluded that the stream of consciousness establishes a permanent record in the brain. A second line of evidence is that if subjects repeatedly recall words that were presented once, recall improves. Thus, failure to report a word does not mean it was lost from storage (Tulving, 1968). In the third place, items forgotten by a subject can sometimes be elicited by prompting (Dong & Kintsch, 1968) or cueing (Tulving & Psotka, 1971). A fourth point is the tip-of-the-tongue phenomenon (Brown & McNeill, 1966), an effect common to any of us who has momentarily forgotten the name of a friend while making an introduction. The final point is logical rather than empirical. Is it really sensible to say, simply because an experimenter presents the word "dog" to a subject, that the subject must acquire and store that word? If he fails to produce the word on a recall test, can we really say that he forgot it, in the sense that it disappeared from storage? While this argument seems to be very telling, its main point is to establish that Tulving has a very unusual

way of conceptualizing what other people have been saying.

What exactly is this "item" that memory theorists mention so often? Is it simply the trace of a word, as Tulving implies, or is it something else? Norman and Rumelhart (1970) consider an item to be an association between aspects of the context in which a word was presented and the meaning attributes of that word. Wickelgren (1970b) considers an item to be the association between structured associates activated by the experimental task and internal representatives of the words that were presented. In memory theories that specify what an item is, some part of the experimental context is part of the item, although, of course, not part of the word. Tulving's retrieval cue is really no more than this; Slamecka's (1968) retrieval strategy is also similar. "Item" will now be defined more rigorously, and the above-mentioned issues will expire forthwith.

An item is a task-specific association between internal representatives aroused by the experimental context and internal representatives aroused by the words presented. An item is thus a short-term association (relation) between long-term memory components corresponding to both the task and the word in question. Enough of the contextual

representative is associated with the word representative to make the word differentiable from all other words that could have been presented. The question asked by the subject during retrieval thus does not concern finding some words to recall, but deciding which words to recall. What of availability, accessibility, trace- and cue-dependent forgetting? Word representatives are always available, so that a failure to produce a required word would indicate that the word representative was not accessible for retrieval. In other words, forgetting, with respect to words, is always cue-dependent. However, an item is defined as an association between the word representative and contextual representatives. Thus, failure to report a word would indicate that the item, of which the word was a part, was not available for retrieval (i.e. the association was lost). In other words, forgetting, with respect to items, is trace-dependent. Although it is possible that items themselves might exist in storage but fail to be retrieved, the issue, as stated by Tulving, results from his peculiar restriction of the term "item" to refer only to the representative of a word in memory.

The Present Theory

The general plan of this section is to consider first the problem of what constitutes the "internal representative"

corresponding to a verbal or contextual stimulus. Secondly, rules by which internal representatives are combined to generate contextual meanings are discussed. Finally, some consequences of the theory for memory performance are considered, by way of introduction to a review of some experimental literature.

The first assumption is that, associated with every word a subject knows, there is a unique internal representative called the meaning of the word. This meaning is aroused upon perception of the word. The current approach is similar to many others, including Osgood's (1963) r_m, Collins and Quillian's (1970) property markers, and Katz and Fodor's (1963) attributes. The meaning response aroused by a word is not independent of all other word meanings, but could be related to (a) other representatives with which it has been repeatedly contiguously aroused (cf Wickelgren, 1970b), (b) other representatives with which it shares a number of fractional anticipatory or emotional reactions (cf Brown, 1958; Osgood, 1963), or (c) other representatives that denote similar referential relationships, as in a hierarchy (cf Katz & Fodor, 1963; Collins & Quillian, 1970). When the meaning of a particular word is activated, so are the related representatives, to greater or lesser degree, depending on

the strength of the relationship between the target word and its associates. This entire conglomerate will be referred to as the "associative meaning" of the word in question (cf Paivio, 1971).

The associative meaning aroused by a word can be conceptualized along the lines of Bartlett's (1932) schema. The schema is a theoretical memory structure which in some ways anticipated current ideas of feedback systems. That is, a word would arouse a cluster of reactions. The reactions would in turn alter the interpretation placed on a word, according to two major classes of influence. A long-term influence could result from a biasing of the interpretation of a word as a function of the past history the subject has shared with the word. Thus, the word "bar" in isolation might result in different interpretations in lawyers than alcoholics. The second influencing factor is short-term, relating to the context in which the word is perceived. If "bar" were preceded by "Let's have a drink at the", even a lawyer would probably interpret the word unambiguously. Note that in the latter case both prior history and immediate context influence the interpretation of the word: if the lawyer's prior experience with "bar" did not include the concept of a brass rail, he might find the entire utterance

semantically anomalous. The result of the joint influence of context and experience on the interpretation rendered a word will be referred to as that word's "contextual meaning." Contextual meaning is thus similar to "item" as defined in the previous section, insofar as both concepts invoke a short-term relation (association) between long-term memory representatives corresponding to a word's meaning and to the immediate context in which that word is encountered.

The notion of contextual meaning as a constructive, dynamic schema allows for infinite flexibility in comprehension. If the utterance "There is a green elephant in the kitchen playing hop-scotch" were encountered, the subject could combine the representatives of the individual words into a new structure, completely different from anything previously encountered in the real world. While recognizing the anomaly inherent in the utterance, the subject would have little difficulty in actually imagining what the situation could be like. Contextual meaning thus allows many metalinguistic operations because of the constructive way in which it is established.

Construction, however, must follow certain principles, or rules of operation, in order for contextual meanings to

have any functional utility. The theoretical discussion will now consider two such generative rules. The rules will be referred to as a "sequence rule" and a "unit rule". By way of disclaimer, it is not assumed that sequences cannot be treated as units, just that this is normally not the case. For a sequence to be treated as a unit (e.g. a familiar telephone number), more practice would be needed than is ordinarily given in memory experiments. To illustrate the operation of the sequence and unit rules, consider the old grammar school conundrum, "What is one and one?". The respondent could answer either "two" or "eleven", depending upon his familiarity with the riddle. According to the sequence rule, the answer would be eleven, since the rule requires that combination take place by stringing the successive components together in a contiguously organized vector. According to the unit rule, the answer is two, since the rule requires that successive components be integrated into whatever structure the prior components instated. In the event that the outcome of an application of the sequence rule is itself unitary, as in a familiar telephone number, the unitary-sequential distinction would not be crucial. Instead, what is here called unitary could be referred to as "integrative", while sequential would become "connective".

That is, the unitary meaning is one in which the various components lose their individual identity in becoming interconnected into an integrated and recoded structure. The sequential meaning is one in which the components retain individual identity, and are connected or grouped together. The terms "unit" and "sequence" will be used here primarily because the tasks and materials used restrict encoding along the lines specified.

Before discussing the application of the rules to verbal material, some direct implications of the above example will be considered. If it is assumed first that one digit occupies one unit of space in a memory, it follows that a unitary structure requires less storage space than a sequential vector, although the saving with respect to space is accompanied by an expense in terms of the precision with which the information is retained. As an alternative method of stating the conclusion, it could be said that the information contained in successive components is "chunked" by application of the unit rule, but not by the sequence rule. On the other hand, following application of the sequence rule, the terminal structure contains a direct representation of its derivational history: that is, all the prior states through which the structure progressed en route to its

terminal form are represented in that terminal form. The unit rule results in the loss of this direct representation of the precise succession of previous states. It is thus not reasonable to conclude that one kind of structure is "better" than the other. Rather, each structure is efficient for a particular requirement: the unitary structure is relatively efficient for retaining summary information from many inputs, or breadth, while the sequential structure is relatively efficient for retaining precise information from few inputs, or depth.

With reference to verbal communication, the sequence and unit rules apply to the combination of associative word meanings into contextual meanings, as a function of both the intraverbal and experimental context in which the words are encountered. The associative meanings themselves can be either sequential or unitary in nature, depending on certain characteristics that will be discussed shortly. Suppose, for example, that the subject is presented with a sentence of some kind, ignoring for the moment any contexts except the intraverbal one. Each word in the sentence arouses some kind of associative meaning reaction that is subject to modification by the meanings of the other words in the sentence. The contextual word meanings are theoretically

combined into a new structure called the sentence's meaning. Either the individual contextual word meanings can be strung together into a sequential structure, or a cumulative abstract of their gist (cf Hunter, 1964) -- a unitary structure -- can be formed. If the sentence arouses a sequential meaning, the meaning is directly composed of the contextual meanings of the individual words that form the elements in the sequence. If the sentence arouses a unitary meaning, the meaning is independent of the words used to generate it, in two ways. First, the unitary meaning contains no representation of the words used to arouse it. Secondly, many other series of words could have generated a similar unitary meaning.

In traditional terms, the acquisition and storage of memory traces corresponding to verbal stimuli have been described to this point. The present theory will be summarized before considering memory behavior. Acquisition of items can be defined as the process whereby a contextual meaning, or an association between contextual and word representatives, is constructed. Storage is the process of maintaining the contextual meaning in a state of arousal. Theoretically, in the course of the acquisition of the contextual meaning of a word, the word and the context in which it appears activate internal representatives. The

internal representative associated with a word includes information about the past history of that word; the contextual representative contains information concerning what aspects of that history are important in the task. Both the historical and contextual influences interact to generate a contextual meaning corresponding to the word in question. If the transmission contains several words, the contextual meanings corresponding to other words become part of the context influencing the generation of contextual meanings corresponding to (usually) later words. The contextual meanings corresponding to the individual words can be combined into higher order meanings by the application of either a sequence rule or a unit rule. If the sequence rule is applied, the individual contextual meanings are combined into a string, which is itself a contextual meaning. If the unit rule is applied, the successive contextual meanings are accumulated into a unitary structure which changes to incorporate each new component. The unitary meaning requires less storage space than the sequential meaning, so that the unit is efficient for maintaining quantities of summary information in a state of arousal. The sequential meaning contains more explicit information concerning its own history than does the unitary meaning, so that the sequence is efficient for

maintaining precise information about a few things. The implicit assumptions are that a limited but constant amount of storage space is available for maintaining the meanings in an aroused state, and that the terminal states of the meanings (their final forms) are the structures that are maintained.

The theory has a strong resemblance to many other theories, so that its major contribution is not one of originality, but of synthesis. A number of theories posit a sequential or vectorial representation of something in memory (e.g. Bower, 1967a; Norman & Rumelhart, 1970). Others posit schemata (Bartlett, 1932), surrogate structures (Dooling & Lachman, 1971; Lachman & Dooling, 1968; Pompi & Lachman, 1967), or unitary meanings (Brent, 1969), all of which have predominantly unitary structures as described here. The closest theoretical relative of the present theory is that of Paivio (1971).

The concept of mental imagery has a close relation to the concept of unitization as developed here. That is, given a picture of a horse, it doesn't require any additional space to color the horse white or green. The phrase "white horse" is thus an example of a phrase which has a fairly easily generated unitary meaning. On the other hand, a phrase such

as "basic theory" does not readily lend itself to pictorial representation. The key word is "readily", since there are clearly several ways in which abstract concepts (concepts that arouse images with difficulty, if at all) can be made to arouse some kinds of images. For example, abstract concepts can be rendered imageable by analogy ("Blood is thicker than water"), by association with concrete concepts (democracy could be seen as a Canadian flag), by schematization (the Bohr model of the atom), or by pictographic punning ("to be or not to be" could be seen as a sequence of pictures -- "2" "bee" "oar" "knot" "2" "bee"). However, such concretization of the abstract may take too long to be useful in a memory task, and, in some cases, may cause serious problems in going back from the image to the concepts that aroused it. The above considerations make it reasonable to assume that images facilitate unitization of the meaning of nominal stimulus items. Consequently, the unitization of meaning is assumed to be a positive function of the operationally-defined image-arousing capacity of the material. In cases where conditions make image-arousal unlikely, the meaning will be sequential in structure, rather than unitary.

The problem of what constitutes forgetting and remembering will be discussed, since theoretical predictions

follow readily from the discussion. The business of recalling is assumed to be the process of searching for an aroused (stored) item, retrieving said item, and converting the information contained in it into an overt verbal response. Forgetting can thus occur because of (a) loss of information from storage, (b) failure to retrieve information from storage, or (c) faulty conversion of the retrieved information into words. Because of the present definition of an item as an association between a context and a word meaning, storage loss refers to loss of the association, not the word, and retrieval failure is also relative to the item, not the word. If memory storage is assumed to be a constant, limited capacity system, and if the amount of information presented in an experiment exceeds the capacity, it is clear that something has to go. What stays will depend on what has been rehearsed (attended to) the most, and what has been there the least amount of time. The assumption is, however, that loss of contextual meanings from storage is not a function of any prior properties of those meanings, or of the attributes of the words that aroused them. That is, loss from storage is assumed to be a random process whereby the least often and least recently rehearsed items are lost, in the sense that the associations between the context and the word

meanings are lost. Since unitary meanings require less space in storage than do sequential meanings, more unitary than sequential meanings will be in storage, and more will still remain after the loss of some items. Loss of information from storage is thus an important factor in forgetting.

