THE ROLE OF CONCRETENESS
AND
SUBJECTIVE GROUPING
IN
ORGANIZED MEMORY

By

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SCOPE AND CONTENTS:

A considerable body of information exists which describes the structures of organized memory and the mechanisms which produce these structures. However, this information is based largely on the study of semantically or conceptually related information. The experiments in this thesis extend this work by investigating the subjective organization of groups of words differing in concreteness. Such studies of subjective organization are particularly interesting because they are more closely analogous to the organizational activities found in more naturalistic settings.

Evidence for subjective organization was found in the input-output consistencies of subjects' recall, and in the results obtained under conditions of cued recall. Both presentation grouping and concreteness were found to enhance organization, but did so differently. The contiguous presentation of groups of items appears to promote the formation of well integrated subjective units. Concreteness, on the other hand, appears to facilitate not only the formation of well integrated subjective units, but also the subsequent access of these units.

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CHAPTER ONE

Introduction

If introspections are to be believed, a major problem in learning new information is to discover a way to organize that information and relate it to previously stored knowledge. If this is true, then a major problem in the psychological study of memory is to find a way of describing what processes produce organized memory structures, and to describe the implications that these structures have for subsequent memory performance. To date, considerable progress has been made towards this goal through the development of a useful and productive way to approach these problems. First, with respect to problems of acquisition, the concept of a functional unit has been proposed, being defined as a group of items which tend to be remembered or forgotten as a whole. The formation of these units is the result of an encoding operation, chunking, which takes nominal input items and combines them into a limited number of functional units. Improving memory performance, given that only a limited number of functional units can be retained, is then accounted for with two additional principles. First, the size of these functional units can be increased with practice. Secondly, functional units can be combined hierarchically to form higher order units, which are limited at any particular level of

construction, but are relatively free to vary between levels (Mandler, 1967).

With respect to the problems of retrieval, several additional concepts have been developed. One of the most important of these is the distinction between the availability and accessibility of information in storage. An item or unit is available, if that information is in a form sufficient for recall under at least some set of recall conditions. Accessibility, on the other hand, refers to the retrievability of an item or unit under any given set of recall conditions. The importance of this distinction is that different units of recall may be differentially accessible depending on the encoding operations performed upon them. More specifically, there is some evidence (e.g., McCauley & Kellas, 1974) that two components of recall can be isolated; the recall of words within a functional unit, and the recall of successive units. It follows from the definition of a functional unit, that unitization at input leads to the increased accessibility of items within the unit at output. Furthermore, the increased accessibility of items within a unit appears to be independent of the means by which the unit is accessed (cf. Mandler, 1967; Tulving and Pearlstone, 1966). The accessibility of successive units, however, is less straight forward. In cued recall, where subjects are provided with retrieval cues which presumably access the functional units formed at input, the accessibility of successive units is necessarily high. Under these

conditions, cued recall should reflect the degree of unitization within groups independently of the recallability of the units themselves. In non-cued recall, however, the process or processes by which these units are accessed is as yet undetermined, although there is some evidence (Mandler, 1967; Wood, 1971) which suggests that units can be organized in much the same way as items can.

Most of these principles or generalizations, however, have been derived through the study of the organization and recall of semantically or conceptually related information. The present experiments, on the other hand, were designed to explore the applicability of these principles to subjective organization. In other words, the present experiments studied organization and recall of information which bore no explicit relationships prior to the experiments themselves. The results of the present experiments are potentially more complex than those of previous experiments because it is more difficult to specify pre-experimentally which units will be salient to subjects, and because the degrees of organization observed will be much more dependent on the activities performed by subjects during acquisition. On the other hand, these experiments are of considerable relevance because they are more closely analogous to the organizational activities found in more naturalistic settings. With respect to previous research, as well, the potential value of such an investigation may be considerable since the differences between subjective organi-

zation and semantic or conceptual organization are quite pronounced. For example, in the study of subjective organization the only experimenter-provided relations are those of contiguity. As a result, the functional relationships between items are derived by the subject, and are the result of measurable (i.e., time consuming) effort. Furthermore, subjective units, because they are formed only at input, can be thought of as exhaustive categories, while many previous studies (e.g., Roediger, 1973) have used experimenter-defined units which are subsets of larger categories, and consequently are not exhaustive. Finally, in subjectively organized units the overall unit relation is specified by the relationship between the members of the unit themselves and is not necessarily related to a superordinate element or label.

Given that these differences exist, it is not unlikely that the results of the following experiments will differ considerably from those conducted previously. For example, the encoding of prepotent relationships, as found in the encoding of semantic or conceptual categories, should proceed much more rapidly than the encoding of subjective categories where the functional relationships must be derived by the subject. As a result, the encoding of subjective units should be much more dependent on processing time than the encoding of semantic or conceptual categories. It follows, that as the amount of processing time increases, the probability that all of the words in a given unit will become functionally related will

also increase. However, if only some of the items in a group become integrated, then the recall of the subjective unit which corresponds to that group, will necessarily lead to the recall of only some of the words in that group.

These differences in integration should further be reflected in the results obtained under conditions of cued recall. For semantic or conceptual categories, cues which provide minimum access to a unit should be maximally effective. In fact, Roediger (1973) has demonstrated that if category members are supplied as cues along with the category label, output interference results. He argued on the basis of these data, that the additional category-member cues were, in some sense, retrieved, and that this act of retrieval produced response competition between the cue items and the to-be-remembered items. However, the cued recall of subjective units, while benefitting from minimal retrieval cues, should obtain increasing benefits as the amount of a unit provided as a cue is increased. This seems probable on at least two grounds. First, if a unit is only partially integrated, then providing more cues increases the probability that the remaining to-be-remembered items will be related to at least one of the cue words. Secondly, since the process of organizing a subjective unit is a constructive process, the act of recall can be viewed as reconstructive. It follows that providing more contextual information at output should increase the probability that the subject is able to reconstruct the unit

formed at input.

A final problem which may be encountered in the study of subjective organization is a lack of independence between group recall and the recall of words within groups. Specifically, this problem arises if it is assumed that group access is provided, or is at least facilitated, by the presence of superordinate elements in the organizational structure (e.g., Mandler, 1967). This problem results from the fact that the probability of a subjective unit having such a common element or theme should increase with the overall degree of integration within that unit.

In order to test some of these notions, three experiments were conducted. In all three experiments, the two variables of interest were the concreteness of the to-be-remembered items, and the method of presentation of those items. In the second and third experiments, the effects of single and multiple retrieval cues were also investigated.

Grouping, as used in these experiments, refers to the simultaneous presentation of two or more words. These groups presumably allow subjects to distribute their processing time equally across all members of a group, and encourage subjects to process the words in each group independently of the words in other groups. This type of processing should result in the development of relatively stable and identifiable subjective groupings in memory.

This approach to the study of subjective organization has several points in its favour. First, the process

of seeking out relationships between items and using these relationships as the basis for subjective groups in memory seems analogous to at least some of the processes used in normal study habits. Secondly, this approach may provide at least some continuity with previous research which investigated the acquisition of semantically or conceptually defined groups (e.g., Cohen, 1966; Tulving and Pearlstone, 1966; Wood, 1971). Keep in mind, however, that the category relationships in these previous studies were in some sense prepotent, while the category relationships to be explored in the present experiments will necessarily be the result of the processing activities of the subject himself. Finally, the use of presentation groupings provides a convenient way of assessing the extent to which subjective organization occurs by measuring the correspondence between the groups provided to the subject at input and those provided by the subject at output.

With respect to concreteness, it will be argued, following Begg (1972, 1973), that the concreteness effect is due to the differential organization of concrete relative to abstract items. However, the source of this organizational advantage must be further specified. At one level, this effect can surely be attributed to the availability of images, or at least concrete referents, for concrete words. More generally, however, the concreteness effect can probably be attributed to the differential processing of concrete relative to abstract items and can be further attributed to that

processing which promotes the formation of well integrated functional units. Given this second approach, it seems reasonable to suggest that the integration of both concrete and abstract items will increase with time, but that the integration of concrete items will proceed more rapidly. It then follows that the differences observed between concrete and abstract items will depend on the amount of processing given to those items at acquisition. Specifically, these differences will be small when the overall amount of processing is small, and will also be small when the overall amount of processing is very large.

These effects, however, are probably not general effects. As noted above, the organizational effects of concreteness are thought to be primarily related to the effects of concreteness on item integration. As a result, the above hypothesis accounts for the effects of concreteness on intra-unit integration, while it fails to account for the potential effects of concreteness on group access. However, Petersen (1974) has suggested that group access may depend on the ease with which the context of encoding can be reinstated at the time of recall. If this is true, concreteness may facilitate group access to the extent that the context of encoding for concrete groups is more unitary and to the extent that this context more easily accesses the products of the original encoding.

CHAPTER TWO

Experiment I

The first experiment in this series investigated the effects of short-term and long-term memory processing on the recall of concrete and abstract words presented in groups of various sizes. These effects were assessed in free recall by comparing the recall of items presented in the middle serial positions to those presented in the recency serial positions, and by comparing immediate recall with a subsequent final free recall. The long-term effects of concreteness and grouping were further investigated by looking separately at the recall of groups and the recall of words within groups in immediate recall, final free recall and in a long-term recall at a one-week delay.

In previous studies of presentation grouping in free recall, items have been grouped either by modality (Murdock and Carey, 1972) or by time (Gianutsos, 1972) with an unfilled interval between groups. In both experiments, the effects of grouping on total recall were small. However, interactions of grouping with serial position were found in both studies due to the facilitatory effects of grouping on the recall of items presented in the recency serial positions. These effects, then, were short-term effects and could be attributed to rehearsal differences between grouped and

ungrouped items. Specifically, the rehearsal sets (cf. Rundus, 1971) across groups appeared to be non-overlapping, and group recall proceeded in a forward order which preserved the rehearsal patterns established at presentation.

More generally, however, it seems likely that such rehearsal patterns should facilitate long-term recall under at least some conditions. Specifically, it has been argued (Craik and Lockhart, 1972) that there are two kinds of rehearsal activities; maintenance or Type I rehearsal and elaborative or Type II rehearsal. As they point out, Type I rehearsal "merely prolongs an item's high accessibility without leading to formation of a more permanent memory trace" (p. 676). Type II rehearsal, on the other hand, involves additional analysis of the stimulus and does lead to the establishment of a more permanent trace. As a result, if a subject is predisposed to using elaborative or Type II rehearsal, then grouping might be expected to facilitate recall. However, in order to outline the way in which this might occur, it is necessary, at least within the organizationl framework developed here, to distinguish between two kinds of elaborative rehearsal.

Organization theories (e.g., Mandler, 1967; Tulving and Pearlstone, 1966) have argued that two processes are involved in the acquisition of information. The first of these processes chunks items into functional units, being groups of words which tend to be remembered or forgotten as

wholes (Tulving, 1968). The second process established a retrieval system which allows these units to be accessed at recall. Moreover, these processes need not co-occur as was evident in the results obtained by Mandler (1967). He argued that the development of well-unitized groups to the exclusion of higher-order retrieval plans reflected the particular emphasis placed on grouping in his experiment. Similarly, the emphasis in the present experiment was focused almost exclusively on the formation of well-unitized groups. As a result, any long-term effects which grouping might have should be more pronounced within groups than between groups.

However, it is still necessary to describe why grouping should have any effects at all. The answer provided by organization theories proceeds as follows. There are only a limited number of functional units which can be freely accessed at any given time. In spite of this limitation, however, the number of words recalled can be increased, by increasing the size of the functional units formed at input. It follows that the formation of functional units in this experiment will be facilitated to the extent that subjects use the groupings provided them to produce well integrated subjective units which are larger than they would otherwise construct.

The effect of grouping on within-group recall, though can be expected to be more pronounced under some circumstances than others. This is especially true with

respect to the concreteness of the to-be-remembered items. As noted previously, organizational differences between concrete and abstract words have provided the basis for the organization-redintegration hypothesis (Begg, 1972, 1973) which attempts to account for the facilitatory effects of concreteness by using the constructs developed by organization theories. This hypothesis argues that there is an organizational advantage provided concrete words due to the availability of imagery for these words. Images can be combined interactively to form well-integrated functional units. Abstract words, on the other hand, are more closely tied to verbal-conceptual modes of representation. These modes of representation are potentially more complex during both encoding and retrieval.

In summary, then, the main variables were presentation grouping and concreteness. Since there was no reason to suspect that one group size would be superior to others (at least with visual presentations as used here), group size was parametrically varied. The recall of words presented in groups of 2, 3, 4 and 6 words was compared to the recall of words presented one at a time. It was predicted that grouping would facilitate the recall of words from the recency serial positions in immediate recall, due to its effects on short-term (Glanzer, 1972) or primary memory (Waugh and Norman, 1965). It was also predicted that the longer-term effects of grouping would lead to the facilitation of within-group recall. Concreteness, on the other hand,

should facilitate both within-group and between-group recall. The source of within-group facilitation for concrete words is derived from their capacity to be combined interactively into well-integrated function units (e.g., Begg, 1972, 1973). The source of between group facilitation, on the other hand, is less easily specified. However, as noted previously, Petersen (1974) has suggested that the recall of groups may depend on the ease with which the context of encoding can be reinstated at the time of recall. If this is true, concreteness will facilitate between-group recall to the extent that the context of encoding for concrete groups is more unitary and is more effective in providing access to the products of the original encoding. Finally, since the locus of the concreteness effect is primarily in secondary memory (cf. Paivio, 1971, pp. 201-203), it is predicted that the concreteness effect will be attenuated over the recency serial positions in immediate recall. Furthermore, this effect will persist in final free and long-term recall if maintenance rehearsal is employed over these serial positions (cf. Craik and Watkins, 1973). This follows from the arguments made previously about the processing differences between concrete and abstract items. Recall that it was argued that the concreteness effect would be attenuated if the overall levels of processing were low.

Method

Subjects

One hundred student volunteers between the ages of 17 and 35 from McMaster University and surrounding secondary schools were paid $2.00 for their participation. Ten subjects served in each of 10 groups.

Materials

One hundred and twenty concrete ($\underline{I} > 6.00$) and 120 abstract nouns ($\underline{I} < 4.10$) were chosen from the Paivio, Yuille and Madigan (1968) norms. The concrete and abstract nouns were approximately equal in frequency of occurrence in print, with no words occurring less than 10 times per million words. Both concrete and abstract nouns were randomly assigned to 10 lists of 12 words, with constraint that no obviously related words occurred contiguously. Each list was typed in lower case letters on index cards, with 1 word on each of 12 cards, 2 words on each of 6 cards, 3 words on 4 cards, 4 words on 3 cards and 6 words on 2 cards. Thus there were five sets of the 10 lists of concrete nouns, and five sets of the abstract nouns.

Procedure

The basic design was a 2 x 5 x 3 mixed design, with concreteness (concrete or abstract) and groups (1, 2, 3, 4 or 6 words at a time) as independent factors, and time of recall (immediate, delayed or long-term) as a repeated factor. Thus, there were 10 groups of 10 subjects who received either

concrete or abstract words, 1, 2, 3, 4 or 6 words at a time. Subjects were tested for written free recall after each of the lists, after the tenth list had been presented and recalled, and again after a period of 6 to 10 days.

At the beginning of each session subjects were randomly assigned to one of the 10 presentation conditions and were given standard free recall instructions. The lists of words were then presented at the rate of 4 sec per word. For each grouping condition, the total presentation time was 48 sec, divided equally over the index cards. Each of the 10 subjects in a given condition received the 10 lists in a different order, so that each list occurred once in each ordinal position in each condition.

After each list was presented, subjects were allowed as much time as they needed for written free recall. After the 10th list had been recalled, subjects were asked for an unexpected final recall of all the words from the 10 lists, again with no time limits. Six days later, without warning, subjects were mailed or given response sheets requesting them to recall the words again. If replies were not received within 3 days, subjects were contacted by telephone. Eight subjects were replaced for failure to complete the long-term recall stage of the task.

Results and Discussion

Due to the larger number of analyses to be reported,

an initial summary of the most important results will be provided at the outset. This summary should provide an overall organization into which the results of each individual analysis can be incorporated. This summary will be followed by a discussion of the results found in each separate analysis.

