THE EFFECT OF ITEM DISTANCE ON ORGANIZATION IN THE FREE RECALL OF WORDS

APPROVED:

Kevin J. Kennelly
Major Professor

Jack R. Hayes
Minor Professor

Harold A. Williams
Chairman of the Department of Psychology

Robert B. Toulouse
Dean of the Graduate School

THE EFFECT OF ITEM DISTANCE ON ORGANIZATION IN THE FREE RECALL OF WORDS

THESIS

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

James Hamilton Clay, B.A.
Denton, Texas
August, 1970

THE EFFECT OF ITEM DISTANCE ON ORGANIZATION IN THE FREE RECALL OF WORDS

The study of human memory has proven to be one of the most fruitful subjects of psychological research. Since the early work of Ebbinghaus (1913), the study of memory has gained in impetus to the point where it is now of major concern to the psychologist interested in verbal learning. One phenomenon of memory which has received extensive investigation is clustering (Bousfield, 1953; Jenkins & Russell, 1952).

By studying clustering, psychologists hope to gain knowledge of the effect of organization on memory. Bousfield (1953) is credited with the discovery of clustering (Adams, 1967, Shuell, 1969). That clustering is assumed to provide some measure of organizational processes in memory is reflected in a quotation from Bousfield's (1953) initial paper:

> The theoretical significance of this undertaking derived in part from the assumption that clustering is a consequence of organization in thinking and recall. If clustering can be quantified, we are provided with a means of obtaining additional information on the nature of organization as it operates in the higher mental processes (p. 229).

It appears that Bousfield first became aware of clustering while he and Sedgewick (1944) were studying characteristics

of sequences of associative responses. In their experiment, Ss were asked to list items in specified categories, e.g., animals, birds, and cities in the United States. In their recalls, Ss tended to respond with sequences of related items. For example, in listing birds, a sequence of birds of prey might be listed, and then followed by a sequence of domestic fowl. Having observed the phenomenon, Bousfield (1953) defined a cluster as "...a sequence of associates having an essential relationship between its members [p. 229]."

Experimental Treatment

With the introduction of clustering, researchers turned to free recall experiments to provide them with data. In free recall experiments, Ss are free to recall the test items in any order they wish. The conventional free recall experiment consists of two phases: (1) the input phase in which the test items are presented, and (2) the output phase in which the test items are recalled. The experiment can be designed to include one or more presentations in the input phase, or one or more recalls in the output phase, or any combination of these. One researcher (Cofer, 1967) has advocated the single-presentation condition as opposed to the multi-presentation situation in that "...it is more likely to represent free recall as it appears in daily life... [pp. 184-185]."

Test Materials

The literature on free recall suggests that Ss strive to structure the test items so as to facilitate recall

(Bousfield, 1953; Tulving, 1962), which is consistent with Bousfield's (1953) original contention regarding organizational processes. In free recall experiments utilizing words, two basic kinds have been used; words may be related through direct association or on the basis of some concept category, or words which appear to have no relation whatsoever may be used. An examination of approaches to free recall utilizing both of these categories of relatedness will reveal the nature of their use as test materials.

Beginning with the second category, words which appear to have no relation, two major methods of structuring have frequently been employed. The two methods are based on either the serial position of a word in the input phase of a list, or on the subjective organization of each individual S. Murdock (1962) has performed an experiment which illustrates structuring through the serial position of a word. In his experiment, Murdock presented lists of words to Ss which varied in length from ten to forty words per list. In the output phase, Ss tended to recall the words in the following order: words presented at the end of the list were recalled first; words presented at the first of the list were recalled next; and, words presented in the middle of the list were recalled last. This phenomenon is referred to as the serial position effect.

The second method of structuring apparently unrelated words, subjective organization, has been the subject of

considerable experimental research. One experimenter (Tulving, 1968) has defined subjective organization as "uninterrupted sequences of words in the recall protocols corresponding to a similar sequence in the input list [p. 9]." Tulving explains that

> ...subjective organization requires data from more than a single output phase, but it does not require that the experimenter know in advance of the experiment what items are to be grouped together. It is therefore, applicable to any set of items.
>
> Measures of subjective organization are defined in terms of the consistency of output orders, either for a single subject recalling the same material in two or more output phases or for a group of subjects recalling the same material in at least one output phase. When two or more items occur in close temporal contiguity in different output phases, they can be thought to represent elements of a larger S-unit which is being processed as a unit [p. 17].

The phenomenon of subjective organization has also been referred to as "chunking," and is more closely related to the subject matter of this thesis, clustering, than is the serial position effect. In clustering, the experimenter utilizes words which are related to one another.

In using related words, the experimenter has at his disposal considerable research data upon which to base his selection of test materials. The use of related words as test materials has been especially prevalent in experiments dealing with clustering (Bousfield, 1953; Bousfield, Cohen & Whitmarsh, 1958). The experimenter may also rely upon studies which have been done to determine the most frequent free associates to common English words (Palermo & Jenkins, 1964), and upon data

gathered by Thorndike and Lorge (1944) which show the relative frequency of occurrence of ordinary English words.