Both retrieval and post-retrieval influences can also result in errors in recall. A retrieval failure, in the sense of failure to locate an intact association, is assumed to be a constant probability function with respect to any particular association. That is, proportionately the same number of unitary and sequential meanings would not be retrieved. Retrieval failures, as with storage loss from the preceding section, would be reflected by omissions in recall. Post-retrieval differences should be reflected in qualitative effects. If a retrieved meaning is unitary, no specific wording information is contained, so that recall is a matter of generating a verbal sequence consistent with the retrieved meaning, while reporting the contents of sequential meanings should include relatively more precision with respect to the details of wording. For the present experiments, post-retrieval effects would not be expected to be especially important, since the verbal units presented were relatively simple. In experiments involving memory for stories or

sentences, the latter effects should be paramount, especially if the stimuli are concrete and amenable to unitization of the entire theme.

Experimental literature which relates to the general theoretical framework will now be reviewed, in order to assess the reasonableness of some of the present assumptions.

LITERATURE REVIEW

The research literature will be reviewed in descending order of verbal complexity, going from memory for stories to passages to sentences, and finally to phrases.

Memory for Stories

When subjects are asked to remember stories, their reports show several things clearly. First, their reports emphasize the meaning of the stories by (a) the exclusion of irrelevant details, and (b) the intrusion of new material related to the theme (Allport & Postman, 1947; Bartlett, 1932; Hunter, 1964). Since omissions are more common in the task than are intrusions, the general result is a shortened but thematically consistent story. Finally, certain types of errors in recall show that the interpretation

of the story is a function of the belief and value systems of the subjects (Allpott & Postman, 1947).

According to Hunter's (1964) interpretation, subjects retain "the moment-by-moment details only long enough to build up a cumulative abstract of the story's characteristics . . . then the exact words are forgotten and their gist retained (p. 154)." Since the stories used were relatively concrete (as are most narrative stories), the results accord well with the present theory. Thus, the "cumulative abstract" could be a unitary image, and reconstruction from the retrieved image produces words that are thematically consistent with the unitary meaning, as if the reconstruction were effected by describing an action picture.

Memory for Passages

When passages are presented to subjects, with one word at a time exposed on a memory drum or on IBM cards, memory performance is consistent with theoretical expectations for relatively concrete material. As the thematicity of the passages increases from random to highly thematic presentations, subjects recall more of the words from the original passages (Brent, 1969; Lachman & Dooling, 1968; Pompi & Lachman, 1967; Rosenberg, 1968; 1970) and make more theme related intrusions (Pompi & Lachman, 1967). Brent suggested

that a single unitary trace of the material was stored in memory, and felt that this suggestion allowed the specification of "(a) the nature of the memory-storage structures ... (b) the manner in which the stimulus materials are transformed ... into a single unitary structure ..., and (c) the manner in which the single unitary structure is re-transformed into a linear string of discrete items during recall (1969, p. 78)". In the present terms, Brent's point (b) is acquisition and point (c) is reconstruction. Brent did not consider the retrieval problem, since the retrieval of one unit is probably automatic, nor did he consider concrete and abstract material separately. He assumed that a sentence was a set of instructions about combining the conceptual referents of the words into a unitary idea or meaning.

The data to this point concern predominantly concrete material, and could be described equally well by several theories, including the present one. The crucial comparisons will thus involve the use of abstract material as well as concrete material, since few theories exist which consider abstract material and concrete material to be different with respect to what is stored in memory.

A study by Yuille and Paivio (1969) included a factorial variation of the concreteness and thematicity of

passages. In the concrete passages, more words were recalled and more thematic intrusions were made in thematic than random passages. However, if anything, the reverse was true for abstract material. The results indicate that the postulated post-retrieval differences attributable to unitary and sequential meanings are reasonable. That is, given a sequential meaning representation in memory, recall is more precise with respect to the words that aroused the meaning than if the meaning is unitary, in the sense that thematic intrusions are relatively less frequent in abstract than concrete thematic material.

The research concerning stories and passages, however, is predominantly a study of reconstruction, since, in the concrete material, the meaning is presumably unitary, and it should not be difficult to retrieve one unit. In the following section, memory for sentences is discussed, since memory for sentences should involve retrieval processes to a greater extent than memory for larger units, which is usually assessed in studies where only one passage is presented to the subjects as to-be-remembered material.

Memory for Sentences

When subjects are asked to remember sentences, they recall them as paraphrases of the original, preserving

meaning but losing the exact words (Binet & Henri, 1896, cited by Wanner, 1968). Further, changes in sentence meaning are more readily detected than changes in the wording of the same sentences (Sachs, 1967a, b), especially if the subjects are not specifically instructed to attend to the exact words (Wanner, 1968). Bregman and Strasberg (1968) concluded that sentence words are not specifically represented in the memory trace for the sentence, but may be represented implicitly by altering the meaning of the sentence. As in the preceding section, the results apply to concrete sentences but do not generalize to abstract sentences. Begg and Paivio (1969) found, as Sachs did, that changes in the meaning of concrete sentences were more detectable than changes in the wording of the same sentences. In abstract sentences, however, the reverse was true. They suggested that the meaning of a concrete sentence was represented imaginally in memory, while the meaning of an abstract sentence was represented verbally. In addition, memory for the meaning of concrete sentences was better than memory for the meaning of abstract sentences. The latter result presumably reflects differences in storage efficiency as a function of the unitary or sequential nature of the meanings, while the former results reflect differential reconstruction processes, which would be relatively precise

with respect to wording in the case of abstract sequential meanings, but theme or meaning related in the case of unitary imaginal meanings.

The general properties of the present theory accord well with the data discussed. However, it would be desirable to separate retrieval and reconstruction processes more directly, and to examine further predictions derived from the theory, before ignoring reconstructive effects entirely, in discussion of memory for adjective-noun phrases.

Begg (1971) conducted an experiment concerned with the storage and retrieval of the meanings of concrete sentences, and the reconstruction of their wording. According to the theory, concrete sentences arouse unitary meanings which do not contain direct representation of the precise words. Thus, subjects should be no better at recognizing that a test sentence has an old meaning if the test sentence is identical to the original than if it is a paraphrase. Although the paraphrase lacks exact syntactic and lexical cues for retrieving the sentence meaning, such cues are irrelevant in the present theory. If anything, paraphrases were slightly <u>better</u> cues than identical sentences, so the prediction was supported. Also, the accuracy of judgments of whether or not the wording of each test item

was identical to an old sentence was statistically independent of the accuracy of meaning judgments, further supporting the contention that the meanings of concrete sentences are represented in memory independently of the words. The reconstruction hypothesis was also examined in the study. If the retrieved meanings contain no exact wording information, wording judgments could be made by generating words to describe the retrieved image, and comparing these words to the test sentence. If the reconstruction process is similar to the way we normally express intended meanings as words, the accuracy of wording judgments should be independent of the length of time between the original and test presentations of a sentence, while the accuracy of meaning judgments should decrease monotonically over the same range. Meaning judgments were almost perfectly correlated with the number of interpolated items, while wording judgments were uncorrelated with the same variable, supporting the theory.

To summarize the preceding sections concerning memory for relatively complex verbal material, one can conclude that concrete meanings might reasonably be represented in memory as unitary images, while abstract meanings seem to be represented sequentially, more directly in terms of the actual words that aroused them. The reconstructive processes

following retrieval seem to operate as hypothesized, but little consideration has been given up to this point regarding the idea that unitary meanings require less storage space than sequential meanings. In the following sections, memory for phrases will be discussed, first because reconstruction is probably more constrained in simple than complex verbal material, and secondly, because the present experiments concerned memory for the information contained in phrases.

MEMORY FOR PHRASES

This section will first consider the kinds of experiments conducted in the present series, and give a general rationale for them. Broad theoretical predictions will be made about the kinds of results to be expected. Both the rationale and the predictions will be made more specific in the Introductions to the three experiments. Empirical generalizations will also be considered, but generally in the individual Discussion sections.

Four kinds of phrases were presented to subjects in the experiments. Concrete phrases, such as "muscular gentleman", had concrete nouns and adjectives. Abstract phrases, such as "common fate", had abstract nouns and adjectives. In the mixed phrases, either the noun was concrete (e.g. "more butter"), or the adjective was concrete

(e.g. "beautiful thought"). There were two general methods of presentation in the experiments. Either the nouns and adjectives were presented separately, as in the free recall tasks, or they were presented together, in three pair tasks. In the pair tasks, subjects were asked to recall as much as they could (whole recall), only the nouns or adjectives (partial recall), or one word from each pair was presented and the subject was required to produce the missing member (cued recall).

The primary concern of this section is with the predicted results for concrete and abstract pairs in the various tasks, and some features of phrase memory in general. According to the theory, a contextual meaning will be constructed to represent each phrase in the experiment, regardless of what kind of phrase is presented. If the phrase is concrete, the meaning will be unitary; if abstract, the phrase meaning is sequential. In the concrete phrases, it should not make much difference whether the presentation is of single words or the same number of phrases, since concrete words and concrete phrases, by virtue of being unitary, will not differ in storage requirements. Cueing should have a positive effect, however, since the cue would actually be a part of the unit in memory. Abstract phrases, on the other

hand, should be affected by the method of presentation, since phrases with sequential meanings should require twice the storage of individual words. Cueing should only be effective to the extent that contiguity cues are effective. Generally, however, all phrases should be stored in terms of their meanings as phrases, even though that meaning is closely tied to the precise words in the case of sequential meanings.

The experiments and relevant research evidence will now be discussed.

EXPERIMENT I: WHOLE RECALL OF PHRASES

In the first experiment, ten each of the four kinds of phrases -- concrete, abstract, or mixed -- were presented to subjects. After the 40 phrases were presented, the subjects were asked to write down as much as they could remember, in any order. They were instructed to include both phrases and isolated words on their recall sheets.

Although there is a dearth of experimental literature concerned with the whole recall of phrases per se, two sources of relevant data exist. First, data exist concerning some measures, such as the number of nouns recalled, which can be taken as indices of performance. Secondly, a theory of phrase recall exists. The latter will be discussed at this

point, and the former will be considered in the Discussion section of the experiment.

Horowitz and Prytulak (1969) conceptualized the phrase memory task as one in which subjects retrieve a phrase by "recalling a most salient feature first", following which "the rest of the phrase is readily recalled (p. 520)". That is, a word from the phrase is retrieved, the word reinstates the phrase in memory, and the subject then produces the phrase. In the present theory, the phrase meaning is itself retrieved without the mediating event of retrieving a word from the phrase. The present theory makes a clear prediction regarding the order of report of phrases and words in the recall protocols of the subjects. The prediction is that correctly recalled whole phrases should occur relatively earlier in the protocols than should correctly recalled isolates. The prediction from Horowitz and Prytulak's theory is not as clear. Given that a word from a phrase has been retrieved, the rest of the phrase will either be retrieved or it will not. If the probability with which the word reinstates the phrase is a constant throughout the task, isolated words should be randomly distributed throughout the protocols. If the probability decreases throughout the response interval, the two theories make identical

predictions.

There are two reasons for expecting that the probability of reinstating the compound, given retrieval of a part, would decrease. First, words retrieved early in the response interval could be from more unitized pairs. Since this would require phrase knowledge prior to retrieving the words from the phrases, it does not seem reasonable. Second, the words retrieved first (the words with, in some sense, stronger memory traces) could also be better retrieval cues for reinstating the pairs in memory. That is, words prominent in recall could inherently be better retrieval cues than less prominent words. If this latter reason is true, it would be expected that the cued recall of phrases would be substantially better than whole recall, if the cue was the word from the phrase that was most prominently recalled in the whole recall task, and if the phrase met some criterion of unitization, or redintegration.