Summary

1) An analysis of the effects of concreteness and grouping on recall over the three time intervals tested, yielded a main effect of concreteness, a main effect of time, and no other effects. In absolute terms the size of the concreteness effect did not diminish over time, and if expressed proportionately, actually increased (cf. Begg and Robertson, 1973).

2) In immediate recall concrete words were recalled than abstract words, but this effect was attenuated over the recency serial positions. In contrast, the effects of grouping were restricted to the recency serial positions with a peak in recall occurring at the serial position corresponding to the first word of the last group in each list.

3) A subsequent analysis of the immediate recall data into short-term memory and long-term memory components (cf. Tulving and Colotla, 1970) revealed that the concreteness effect can be attributed solely to the long-term memory component of recall. There was a tendency for group sizes four and six to enhance short-term memory recall, while there were no effects of grouping on long-term memory recall.

4) In both final free recall tests, recall generally declined from the first serial position to the last. While more concrete words were recalled than abstract words, these effects were again attenuated over the recency serial positions. There were no systematic effects of grouping in these analyses.

5) The apparent effects of negative recency in the first final free recall were subsequently shown to be present at both levels of concreteness, and at each level of grouping.

6) Finally, organizational analyses were conducted on the first final free recall data comparing each grouped condition to the one-at-a-time condition separately for the recall of groups and the recall of words within groups. Concreteness was shown to have a large facilitatory effect on both the recall of groups and the recall of words within groups. Presentation grouping, on the other hand, facilitated within-group recall but had no reliable effect on the recall of groups. However, in most analyses, the group recall of singly presented items exceeded that of words presented in groups, although none of these differences reached significance.

Recall Data

Word recall. The number of words recalled of a possible 120 was analyzed by a 2 x 5 x 3 analysis of variance with concreteness (concrete or abstract) and groups (1, 2, 3, 4 or 6 words at a time) as independent factors, and time

(immediate, final free or long-term recall) as a repeated factor. For all statistical tests a significance level of $\alpha = .05$ was used. The main effects of concreteness, $F(1,90) = 60.0$, $MSe = 371$, and time, $F(2,180) = 1680$, $MSE = 68.7$, were the only reliable effects. Over the respective time intervals there were 89.5, 39.9, and 24.1 concrete nouns recalled on the average, compared to 72.5, 20.5, and 8.8 abstract nouns recalled. Thus, in absolute terms, there is no evidence for a diminution of the effects of concreteness over time. Further, when final free recall was conditionalized on immediate recall, .41 of the concrete words and .26 of the abstract words that were recalled initially, were also recalled in final free recall, $F(1,90) = 45.5$, $MSe = 142$. Of the words recalled in both tasks on the first day, .48 of the concrete words and .32 of the abstract words were recalled in the long-term task, $F(1,90) = 22.9$, $MSe = 17.4$. Thus, as concluded by Begg and Robertson (1973), concreteness not only facilitates acquisition, but also retention. It is perhaps of note, as well, that successive recall levels were highly correlated over subjects, with rs of .72 between immediate and final free recall, and .81 between final free and long-term recall.

Serial position effects. The number of words recalled for each of the 12 serial positions, averaged over the 10 lists, was analyzed separately for each time interval by a 2 x 5 x 12 analysis of variance with concreteness and groups as independent factors and serial position as a

repeated factor. As above, concreteness was positively related to recall at each time interval. There were also reliable main effects of serial position at each time interval, $Fs(11,990) > 24.0$, $MSe < 2.18$. Recall was the usual bowed function of serial position in immediate recall, while recall declined from the first serial position to the last on both longer retention tests. The correlations between recall probability and serial position were .47, -.98, and -.94 respectively over the three retention intervals. When the final free recall was conditionalized on immediate recall, and long-term recall was conditionalized on both prior recalls, the correlations became -.96 and -.71. Consequently, on both delayed tasks, recall probability is negatively related to serial position, and even those words recalled best in immediate recall, those in later serial positions, are less likely to be recalled again at a later testing than words in earlier positions.

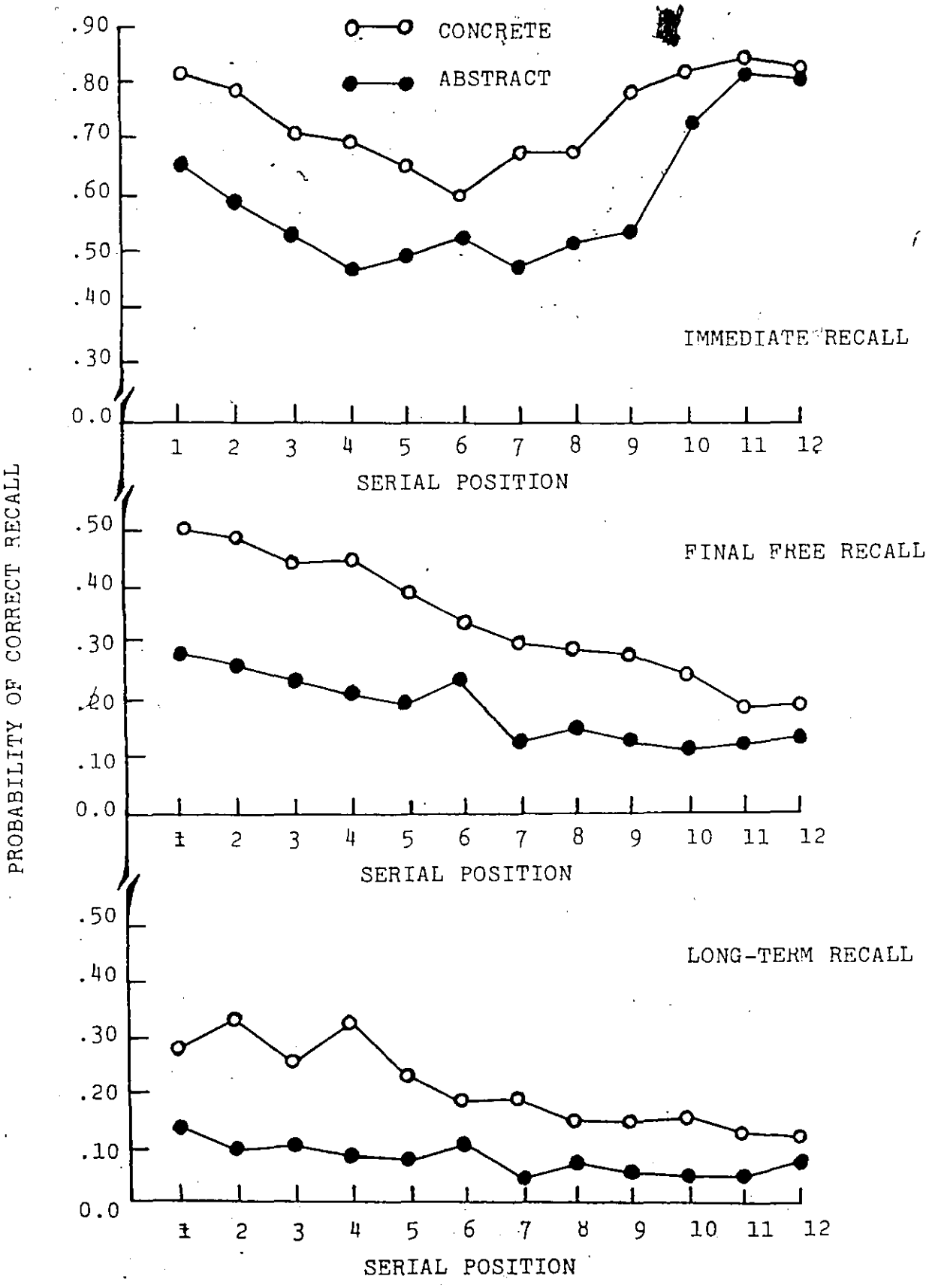
Concreteness and serial position interacted at each time interval, $Fs(11,990) > 6.0$, $MSe < 2.18$, since the difference in recall between concrete and abstract nouns was reduced in the recency portion of the curves, as shown in Fig. 1.

Figure 1 about here

In fact, when the difference between the recall of concrete and abstract nouns was correlated with serial position, the respective correlations of -.75, -.77, and -.74 were quite

FIGURE I

The Relationship Between Concreteness and Serial Position in Immediate, Final Free, and Long-Term Recall (Experiment I).



high. The size of the concreteness effect is thus progressively less pronounced across serial positions. When both delayed and long-term recall were expressed as conditional probabilities, the correlations became -.65 and -.02; that is, for words recalled immediately, the difference in the probability of recall between concrete and abstract words in final free recall becomes less for words presented and recalled from later serial positions. Once words have been recalled in the final free recall task, the concreteness effect is no longer altered by the serial position in which the words were originally encountered.

The groups variable interacted with serial position in immediate recall, $F(44,990) = 8.64$, $MSe = 2.18$, as shown in Figure 2. For each group condition, a peak in recall

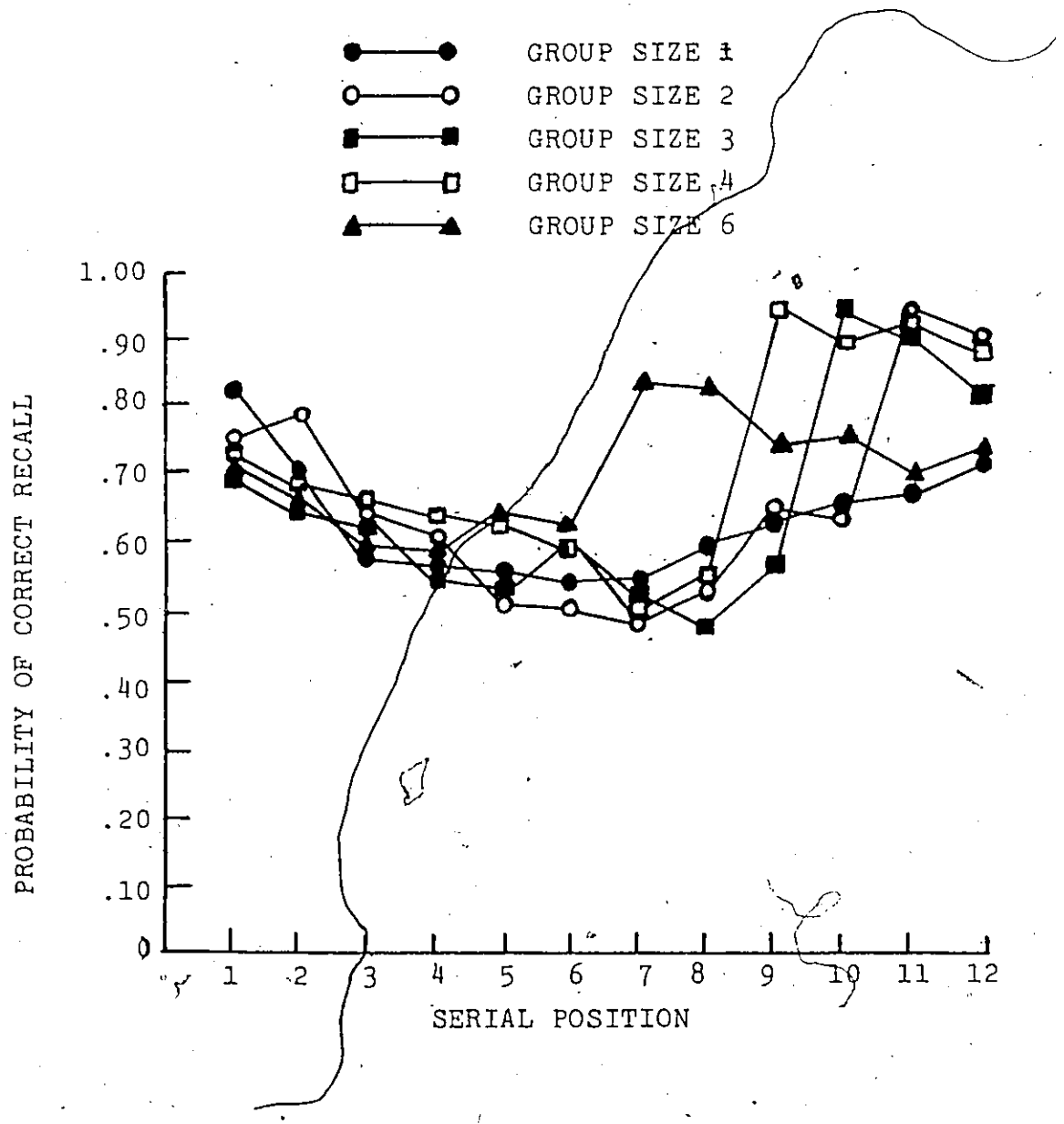
Figure 2 about here

occurred for the first word in the last group of items presented. The three variables interacted in immediate recall, $F(44,990) = 1.48$, $MSe = 2.18$, which may reflect the fact that the difference between concrete and abstract nouns in the recency portion of the curve was greatest in groups of size 6. Finally, at both longer time intervals, interactions between groups and serial position, $Fs(44,990) = 3.33, 1.44$, $MSe's = 1.41$ and .97 respectively, represent no systematic effects.

To summarize, the effects of concreteness were most pronounced over early serial positions at all time intervals.

FIGURE II

The Interaction of Group Size with Serial Position in Immediate Recall (Experiment I).



Grouping only affected the recency portions of immediately recalled lists. Thus, it appears that concreteness affects secondary memory while grouping affects primary memory. These effects are examined in detail below. The usual serial position curve obtained in immediate recall was replaced in both longer-term tasks by a curve in which recall was a negative function of serial position. This affect is also examined in detail below.

Recall from short-term and long-term memory. Subsequent to the immediate recall analysis reported above, the data were reclassified as reflecting recall from short-term memory (six or fewer input or output items intervening between an item's presentation and recall) or recall from long-term memory (seven or more intervening items) (cf. Tulving and Colotla, 1970). Watkins (1974) in an article on primary memory and its assessment has argued that this procedure is desirable not only for its efficiency, but also for its overall precision. These data were then analyzed using an analysis of variance, with groups and concreteness as independent factors, and memory component as a repeated factor. There was a main effect of concreteness, $F(1,90) = 38.2$, $MSe = 94.8$ with concrete words being better recalled than abstract words. There was also a main effect of memory component, $F(1,90) = 125$, $MSe = 145$, with an average of 5.10 words being recalled from long-term memory, compared to only 3.10 words recalled from short-term memory. These two factors interacted, $F(1,90) = 22.7$, $MSe = 145$,

since the facilitatory effects of concreteness are limited to the long-term component of recall, as shown in Figure 3. Finally, grouping also interacted with memory component,