In designing clustering experiments, any of the above sources would be adequate. However, to draw words from past clustering experiments would probably permit a better comparison of the present study to studies already extant in the literature. Also, early research in the area of clustering has relied heavily upon the studies mentioned above, i.e., (Palermo & Jenkins, 1964; Thorndike & Lorge, 1944).

Associative Versus Concept Category as an Explanation

A review of the attempts to explain clustering will serve well as an illustration of its development. Two explanations have been generated in an attempt to account for clustering. The earliest of these was suggested by Bousfield (1953), and is based on his use of conceptual categories. The second explanation is based solely on associative strength between test words, and has received support from several investigators (Jenkins & Russell, 1952; Deese, 1959). Though both of these explanations have received considerable investigation, neither in their present form seems capable of completely accounting for clustering.

Bousfield's argument for conceptual categories as a basis for clustering is founded on Hebb's (1949) conception of the development of superordinate perceptions. Bousfield originally believed that a subordinate word from the category would activate the superordinate of the category, which in

turn would activate other subordinates. For example, the subordinate trout would activate the superordinate fish, which in turn would activate such subordinates as salmon, perch, shark, etc., thereby resulting in clustering. To accept the superordinate concept as an explanation is to assume the involvement of higher mental processes in mediating clustering. It is perhaps partially for this reason that other researchers sought a simpler explanation of the phenomenon, for clustering based only on associative strength requires no such assumption.

In Bousfield's (1953) initial experiment he used a list composed of sixty nouns, broken down into four different categories of fifteen words each: animals, names, professions, and vegetables. In quantifying clustering, he used what he called "repetitions," which were sequences of two or more words from the same category. After computing the number of repetitions that could be expected on the basis of chance alone, Bousfield found that Ss, in their recalls, produced significantly more repetitions than could be attributed to chance. In a similar study, Bousfield, Cohen, and Whitmarsh (1958) confirmed Bousfield's findings.

Jenkins and Russell (1952) were the first experimenters to investigate clustering on the basis of associative strength. In their list, twenty-four pairs of words were used from the Kent-Rosanoff Free Association Test (1910). Each pair was made up of a stimulus and its primary response, such as

MAN-WOMAN. The words were randomly presented, and the Ss showed a marked tendency to recall the words in the stimulus-response order. As a more complete check, the occurrence of both forward (stimulus-response) and reverse (response-stimulus) associations was computed. It was found that "Reversed associations....occurred significantly more than chance pairings but significantly less than the forward sequence [p. 821]." The mean number of words recalled was twenty-four, and of these, fifty percent were accounted for by forward and reverse associations. Though Jenkins and Russell did not deny Bousfield's explanation on the basis of concept category, they did imply that his findings could be accounted for on the basis of associations.

A subsequent study by Deese (1959) yielded results which seemed to challenge the concept category hypothesis, while supporting the associative explanation. In his experiment, Deese devised an index of associative relatedness which he called inter-item associative strength (IIAS); he defined IIAS as, "...the average relative frequency with which all items in a list tend to elicit all other items in the same list as free associates [p. 305]." The experiment consisted of eighteen lists of fifteen words each. The eighteen lists were further broken down into six groups of three lists each, and each group contained lists at three levels of IIAS; high IIAS; low IIAS; and, zero IIAS. In addition, a list name was presented with each list. For half of the Ss, the list

name was relevant to the other words in the list, while for the other half it was irrelevant. Deese's results, based on absolute number of words recalled, are as follows: for each level of IIAS the mean number of words recalled by the Ss presented with the inappropriate list name slightly exceeded the mean number of words recalled by the Ss presented with the appropriate list name, and the number of words recalled correlated .88 with the index of IIAS.

Cofer (1965) feels that Deese's (1959) results are partially responsible for causing Bousfield to shift from a superordinate to an associative explanation of clustering. However, both explanations of clustering have continued to be investigated. A recent experiment investigating clustering on the basis of superordination was performed by Underwood (1964).

Underwood presented four lists of sixteen words each to the same group of Ss. Lists one and four contained words of low inter-item similarity, while lists two and three contained words of high inter-item similarity; both lists two and three were further broken down into four items in each of four concept categories. The results revealed that thirty-eight percent of the recall protocols showed perfect recall for the high similarity lists, and only three percent showed perfect recall for the low similarity lists. In discussing the results, Underwood stated that

> ...In recall of the high-similarity lists, clustering was nearly perfect. Only five of the thirty-seven Ss

> might be said not to have shown extreme clustering. The other thirty-two Ss in general produced recall protocols in which all four items in a category were recalled together, then another four, and so on. The Ss were not told the number of items in the list, yet it was clear in many of the protocols that the S knew there were sixteen items and four instances of each of four concepts. No S ever gave five words from a concept. In seventy-four recalls only three showed a failure to recall any word from a category. That is, these three protocols showed perfect or nearly perfect recall for the twelve units forming three categories but no recall for the fourth. In several of the protocols in which fifteen items were given correctly, a blank space was left for the fourth item in the category. No S ever wrote down less than three items from a given category [p. 64].