Horowitz and Prytulak (1969) suggest as a criterion of redintegration that the proportion of words recalled that are in phrases should exceed .60. One could thus espect, in the cued recall tasks (Exps. II and III), that cued recall would exceed whole recall when (a) the phrases in question meet the above criterion, and when (b) the cues used are the

words from the phrases that were most often recalled in the whole recall task. In the present experiment, it was determined whether the phrase types did meet the criterion, as well as which member of each phrase type was most prominent in the whole recall task.

Horowitz and Prytulak (1969) made an additional generalization which can be tested in the present experiment. They emphasized that recall "symmetry does not seem to occur when the criterion for redintegration is met (p. 528)." The phrases used in their experiment all had concrete nouns and the adjectives ranged from concrete (e.g. "dead") to abstract (e.g. "common"). They found that more nouns than adjectives were recalled, which is not surprising in the light of other results (e.g. Paivio, 1969) which indicate that concrete words tend to be more often recalled than do abstract words. The present experiment included a factorial variation of noun and adjective concreteness to examine further the question of symmetry, or lack of it, in the task. This point will be addressed further in the Discussion.

A further prediction from the present theory is that concrete pairs, which presumably arouse unitary meanings, should be more prominent in recall than should abstract pairs, whose meanings are sequential. The prediction, if

supported, will not add much to the confirmation of the present theory, since positive effects of concreteness are common in free recall situations. Stronger tests will be provided in the following experiments, in which performance can be assessed across a variety of different recall tasks.

Of the several purposes of this experiment, the most important is to gather data for use in comparisons to be made later in this paper. In its own right, the experiment will examine (a) the order of report of phrases and isolated words, (b) the symmetry, or lack of it, in the recall of the nouns and adjectives in the different phrases, and (c) some indices of the degree to which the words from a given phrase are associated with each other.

Method

Subjects. Twenty-five introductory psychology students from the University of Western Ontario served as Ss as part of a course requirement. Seven Ss heard the first list order, and six heard each of the remaining three orders (see below).

Materials and Procedure. Twenty concrete nouns with a mean I rating of 6.47, and 20 abstract nouns with a mean I of 2.72 were selected from the Paivio, Yuille, and Madigan (1968) norms. Similarly, 20 concrete and 20 abstract

adjectives, with respective mean ratings of 5.43 and 2.22 were selected from norms supplied by A. Paivio. The adjectives had been rated on I after the procedure of Paivio et al (1968). The concrete and abstract nouns and adjectives were paired factorially into four groups with ten pairs in each group. The adjectives were paired with nouns for which they were appropriate modifiers, according to the experimenter's judgment. The materials are presented in Table 1.

The 40 phrases were arranged in four lists, so that every type of phrase (concrete, abstract, and both mixed types) occurred once in each of the 40 list positions across the four lists. Each list was read aloud to a group of six or seven Ss, at a rate of one phrase every four sec. Following presentation of the list, the Ss were each given a blank sheet of paper, and were instructed to write down as much as they could remember of the list, whether it be phrases or isolated words. The task was thus a whole recall task, but the Ss did not know what they would be required to produce until after the presentation of the list had been completed. Five minutes were allowed for the recall task.

Results

Since a considerable amount of data was collected in

Table 1

The Adjective-noun Phrases used in Experiment I (as well as II and III)

Unmixed Pairs

Concrete Pairs (CC)	Abstract Pairs (AA)
Square Door	Impossible Amount
Rusty Engine	Better Excuse
Flaming Forest	Apparent Fact
Muscular Gentleman	Common Fate
White Horse	Subtle Fault
Crippled Judge	Available Knowledge
Young Mother	Rational Method
Hungry Prisoner	Particular Soul
Round Temple	Basic Theory
Muddy Village	Absolute Truth

Mixed Pairs

Concrete-Abstract (CA)	Abstract-Concrete (AC)
Hot Answer	Competent Army
Dead Attitude	Previous Baby
Fat Chance	More Butter
Colorful Event	Essential Clothing
Wild Idea	Additional Coffee
Dark Moment	Adequate Hospital
Ugly Occasion	Acceptable Hotel
Vertical Position	Unfair Letter
Wet Situation	Recent Newspaper
Beautiful Thought	Ordinary Seat

the experiment, an attempt was made to simplify the results for the purpose of communication. Toward that end, the results will be presented first in tabular form, and discussed briefly. Then the individual tabular entries will each be presented separately in traditional statistical form.

The proportionate mean recall data from Exp. I are presented in Table 2. The proportions can be converted to the mean number recalled by multiplying each proportion by ten. Each type of phrase is presented separately, with recall partitioned according to whether or not the nouns or adjectives from the phrases were recalled. Four events could occur in the recall of any particular phrase. The whole phrase could be recalled at once, only the noun could be recalled, only the adjective could be recalled, or nothing could be recalled. The four events are respectively presented in the upper left, upper right, and lower left and right cells in each matrix.

There are several points to note in Table 2. First, in all cases, the most prominent cell in the matrix is the omission cell, indicating that the task was fairly difficult. Secondly, the cells representing isolated recalls are the least prominent cells in each case, suggesting that the recall of phrases tended to be all-or-none. This point will

Table 2

Data from Exp. I, Partitioned According to the Recall or Non-recall of Nouns and Adjectives

Unmixed Pairs

		Concrete				Abstract	
		Adjective Recall				Adjective Recall	
		Yes	No			Yes	No
Noun Recall	Yes	.360	.044	Noun Recall	Yes	.088	.024
	No	.052	.544		No	.020	.868

Mixed Pairs

		Abstract-Concrete				Concrete-Abstract	
		Adjective Recall				Adjective Recall	
		Yes	No			Yes	No
Noun Recall	Yes	.224	.096	Noun Recall	Yes	.184	.012
	No	.032	.648		No	.064	.740

Note: Yes and No refer to the recall and non-recall of the respective words. The yes-yes cell is the proportion of phrases recalled; the yes-no cell is the proportion of nouns recalled in isolation; the no-yes cell is the proportion of adjectives recalled in isolation; the no-no cell is the proportion of non-recalls, or omissions.

be expanded somewhat in one of the following sections. A third point is that concrete phrases were most prominent in recall, with abstract phrases the least, and mixed phrases intermediate. The final point regards comparison of noun and adjective recall within each phrase type. In the concrete and abstract pairs, nouns and adjectives were about equally often recalled in isolation, while in the mixed pairs, the more concrete members were more often recalled in isolation than their abstract fellows, regardless of the grammatical class of the items.

The following sections consider phrase recall, recall of isolated words, measures of statistical association, and the order of recall.

Phrase Recall. The number of whole phrases recalled by each S was tabulated for each type of phrase, as shown in the upper left-hand cells of Table 2, and analyzed by a 2 x 2 analysis of variance, with both noun and adjective concreteness (concrete or abstract) as repeated factors. Both main effects were statistically reliable, with respective Fs (1,24) of 36.3 and 61.8 for noun and adjective concreteness, but the interaction was not. The results are presented in Figure 1, which shows that concrete phrases were the most frequently recalled, exceeding abstract phrases by

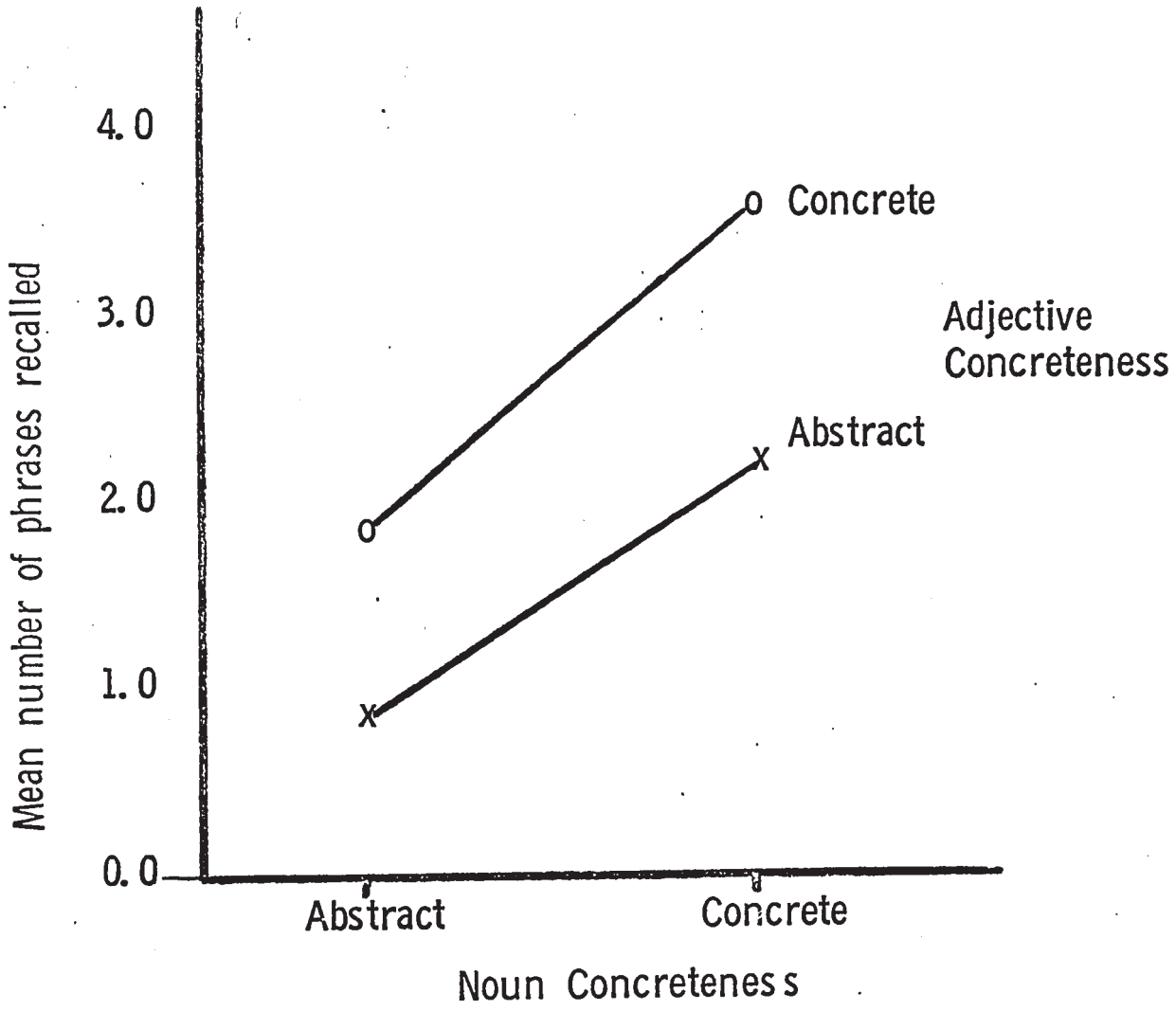

Figure 1: The number of whole phrases (out of ten) recalled, as a function of the concreteness of the nouns and adjectives in the phrases.

a factor of over four, while mixed pairs were recalled at an intermediate level.

Recall of Isolated Nouns and Adjectives. The mean number of isolated nouns and adjectives recalled by each S was calculated for each type of phrase, as shown in the minor diagonals of the matrices in Table 2. Noun and adjective recall were virtually identical in the concrete and abstract phrases. In the AC phrases, more nouns than adjectives were recalled, replicating Horowitz and Prytulak's (1969) finding. However, in the CA phrases, more adjectives than nouns were recalled, $t(24) = 3.16$, $p < .01$ (although the number of both nouns and adjectives recalled was correlated with the number of CA phrases recalled, the difference between adjective and noun recall was uncorrelated with the number of phrases recalled, $r = .004$). Thus, the differential recall of nouns and adjectives was only reliable in the phrases whose members were mixed in concreteness, in which cases recall prominence was a positive function of differential concreteness, not grammatical class.

Measures of Statistical Association. If nouns and adjectives were recalled independently of each other, the proportion of phrases recalled would be simply the product of the proportions of nouns and adjectives recalled. For example, in the concrete phrases, about 40% of the nouns and

41% of the adjectives were recalled. If they were recalled independently of each other, about 17% of the phrases would have been recalled, in contrast to the 36% actually observed. A chi-square measure indicates whether the observed proportions are sufficiently different from the proportions expected with independent recall to conclude that recall of nouns is associated with recall of adjectives, or alternatively, that the phrases tend to be recalled or not recalled as units. For each pair type, the chi-square value was larger than would have been expected by chance. In concrete and abstract phrases, the respective values were 6.38 and 5.86, while in the AC and CA pairs the values were 4.83 and 6.18. The chi-square values did not covary with the number of phrases recalled, and in fact did not differ very much from each other, probably because the range of variation in performance was not large enough.