Figure 3 about here

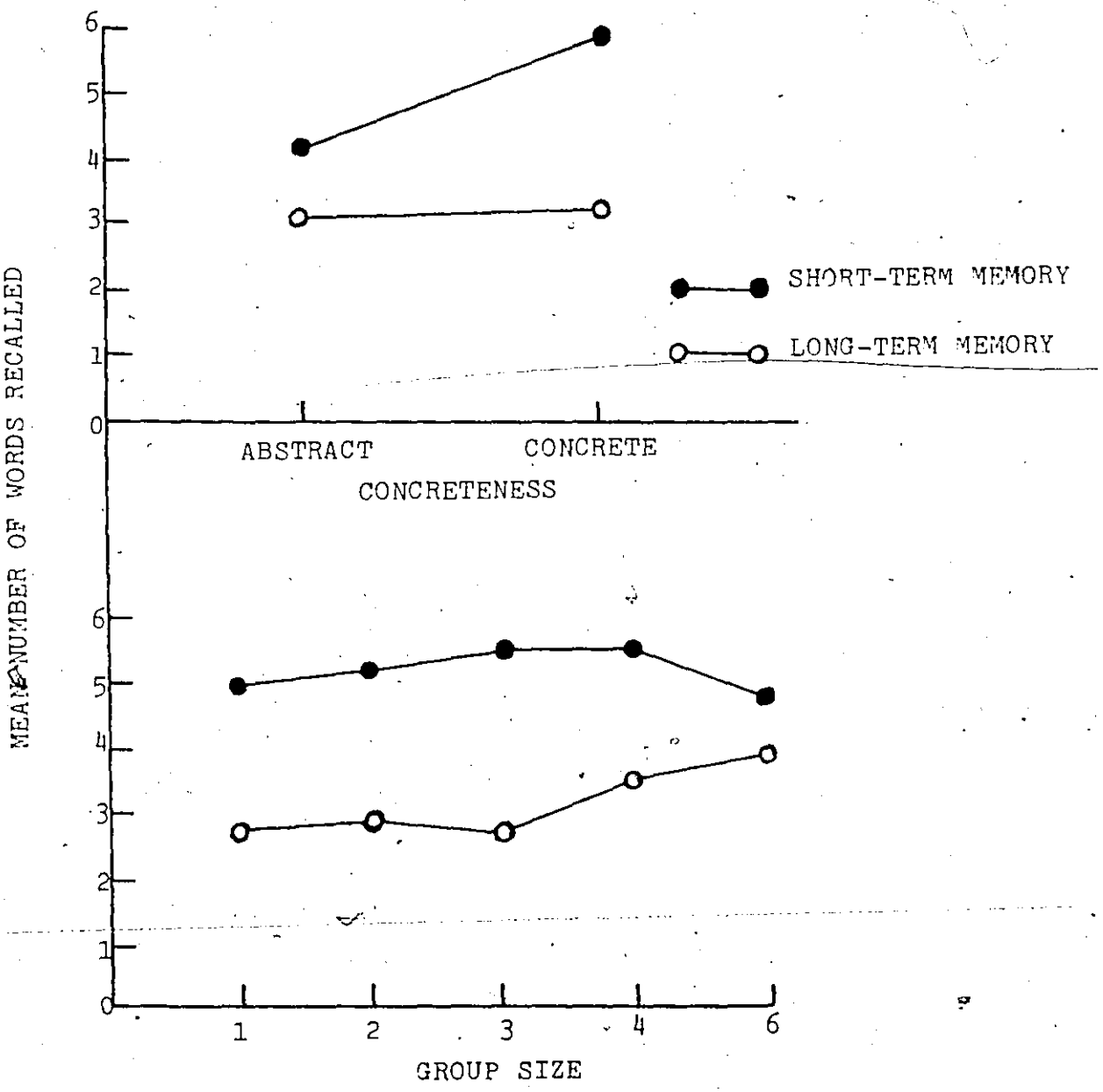
$F(4,90) = 3.46$, $MSe = 145$ (see Figure 3). In this case there is a tendency for group sizes four and six to facilitate recall from short-term memory, relative to other group sizes.

Negative recency. In order to determine whether the apparent negative effects of recency in final free recall were reliable, separate 2 x 2 analyses of variance, with concreteness as an independent factor and the recency comparison (middle vs. end) as a repeated factor, were conducted for each group condition. For the groups of size 1, 2, and 4 the middle four serial positions were compared to the last four; for group size 3, the final 3-word group was compared to the preceding 3-word group; and for group size 6, the first six items were compared to the last six items. In every analysis, recall of the middle items exceeded recall of the end items, $F(1,18) > 11$, $MSe < 15.5$. Thus negative recency obtained in every analysis. With group size 4, the negative recency effect was attenuated in abstract nouns, as evidenced by the interaction between the variables, $F(1,18) = 5.98$, $MSe = 7.03$, probably due to the overall low levels of recall in this condition.

Generally, then, items in the recency portion of

FIGURE III

The Interactions of the Short-Term and Long-Term Memory Recall Components with Concreteness (Figure 3a) and Group Size (Figure 3b).



lists were better recalled than middle items in immediate recall, but by the final free recall test, items from the recency positions were recalled less well than those in the middle positions. The negative recency effects obtain in both concrete and abstract nouns, and in all grouping conditions.

Organizational Data

Category clustering: number of categories. A category, as used here, refers to the experimenter-defined presentation group, a category is recalled if one word from that category is recalled (cf. Cohen, 1966). Analyses of category recall were conducted separately for group sizes 2, 3, 4, and 6. In each case, category recall was compared to a group size 1 control, scored as if it had been presented in groups of size 2, 3, 4, or 6 respectively. Consequently the comparisons being made are between category recall after grouped vs. ungrouped presentations, separately for each level of grouping.

Analyses of variance were conducted with concreteness (concrete or abstract) and presentation grouping (grouped or ungrouped presentation) as independent factors, and category serial position within lists as a repeated factor. The analyses were conducted separately for immediate, delayed, and long-term recall, and for group sizes 2, 3, 4, and 6. Recall of concrete categories was higher than recall of abstract categories. This effect was highly reliable in delayed and long-term recall,

and for group size 2 in immediate recall, $Fs(1,36) > 8.19$, $MSe < 10.2$ (see Table 1). In immediate recall a ceiling effect caused this difference to be reduced for group size 3, $F(1,36) = 6.56$, $MSe = 2.58$, and absent for group sizes 4 and 6. In immediate recall only, there were more categories recalled by the ungrouped than by the grouped conditions, although these effects on the average were small ($Fs(1,36) =$ 6.50, 3.88, 5.16 and 6.34, MSe's = 6.15, 2.58, .93, and .20 for group sizes 2, 3, 4, and 6 respectively) (see Table 1).

Table 1 about here

In all cases, there was a main effect of category serial position, $Fs(1,36) > 8.88$, MSe's < 2.11. Category recall is a bowed function of serial position in immediate recall and declines in a regular fashion as a function of serial position in delayed, and long-term recall, just as in the previous analysis of word recall. Concreteness interacted with serial position in some analyses, and in those cases seems to be the result of a reduction in the advantage to concrete categories over the recency part of the serial position curve. This occurred for group size 2 in immediate, delayed, and long-term recall, $Fs(5,180) > 3.64$, $MSe < 2.11$, for group size 4 in delayed and long-term recall, $Fs(2,72) > 4.52$, MSe's < 1.88, and for group size 3 in long-term recall, $F(3,108) = 3.16$, $MSe = 1.17$. Finally, grouped vs. ungrouped presentations interacted with serial position, but in immediate

TABLE I

Mean Number of Categories Recalled as a Function of Concreteness and Mode of Presentation (Grouped or Ungrouped) Separately for Group Sizes 2, 3, 4 and 6.

	CONCRETENESS		MODE OF PRESENTATION		
	CONC.	ABST.	GRPD.	UNGRPD	MSe
IMMEDIATE RECALL					
2 (out of 6)	4.98	4.43	4.46	4.90	6.15
3 (out of 4)	3.66	3.39	3.43	3.63	2.58
4 (out of 3)	2.83	2.85	2.78	2.89	.93
6 (out of 2)	1.98	1.96	1.94	1.99	.20
FINAL FREE RECALL					
2 (out of 6)	2.61	1.66			10.04
3 (out of 4)	2.27	1.37			9.36
4 (out of 3)	1.84	1.33			8.38
6 (out of 2)	1.49	1.08			6.28
LONG-TERM RECALL					
2 (out of 6)	1.79	.84			10.21
3 (out of 4)	1.62	.69			8.45
4 (out of 3)	1.45	.82			10.24
6 (out of 2)	1.23	.57			8.37
MEAN TOTAL RECALL					
2 (out of 6)	3.12	2.13			111.3
3 (out of 4)	2.15	1.82			58.9
4 (out of 3)	2.04	1.66			38.5
6 (out of 2)	1.57	1.19			17.7

SIZE GROUP

recall only, $\underline{F}s(1,36) = 8.88$, $\underline{MS}e = 1.63$, since category

Figure 4 about here

recall was higher for ungrouped than grouped conditions in all serial positions except the last (see Figure 4).

Subsequent to these analyses, the data were averaged over serial positions, and the effects of time of recall were investigated. Thus, four analyses of variance were performed, with concreteness and grouped vs. ungrouped as independent factors, and time (immediate, delayed, or long-term recall) as a repeated factor. These analyses were conducted separately for group sizes 2, 3, 4, and 6 and their respective controls. Because these are not independent of the previous ones, only the effects of time and its interactions will be reported here. In all cases, there was a large main effect of time; $\underline{F}s(2,72) > 37.9$, $\underline{MS}e$'s < 30.9, with category recall declining from immediate recall to delayed free recall to long-term recall. There was also a two-way interaction of concreteness and time in each analysis, $\underline{F}s(2,72) = 6.04$, 12.7, 12.0 and 3.37, $\underline{MS}e$'s = 8.73, 11.3, 10.1, and 30.9, for group sizes 2, 3, 4, and 6, respectively (see Figure 5). The difference

Figure 5 about here

between concrete and abstract category recall increases with time in all cases. Finally, there was a three-way interaction of concreteness, grouped vs. control conditions and time in

FIGURE IV

Category Recall: The Interaction with Serial Position of Words Presented in Groups Compared to Words Presented Singly, in Immediate Recall (Experiment I).

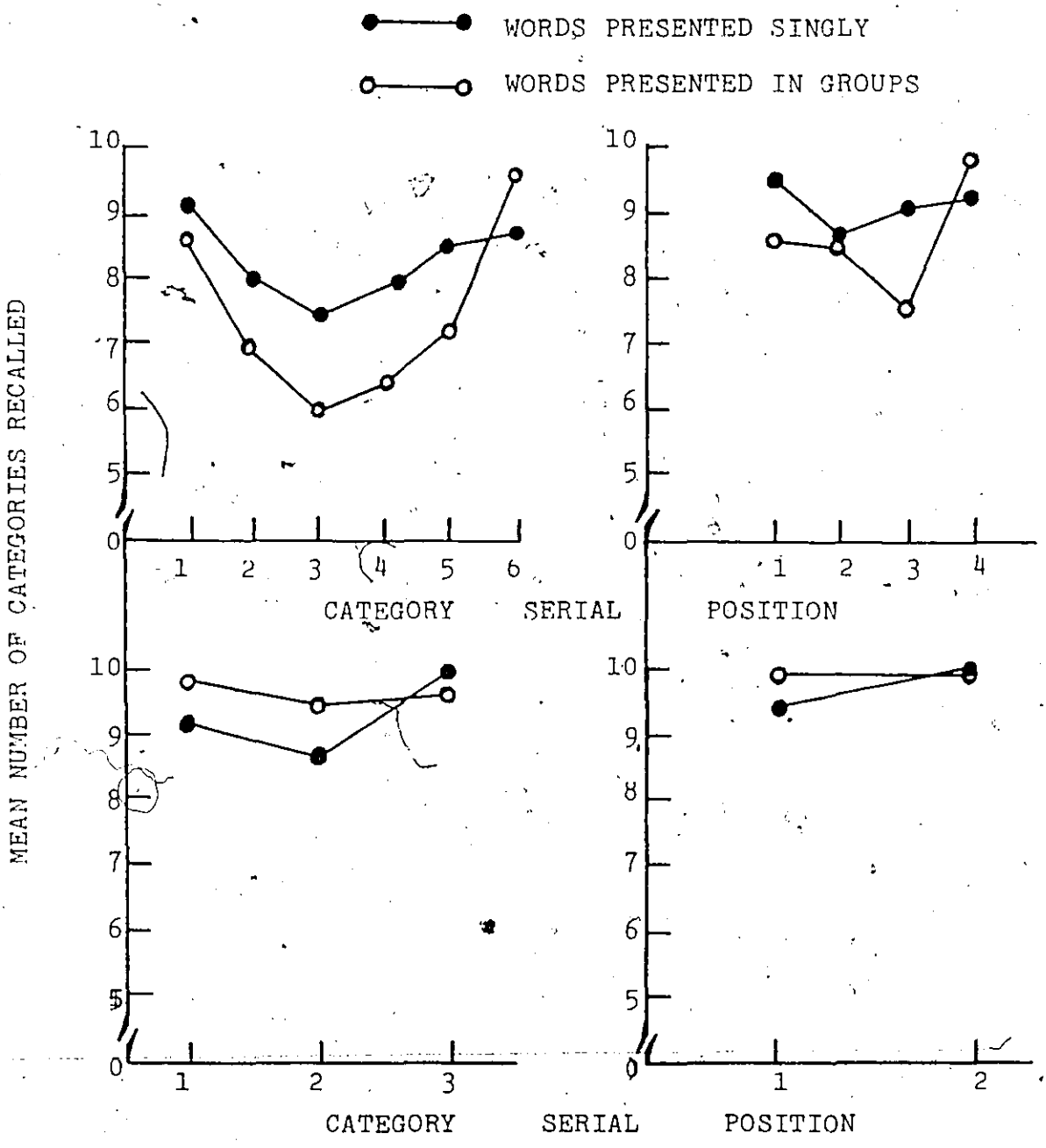
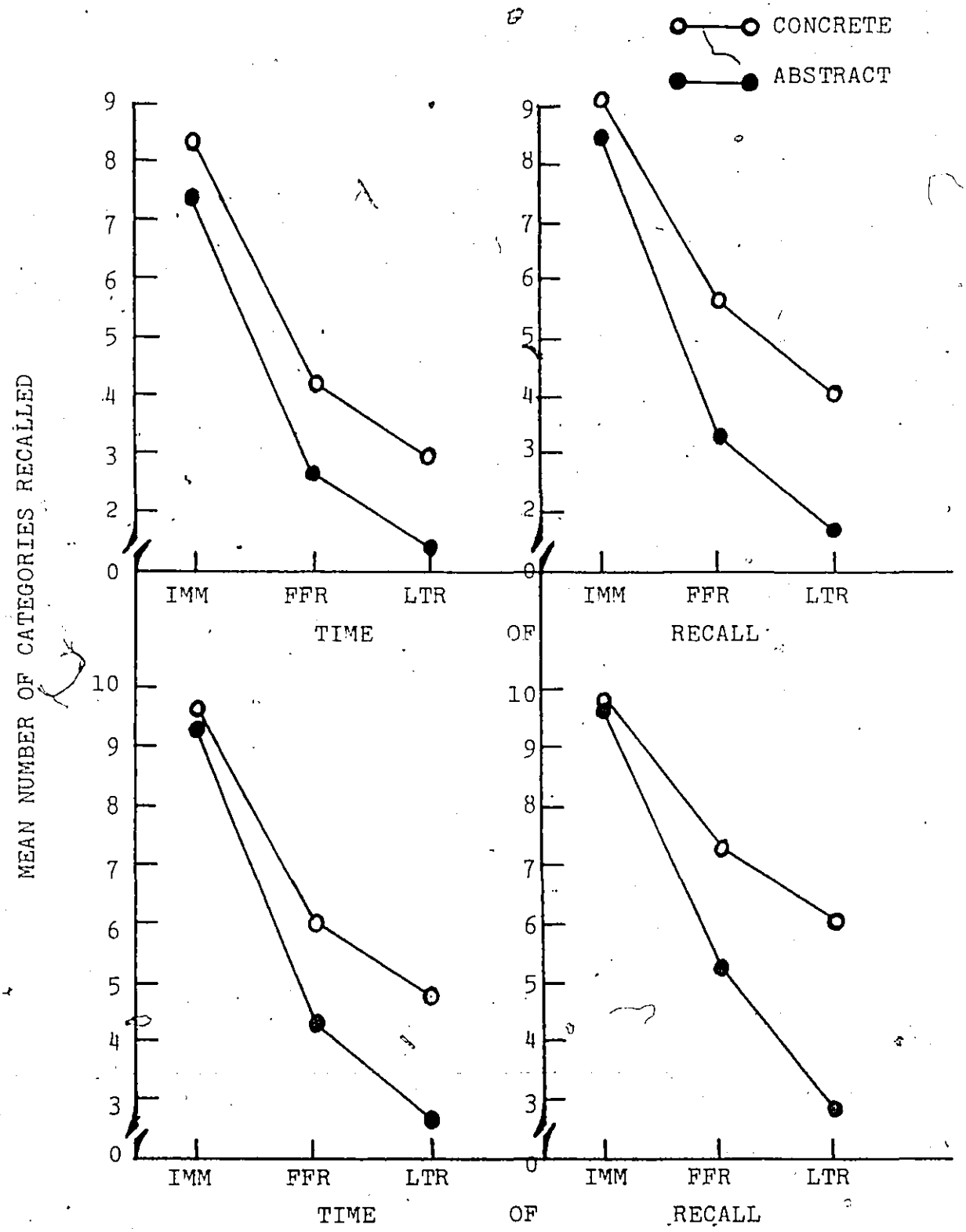


FIGURE V

Category Recall: The Interactions of Concreteness with Time of Recall (Immediate, Final Free, and Long-Term Recall).



the group size 2 analysis, $F(2,72) = 11.3$, $MSe = 8.73$. Category recall of abstract items did not differ with respect to the grouped vs. ungrouped variable in delayed and long-term recall, while this difference persisted over delayed and long-term recall for concrete items.