Another measure of association, or of the relative prominence of phrases in recall, was suggested by Horowitz and Prytulak (1969) as a measure of redintegration. They suggested that, in order for pairs of words to be classified as redintegrative, the ratio of the number of words recalled in phrases to the total number of words recalled should exceed .60. All phrase types in the present task met the

criterion. In concrete pairs, .891 of the nouns and .874 of the adjectives, or altogether about 88% of the words that were recalled were in phrases. In abstract pairs, .786 of the nouns, .815 of the adjectives, or about 80% of the words were in phrases. In AC pairs, .700 of the nouns, .875 of the adjectives, or about 79% of the words were in phrases, while for CA pairs, the respective figures were .939, .742, or about 84%. There are two important points here. First, the average proportions of words recalled that were in phrases bear no obvious relationship to the proportions of phrases recalled. Secondly, despite relatively large differences in the proportions of phrases recalled as a function of the type of phrase, the redintegrative measures do not show a similar range of variation. There are perhaps two possibilities relative to redintegration. Either redintegration does not imply anything about the relative efficiency of memory, or the measures of redintegration are not satisfactory.

Order of Report. Horowitz and Prytulak (1969) conceptualized redintegration as occurring in three stages. First, Ss retrieved the more salient member of a pair. Second, the retrieved member served as a cue for reinstating the entire pair in memory. Finally, the S reported the pair. In the

present theory, the S is assumed to retrieve the phrase meanings and report them, recalling isolates, as it were, as a measure of desperation when the retrieval of phrases is not effective. The recall protocols of the Ss were divided at the median position, and the proportion of isolated words relative to the total number of correct recalls was calculated at both sides of the median. In the first half, .134 of the recalls were isolated words, while in the last half, .435 were isolates, $t(24) = -4.25$, $p < .01$, indicating that isolated recalls were relatively prominent later in the list rather than near the beginning. Either Ss do generally recall isolates after failure to retrieve pairs, or there is a systematic decrease in the probability that a retrieved word from a phrase will serve as a cue for reinstating the whole phrase in memory.

Discussion

In sum, the results indicate that concrete phrases were most common in recall, exceeding abstract phrases by a factor of about four, while mixed phrases were intermediate. In concrete and abstract phrases, the number of nouns and adjectives recalled were about equal, while recall was asymmetrical in mixed phrases, with the more prominently recalled member also being the more concrete member of the

phrase. All phrases evidenced dependence, in the sense that phrases tended to be recalled or not recalled as units, with non-recall being somewhat more frequent. All pairs met the criterion for redintegration suggested by Horowitz and Prytulak (1969), despite the wide range across pair types in the quality of the recall performance. Finally, phrases tended to occur sooner in the recall protocols than did isolates. The theoretical implications of the results will be discussed in turn.

The finding that concrete phrases exceeded abstract phrases in recall is notable not for the direction but for the size of the effect. In the free recall of individual words, concrete words exceed abstract words by a factor of typically less than two (e.g. Paivio & Csapo, 1969; Paivio, Yuille & Rogers, 1968), while with phrases, the factor turned out to be about four. If, for example, a subject had a memory capacity of four concrete words, the present theory would predict a capacity of about four phrases as well, since the phrase meanings are presumably unitary, and require no more memory space than the words. On the basis of the present performance, it can be expected that the free recall of concrete nouns and adjectives in the following experiments will be on the order of 40%. For the abstract phrases,

however, the sequential meaning should require about twice the space in memory for a phrase as for a word. The prediction is thus that free recall of the individual abstract words would be about twice as good, or at about a 20% level, as the recall of the words in the whole recall task. The observed factor of about four thus theoretically seems to represent the product of two separate factors, each about two. One factor is the difference in free recall prominence of the concrete and abstract words alone; the other factor refers to a relative gain in prominence for concrete words in concrete phrases, as a function of unitization of meaning.

Horowitz and Prytulak's (1969) statement that the whole recall of criterial phrases is asymmetrical is wrong, probably because they used phrases that were on the average asymmetrical in concreteness. The fact that asymmetry in recall is a function of asymmetrical concreteness is certainly not surprising in light of the fact that concreteness effects in free recall are positive and pervasive. One more instance of the effect of concreteness is thus given here.

Since all phrase types used in the experiment met Horowitz and Prytulak's (1969) criterion for redintegration, and since there was a considerable range of performance in recall that was not paralleled by changes in the degree to

which the criterion was exceeded by the phrases, the suggestion is that the criterion is insensitive to performance, and as such, is of marginal utility. However, ultimate rejection of the criterion will hinge on results in the following experiments. According to Horowitz and Prytulak's theory, cued recall should be considerably better than whole recall when the cue is the most prominently recalled phrase member. In Exp. II, an experiment will be reported in which the phrase adjectives served as cues. In mixed phrases with concrete adjectives, cueing should thus be effective, as in the concrete and abstract pairs. Cueing should be least effective in the mixed pairs with concrete nouns. The predicted effect of cueing in mixed pairs should reverse in Exp. III, where the nouns were the cues. The predictions will be discussed further in the individual Introductions.

The final point is with respect to the order of recall. The results were exactly as predicted by the present theory, and possibly either confirmatory or contradictory with respect to the alternative. The empirical statement, however, is unqualified by the theories. For whatever reason, subjects tend to recall phrases before isolates. The present theory suggests that the reason for the effect is that initial retrieval is of phrase meanings, which, regardless

of the type of phrase, are connected contextual meanings in memory. Consideration of the alternative theory will be given in the context of the following experiments.

EXPERIMENT II: FREE, PARTIAL, AND CUED RECALL OF NOUNS

The second experiment was concerned with memory for nouns as a function of the way in which they were presented to the subjects, and the way in which recall was requested. The major presentation variable was whether the nouns were presented alone for free recall, or in phrases of the four types used in Exp. I. The other variable, after presentation of the phrases, was whether the subject was asked only to produce the nouns (partial recall), or whether his recall of the nouns was cued with the adjectives from the phrases. The general expectation was that the method of presentation would be an effective determinant of behavior concerning abstract material, but method of recall would be the effective variable for concrete material. Thus, it was expected that proportionately more abstract nouns would be recalled after presentation of the words alone than after presentation of the phrases, regardless of the recall method. In the concrete phrases, on the other hand, the proportion of nouns recalled should not differ as a function of whether

words or phrases were presented, but should increase substantially with cued recall. The reasons for the predictions will be expanded below. An additional feature of the experimental results was a comparison between the results of Exps. I and II, for the different types of pairs in the different tasks.

In the preceding experiment, it was pointed out that the free recall of concrete nouns should be on the order of 40%, while the free recall of abstract nouns should be on the order of 20%, according to the present theory. By the same line of reasoning, partial recall performance would be expected to be at about a 40% level for concrete phrases and a 10% level for abstract phrases, since whole and partial recall of nouns would not be any different if the subject does indeed attempt to retrieve phrase meanings in both tasks. It is difficult to determine what Horowitz and Prytulak (1969) would predict about the relationship between whole and partial recall, but there is no reason to expect that they would consider the two tasks to be very different. The present theory and the alternative make clearly different predictions about cueing, however.

Both the concrete and the abstract phrases were symmetrical with respect to noun and adjective recall in

Exp. I, and both phrase types met the criterion for redintegration. Therefore, according to Horowitz and Prytulak's conceptualization, cued recall should be substantially better than partial recall in both concrete and abstract phrases. That is, more than 40% of the concrete and 10% of the abstract nouns should be recalled in the cued recall task. The present theory is in agreement regarding the concrete pairs, since presenting a cue is equivalent to reinstating part of the unitary phrase meaning corresponding to the pair. However, in abstract phrases, with sequential meanings, the components of the sequence are assumed to be contiguously organized. Bregman (1968) has shown that contiguity cues are not effective in enhancing recall, so that no facilitative effect of cueing is expected in the abstract phrases. The present prediction is that cued recall of nouns after presentation of abstract pairs will lead to about a 10% level of performance.

Regarding performance in mixed pairs, Horowitz and Prytulak (1969) make more explicit predictions than the present theory. Their prediction is that cued recall performance should be especially facilitatory with respect to partial recall when the concrete adjectives serve as cues, since those adjectives are asymmetrically prominent in

whole recall, but that there should also be facilitation in the case where the abstract adjectives serve as cues, since those phrases also met the redintegration criterion. The present theory has nothing important to say about mixed phrases. Nor have any published experiments dealt with comparisons of cued and partial recall of such (or any) pairs. What data there are concerning mixed pairs are usually in relation to comparing the relative effectiveness of the pair members as cues, not the absolute effectiveness as in the present case. Such data, although not relevant here (they will be discussed in the General Discussion, where the question of relative effectiveness will be addressed), do allow some generalizations. The general finding is that concrete cues are better than abstract cues, and that concrete to-be-remembered items are better than abstract items (cf Paivio, 1969). Such results can thus be expected here.

The clear predictions from the present theory are that (a) concrete phrases will be substantially better than abstract phrases in both partial and cued recall, (b) cued recall will exceed partial recall (as well as whole recall) in concrete but not abstract phrases, and (c) free recall should be no different from partial (or whole) recall of

nouns from concrete phrases, while free recall of nouns from abstract phrases should be about twice as good as partial (or whole) recall of the same nouns. It is interesting that the present theory predicts that there will be no difference between free and partial recall in concrete pairs. In the only relevant experiments, Cofer, Segal, Stein, and Walker (1968) found that generally partial recall of nouns was worse than free recall of the same nouns alone, except when the adjective-noun phrases made sense, as in the present case. Their phrases were of indeterminate concreteness so that no ready generalization is possible. The present experiment should provide data relevant to the questions.

In Exp. II, partial and cued recall of nouns presented in phrases were compared to each other and to free recall of the nouns alone, as well as to the results of Exp. I.

Method

Subjects. Seventy-four summer school students at the University of Western Ontario served as Ss as part of a course requirement. Twenty-six Ss served in the free recall group, and 24 served in each of the partial and cued recall groups.

Materials and Procedure. The four orders of the 40 item lists of phrases used in Exp. I were used as material

for the Ss in the partial and cued recall groups. Each of the lists was read to a group of six Ss who were then asked to write down as many of the nouns from the lists as they could remember, and to another group of six Ss who were given sheets on which the adjectives were typed, and instructed to fill in as many of the nouns in the appropriate places as they could. The groups were not treated differently from each other or from the groups in Exp. I, until the retrieval phase of the task. In addition, the nouns from the above lists, 20 concrete and 20 abstract, were presented to two groups of 13 Ss. Two orders were used to counterbalance the concreteness of the nouns with list position. In all groups, the presentation rate was one item (phrase or word) every four seconds. Five minutes were allowed for recall in all cases.

Results

Partial and Cued Recall. The partial and cued recall data from Exp. II are presented in Table 3. The tabular data will be discussed briefly before the statistical analyses are reported. The cell entries in the top two matrices in Table 3 consist of the mean number of nouns recalled, out of ten, partitioned according to the type of task. Within each matrix, the data are partitioned according to the concreteness

Table 3

Mean Partial and Cued Recall of Concrete and Abstract Nouns which were Presented with Concrete and Abstract Adjectives

Partial Recall	Concrete Adjectives	Abstract Adjectives	(Row Means)
Concrete Nouns	3.58	2.17	(2.88)
Abstract Nouns	2.46	1.25	(1.86)
(Column Means)	(3.02)	(1.71)	
Cued Recall			
Concrete Nouns	6.38	2.21	(4.30)
Abstract Nouns	2.13	0.75	(1.44)
(Column Means)	(4.26)	(1.48)	
Mean of Partial and Cued Recall			
Concrete Nouns	4.98	2.19	(3.58)
Abstract Nouns	2.30	1.00	(1.65)
(Column Means)	(3.64)	(1.59)	

of the phrase nouns and adjectives. The bottom matrix contains the pairwise means for each phrase type, averaged across the task variable. To the right of each matrix, pairwise means within each level of noun concreteness appear in parentheses. Pairwise means within levels of adjective concreteness appear below each matrix.

It can be seen in Table 3 that there was a consistent positive effect of noun concreteness on the number of nouns recalled. In each vertical comparison between individual cell entries or between row means, the upper entry is larger than the lower. The generalization is that more concrete than abstract nouns were recalled in both tasks and within each level of adjective concreteness. The size of the positive effect of noun concreteness, however, was not constant. The effect was larger in cued than partial recall, and larger with concrete than abstract adjectives, predominantly because of the disproportionate level of recall of nouns which were presented in concrete phrases, and which were subsequently cued by the adjectives.

There was also a consistent positive effect of adjective concreteness which precisely paralleled the effect of noun concreteness. In each horizontal comparison between cell entries or column means, the left member is the larger.

That is, more nouns that were presented with concrete than abstract adjectives were subsequently recalled. The size of the effect was greater in cued than partial recall, and greater with concrete than abstract nouns, primarily because of the very high performance level observed in the condition where concrete phrases were presented and the nouns recalled under cued conditions.

Cueing only enhanced performance relative to partial recall when both the to-be-remembered nouns and the adjectival cues were concrete. In fact, if the to-be-remembered noun was abstract, cueing hurt performance slightly, even when the cue was concrete.

The reliability of the effects mentioned above was assessed by a 2 x 2 x 2 analysis of variance, with noun and adjective concreteness (abstract or concrete) as repeated factors, and the type of recall task (partial or cued) as the independent factor. All F ratios had df of 1, 46. Significant main effects of noun and adjective concreteness, with respective Fs of 78.2 and 98.0, indicated that both types of concreteness were positively related to the number of nouns recalled. Both noun and adjective concreteness were involved in significant interactions with the type of task, respective Fs = 17.5, 12.5, indicating that the positive effect of each

kind of concreteness was greater in cued than partial recall, and that cued recall exceeded partial recall only when concrete nouns were recalled or concrete adjectives were cues.

The interaction between noun and adjective concreteness, $F = 17.6$, is presented in Figure 2. Figure 2 is similar to Figure 1 from Exp. I, except for the point representing concrete phrases, which is somewhat higher in Figure 2 than in Figure 1. That is, noun recall only deviated from phrase recall with respect to concrete phrases. The reason for the superiority of the concrete phrases in noun recall is illustrated in Figure 3, where the three-way interaction between noun and adjective concreteness and task type, $F = 13.1$, is plotted. The partial recall panel of Figure 3 is very similar to Figure 1; so are three of the four points in the cued recall panel. However, when concrete adjectives were used as cues for recalling concrete nouns, cueing provided substantial facilitation relative to partial recall. In no other case did cueing help.

In summary, cueing was only superior to partial recall when concrete pairs were presented. Concrete nouns were more often produced than abstract nouns, especially when the adjectives with which the nouns were presented were concrete

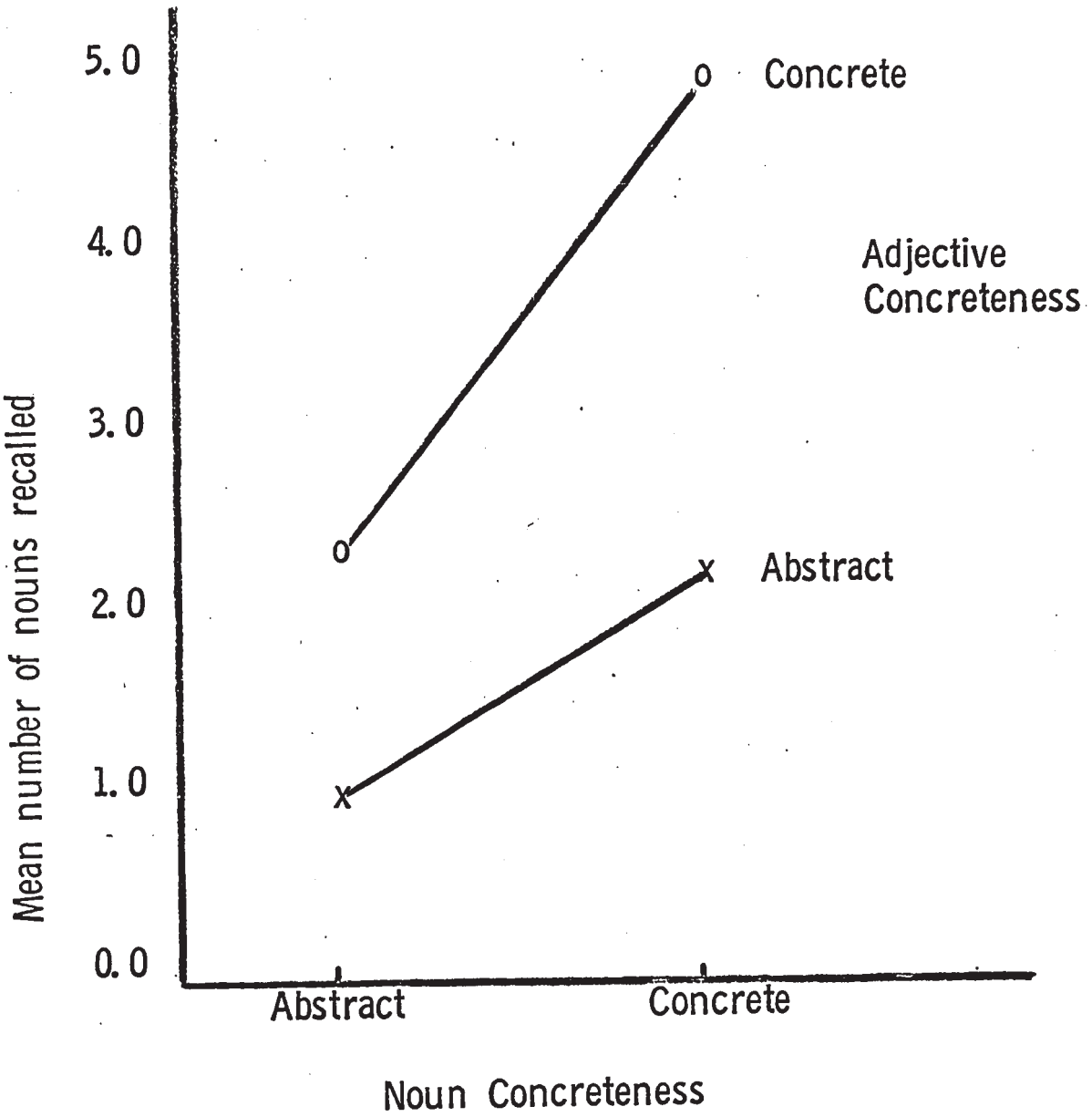

Figure 2: Recall of concrete and abstract nouns as a function of the concreteness of adjectives with which the nouns were presented.

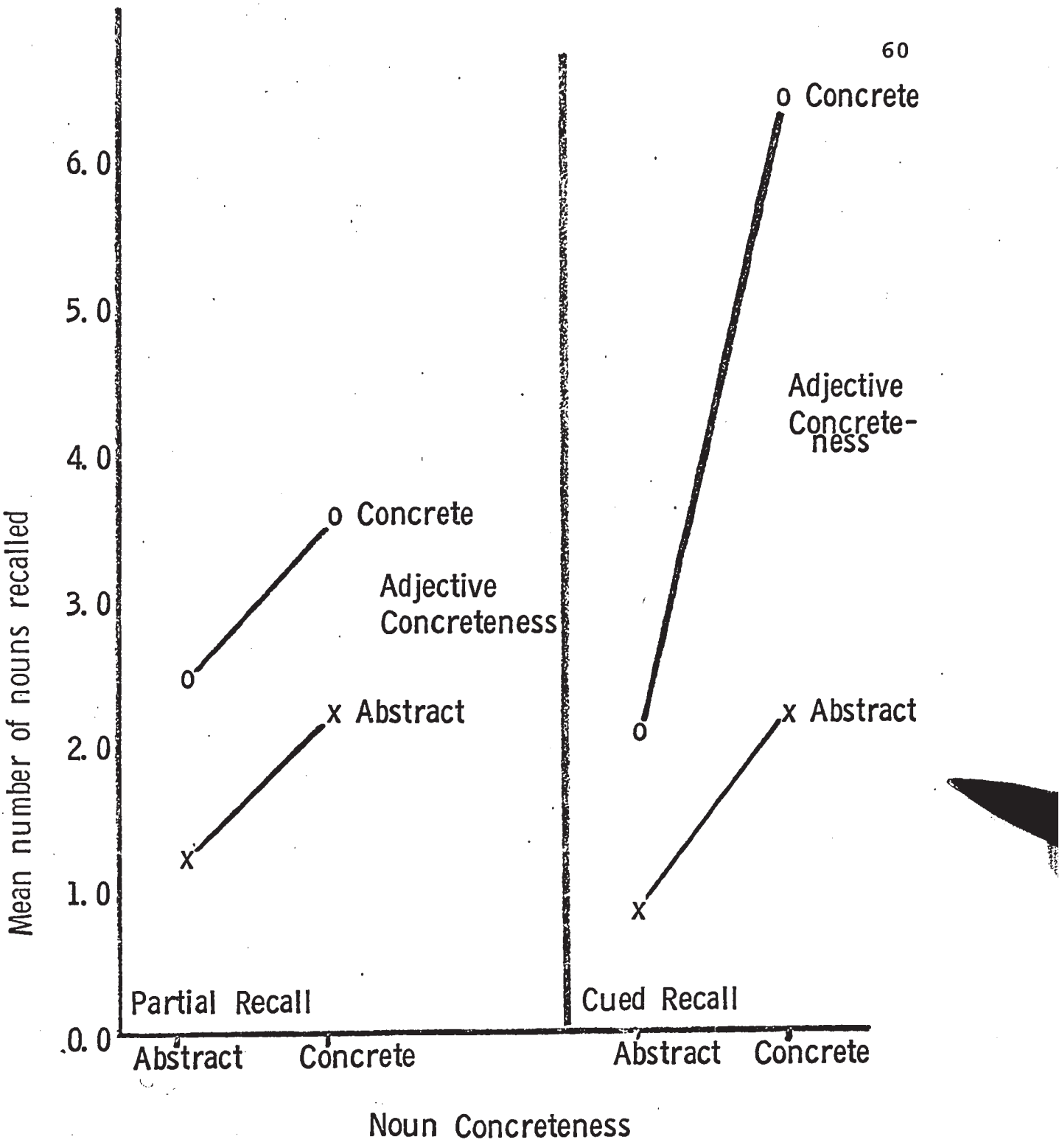

Figure 3: Partial and cued recall of concrete and abstract nouns, as a function of the concreteness of the adjectives presented with the nouns.

and used as cues. Nouns presented with concrete adjectives were more prominently recalled than nouns presented with abstract adjectives, especially when the concrete adjectives were used as cues and the nouns to be remembered were also concrete. Thus, in both partial and cued recall, concrete pairs led to the best noun recall, abstract pairs worst, and mixed pairs to an intermediate level of recall of the nouns.

Free Recall. The number of concrete and abstract nouns recalled was tabulated for each S, as a function of the kind of adjective with which the nouns appeared in the other tasks. For concrete nouns presented in concrete and mixed pairs, the mean numbers recalled were 4.35 and 5.10 out of ten, respectively. For abstract nouns presented in abstract and mixed pairs, the respective mean numbers recalled were 2.23 and 3.69. Since there were obvious differences in the mean numbers recalled, performance in the phrase tasks was compared to performance in the free recall task. The analysis is presented in the following section, in which the results of Exps. I and II are compared.

Noun Recall: Results from Exps. I and II

The number of nouns recalled in whole, partial, and cued recall, as a function of the type of phrase in which the

noun was presented, was compared to the mean number of the same nouns recalled in free recall. The results are presented in Table 4. In the abstract and mixed pairs, all tasks were significantly inferior to free recall; in fact, about half as many nouns were recalled in the phrase tasks as in the word tasks. The value one half is theoretically important, since exactly twice as many items were presented to the Ss in the phrase tasks as in free recall. If each word were to take a constant amount of space in memory, and if memory space was constant, performance in the three tasks should be exactly half as good as performance in free recall. On the other hand, with concrete pairs, neither whole nor partial recall differed reliably from free recall, while cued recall was actually better than free recall. If a concrete pair only took as much memory space as a concrete noun, the ratio of either whole or partial recall to free recall should be 1.00. How could two words take only as much memory space as one? The answer is that the two words could be chunked, and stored, as one image. If that is so, cued recall should be better than free recall, since part of the unit is actually presented to the S. In fact, the ratio of cued to free recall was about 1.50, supporting the chunking idea.