To summarize, the main variables affecting category recall in this study were concreteness, serial position of the category and time. More concrete categories were recalled than abstract categories, and this effect increased over time. Category recall varied as a function of serial position in much the same way as did word recall. Finally, presenting words in groups depressed category recall relative to an ungrouped control, but only in immediate recall, and only over the primacy and middle serial positions.

Category clustering: number of words per category. Mean words-per-category is the total number of words recalled divided by the number of categories recalled. For group sizes two through six, therefore, there is a maximum recall of 2, 3, 4 or 6 words-per-category, respectively. Again, the comparisons being made are those between the words-per-category recall of grouped vs. ungrouped presentation conditions, separately for each level of grouping.

Analyses of variance on the words-per-category data were performed with concreteness (concrete or abstract) and presentation grouping (grouped or ungrouped) as independent factors, and serial position of the category as a repeated

factor. These analyses were conducted separately for group sizes 2, 3, 4 and 6 and their respective controls, within immediate, delayed and long-term recall. In all analyses there was a main effect of concreteness, Fs(1,36) > 7.96, MSe's < .98, with more words being recalled from concrete than abstract categories (see Table 2). There was a main effect of

Table 2 about here

grouped vs. ungrouped presentations in all analyses in immediate and delayed recall, and in two of the four long-term analyses (see Table 2). The effect appears to decline over time; from immediate recall, Fs(1,36) = 46.2, 4.17, 17.4 and 7.81, MSe's = .08, .24, .39, and .67, for group sizes two through six respectively, to delayed recall, Fs(1,36) = 10.3, 4.85, 5.94, and 6.78, MSe's = .44, .53, .30, and .76, for group sizes 2 through 6, respectively to long-term recall, Fs(1,36) = 4.77, and 4.00, MSe's = .47 and .98, for group sizes 2 and 6 respectively. The decline over time of the difference between grouped and ungrouped presentations appeared to be due to a basement effect in long-term recall. In immediate recall for group size 6, concreteness interacted with the grouped vs. ungrouped comparison, F(1,36) = 5.80, MSe = .67. The superior within-category recall found with grouped presentation, was more pronounced for concrete than abstract categories. There was a large main effect of serial position in all analyses, Fs(1,36) > 6.56, MSe's < .30. The serial

TABLE II

Mean Number of Words Recalled per Category as a Function of Concreteness and Mode of Presentation (Grouped or Ungrouped) Separately for Group Sizes 2, 3, 4 and 6 in Immediate, Final Free and Long-Term Recall.

		CONCRETENESS		MODE OF PRESENTATION		
IMMEDIATE RECALL		CONC.	ABST.	GRPD.	UNGRPD	MSe
SIZE	2 (out of 2)	1.70	1.57	1.76	1.51	.08
	3 (out of 3)	2.26	2.04	2.26	2.04	.24
	4 (out of 4)	3.05	2.59	3.65	2.47	.39
	6 (out of 6)	4.49	3.57	4.29	3.78	.67
FINAL FREE RECALL						
GROUP	2 (out of 2)	1.39	1.11	1.39	1.11	.44
	3 (out of 3)	1.67	1.26	1.59	1.34	.53
	4 (out of 4)	1.92	1.36	1.75	1.52	.30
	6 (out of 6)	2.74	1.64	2.45	1.94	.76
LONG-TERM RECALL						
	2 (out of 2)	1.11	.78	1.09	.85	.47
	3 (out of 3)	1.30	.88	1.15	1.03	.67
	4 (out of 4)	1.46	1.04	1.31	1.18	.42
	6 (out of 6)	2.15	1.16	1.87	1.43	.98

position curves for within-category recall are similar in form to those observed in word recall and category recall. Within-category recall was a bowed function of serial position in immediate recall, and declined over serial positions in delayed and long-term recall. Concreteness interacted with serial position in three of the four immediate recall analyses, $F(5,180) > 2.99$, MSe's $< .15$, for group sizes, 2, 3, and 4 and for group size 4 in long-term recall, $F(2,72) = 4.69$, MSe = .14. In all cases, the concreteness effect, while present over the primacy and middle portions of the curve, was absent over the recency portion. Finally, grouped vs. non-grouped conditions interacted with serial position in immediate recall, $Fs(5,180) > 2.80$, MSe's $< .30$. In all cases, grouping enhances

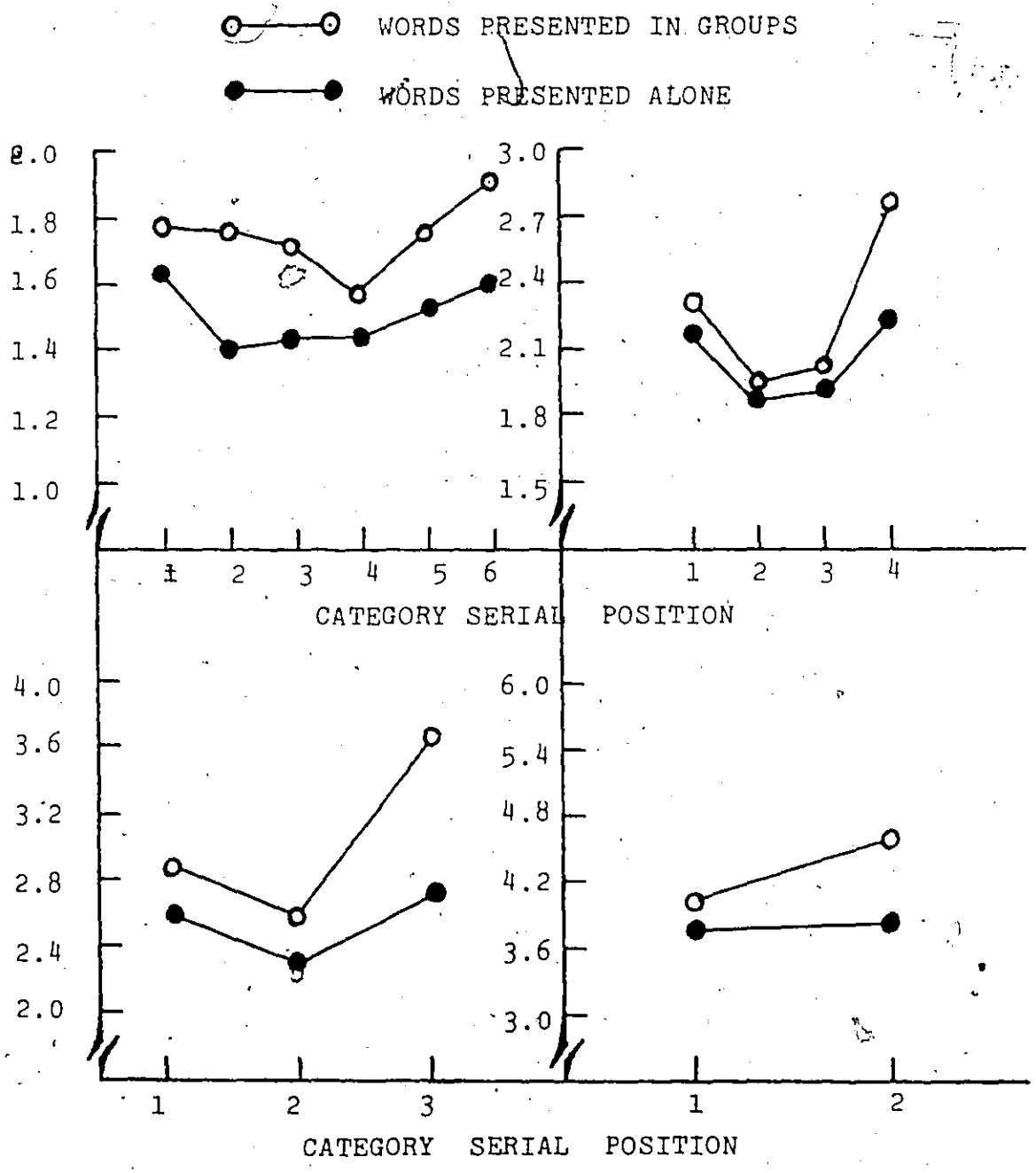
Figure 6 about here

within-category recall over the recency portion of the curve, more than over the primacy and middle serial positions.

Subsequent to these analyses, the data were averaged across serial position, and the effects of time of recall were investigated. Thus, four analyses of variance were conducted with concreteness and grouped vs. ungrouped presentation conditions as independent factors, and time of recall (immediate, delayed or long-term) as a repeated factor. Again, since these analyses are not independent of the previous ones, only the effects of time and its interactions will be reported here. There were significant main effects of time in all

FIGURE VI

Within-category Recall: The Interaction with Serial Position of Words Presented in Groups Compared to Words Presented Singly in Immediate Recall (Experiment I).



analyses, $\underline{F}s(2,72) > 134$, $\underline{MSe}$'s < 1.26. Within-category recall declined from immediate to delayed to long-term recall. Finally, only in the group size 4 analysis did grouping interact with time, $\underline{F}(2,72) = 6.27$, $\underline{MSe} = .45$. In this case, the advantage to grouped presentation over ungrouped presentation decreased with time.

To summarize, within-group recall is a function of concreteness, grouping, category serial position and time. Within-group recall was higher for concrete than abstract groups, although in some analyses this effect was attenuated over the recency serial positions. Within-group recall was enhanced by grouping words at presentation. Furthermore, the difference between grouped and ungrouped conditions, although present in all serial positions, was especially pronounced over the recency serial positions in immediate recall. Neither the facilitation afforded concrete categories nor the facilitation provided by grouping at presentation diminished with time. Finally, within-group recall varied as a function of serial position in much the same way as did word recall and category recall.

General Discussion

Although the most straight-forward objective of this experiment, to enhance recall by grouping items at presentation, was not fulfilled, discussion of two different aspects of the data is still in order. First, there are the effects of concreteness on both recall and organization.

Second, there are the effects of grouping, particularly those found in the organizational analyses.

The effects of concreteness observed in this study are consistent with the notion that concreteness effects, in general, are mediated by long-term memory mechanisms. In this experiment, concreteness facilitated recall over the primacy and middle serial positions, while these effects were attenuated over the recency serial positions. When the data were partitioned into short-term memory and long-term memory components, the effects of concreteness were apparent only in the long-term memory component. This short-term memory, long-term memory distinction, furthermore, provides an explanatory device by which to account for the effects of negative recency in final free recall, and the attenuation of the concreteness effect over the recency serial positions. Specifically, it has been argued (e.g., Craik, 1970; Craik, Gardiner and Watkins, 1970; Madigan and McCabe, 1971) that negative recency reflects a lower level of processing at input, given to items in the recency serial positions. This lower level of processing is thought to be reflected in the poorer long-term retention of items in these serial positions. However, if it is further assumed that the concreteness effect is the result of the more efficient processing of concrete relative to abstract items, then the concreteness effect should be least pronounced where the overall levels of processing are the lowest. Finally, the facilitatory effects of

concreteness found in this experiment were not attenuated over the recall intervals studied here and could be attributed both to the recall of groups and the recall of words within groups.

In contrast to the effects of concreteness, the only effects of grouping on recall were those found over the recency serial positions in immediate recall. These effects are clearly short-term memory effects resulting from the fact that almost all subjects output the last group in each list first, and output this group in a forward order. The long-term effects of grouping on organization are much more interesting, however. Previous accounts of organized memory (e.g., Mandler, 1967; Tulving and Pearlstone, 1966) have suggested that the recall of groups and the recall of words within groups are independent processes. However, in most experiments this independence is demonstrated by manipulating the levels of group recall by the use of retrieval cues, while the number of words recalled per group remains relatively constant. Of some interest, then, are the results of this experiment where the number of words recalled per group increases as a function of grouping, while the number of groups recalled remains relatively constant. Comparable results have been found by Mandler (1967), however, using a markedly different experimental procedure. His work further suggested that this effect of grouping only holds for group sizes up to 5 ± 2 words.

Thus, the effects of concreteness and grouping on within-group recall can be attributed to the effects these variables have on item integration. Concreteness facilitates the formation of functional units because of the special combinatorial properties of imagery, while grouping produces a similar facilitatory effect by inducing subjects to adopt more systematic rehearsal strategies. However, two problems remain. First, as Mandler (1967) states, "a set of objects or events are said to be organized when a consistent relation among the members of set can be specified, and specifically when membership of the objects or events in subsets (groups, concepts, categories, chunks) is stable and identifiable (p. 330)" (italics mine). In Experiment I, however, the conclusions about long-term effects of grouping are largely inferential, especially in light of the fact that no long-term effects of grouping were found in the recall analyses. Secondly, problems of group access were not addressed in any direct way by this experiment. For example, the processes by which concreteness facilitates group recall remain unspecified. Furthermore, the lack of an effect of grouping on group recall can only tentatively be attributed to a predisposition on the part of subjects to form functional units to the exclusion of higher-order retrieval plans.

Consequently, two more experiments were carried out to investigate these problems further through the use of retrieval cues. Of importance was the relationship between

integration and recall, the relationship between integration and group access, and the relationship between the amount of contextual information provided to facilitate unit access and recall.

CHAPTER THREE

Experiment II

The relationship between integration and recall as it relates to concreteness has been explored previously (Begg; 1972). Begg argued that word pairs stored as integrated units should be recalled as well as single words which are stored separately. To demonstrate this, he had subjects learn lists of concrete or abstract adjective-noun phrases and compared the recall of these lists, to lists composed of the nouns alone. He found that subjects could recall twice as many concrete words from adjective-noun lists, as from lists of nouns alone. On the other hand, the number of words recalled in the two conditions was equal when the lists were composed of abstract words. He argued that the concrete phrases were stored as integrated units, and when one member of such a phrase was recalled, the subject could redintegrate or reconstruct the rest of the unit. Abstract phrases, on the other hand, were not integrated, and thus only as many words could be accessed from the adjective-noun phrases as could be accessed from lists of nouns alone.

In the present experiment, similar effects can be expected to occur. In this experiment, concrete and abstract groups of 2, 3 and 4 words are presented to subjects. Following Begg's (1972) reasoning, it is predicted that a

constant number of words will be recalled from abstract groups regardless of the number of words in the group presented to subjects. For concrete groups, on the other hand, a constant proportion of each group should be recalled, all other things being equal.

In the present experiment, two different cued-recall conditions were also investigated. In the first case, the set size condition, the first word of each group was presented as a retrieval cue and to-be-recalled set was left free to vary from 1 to 3 words for group sizes 2 to 4, respectively. Cued recall was compared to non-cued recall by scoring only those non-cued items that correspond to the cued items in cued recall. As noted previously, the recall of groups and the recall of words within groups are believed to be independent aspects of performance (cf. Tulving and Pearlstone, 1966). Furthermore, retrieval cues within this framework, are believed to provide group access while leaving within group recall unchanged. As a result, any difference arising from the comparison of cued and non-cued recall can be attributed to the additional groups accessed under conditions of cued recall.

In the set size condition, as well, the retrieval cues serve to access to-be-recalled groups of increasing size. As a result, it is possible that a retrieval cue could become increasingly less effective, as the number of items for which it must act as a cue increases. However, in a previous study using categorized lists (Earhard, 1972), this was not found

to be true for groups of less than 6 words. This suggests that a cue may serve to provide minimum access to a group, and once this is provided, no additional facilitation is possible. It also suggests that the cues used in this condition should be equally effective (i.e., should serve to access a constant proportion of a group regardless of size) given that all other things are equal.