Table 4

Recall of Nouns as a Function of the Recall Task and the Type of Pair in which the Noun Appeared

Pair Type	Task	Mean	S.D.	$t^{@}$ (vs free)	Ratio*
CC	Free Recall	4.35	1.98		
	Whole Recall	4.04	1.48	0.62	0.93
	Partial Recall	3.58	1.82	1.40	0.82
	Cued Recall	6.38	1.93	-3.77¢¢	1.47
AC	Free Recall	5.10	1.40		
	Whole Recall	3.20	1.17	5.15¢¢	0.63
	Partial Recall	2.17	1.62	6.72¢¢	0.43
	Cued Recall	2.21	1.61	6.63¢¢	0.43
CA	Free Recall	3.69	1.59		
	Whole Recall	1.96	1.15	4.36¢¢	0.53
	Partial Recall	2.46	1.35	2.87¢¢	0.67
	Cued Recall	2.13	1.48	3.51¢¢	0.58
AA	Free Recall	2.23	1.40		
	Whole Recall	1.12	0.91	3.30¢¢	0.50
	Partial Recall	1.25	1.33	2.43¢	0.56
	Cued Recall	0.75	0.78	4.47¢¢	0.34

@ - Positive t-values denote decremental performance relative to free recall; negative values are increments; ts for whole recall have 49 df; all others have 48 df.

* - The ratio is from the various tasks divided by the free recall scores.

¢ - $p < .05$.

¢¢- $p < .01$.

Discussion

In summary, the results of Exp. II indicated that nouns in concrete phrases were most often recalled in both partial and cued recall, with nouns in abstract phrases the least, and nouns from mixed phrases at an intermediate level. The only difference between partial and cued recall was in the concrete phrases, in which cued recall far exceeded partial recall of the same nouns, despite the fact that scoring in cued recall is relatively strict, in the sense that the subject must recall the right word in the right place to receive credit for a correct response. Partial recall of nouns from concrete phrases was at about a 40% level, while both partial and cued recall of nouns from abstract phrases were at about a 10% level. Comparing the free, partial, whole, and cued recall of nouns presented in concrete phrases, it was found that cued recall exceeded the other three conditions, which were about equal to each other. In abstract phrases, on the other hand, free recall exceeded whole, partial, and cued recall by a factor of about two. The same pattern of results as in abstract phrases obtained in both types of mixed phrases.

Partial recall, as expected, was very similar to whole recall, and much the same comments apply here as in

the preceding experiment. The fact that cueing was only effective in the concrete pairs is particularly supportive with respect to the present theory, and damning with respect to Horowitz and Prytulak's (1969) major premises. Possibly a redintegrative phrase should be defined as one in which cued recall exceeds whole recall, since the effectiveness of cueing seems to reflect the theoretical degree of unitization of the phrase meaning in memory. Since the differential cueing effectiveness of noun and adjective cues as a function of concreteness in mixed pairs will be discussed after Exp. III, the mixed pairs will not be discussed here, except to say that even a concrete cue did not lead to facilitation in recall, relative to partial and whole recall performance. However, typical experiments concerned with mixed pairs as material (e.g. Lockhart, 1969; Yuille, Paivio, & Lambert, 1969) have been concerned with relative rather than absolute cueing effects.

Before a lengthy consideration of the results, Exp. III will be described, since the third experiment constitutes a replication of the present one, except that adjectives were the to-be-remembered items. It seems to be practical to replicate the major results before discussing them at greater length.

EXPERIMENT III: FREE, PARTIAL, AND CUED RECALL OF ADJECTIVES

The third experiment differed from the second only in that adjectives rather than nouns were recalled by the subjects. Recall of adjectives in abstract phrases was expected to vary as a function of the type of presentation used, so that free recall of the words alone should be at about a 20% level, twice as good as partial or cued recall, which should be at about a 10% level. Adjectives from concrete phrases were expected to be recalled best in the cued recall condition, with free and partial recall being at about a 40% level of accuracy.

The major purpose of Exp. III was to collect more data in order (a) to determine what features of the noun recall comparisons in Exp. II generalize to adjective recall, and (b) to allow comparisons across the various task types so that conclusions about recall of information contained in phrases of different varieties can be made.

Method

Subjects. Sixty introductory psychology students served as Ss as part of a course requirement. Twenty Ss served in the free recall task, and 20 served in each of the partial and cued recall groups.

Materials and Procedure. The materials were identical to those used in Exp. II, except that in the free recall task, the adjectives were presented to the Ss. The presentation of phrases was the same as in Exps. I and II. At retrieval, however, Ss were requested to produce the adjectives, either in any order, in the partial recall task, or next to the appropriate noun cues, in the cued recall task. As before, all item types occurred equally often in all serial positions, the presentation rate was one item every four seconds, and five minutes were allowed for recall.

Results

Partial and Cued Recall. The mean number of adjectives recalled, out of ten, are presented in Table 5, partitioned according to the type of recall task, and the concreteness of the nouns and adjectives in the phrases. Adjective concreteness was positively related to the number of adjectives recalled, as was true for noun concreteness and noun recall in Exp. II. However, while the effect of noun concreteness on noun recall was considerably greater in cued than partial recall, the effect of adjective concreteness on adjective recall was only slightly more pronounced in cued than partial recall. Noun concreteness was positively related to adjective recall, especially when the concrete

Table 5

Mean Partial and Cued Recall of Concrete and Abstract Adjectives which were Presented with Concrete and Abstract Nouns

	Concrete Nouns	Abstract Nouns	(Row Means)
Partial Recall			
Concrete Adjectives	4.60	2.75	(3.68)
Abstract Adjectives	2.15	1.35	(1.75)
(Column Means)	(3.38)	(2.05)	
Cued Recall			
Concrete Adjectives	7.10	2.75	(4.93)
Abstract Adjectives	3.40	1.25	(2.33)
(Column Means)	(5.20)	(2.00)	
Mean of Partial and Cued Recall			
Concrete Adjectives	5.85	2.75	(4.30)
Abstract Adjectives	2.78	1.30	(2.04)
(Column Means)	(4.31)	(2.03)	

nouns were used as cues, yielding the same pattern of results as the effect of adjective concreteness on noun recall in Exp. II.

Cueing with concrete nouns had a facilitatory effect relative to partial recall, regardless of the concreteness of the to-be-remembered adjectives, although the effect of cueing was larger when the adjectives were concrete than when they were abstract. Recall that, in Exp. II, the only case where cueing was effective was when both the cues and the to-be-remembered items were concrete. Thus concrete noun cues are somewhat more potent than concrete adjective cues, since concrete noun cues facilitated recall of abstract adjectives, while concrete adjectives did not facilitate recall of abstract nouns. This point will be addressed further in the General Discussion.

The reliability of the effects was assessed by a 2 x 2 x 2 analysis of variance, with noun and adjective concreteness (abstract or concrete) as repeated factors, and the type of recall task (partial or cued) as the independent factor. All Fs had df of 1, 38. The main effects of both noun and adjective concreteness, Fs = 115 and 151, indicated that more concrete than abstract adjectives were recalled, and that more adjectives were recalled when they had been presented

with concrete than with abstract nouns. Also, more adjectives were recalled in cued recall than partial recall, F 6.46. The task variable interacted marginally with adjective concreteness, $F = 3.37$, $p < .10$, and strongly with noun concreteness, $F = 20.3$, indicating that the positive effect of adjective concreteness on the number of adjectives recalled was slightly greater in cued than partial recall, and that the positive effect of noun concreteness was substantially greater in cued than partial recall.

The interaction between noun and adjective concreteness, $F = 15.4$, is presented in Figure 4. Figure 4 is very similar to Figure 2, the analogous figure from Exp. II, and indicates that, as before, concrete pairs were disproportionately better than all others in determining the number of words recalled, whether the recalled words were nouns (Fig. 2) or adjectives (Fig. 4). Although the three-way interaction was not significant, $F = 1.93$, it is presented in Figure 5, to allow comparison with Figure 3 from Exp. II. In Figure 5, concrete-noun cues facilitated cued recall performance relative to partial recall performance, while abstract cues did not (i.e., an interaction between noun concreteness and task, as presented above). In Figure 3, the only effect of cueing was in the case where both the cue and

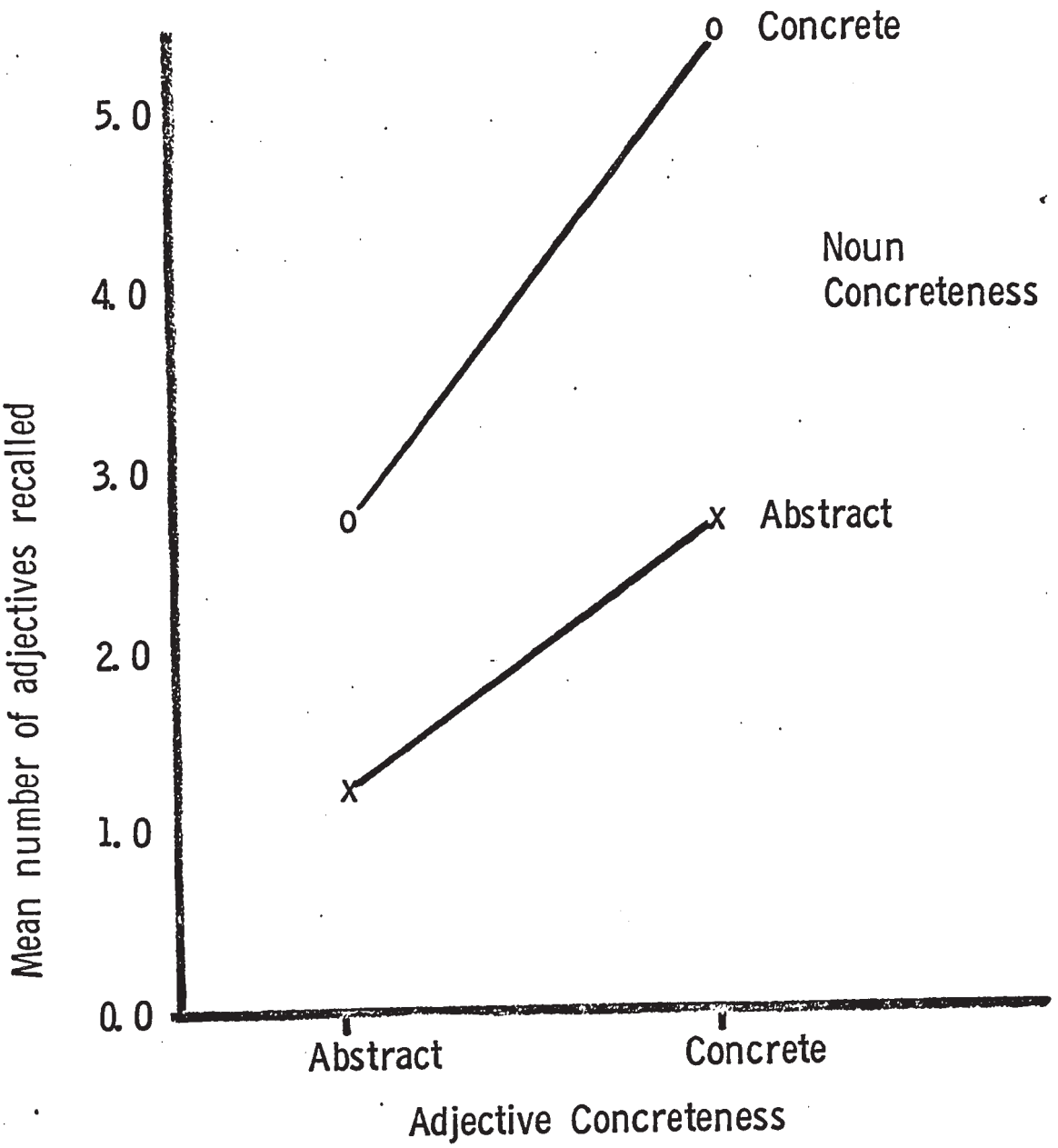

Figure 4: Recall of concrete and abstract adjectives, as a function of the concreteness of the nouns in the phrases.

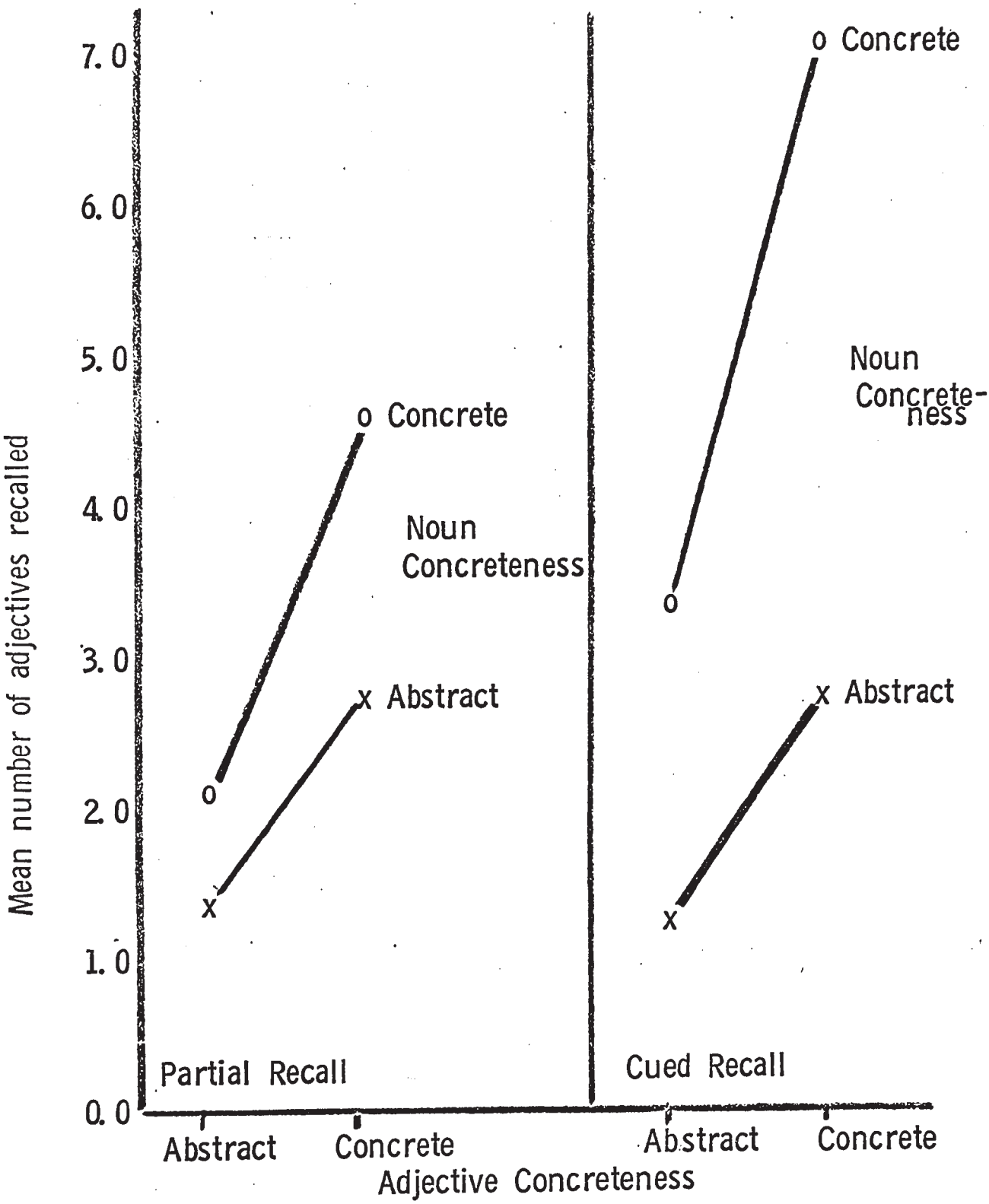

Figure 5: Partial and cued recall of concrete and abstract adjectives as a function of the concreteness of the nouns in the same phrases.

the to-be-remembered word were concrete. In Figure 5, only the concreteness of the cue was important.

In summary, the concreteness of the to-be-remembered word from a pair, and of its fellow, were both positively related to recall, especially when the concrete nouns were used as cues. Cued recall was superior to partial recall whenever concrete nouns were used as cues, in contrast to Exp. II, where both the cue and the to-be-remembered word had to be concrete in order for cueing to show a facilitative effect.

Free Recall. The concrete adjectives that were also in concrete and mixed pairs had respective means of 3.90 and 5.25 words recalled, while the abstract adjectives from the abstract and mixed phrases had means of 2.35 and 2.75. As in Exp. II, the means obviously differed from each other, so subsidiary analyses were performed, and are detailed in the next section.

Adjective Recall: Results from Exps. I and III

The mean number of adjectives recalled in the four tasks is presented in Table 6. The results are presented separately for each phrase type. The means and standard deviations of the number of adjectives recalled are presented in the first two data columns. The number of adjectives

Table 6

Recall of Adjectives as a Function of the Recall Task and the Type of Pair in which the Adjective was Presented

Pair Type	Task	Mean	S.D.	t[@](vs free)	Ratio*
CC	Free Recall	3.90	1.68		
	Whole Recall	4.12	1.48	-0.46	1.06
	Partial Recall	4.60	1.92	-1.17	1.18
	Cued Recall	7.10	1.48	-6.18¢¢	1.82
CA	Free Recall	5.25	1.62		
	Whole Recall	2.48	1.30	6.28¢¢	0.47
	Partial Recall	2.75	1.48	4.97¢¢	0.52
	Cued Recall	2.75	1.25	5.33¢¢	0.52
AC	Free Recall	2.75	1.15		
	Whole Recall	2.56	1.11	0.44	0.93
	Partial Recall	2.15	1.39	1.45	0.78
	Cued Recall	3.40	2.26	-1.12	1.24
AA	Free Recall	2.35	1.18		
	Whole Recall	1.08	0.89	4.05¢¢	0.46
	Partial Recall	1.35	1.18	2.61¢	0.57
	Cued Recall	1.25	1.33	2.70¢	0.53

@ - Positive values denote decremental performance relative to free recall; negative values denote increments; ts for whole recall have 43 df; all others have 38 df.

* - The ratio is from the various task means divided by the free recall mean.

¢ - $p < .05$.

¢¢- $p < .01$.

recalled in whole, partial, and cued recall was compared to the free recall of the same adjectives. The t values from the comparisons are indicated in the third column. Concerning concrete phrases, cued recall of the adjectives exceeded free recall of the same adjectives, while whole and partial recall did not differ from free recall. Recall that in Exp. II cued recall of nouns exceeded free, partial, and whole recall of the same nouns. The generalization is thus justified that the free, partial, and whole recall of words presented in concrete phrases lead to about equivalent levels of performance, while the cued recall of the words is substantially superior.

With abstract phrases, whole, partial, and cued recall of adjectives were inferior to free recall of the same adjectives. In fact, the three tasks led to performance that was proportionately only about half as good as free recall performance, exactly as found when the nouns were recalled (Exp. II).

With mixed phrases, however, adjective and noun recall were not equivalent. In the CA phrases, where the adjective that was recalled was concrete, the pattern of results was the same as for the abstract phrases, and for the AC phrases when concrete nouns were recalled, in Exp. II. That is, free

recall exceeded whole, partial, and cued recall. The generalization is that when the concrete members of mixed phrases are recalled, performance in partial, whole, and cued recall tasks is uniformly inferior to the free recall of the same concrete words alone. When the abstract adjectives from mixed pairs were recalled, however, none of the phrase tasks differed reliably from free recall, although cued recall exceeded partial recall. The same finding was not true in Exp. II, when abstract nouns from mixed phrases were recalled. This finding will be addressed further in the General Discussion.

Correlational Analysis of the Data from Exps. I, II, and III

Each of the 40 adjective-noun phrases was treated as an experimental subject. For each phrase, 11 measures were tabulated and intercorrelated with each other. Three of the measures were related to imagery. They were noun I, adjective I, and the average of the two, called phrase I. Two measures were related to the presentation and recall of the nouns and adjectives separately, so these are not strictly speaking measures of phrase performance. The two measures were the proportions of Ss who correctly recalled the phrase noun or adjective in the free recall task. The final six measures were concerned with performance following the

presentation of the whole phrases. The three measures related to nouns were the proportions of Ss who recalled each noun in whole, partial, and cued recall; the analogous three adjective measures were also tabulated.

First, the relationships between the imagery measures and performance will be described. All correlations in excess of .30 are statistically significant. Because of the orthogonal pairing of noun and adjective I, the two variables were only correlated .03, although both were highly correlated with their average, as one would expect, with respective rs of .77 and .66. Noun I was correlated .41 with the free recall of nouns, while phrase and adjective I were correlated .36 and .08 with the same measure. Similarly, adjective I was correlated .48 with adjective recall, while phrase and noun I were correlated .17 and -.18 with adjective recall. The generalization is that the free recall of isolated words was predicted moderately well by the independently-rated I values.

The relationships between imagery and performance in the phrase tasks are presented in Table 7. The intercorrelations show several things. First, as the correlations were from moderate to high throughout the entire table, the suggestion is that some degree of imaginal involvement is

Table 7

Correlations Between Imagery Ratings and Performance in Whole, Partial, and Cued Recall of Nouns and Adjectives

	Noun Recall			Adjective Recall		
Imagery	Whole	Partial	Cued	Whole	Partial	Cued
Noun	.52	.33	.58	.41	.37	.56
Adjective	.27	.42	.57	.43	.52	.53
Phrase	.56	.51	.80	.58	.61	.76

For statistical significance, r must exceed .30.

present in all the tasks. Second, the phrase I measure was generally correlated more highly with performance than either noun or adjective I, suggesting, to the extent that the measure of phrase I would reflect ratings of the phrases, that Ss were retrieving phrases rather than isolated words. Finally, the correlations were generally highest between imagery and cued recall, suggesting that imagery and unitization are related, to the extent that cued recall reflects the degree to which pairs are remembered as units.

The second class of relationships to be discussed will be the correlations between the free recall of isolated words, and recall of the same words in the various tasks where pairs were presented. The free recall of nouns correlated .59, .55, and .36 with the whole, partial, and cued recall of nouns, and .43, .49, and .23 with the whole, partial, and cued recall of adjectives. The free recall of adjectives was essentially uncorrelated with all six measures (the respective rs were -.04, -.04, .04, .04, .11, .10, .12). The results suggest first that nouns are more invariant in the tasks than adjectives, since nouns that were most prominent in free recall tended to be prominent in the other tasks. Possibly nouns are more important as "pegs" in the pairs (cf Paivio, 1969). Secondly, free recall of nouns

was slightly more related to the other tasks where nouns were recalled than when adjectives were recalled. Finally, the free recall of nouns was more highly related to performance in the whole and partial recall tasks than to performance in the cued recall tasks, in direct contrast to the imagery ratings above, which were better predictors of cued recall than of the other tasks. Perhaps the availability of nouns, as assessed by their prominence in free recall, is less important as a factor in cued recall than it is in partial or whole recall.

The third class of relationships to be considered concerns the relationships between the various tasks where nouns were recalled, and where adjectives were recalled. The whole recall of nouns was correlated .78 and .77 with the partial and cued recall of nouns, while the latter two were correlated .68 with each other. The analogous values for adjectives were .79, .76, and .63. The results indicate to a large extent that the same words were relatively most and least prominently recalled across the tasks, so that whatever is reflected in any task is highly related to whatever is reflected in the others.

The final class of relationships concerns the correlations between noun and adjective performance in the same

pairs. High correlations would indicate that phrases tend to be central in recall. That is, if the relatively best recalled nouns and adjectives happen to appear in the same phrases, the intercorrelations would be high. If the correlations were higher than the correlations between free recall and the other tasks, the results would be doubly convincing. The lowest intercorrelation between pair members was higher than the highest correlation between free recall and the other tasks. Thus, the whole recall of nouns was correlated .93, .75, and .70 with the whole, partial, and cued recall of adjectives; the partial recall of nouns was correlated .71, .77, and .64 with the same measures; and cued recall of nouns was correlated .77, .72, and .86 with the measures.

Summary of Correlational Results. Phrase imagery predicted word recall in the phrase tasks quite well, especially in the cued recall tasks. To the extent that cued recall performance reflects phrase unitization, imagery is a good predictor of unitization. The availability of the individual nouns, as assessed in free recall, was a fair predictor of performance in the phrase tasks, but less so with adjectives than nouns, and less so with cued recall than the other tasks. In any case, the phrase imagery ratings

were better predictors of the phrase performance than were the free recall scores. In all three phrase recall tasks, the same nouns were generally the most often recalled; the same was true for the adjectives. Additionally, noun and adjective recall in the phrase tasks were highly correlated with each other, indicating that the most prominently recalled nouns and adjectives tended to come from the same phrases. The correlational results support two generalizations. First, phrases are remembered as phrases, in terms of their meanings, not simply as independent words. Secondly, the phrases that lead to the best performance are those that, on the average, are more imaginable, suggesting the conclusion that they are indeed remembered as images.