However, there is good reason to believe that the effectiveness of single cues will vary under at least some conditions in this experiment. Recall that it was predicted that a constant proportion of the words in concrete groups would be freely recalled, while a constant number of the words in abstract groups would be recalled. If this measure, the proportion of a group recalled, is taken as a rough index of the degree to which a group is integrated, it suggests that concrete groups of various sizes will be equally well integrated, but that the degree of integration will be inversely related to group size for abstract groups. As noted previously, once part of a functional unit is accessed, this serves as an aid in redintegrating or reconstructing the remainder of the unit. It follows that since concrete groups are equally well integrated, a retrieval cue should serve to redintegrate a constant proportion of the unit it accesses. However, since the degree of integration of abstract groups decreases as group size increases, the effectiveness of retrieval cues for these groups should decrease as group size increases.

Thus, to this point it has been suggested that free recall performance will vary as a function of concreteness and group size, with a constant proportion of concrete words being recalled from groups of different sizes, and a constant number of abstract words being recalled from different sized groups. In cued recall with single cues, these differences in integration will be reflected in a constant effect of cueing for concrete words and a decreasing effect of cueing for abstract words.

The last problem addressed in this experiment, however, extends this investigation by looking at the problems of cued recall when the retrieval cue provides more than minimum access. This condition, the cue size condition, uses all but the last word of each group as a retrieval cue for the remaining item. Again, the cued recall of the last member of each group is compared to the free recall of these same items. Since all three groups in this experiment received the same set of items under the same set of instructions, the only difference between groups lies in the requirement of the recall task. Furthermore, as in the previous cueing condition, it is assumed that retrieval cues facilitate group access, while leaving within group recall unchanged. As a result, non-cued recall is the appropriate control for these cued recall comparisons.

In order to discuss the effects of multiple cues, however, it is necessary to consider the role of cueing in

general. Recently, memory theorists have placed considerable emphasis on the context of acquisition, the context of retrieval, and the correspondence between these two (e.g., Tulving, 1972; Tulving and Thomson, 1973). Specifically, it is held that if the recall context is similar to that of acquisition, then retrieval may be facilitated. Thus, the role of retrieval cues, within this framework, is to aid in reinstating the context of acquisition. However, the effectiveness of these retrieval cues is also limited by two potential constraints. First, the retrieval cue must serve as a functional route of access to the information in question, and secondly, it must serve to access information which could not otherwise be accessed.

Given these constraints, the role of multiple cues can be accounted for in more detail. First, if a group of words is only partially integrated, then multiple cues for a single to-be-recalled item may facilitate recall. This follows from the fact that the cue serves to reinstate the context of encoding. Providing more cues for a partially integrated unit increases the probability that the particular to-be-remembered item in question was encoded with at least one of the cue words. With well integrated units, on the other hand, one cue should be as effective as several. Clearly, both of these suggestions are qualified by the fact that in either case more information must be available (retrievable under some set of recall conditions) than are accessible

(retrievable under any given set of recall conditions) in free recall (cf. Tulving and Pearlstone, 1966).

Finally, when more cues are available than are necessary, the possibility exists that the additional cues will cause output interference. On the basis of data demonstrating such an effect, Roediger (1973) argued that subjects must in some sense retrieve items provided as cues, and that the retrieval of these items then interferes with the recall of subsequent category members. However, it is possible that such an effect is limited to taxonomic or conceptual categories as used by Roediger, and does not extend to the subjective organization provided by images and/or sentences as used in this study. With conceptual or taxonomic categories, the basis of category membership is the category label itself. Thus, as more members of the category are provided as cues, the distinctiveness of any remaining members may be decreased. Presenting more members of an image-defined or sentence-defined category, on the other hand, may simply serve to increase the probability of reinstating the unit as a whole. In other words, the recall of category members is probably based on the relative memory strength of the members of the category, while the recall of the members of an image or sentence is more likely to be reconstructive or redintegrative within that category.

Thus, assuming that more groups are available than are accessible under conditions of free recall, it is predicted

that multiple cues will facilitate recall. Furthermore, the possible output interference effects of multiple cues as found by Roediger (1973) are not expected in the present experiment. However, the degree of integration achieved during the encoding phase is of necessity, a limiting factor on the effectiveness of any kind of retrieval cue. As a result, the effects of multiple cues should vary as a function of concreteness and group size, in much the same way as predicted for the effects of single cues.

In summary, subjects were presented with concrete and abstract groups of 2, 3 and 4 words. Recall was then cued or not cued, and when retrieval cues were used, the cue was either the first word of each group, or all but the last word. The first of these cueing conditions is the set size condition, with the size of the cue remaining constant at one word, and the size of the to-be-recalled set varying from 1 to 3 words for group sizes 2 through 4, respectively. The second cueing condition is the cue size condition, with the size of the cue varying from 1 to 3 words for group sizes 2 through 4 respectively, and with the size of the to-be-recalled set remaining constant at one word. Presentation time was also varied between subjects, being 15 seconds per group for all groups or 10 seconds for 2 word groups, 15 seconds for 3 word groups and 20 seconds for 4 word groups. If the total time hypothesis (e.g., Cooper and Pantle, 1967; Murdock, 1960; Waugh, 1967, 1970; Zacks, 1969) is correct, then this variable should have

no effect since the total presentation is the same for both groups. However, if the time sharing implied by this hypothesis does not occur in this experiment, then the distributed time condition should be superior overall to the constant time condition.

Method

Subjects

Seventy-two student volunteers from McMaster University were paid $2.00 for their participation. Twelve subjects served in each of six conditions.

Materials

Forty-five concrete nouns ($I > 5.60$) and 45 abstract nouns ($I < 3.85$) were chosen from the Paivio, Yuille and Madigan (1968) norms. The nouns were equated for frequency of occurrence in print, with all words having frequencies of A or AA. The concrete and abstract nouns were also equated for m with means of 5.81 and 5.64, respectively. Within each level of concreteness the nouns were randomly selected to form five pairs, five triplets, and five groups of four. This produced a list of 15 concrete and 15 abstract groups, with each group containing 2, 3 or 4 words. For presentation, the groups were typed, in lower case, on index cards. Six random orders of the list were then constructed such that each group size (2, 3 or 4 words) and each level of concreteness (concrete or abstract) was represented once at each input position.

For the purpose of cueing recall, two different random orders were constructed. The cues appeared in a list down the left side of a page with a blank opposite each cue for responses.

Procedure

The size of the cue, and the size of the to-be-remembered (TBR) set was varied in this study in the following way. In the cue size condition, 1, 2 or 3 cue words were given for groups of size 2, 3 and 4 words, respectively. Thus, the proportion of the memory unit serving as cue increased from .50 to .67 to .75 for group sizes 2, 3 and 4 respectively, while the TBR unit was always one word. In the set size condition, the cue was always the first word of a group, and the size of the TBR unit increased proportionately with group size, from .50 to .67 to .75 for group sizes, 2, 3 and 4, respectively. For both these groups a single non-cued control condition was used. Presentation time was also varied, being 15 seconds per group, for all groups (condition 15-15-15), or 10 seconds for 2 word groups, 15 seconds for 3 word groups and 20 seconds for 4 word groups (condition 10-15-20). Note that the total presentation time is the same for both conditions.

The design, then, was a mixed design with cueing condition (cue size, set size, or non-cued) and time (15-15-15 or 10-15-20) as independent factors. Concreteness (concrete or abstract) and group size (2, 3 or 4 words) were within-subjects variables.

Twelve subjects were randomly assigned to each condition, and were divided equally across the six presentation orders. Subjects were instructed to try to find a relationship between the words in each group, or to try and associate them in some way. When all 30 groups of words had been presented twice, subjects were given recall sheets and asked to recall the words. In the cued recall conditions, the two subjects receiving any one presentation order were given the cues in different random orders. There was no time limit on recall.

Results

Free recall. An initial analysis was performed on the free recall data to investigate the effects of concreteness, group size, and time independently of the effects of cueing. In this analysis all free recall responses were included. As a result, each subject could potentially recall 20 words from pairs, 30 words from groups of three, and 40 words from 4 word groups.

A 2 x 2 x 3 analysis of variance was conducted with time (15-15-15 or 10-15-20) as an independent factor, and concreteness (concrete or abstract) and group size (2, 3 or 4 words) as repeated factors. For all statistical tests a significance level of $\alpha = .05$ was used. There was a main effect of concreteness, $F(1,22) = 55.0$, $MSe = 9.72$ and a main effect of group size, $F(2,44) = 6.71$, $MSe = 10.6$. A mean proportion

of .53 concrete words were recalled compared to only .28 abstract words. Furthermore, while group recall varied only slightly with group size from 11.2 out of 20, to 10.1 out of 30, to 14.8 out of 40, for group sizes 2 through 4 respectively, there was a large proportionate decrease from group size 2 to group sizes 3 and 4. Mean proportions of .56, .34 and .37 words were recalled from these groups. These two main effects, however, were qualified by a two-way interaction, $F(2,44) = 3.52$, $MSe = 10.6$. Generally, this result is in the predicted direction with the recall of concrete words increasing as a function of group size, especially for group size 4, while the recall of abstract words does not (see Table 3). These

Table 3 about here

effects are examined in detail below.

Since the predictions made about the effects of concreteness and group size on total recall were based on certain assumptions about the effects of these variables on within-group integration, it is of some importance to look separately at the recall of groups and at the recall of words within groups. Furthermore, the results of these analyses will be important when looking at the differences between cued and non-cued recall, since these differences can be expected to vary both as a function of the proportion of groups which can be freely recalled and as a function of the degree of integration within groups. As a result, the data were re-

TABLE III

The Mean Number of Words Recalled and the Respective Proportions of Words Recalled from the Free Recall Analyses (Experiment II).

WORD RECALL

TOTAL RECALL

	GROUP SIZE 2	3	4
CONCRETE	6.79	6.62	10.3
ABSTRACT	4.42	3.67	4.50
	out of 10	out of 15	out of 20

PROPORTIONATE RECALL

	GROUP SIZE 2	3	4
	.68	.44	.51
	.44	.25	.23

GROUP RECALL

	GROUP SIZE 2	3	4
CONCRETE	7.25	5.25	6.25
ABSTRACT	4.83	3.42	4.08
	out of 10	out of 10	out of 10

GROUP SIZE 2	3	4
.73	.53	.63
.48	.34	.41

WITHIN-GROUP RECALL

	GROUP SIZE 2	3	4
CONCRETE	1.90	2.17	3.37
ABSTRACT	1.71	1.67	1.76
	out of 2	out of 3	out of 4

GROUP SIZE 2	3	4
.95	.72	.84
.85	.56	.44

analyzed, looking separately at the recall of groups, and at the recall of words within groups. Both analyses were 2 x 2 x 3 analyses of variance with the same factors as above. The recall of groups varied solely as a function of concreteness, $F(1,22) = 3.15$, $MSe = 1.31$, and groups, $F(2,44) = 5.52$, $MSe = 1.59$. A mean proportion of .60 concrete groups were recalled compared to only .41 abstract groups. For group size, the proportions were .60, .43 and .52 groups recalled for group sizes 2 through 4, respectively (also see Table 3).

In the analysis of within group recall, on the other hand, there were main effects of concreteness, $F(1,22) = 38.4$, $MSe = .53$, and group size, $F(2,44) = 13.9$, $MSe = .54$, and also a two-way interaction between these variables, $F(2,44) = 28.7$, $MSe = .22$ (see Table 3). There was a mean proportion of .82 words recalled from concrete groups compared to .57 words recalled from abstract groups. For group size 2 there was a mean proportion of .92 words recalled, compared to .64 words recalled both for group sizes 3 and 4. However, the mean words recalled for concrete words alone increased with group size, with means of 1.90 words, 2.17 words and 3.37 words being recalled from group sizes 2 through 4 respectively. In contrast, the number of words recalled from abstract groups was relatively constant with means of 1.71 words, 1.67 words and 1.76 words being recalled from group sizes 2 through 4 respectively. Expressed proportionately, this means that the recall of words within concrete groups varied less than

the recall of words within abstract groups, and did so unsystematically (means of .95, .72 and .84 words being recalled from these groups). The recall of words within abstract groups, however, when expressed proportionately, systematically decreased with group size, with means of .85, .56 and .44 words being recalled from group sizes 2 through 4 respectively.

In summary, then, free recall was a function of concreteness and group size. As in the previous experiment, the way in which different groups are accessed is still unclear, although in this experiment group recall varied as a function of both concreteness and group size. The recall of words within groups, however, conforms closely to our predictions about imaginal integration and the interaction of these effects with group size. Specifically, an increasing number of words were recalled of the words from concrete groups of increasing size, at least over the range of group sizes tested here. In contrast, a constant number of the words in abstract groups were recalled regardless of group size. Finally, it should be noted that there were no effects of the time variable in any of the analyses conducted to this point.

Cued Recall: Single Cues. For the purposes of this analysis the free recall data were scored for recall of all words except the first word in each group. These data were compared to the set size data collected with each group being cued by its first member. As a result, the number of words subjects could potentially recall increases as a function

of group size from 1 to 2 to 3 words for group sizes 2 through 4 respectively. Consequently, caution must be taken in interpreting the effects of group size since a random selection of items from memory would produce a main effect due to group size with proportions of .22, .33 and .44 of the words recalled being from groups 2 through 4, respectively.

To test for effects of single cues, a 2 x 2 x 2 x 3 analysis of variance was conducted with cueing (present or absent) and time (15-15-15 or 10-15-20) as independent factors, and concreteness (concrete or abstract) and group size (2, 3 or 4 words) as repeated factors. There were main effects of presentation time, $\underline{F}(1,44) = 5.27$, $\underline{MSe} = 15.0$, and concreteness, $\underline{F}(1,44) = 222$, $\underline{MSe} = 3.61$, as well as an apparent main effect of group size, $\underline{F}(2,88) = 40.5$, $\underline{MSe} = 4.63$. With respect to the presentation time variable, distributed (10-15-20) presentation times led to superior recall when compared to constant (15-15-15) presentation times. Furthermore, more concrete words were recalled than abstract words. However, while more words were recalled from groups of increasing size, with means of 13.2 words out of 20, 14.8 words out of 40, and 23.5 words out of 60 being recalled from group sizes 2, 3 and 4, respectively, these values, when compared to those expected by chance, show that words recalled from 2 word groups are over represented in the protocols, while 3 and 4 word groups are somewhat under represented (expected values of 8.6, 17.0 and 25.8, respectively). There was also a two-way interaction

between the presentation time and group size variables, $F(2,88) = 4.19$, $MSe = 4.63$, since the effects of distributed time increased with increasing group size.

Although concrete words were generally better recalled than abstract words, this effect was qualified by a two-way interaction with group size, $F(2,88) = 29.8$, $MSe = 3.68$ (see Table 4). The recall of concrete words increased

Table 4 about here

with increasing group size, while the recall of abstract words did not. Furthermore, concreteness also interacted with cueing, $F(1,44) = 17.0$, $MSe = 3.61$, since retrieval cues facilitated the recall of concrete words while providing no such facilitation for abstract words. Finally, there was a three-way interaction of concreteness, group size and cueing, $F(2,88) = 3.19$, $MSe = 3.68$ (see Figure 7). The advantage

Figure 7 about here

provided by retrieval cues to concrete items did not diminish with group size, and may have increased slightly. However, the effects of cueing on abstract items, while positive for group 2 actually became negative for group size 4.

In summary, then, the effects of a single retrieval cue are generally as predicted. The differences between cued and non-cued recall for concrete items are relatively constant across the group sizes tested here (mean differences of 1.1

TABLE IV

The Effects of Concreteness and Group Size in the Cued Recall Conditions of Experiment II.