Discussion

The results from Exp. III will first be summarized briefly, and then extended discussion of the results across the three experiments will be offered. The results of Exp. III were similar to the results of Exp. II in that the to-be-remembered items, the adjectives, were most often recalled after presentation in concrete phrases, least often after abstract phrases, and intermediate after mixed phrases, in both partial and cued recall. Cued recall exceeded partial recall in concrete but not abstract pairs.

Additionally, cued recall exceeded partial recall in mixed phrases when the concrete noun from the phrase was used as a cue; in the analogous condition in Exp. II, concrete adjectives did not provide facilitation in recall. Again as in Exp. II, concrete-phrase adjectives were recalled at an equivalent level in the free, partial, and whole recall tasks, while cued recall was somewhat better than all three. A different pattern emerged for abstract phrases where free recall exceeded whole, partial, and cued recall of the same adjectives by a factor of about two. In mixed phrases with concrete adjectives, the results were similar to the results with abstract phrases. With mixed phrases having concrete nouns, no conditions differed reliably from free recall, although cued recall exceeded partial recall.

In the following section, the results across the three experiments will be discussed in relation to other data, as well as to the present theory.

GENERAL DISCUSSION

The preceding sections were concerned mainly with the present theory and predictions derived from it. However, other aspects of the data are related to questions asked by other investigators, so that some empirical comparisons are

warranted.

Concrete Phrases

If one ignores the differences between nouns and adjectives, and averages over that variable, the general results were that 41% of the concrete words were recalled in each of the noncued recall tasks (free recall of the words in isolation, whole recall of everything, or partial recall of either the nouns or adjectives), whereas 67% of the words were produced in the cued recall task. The findings are striking for two reasons. First, proportionate recall was no worse in whole and partial recall than in free recall, despite the fact that twice as many words were presented to the subjects in the former two tasks. Secondly, proportionate recall was best in the cued recall task, which was actually the most restrictive task, since subjects were forced to recall the correct word and put it in the correct place to get credit for a correct response. The results were interpreted to mean that concrete phrases arouse unitary meanings or integrated images, so that chunking occurs in the task.

That chunking of concrete information occurs through imaginal mediation is not a new concept. When subjects are instructed to image concrete words or phrases in free recall, their level of performance increases (e.g. Kirkpatrick, 1894;

Gupton & Frincke, 1970). Recall is similarly enhanced in paired-associates learning of concrete pairs if imagery rather than rote instructions are given (e.g. Schnorr & Atkinson, 1969). Instructions to link each item to the previous one by mental images also produce facilitation relative to standard instructions in serial learning (Delin, 1969). Imagery mnemonic instructions enhance performance in learning a serial list of items (Bugelski, 1968; Bugelski, Kidd, & Segmen, 1968; Paivio, 1968). Winograd, Krachmer, and Russell (1971) attempted to increase the degree of unitization of concrete noun pairs by imagery instructions, and demonstrated enhanced recall. Bower (1970) has found that the major functional feature of imagery mediation is not imagery per se, but the unitization afforded by allowing the components of the images to interact with each other. Paivio (1968) has demonstrated that the imaginal rather than the mnemonic aspect of the instructions is the necessary component of the instructions to ensure facilitation in recall. The conclusion is thus that imaginal facilitation of memory for concrete stimuli occurs, and that the reason for the facilitation is the functional property of images in allowing interconnectedness of the components of the image, with two important consequences. First, there is a

substantial saving in storage space due to the elaborative or chunking function of images, as also suggested by the present finding that phrase and word recall do not differ for concrete material. Secondly, the interconnectedness of the imaginal components leads to enhancement in cued recall relative to recall without cueing, again as found in the present study. The suggestion that concrete phrases arouse unitary meanings is thus reasonable.

In the concrete phrases used in the present study, the nouns were slightly more concrete than the adjectives, so that noun-adjective differences in cueing efficacy could most parsimoniously be attributed to concreteness rather than the form class factor *per se* (cf Lockhart, 1969). The nouns were somewhat better cues than the adjectives in the present case (cf Yuille et al, 1969), whether the mean number of words recalled in the cued task (7.10, 6.38) is used as the measure, or whether various techniques are used to partial out differential availability of the response items. Thus, nouns are better cues than adjectives when cued recall performance is expressed as a ratio relative to free recall performance (1.82, 1.47), as a difference score relative to free recall (3.20, 2.03), or as a *z*-score relative to the mean and standard deviation of free recall

performance (1.90, 1.03). As mentioned above, however, the result is here interpreted in terms of differential concreteness of nouns and adjectives.

There seems to be ample evidence that what is remembered when concrete nouns are presented to subjects are the meanings of the phrases. The meanings, constructed on the basis of historical and contextual interpretations of the individual word meanings, are assumed to arouse unitary, chunked meanings, and the medium afforded by mental imagery is considered to be a reasonable one for this unitization function. The consequences of unitization of meaning are, first, that more stimulus information can be represented in a fixed amount of memory space than if the word meanings are maintained separately and, second, that cueing recall with part of the unitary meaning representative is especially good for reinstating the entire unit in memory. Thus, the meaning of a concrete phrase in a particular context comprises an "item" in memory.

Abstract Phrases

Collapsing over the noun-adjective variable, the general results were that 23% of the words from abstract phrases were recalled after they were presented alone, 11% were produced in whole recall, 13% in partial recall, and

10% in cued recall. The major generalization is that the presentation of the words was crucial, while recall method was not. That is, proportionately about twice as many words were recalled after they were presented alone as when the words were presented in abstract phrases. Since twice as many words werepresented in the phrase tasks as in the free recall task, it seems that subjects retained about the same number of words in all the tasks, indicating that memory storage space is limited to a constant number of word meanings, with no chunking attributable to the presentation of meaningful phrases. In every phrase task, abstract pairs led to the worst performance of any phrase type, suggesting that memory demands are especially high for such pairs.

The fact that proportionate recall of the words alone was about twice as good as performance in the phrase tasks suggests that the meanings of abstract phrases require as much storage space as the words would separately. If the individual contextual word meanings are contiguously ordered in a sequential phrase meaning, cued recall should not be any different from partial recall, as was found. The conclusion is thus that abstract phrases do not normally lead to unitization of meaning in memory.

Another possible reason why cueing did not facil-

itate recall of abstract words can be seen by examining the stimulus pairs in Figure 1 (p. 37). In the abstract pairs, almost any adjective-noun pairing makes sense. For example, "common", from "common fate", could reasonably describe any other noun in the list, except possibly "soul". In the concrete pairs, however, the adjective-noun constraints are more pronounced, and most of the pairings do not make sense. Thus, it is possible that cueing with the words from the abstract pairs did not provide adequate discriminative information for the subjects to choose the appropriate response terms, although the words might have been in storage. This explanation will be rejected for two reasons. First, the AC pairs, such as "more butter", are similar to the abstract pairs in that many of the pairings make sense, and in these pairs, cueing with the concrete nouns facilitated recall of the abstract adjectives relative to partial recall of the same adjectives. Second, in whole recall, there was not a large difference between concrete and abstract pairs, in the proportion of words recalled that were in the correct phrases. Recall of all types of phrases tended to be all-or-none, which should not have been true unless the phrases were all discriminable in memory.

The noun-adjective difference in cueing efficacy was

the same as for concrete pairs, with nouns somewhat better than adjectives as cues, expressed as raw means (1.25, 0.75), ratios to free recall (0.53, 0.34), differences from free recall (-1.10, -1.48), or z-scores relative to free recall (-0.97, -1.06). The findings are similar to those reported by Yuille et al (1969), and again will be interpreted in terms of the differential concreteness of the nouns and adjectives.

A major finding concerning abstract as well as concrete phrases is with respect to similarities in noun and adjective performance, rather than differences. Whatever differences occur across tasks as a function of form class are small and unstable, indicating quite a high degree of symmetry in the associations between the words, contrary to Horowitz and Prytulak's (1969) conclusion. Asymmetry, however, seemed to be the case in the mixed phrases, which will now be described.

Mixed Phrases

This section examines the relative effectiveness of cues as a function of their concreteness and form class in mixed phrases. Yuille et al (1969) found that, in randomly-paired concrete and abstract nouns and adjectives, the more concrete members of mixed pairs were better cues than their

abstract counterparts. That is, in mixed pairs with concrete nouns, the nouns were better cues than the adjectives; in mixed pairs with concrete adjectives, the adjectives were better cues than the nouns. In the present experiments, in mixed pairs with concrete nouns, the nouns were indeed better cues than the adjectives (3.40, 2.21), but the nouns were also slightly better cues than the adjectives in the mixed pairs with concrete adjectives (2.75, 2.13). However, in the case where the nouns were the cues, the subjects were intramural students, while when the adjectives were cues, summer school subjects were used. In order to minimize the group differences statistically, several methods of equating the availability of the to-be-remembered items were used.

When cued recall scores were expressed as ratios relative to free recall of the to-be-remembered items, concrete nouns were better cues than the adjectives with which they appeared (1.24, 0.43), while concrete adjectives were slightly better than the abstract nouns with which they were presented (0.57, 0.52). That is, concrete cues were better than abstract cues and noun cues were better than adjective cues, with the former effect considerably larger than the latter. Precisely the same pattern of results emerged when cued recall performance was expressed as

difference scores or z-scores relative to free recall. In difference scores, noun cues were better than adjective cues when the nouns were the concrete members (0.65, -2.89), while adjectives were better cues (-1.56) than nouns (-2.50) when the adjectives were concrete. In z-units, concrete nouns (0.57) were better than their abstract adjective companions (-2.06), while concrete adjectives were better (-0.98) than their abstract noun counterparts (-1.54). In each analysis, the effect of concreteness was the largest effect, although, on the average, the nouns were better cues than the adjectives. Since the nouns were on the average more concrete than the adjectives, the form class effect can be interpreted most parsimoniously as another, although smaller, concreteness effect, in agreement with Lockhart's (1969) suggestion. Since nouns are generally more concrete than adjectives, it seems likely that nouns will generally be better cues than adjectives (cf Paivio, 1963).

It should again be emphasized that the only facilitative effect of cueing in the mixed pairs relative to partial recall, was in the pairs with the concrete nouns, when the nouns served as the cues. The above considerations concerned relative effects, since most existing literature has addressed itself to that question.

Conclusions

In a typical memory task involving words, the subject remembers the contextual meanings of the words, or items. An item can be defined as a short-term association between internal representatives activated by the experimental context, and internal representatives activated by the particular words used in the task. Since the representative aroused by a word depends on the prior history of the word, and the representative aroused by the context depends on immediate situational factors, the terminal form of a contextual meaning is a joint function of the history of a word and the situation in which it is encountered.

If the context in question happens to be intraverbal, each word in the sequence arouses its own representative, and the word representatives become part of the context influencing the interpretation of other words. The contextual meanings corresponding to the individual words are combined to generate a new structure which corresponds to the contextual meaning of the entire meaningful input. There are two ways in which the combination can take place. For concrete material, the individual word meanings are integrated into a unitary image. For abstract material, the word meanings are ordered into a contiguously connected sequence.

A unitary meaning is characterized by the chunking of relatively large amounts of information in a limited amount of space, while sequential meanings are characterized as containing relatively precise information about a few things.

At the time of retrieval, the meaning, whether unitary or sequential, tends to be found or not found as a whole. Upon retrieving the meaning, the subject "puts words to it", and responds. A failure to respond could indicate that the contextual meaning in question is no longer maintained in an active state, as would occur if the amount of material to be remembered exceeded the amount of space available, or that the trace was active but unretrieved. If the latter were the case, prompting should bring the phrase out.

As a strong speculation, it appears that integration is a necessary and sufficient condition for cued recall to exceed noncued recall. That is, if A and B are presented together, and if B is recalled better when cued with A than without the cue, and vice versa, A and B must be stored together in an integrated unit. Similarly, if A and B are stored as an integrated unit, cueing with either member would facilitate recall of the other member, relative to a noncued control condition. If A and B form a meaningful but

not integrated unit, cueing will not help, but it won't hurt either. Cueing will actually hurt performance when meaning and integration are minimal. As an important side effect, integration also reduces the amount of storage space required to maintain meanings in memory.

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