MULTIPLE CUES

WORD RECALL

	GROUP SIZE 2	3	4
CONCRETE	4.04	5.19	8.73
ABSTRACT	2.54	2.27	3.04
	out of 5	out of 10	out of 15

PROPORTIONATE RECALL

	GROUP SIZE 2	3	4
CONCRETE	.81	.52	.58
ABSTRACT	.51	.23	.20

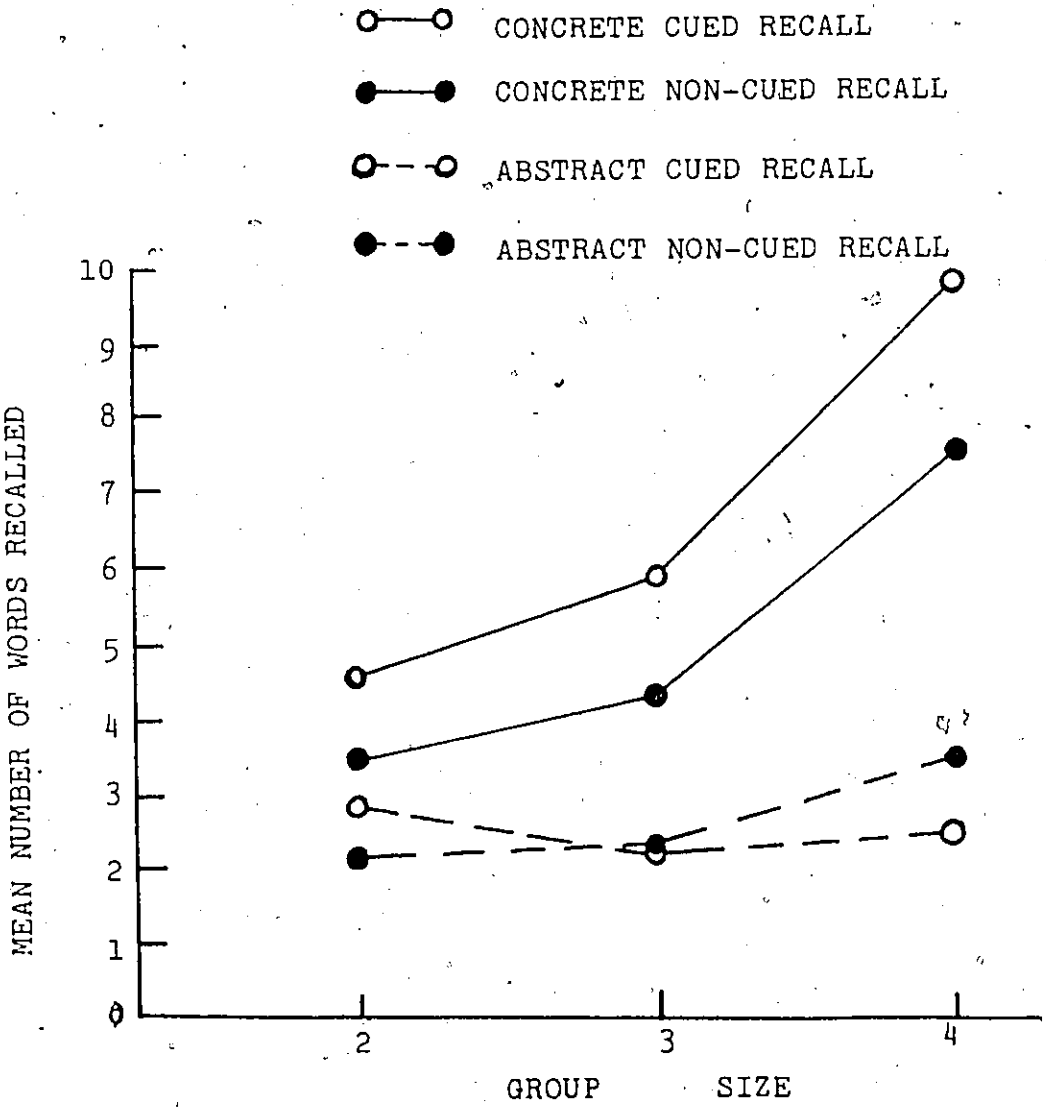
SINGLE CUES

	GROUP SIZE 2	3	4
CONCRETE	4.02	2.77	3.39
ABSTRACT	2.73	1.73	1.50
	out of 5	out of 5	out of 5

	GROUP SIZE 2	3	4
CONCRETE	.80	.55	.68
ABSTRACT	.55	.35	.30

FIGURE VII

The Interaction of concreteness, Cueing and Group Size in the Single Cue Condition (Experiment II).



words, 1.5 words, and 2.2 words for groups 2 through 4 respectively). This effect can tentatively be attributed to the fact that these concrete groups are well integrated, and to the fact that the degrees of integration did not vary widely across the various group sizes. The effect of cueing for abstract items, on the other hand, decreased with increasing group sizes (mean differences of .5 words, -.1 words, and -.9 words). This decrease can be attributed to the decreasing degrees of integration found with increasing group sizes. It is of some importance to note, as well, that when units are very poorly integrated, retrieval cues may actually interfere with recall. Finally, in this analysis there were small but significant effects of the presentation time variable. In this case, the facilitatory effects of distributing total presentation time as a function of group size could not be compensated for by time sharing in the constant time condition, particularly for group size 4.

Cued Recall: Multiple Cues. For the purposes of this analysis, the non-cued recall was scored for the recall of the last word in each group only. These data were compared to those collected when the cue size varied from 1 cue to 2 cues to 3 cues for group sizes 2, 3 and 4, respectively.

In order to test for the effects of cue size, a 2 x 2 x 2 x 3 analysis of variance was conducted with the same factors as above. In this analysis, there were main effects of concreteness, $F(1,44) = 144$, $MSe = 1.18$, cueing, $F(1,44) =$

21.9, MSe = 2.93, and group size, F(2,88) = 48.2, MSe = .93. Although concrete words were better recalled than abstract words, and cued recall was superior to non-cued recall, these two effects were also qualified by a two-way interaction, F(1,44) = 9.20, MSe = 1.18. In this case the facilitatory effects of cued recall were more pronounced for concrete than abstract items. For the various group sizes, the last words from two word groups were best recalled, those in three word groups being worst recalled, and those in four word groups falling between these two (mean proportions of .68, .41, and .49 words recalled, respectively) (also see Table 4). Finally, all of the above effects were qualified by a three way interaction of concreteness, group size, and cueing, F(2,88) = 3.31, MSe = .81 (see Figure 8). The facilitatory effects of cueing

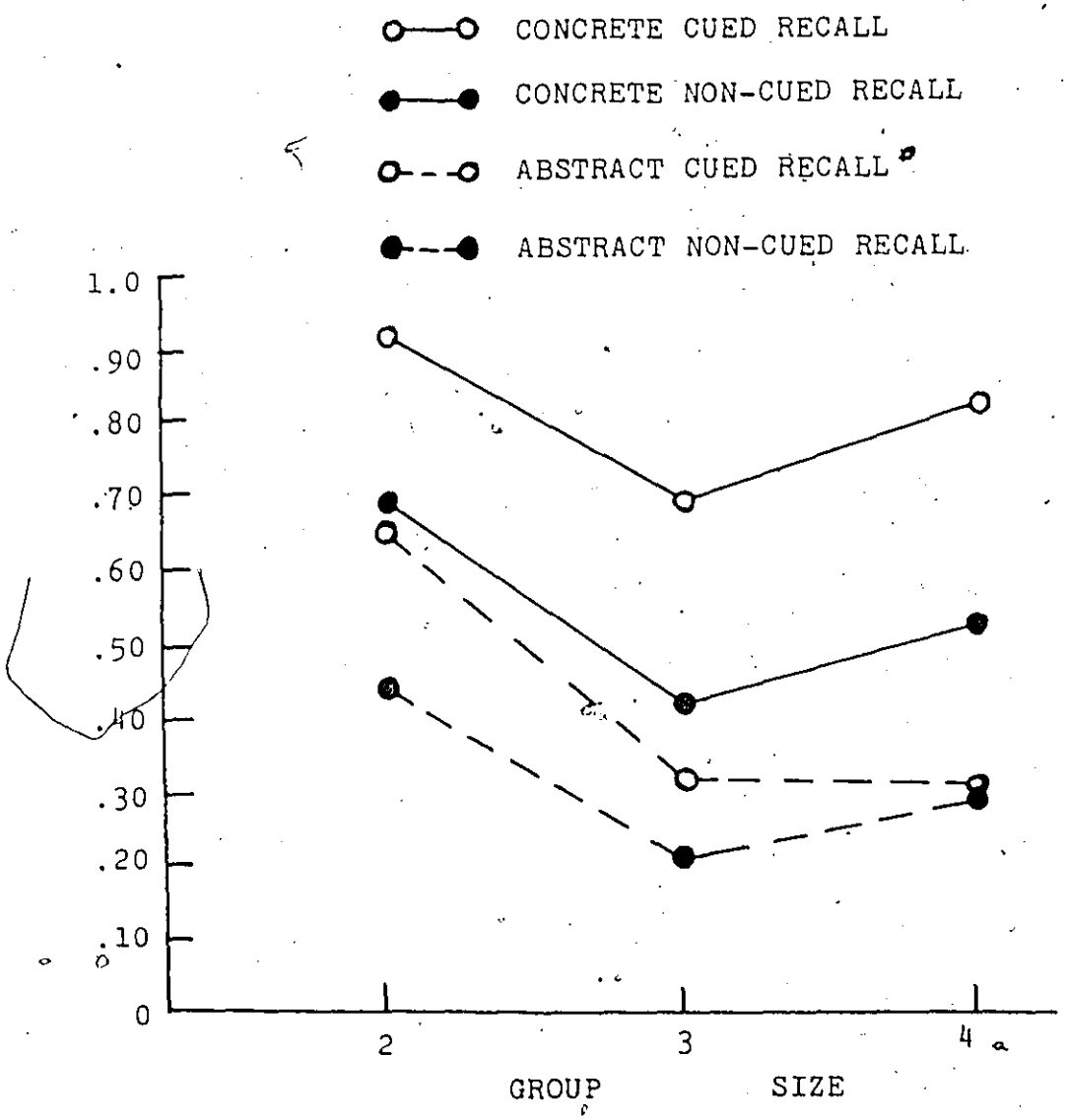
Figure 8 about here

do not diminish as group size increases for concrete items, while the effects of cueing decrease with increases in group size for abstract items. However, at no point do the effects of cueing become negative, even for the abstract four word groups.

In summary, then, the effects of multiple cues are as strong as if not stronger than the effects of single cues. In support of the hypothesis that multiple cues are more effective than single cues, is the fact that only in the multiple cue condition was there a main effect of cueing,

FIGURE VIII

The Interaction of Concreteness, Cueing and Group Size in the Multiple Cue Condition (Experiment II).



and the fact that in this analysis the effects of cueing on abstract items were in some cases positive, and were never negative. These effects are shown clearly in Figure 9 where the differences between cued and non-cued recall, expressed in proportions of the to-be-remembered recalled, are plotted. The combined effects of concreteness and group size, as found

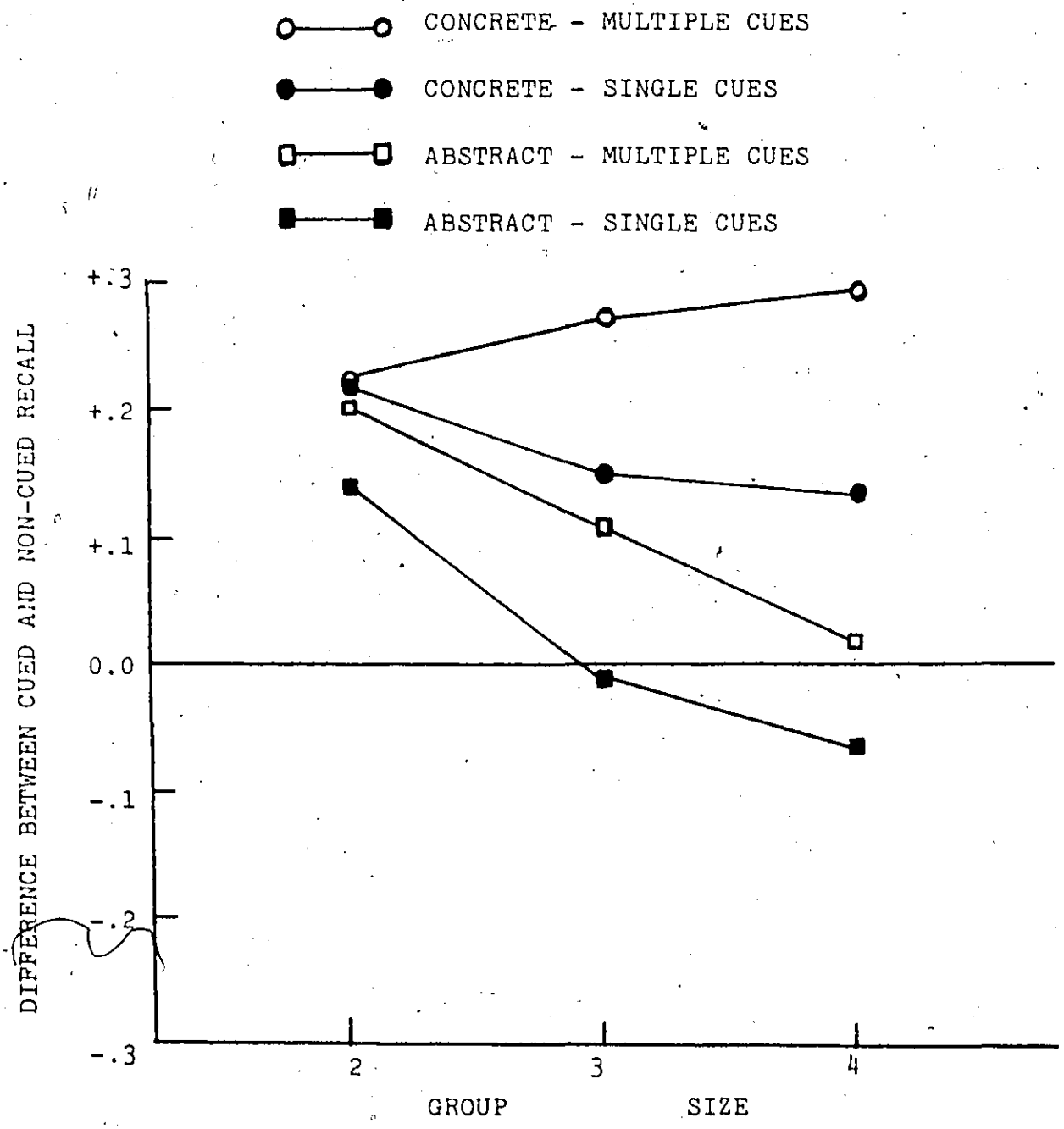
Figure 9 about here

previously, can be accounted for with reference to our notions about the differential organization of concrete and abstract items. Finally, as in the free recall analyses, there were no main effects or interactions of the presentation time variable.

However, two cautions are in order with respect to the interpretation of these results. First, in free recall, the availability of the various groups differed initially (proportion of groups recalled were .60, .43, and .52 for groups 2 through 4, respectively) so that the range of facilitation in cued recall is greatest for group size 3, and is somewhat less for group sizes 4 and 2. Secondly, in the multiple cue condition, the size of the cue serves as a possible source of information with which to limit the response set; that is, a single cue must be from a group of size 2, two cues from a 3 word group, and 3 cues from a 4 word group. However, neither of these factors appear to be a major contanimant of our results. The factor of initial

FIGURE IX

The Difference Between Cued and Non-cued Recall in the Single Cue and Multiple Cue Conditions, Expressed in Proportions of the To-be-remembered Unit Recalled (Experiment II).



availability should bias the results in favour of group size 3, while the actual results for this group do not differ markedly from the results found with other group sizes. If limiting the response set was a major factor, then the multiple cue condition should be superior to the single cue condition even for group size 2 where the cue sizes are equal. Although the results found in the cued recall of abstract groups suggest this possibility, there is no comparable effect for concrete groups.

Discussion

In the previous experiment, it was argued that when processing in general is attenuated, the size of the concreteness effect is attenuated. At intermediate levels of processing, however, an advantage is afforded concrete items, as shown in both of the previous experiments. Furthermore, it has previously been argued that this advantage is due to the differential organization of concrete words relative to abstract words (Begg, 1972, 1973). Such an effect is clearly in operation in the current experiment. The degree of unitization for concrete groups is both reasonably high and relatively constant for all group sizes. The degree of unitization for abstract groups, on the other hand, decreases with group size, and is generally lower than that found with concrete groups.

The means by which these differences arise, in terms of processing strategies, is worth pursuing further,

however. Specifically, it seems possible that subjects distribute their processing time as a function of group size for concrete groups, but distribute their time equally across group sizes for abstract groups. However, in this experiment, the concrete and abstract groups were randomly assigned to the various serial positions in the list. As a result, it seems unlikely that such time-sharing strategies could be strictly maintained. Consequently, the following tentative hypothesis is offered, at least as a possible direction for future research. The organization of both concrete and abstract word groups increases with time, and more specifically, are inverted U-shaped functions of time. However, the function describing the organization of abstract items is displaced up the time axis relative to the function describing the organization of concrete items. It follows from this description, that at very low levels of processing, and at very high levels of processing, concrete and abstract groups will not differ. However, at the level of processing found in this experiment, small increments in processing time produce relatively large increments in the organization and recall of concrete items, while similar increments in the processing time of abstract items produce relatively small increments in organization and recall.

The effects discussed above, however, can be attributed to the effects of concreteness on the integration of items within groups. A second and equally important problem

addressed in this experiment was the problem of group access. In previous work (Earhard, 1972; Roediger, 1973) it has been argued that retrieval cues must provide access to the groups formed at input, and provide no additional facilitation once this function is performed. In fact, Roediger (1973) has argued that if more cues are provided than are required, then output interference would result. In this experiment, however, multiple cues were, if anything, more effective than single cues. As noted previously, this effect can probably be attributed to the fact that the groups in this experiment were not fully integrated. As a result, providing additional cues increased the probability that the to-be-remembered word was encoded in the context of at least one of the cue words. However, it could have been argued that additional cues should interfere with the recall of previously unrecalled words. The fact that this does not occur suggests that the cued recall of subjective units, as formed in this experiment, differs from the cued recall of categories defined on a taxonomic or conceptual basis. Moreover, the critical difference may lie in the inclusive or exhaustive nature of subjective categories when compared to those which are based on long-term semantic or conceptual relations.

In general, then, a central theme in the present experiment was clearly that the effects of various kinds of retrieval cues depend critically on the degree to which groups are integrated. However, the differences in integration

observed for various sized concrete and abstract groups has also left several problems unanswered. For example, these differences have severely limited the generality of any conclusions that might be made about the problems of group access as they apply to groups of different sizes. Furthermore, in the set size and cue size conditions, there was a confounding between the size of cue or to-be-remembered item, and the degree of unitization for various group sizes.

CHAPTER FOUR

Experiment III

As a result of the above problems a third experiment was conducted in order to explore the problems of group access more fully. In order to achieve this, subject-controlled presentation times replaced the experimenter-controlled presentation times used previously, while the basic design of the experiment remained unchanged. The intent of this change was to allow subjects to organize the words in different groups to an equal degree, regardless of group size, by adjusting the presentation time of each group appropriately.

Method

Subjects

Thirty-six student volunteers from McMaster University were paid $2.00 each for their participation. Twelve subjects served in each of three groups.

Materials

The word pool and randomizing procedures were identical to those used in Experiment I. However, in this experiment, the words, after being re-grouped were mounted on slides in upper case.

Procedure

The design was a 3 x 2 x 3 mixed design, with cueing condition (cue size, set size or non-cued) as an independent factor, and concreteness (concrete or abstract) and group size (2, 3 or 4 words) as repeated factors.

Twelve subjects were randomly assigned to each condition, and were divided equally across the six presentation orders. Each subject was instructed to push a button in front of him to expose a slide, and while this slide was exposed, he was to organize the words on that slide into a unit of some kind. When a subject had such an organization, he pressed the button again, and a blank slide appeared. During this time, subjects briefly described the organization they had chosen. This procedure was repeated for all 30 word groups. Exposure times were recorded. When all 30 groups of words had been exposed, subjects were given recall sheets and asked to recall the words. There were no time limits on recall.

Results

Presentation times. The slide exposure times were analyzed by a 3 x 2 x 3 analysis of variance, with cueing condition (cue size, set size or non-cued) as an independent factor, and concreteness (concrete or abstract) and group size (2, 3 or 4 words) as repeated factors. There was a main effect of concreteness, $F(1,33) = 32.1$, $MSe = 6.20$, with means of 22.9 seconds and 29.0 seconds for concrete and abstract condi-

tions, respectively. Exposure time increased linearly as a function of group size, $F(2,66) = 139$, MSe = 67.6, with means of 14.6 sec, 26.0 sec and 37.4 sec for group sizes 2 through 4, respectively. Finally, both these main effects were qualified by a two-way interaction of concreteness and group size, $F(2,66) = 5.25$, MSe = 35.7. In this case, the difference between concrete and abstract exposure times was larger for group size 4 than for group sizes 2 and 3 (mean differences of 9.6 sec versus 5.4 sec and 3.3 sec, respectively).

Free Recall. The free recall data were analyzed by a 2 x 3 analysis of variance with concreteness and group size as within-subject factors. More concrete words were recalled than abstract words, $F(1,11) = 110$, MSe = 3.83, with mean proportions of .61 and .28 words being recalled, respectively. Somewhat surprisingly, these proportions are quite close to those found in the previous experiment (.53 and .28, respectively). Recall also increased as a function of group size, $F(2,22) = 38.6$, MSe = 7.77, being 8.25 out of 20, 10.33 out of 30, and 21.33 out of 40 for group sizes 2 through 4, respectively. When expressed proportionately, these were .41, .34, and .53 words recalled from groups 2 through 4. These contrast to the respective proportions of .56, .34, and .37 words recalled in the previous experiment. Thus, in this experiment, there is a tendency for the recall of items from 2 word groups to be lower than found previously, and for the recall of items from 4 word groups to be higher than before. Finally, con-

creteness and group size interacted, $F(2,22) = 13.4$, MSe = 6.45. For concrete groups mean proportions of .27, .24 and .39 words were recalled compared to .14, .10, and .17 words recalled for abstract groups. Thus, the source of the interaction is clearly due to the increase in the recall of words from concrete groups of size 4.

Subsequent to the above analysis, the data were reanalyzed, looking separately at the recall of groups and the recall of words within groups. Both analyses were 2 x 3 analyses of variance with the same factors as above. The recall of groups varied as a function of concreteness, $F(1,11) = 90.4$, MSe = .36, and group size, $F(2,22) = 8.00$, MSe = .99, only. More concrete groups were recalled than abstract groups with mean proportions of .63 and .36 groups recalled, respectively. This level of recall is not very different from that found previously (mean proportions of .60 and .41 groups recalled respectively). Groups of size 2 and 3 were less well recalled in this experiment than groups of size 4 (mean proportions of .45 and .41 versus .63, respectively) which is quite different than the pattern found in the previous experiment (proportions of .60, .43 and .52 respectively).

Within-group recall also varied only as a function of concreteness, $F(1,11) = 21.4$, MSe = .31, and group size, $F(2,22) = 51.2$, MSe = .34. While words within concrete groups were better recalled than words within abstract groups (mean proportions of .92 and .72 words recalled respectively), they

were both higher and not as different as those in the previous experiment (proportions of .82 and .57, respectively). The recall of words within groups also varied less as a function of group size than in the previous experiment (mean proportions of .88, .73, and .85 words recalled in this experiment compared to .92, .64, and .64 words recalled previously). Finally, as noted previously, concreteness and group size did not interact in this analysis as they did in the previous experiment.

In summary, then, free recall is a function of concreteness and group size. Furthermore, although concreteness and group size interacted in the recall analysis, this effect did not persist in the analysis of group recall or in the analysis of within-group recall. As a result, one of the goals of this experiment, to unconfound the effects of concreteness and group size on within group recall, seems to have been fulfilled. More generally, it appears that when presentation time is left free to vary, subjects tend to equate the levels of integration within groups, within certain limits, for the various group sizes. Of some interest is the fact that this appears to enhance the recall of four word groups.

Cued Recall: Single Cues. The recall of words given a single cue was analyzed by a 2 x 2 x 3 analysis of variance with cueing (present or absent) as an independent factor, and concreteness and group size as repeated factors.

As before, the cued recall data were compared to the free recall data scored for the recall of all but the first word in each group. There were main effects of both concreteness, $F(1,22) = 107$, $MSe = 4.21$, and group size, $F(2,44) = 57.8$, $MSe = 4.77$. The recall of concrete words exceeded the recall of abstract words (proportions of .64 and .29, respectively), while recall increased as a function of group size from 5.0 out of 10, to 8.6 out of 20, to 14.5 out of 30 for group sizes 2 through 4, respectively. The main effect of grouping, however, should be interpreted with caution, since the values expected by chance are 4.68 out of 10, 9.27 out of 20, and 14.05 out of 30. The effects of concreteness and group size also interacted, $F(2,44) = 12.6$, $MSe = 3.11$. In this case, the recall of both concrete and abstract words increased as a function of group size, but this increase was more pronounced for concrete than abstract items. Finally, group size also interacted with cueing, $F(2,44) = 5.75$, $MSe = 4.77$. Cueing

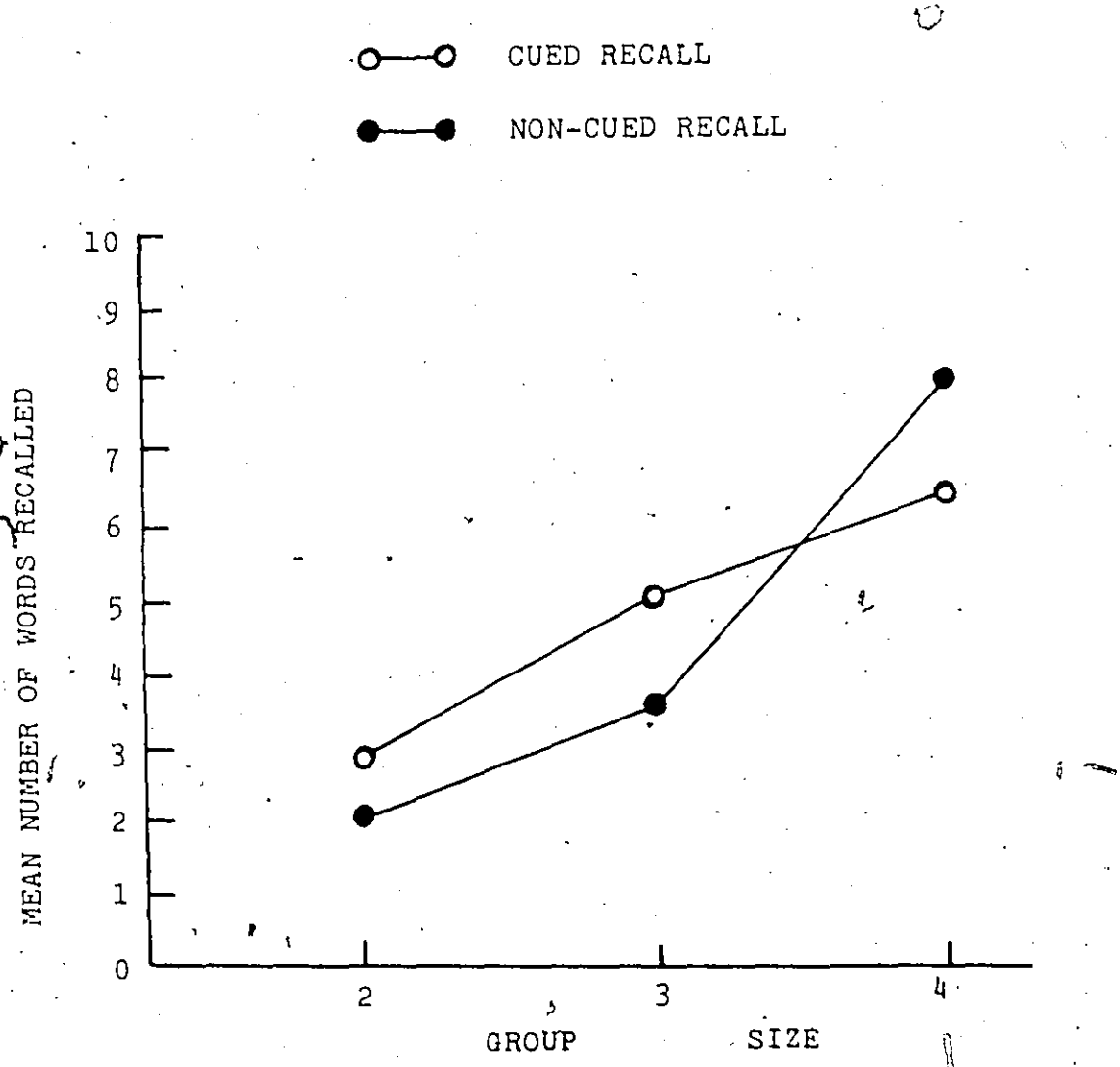
Figure 10 about here

facilitated the recall of words from 2 and 3 word groups, but for group size 4 non-cued recall exceeded cued recall (see Figure 10).

In summary, then, recall in this condition varied as a function of concreteness, group size and cueing. However, the increases in recall as a function of group size for both concrete and abstract items suggest that when presentation

FIGURE X

The Interaction of Group Size with Cued and Non-cued Recall in the Single Cue Condition (Experiment III).



time is left free to vary, abstract groups begin to acquire the integrative properties normally found with concrete items. This effect is reflected in the fact that no interaction between concreteness and cueing was obtained. However, cueing did have a negative effect on the recall of four word groups. This may be due to some kind of output interference, or may simply reflect the fact that subjects under conditions of free recall are able to access all the available 4 word groups. More will be said of this later.

Cued Recall: Multiple Cues. The cue size analysis for recall of last words was a 2 x 2 x 3 analysis of variance with the same factors as above. The cued recall data were compared to the free recall data scored for the recall of the last word in each group only. There were main effects of concreteness, $F(1,22) = 76.7$, $MSe = 1.24$, and cueing, $F(1,22) = 15.8$, $MSe = 3.34$. More concrete words were recalled than abstract words (proportions of .74 and .42, respectively), and cued recall exceeded non-cued recall (proportions of .70 and .46, respectively). Finally, cueing also interacted with group size, $F(2,44) = 5.32$, $MSe = .85$ (see Figure 11). In this

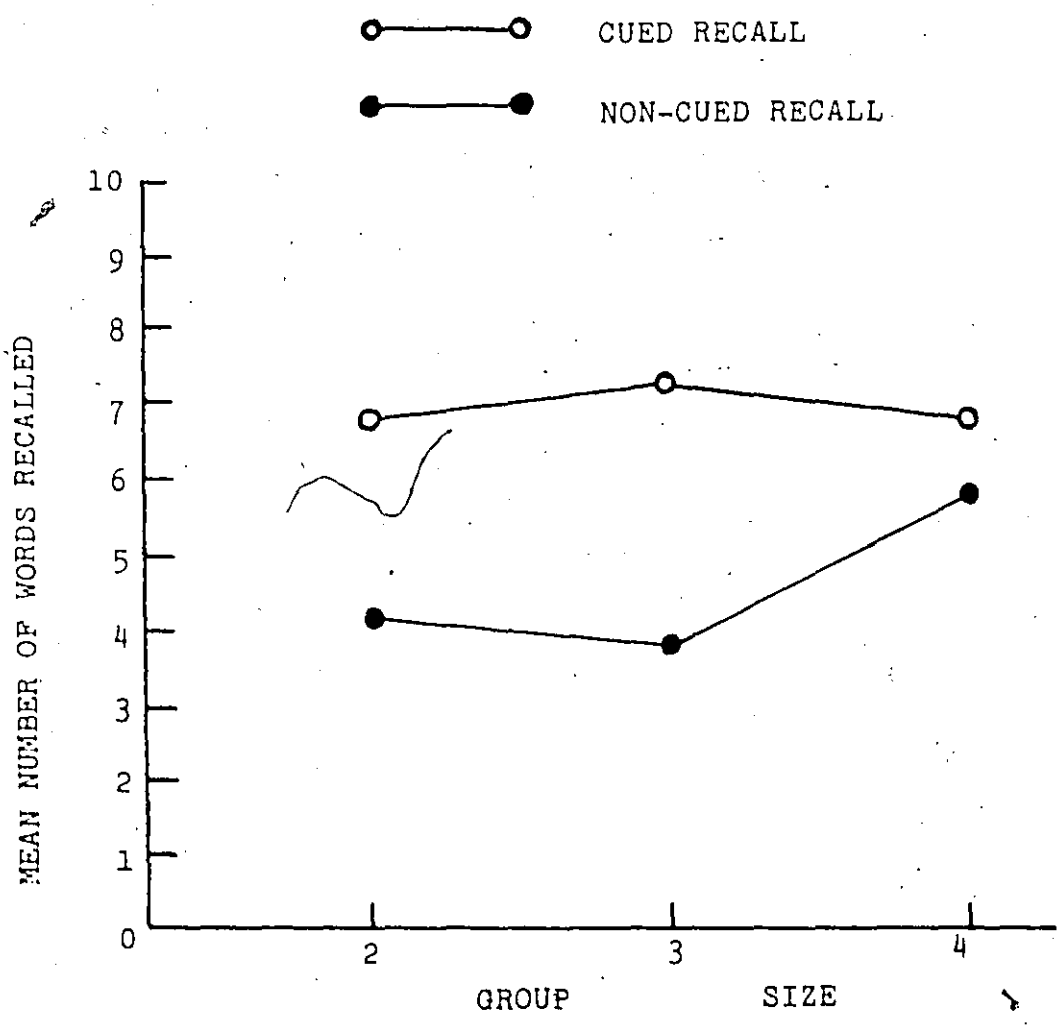
Figure 11 about here

case, cued recall was superior to non-cued recall in all cases, but was less facilitatory for group size 4 than for group sizes 2 and 3.

In summary, recall in this condition was a function

FIGURE XI

The Interaction of Group Size with Cued and Non-cued Recall in the Multiple Cue Condition (Experiment III).



of concreteness and cueing. As noted previously, the lack of a concreteness by cueing interaction suggests that the abstract groups in this experiment have acquired some of the integrative properties normally found with concrete groups. Furthermore, the main effect of cueing in this analysis, and the lack of any negative effects of cueing suggest that multiple cues are more effective than single cues. However, since the difference between single and multiple cues is nearly constant for all group sizes (see Figure 12), it is possible that the limitations

Figure 12 about here

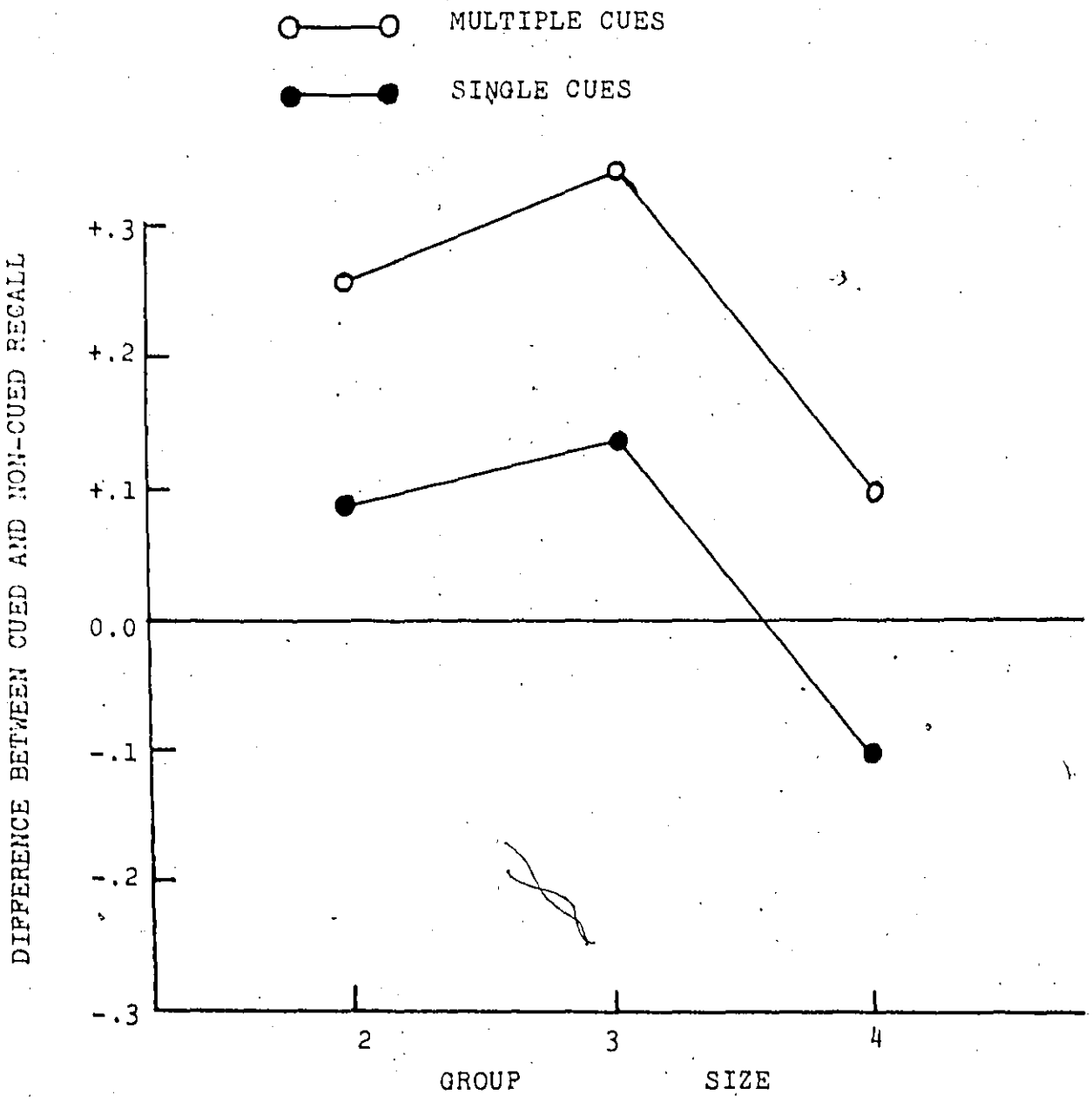
placed on the response set by multiple cues, as discussed in the last experiment, are a contributing factor. These limitations, though, can be viewed as an additional source of contextual information and as a result do not seriously affect the arguments being made here. Finally, these results strongly suggest that interference effects of the kind found by Roediger (1973) have no counterpart in these experiments. Such effects would, by definition, be more pronounced in a multiple cue situation than in a single cue situation.

Discussion

This third experiment has been most revealing. First, it provides additional evidence in support of the hypothesis that facilitation afforded concrete items is due to the differential processing these items receive. In this

FIGURE XII

The Difference Between Cued and Non-cued Recall in the Single Cue and Multiple Cue Conditions, Expressed in Proportions of the To-be-remembered Unit Recalled (Experiment III).



experiment, where presentation time was free to vary, it was found that abstract items began to acquire the integrative properties previously found for concrete items (e.g., Expt. II; Begg, 1972). The effects of this change are marked indeed, and are reflected in the lack of any concreteness by cueing interactions in this experiment.

The possibility of interference effects of the kind found by Roediger (1973) can also be ruled out. As noted previously, only in the multi-cue situation was there a main effect of cueing, and only in the single cue situation were there negative effects of cueing. However, these negative effects of cueing do suggest the presence of some kind of output interference. In order to account for these effects, the following tentative hypothesis is offered. Roediger (1973) found that output interference resulted when category members were provided as cues along with the category label itself. As a result, it seems likely that these interference effects are within-group effects due to loss of item discriminability caused by the experimenter-provided category members. However; additional interference effects may result when subjects can freely access all or most of the available groups formed at input. In contrast to the interference effects found by Roediger, this interference would affect the recall of groups rather than the recall of words within groups. In the multi-cued condition, these interference effects are then partially offset by the additional within-group facilitation

provided by multiple cues.

Finally, it is of some importance to attempt to account for facilitation of group recall afforded 4 word groups. Perhaps the simplest hypothesis would assume that each item in a group serves as a potential route of access to that group. Given that 44% of the words are from 4 word groups, it is, then, possible to account for this facilitation in the following way. If subjects randomly sample a word from the set of all to-be-recalled items, and then attempt to recall the items from the group in which that word occurred, there would be a strong bias in favour of the recall of 4 word groups. In fact, if all the to-be-recalled items were equally accessible, 44% of the groups recalled would be 4 word groups, compared to 33% for 3 word groups, and 22% for 2 word groups. This, of course, also requires the additional assumption that items are sampled without replacement. By further assuming that concrete items are more accessible than abstract items, this hypothesis can also account for the differences found in the levels of group recall for concrete and abstract items.

A different approach, in line with the work of Petersen (1974), however, considers the context of encoding as the critical factor in the process of group recall. In much the same way as a conceptual category has a label, a subjective category may have a common element or theme which serves as a superordinate referent to that category. These common elements may then serve as the basic units in a higher-

order retrieval scheme of some kind.

When applied to subjective organization, however, this approach also implies that the recall of groups and the recall of words within groups may not be independent processes. That is, the probability that such a superordinate referent is generated for a subjective category should increase with the overall degree of unitization within that group. If this is assumed to be true, however, it would explain why the recall of concrete groups is generally superior to the recall of abstract groups. It also suggests, as Peterson (1974) argued, that the critical variable influencing group recall is the associative strength of the relationship between the context and the to-be-recalled items, and is not related to concreteness in any direct way. Finally, this approach can be extended to account for the superior group recall of 4 word groups. In order to do this, one need only assume that the more processing a group receives, the more effective is the superordinate referent generated for that group. Note that this approach has much in common with the depth of processing notions (Craik and Lockhart, 1972) currently being developed in other areas of human memory research.

CHAPTER FIVE

Summary and Concluding Discussion

The present research has been concerned with subjective organization and the effects of concreteness and presentation groupings on this organization. In the first experiment different groups of subjects were presented with lists of words presented in groups of various sizes and differing in concreteness. The recall of these words was tested immediately, in a final free recall, and in a recall at a one week delay.

In general, presentation grouping appeared to have its effect primarily in short-term memory, while concreteness had its effect primarily in long-term memory. At longer retention intervals the concreteness effect persisted (cf. Begg and Robertson, 1973), while the effects of presentation grouping did not. As well, there was some evidence that the recall of concrete and abstract words did not differ following low levels of processing (cf. Craik and Lockhart, 1972) but differed considerably following higher levels of processing.

In the organizational analyses of category recall and within-category recall it was found that grouping items at presentation led to higher levels of within-category recall than did the presentation of items one at a time. These effects appeared to be due to the fact that subjects

rehearsed grouped items in non-overlapping sets. Presentation grouping, on the other hand, had no reliable effects on the recall of categories, although the group recall of singly presented items tended to exceed that of words presented in groups. Concreteness, however, facilitated both the recall of categories and the recall of words within categories. The facilitation of within-group recall was attributed to the availability of imagery, or at a concrete referent, for concrete words. Images, it was aruged, can be more readily combined to form well-integrated subjective units. The source of the facilitation of category recall, on the other hand, was more difficult to specify. This particular problem will be discussed in a later section of this chapter.

In the first experiment the evidence for the organizational effects of concreteness and grouping was largely inferential. As a result two subsequent experiments were conducted in order to test these effects more directly by the use of retrieval cues. In the second experiment subjects were presented with two, three and four word groups of concrete and abstract words. The recall of these groups was subsequently tested by free recall, by cued recall with a single word serving as a cue, or by cued recall with all but the last word in each group serving as a cue.

In free recall it was found that the recall of words from concrete groups increased as a function of group size while the recall of words from abstract groups remained

relatively constant. Subsequent analyses of category and within-category recall demonstrated that these effects could be attributed solely to the effects of concreteness on within-group recall. These results are comparable to results found by Begg (1972) and provide additional evidence in support of the hypothesis that concrete words are more readily organized into well-integrated subjective units than are abstract words. In free recall more words were recalled from groups of increasing size, but these values were not very different from those expected by chance.

In cued recall with single cues additional support was found for the conclusions drawn from the free recall results. As well, the effects of cueing on concrete items were positive and relatively constant across the various group sizes, while the effects of cueing on abstract items decreased with group size and actually became negative for group size four. There was no main effect of cueing, however. It was argued that the concrete groups were equally well integrated and that this equality in the degrees of integration was reflected in the effects of the retrieval cues. The degrees of integration for abstract groups, however, declined with group size and this produced the subsequent decline in the effects of retrieval cues. The negative effects of cueing can be accounted for in the following way. If at least some of the items provided as retrieval cues were neither available nor accessible, then these items rather than facilitating

recall actually interfere with recall by serving as distractors.

In cued recall with multiple cues the free recall results were again supported. However, in addition, there was a main effect of cueing, suggesting that in this experiment multiple cues were more effective than single cues. As previously, the effects of cueing on concrete groups of various sizes were positive and relatively constant. The effects of cueing on abstract groups declined as group size increased, but in this case never became negative. In general, the superiority of multiple cues over single cues can be attributed to at least two sources. If the groups encoded by subjects are not completely integrated, then providing more of a group as a cue should increase the probability that the remaining to-be-remembered items are associated with at least one of the cue words. Alternately, if the recall of subjectively organized units is viewed as a reconstructive process, then additional cues should increase the probability that the unit as a whole can be reconstructed. A third source of facilitation in this experiment is provided by the restrictions placed on the response set by multiple cues. That is, a single cue must come from a two word group, two cues from a three word group, and three cues from a four word group. However, in this experiment, this source of contextual information was ruled out as a major contributor to the overall levels of cued recall with multiple cues.

In the second experiment a serious constraint was

placed on the effects of cued recall as they related to both concreteness and grouping by the levels of integration established during acquisition. In order to rectify this situation a third experiment was conducted using the same list structure, but allowing subjects to control the presentation times for each group.

In free recall, more concrete and abstract words were recalled from groups of increasing size, but this increase was more marked for concrete than abstract groups. This result indicated that abstract groups, with sufficient amounts of processing time, begin to take on the integrative properties normally associated with concrete words. In the analyses of category and within category recall, the only effects were the main effects of concreteness and group size. This result was important, because it indicated that the confounding present in the previous experiment had been eliminated.

Cued recall with single cues provided additional evidence for the conclusions drawn from the free recall data. As well, there were no interactions of concreteness and cueing, although group size and cueing did interact. In this case, the effects of cueing were positive for group sizes two and three, but negative for group size four. Tentatively it was argued that the negative effects of cueing for group size four resulting from a situation is analogous to negative transfer. In this case, subjects have not only integrated the units to a considerable degree but have

established a retrieval system to aid in the recall of these units. The presentation of randomly ordered retrieval cues then disrupts the established retrieval plan and results in the loss of accessibility to some units.

Cued recall with multiple cues again supported the free recall data. As well, there was a main effect of cueing, and an interaction of cueing with group size. Cueing facilitated the recall of all group sizes but provided less facilitation for group size 4 than for group sizes two and three. As in the previous experiment, then, multiple cues appear to be more effective than single cues. Also note that the levels of integration found with abstract groups in this experiment have eliminated all interactions between concreteness and cueing. Finally, the facilitation provided by multiple cues was attributed to the same sources as found in experiment II, although the additional factor of response set limitation cannot be discounted in this experiment.

Concreteness, then, appears to have fairly general effects on organization, facilitating both the recall of groups and the recall of words within groups. The source of within-group facilitation appears to be the ease with which concrete words can be organized in well-integrated subjective units. It is important to note, however, that subjects, if given enough time, can organize abstract items to the same degree as concrete items. When this occurs, the abstract groups seem to function in much the same way as comparable concrete groups.

The source of the facilitation of group recall by concreteness remains unspecified in these experiments. For example, it is possible that concrete groups are better recalled because they are more highly integrated. Petersen (1974) has argued that the effectiveness of a retrieval cue is a function of the strength of the association between the cue and the to-be-recalled items. If this is true, then the better integrated a subjective unit, the better will be its subsequent cued recall. If some analogous process operates in free recall, the group recall should be dependent upon within-group integration.

Finally, presentation grouping appears to provide convenient processing units from which to build subjective units in memory. As with concreteness, one of the most interesting and as yet unanswered questions now centers on the means by which these groups are accessed. Again it would be of considerable importance to know if equally well integrated groups of various sizes are accessed equally well, or if perhaps some group sizes are accessed better than others.

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