This combination of findings caused Underwood to conclude that superordination rather than mere association accounted for the clustering he obtained. In arguing against an associative explanation, Underwood observed,

> That some relatively free association within the category might have occurred cannot be denied, but even this was probably minimal since relatively few intrusions occurred and since a number of protocols showed that the S knew that one more word was required for a given cluster but none was given. This failure in the latter instance could not possibly be because the S could not think of another unit that fitted the category; rather, it indicates a clear editing process [p. 65].

Recent experiments in associative clustering have been largely concerned with words which are not directly related. For example, A elicits B, B elicits C, but A does not elicit C; A and C are the words presented. Several studies have shown that clustering can be predicted on the basis of the extent to which words elicit common associates. Bousfield, Steward, and Cowan (1964) suggest that "...clustering in a categorized list can be predicted better with an index of

associative overlap, that is, the extent to which the words elicit common responses, than by means of an index of inter-item associations, that is, the extent to which the items in the list elicit one another [Shuell, 1969, p. 366]."

Marshall (reported in Cofer, 1965) performed an experiment to investigate both superordination and association as they affect clustering. He created six lists from a Mutual Relatedness Index (MR) which is based on all the associations that any two words of the list have in common. The pairs of a list, having approximately the same number of associates in common, were at the same MR level. Each list contained six categorized, and six uncategorized (related through direct association) pairs of words. Marshall used six levels of MR, from low to high, and a different group of Ss for each MR level. Each list was given four trials and clustering was calculated on the basis of repetitions (Bousfield, 1953). Cofer (1965) explained that the results indicated that superordination accounted for "...from twenty percent to forty percent of the clustering obtained at the three lowest MR levels, but account for virtually none of it at the higher MR values [p. 268]." In interpreting the results, Marshall held that superordination and association interacted in such a way that at the lower MR levels superordination was significantly superior in facilitating clustering, while at the higher MR levels, the effect was neutralized.

It appears, therefore, that both association and superordination are at least partially responsible for clustering. In that a word is likely to be given as a free associate to a stimulus word, clustering on the basis of association is likely to result. When words are used which are not likely to elicit one another as free associates but which are all members of the same category, clustering on the basis of superordination is likely to be obtained. In recognizing a need to distinguish between these two opposing hypotheses, Bousfield, Steward and Cowan (1964) have stated, "There is the question of whether organization of verbal responses can be explained in terms of relatively simple associative connections between words, or whether it is necessary to invoke an additional principle such as superordination [p. 206]." In regard to the heuristic value of studying these two paradigms, Tulving (1968) has concluded, "...The attempts to distinguish between associative and mediational mechanisms of clustering, even if only to assess their relative effects in various learning processes are futile in the present state of the art [p. 19]."

Variables Affecting Clustering

The early work in clustering was primarily concerned with the question of association versus superordination as an explanation. More recently, experimenters have investigated the effects of many different variables upon clustering.

Some of the variables include the number of categories used; exhaustive versus nonexhaustive categories; single trial versus multitrial presentation; changes in organization and recall as a function of time; and the role of context (Shuell, 1969). Some of the variables which are relevant to the present study will be considered here.

Blocked versus random presentation. In blocked presentation the words belonging to a particular category are presented contiguously. For example, all the words of one category are presented before the words of another category. However, the order of presentation of both categories and words within a category can be varied if multitrial presentation is used. The early studies of clustering used random presentation, often placing restrictions upon the number of words from a category that could be presented together (Shuell, 1969).

In two recent studies, both Dallett (1964) and Puff (1966) obtained superior recall when blocked presentation was used. Dallett found that the two modes of presentation interacted with the number of categories used, such that the greatest difference occurred in the condition in which there were three words per category. In Puff's study he presented lists which contained either zero, nine, eighteen, or twenty-seven repetitions. His results indicate that both recall and clustering are directly related to the number of repetitions presented. A quotation from a recent article by Shuell

(1969) will illustrate the current position of blocked presentation:

> Blocked presentation is frequently considered to be more effective than random presentation for helping the subject perceive the categorized nature of the list. This is thought to be particularly true for lists comprised of low-frequency associates to the category name and for categories with only a few items [p. 363].

Cued recall. In cued recall, Ss are provided with cues which are either related or unrelated to the words used in the experiment. The cue may be presented in the output phase in an attempt to facilitate recall of the words presented in the input phase. For example, a categorized list of animal names might be presented, and at the beginning of the output phase the word ANIMAL would be given as a cue. It has been found that when Ss are provided with related cues recall is facilitated (Tulving & Pearlstone, 1966; Tulving & Osler, 1968).

In a recent study, Tulving and Pearlstone (1966) demonstrated the effectiveness of cues in facilitating recall. The presented Ss with what they called words to be remembered (TBR) either in the presence or absence of category names (cued recall). The category names they used as cues were high associates to the other words in the list, and were again presented to Ss in the cued condition at the beginning of the output phase. The results indicated

that the cued condition significantly facilitated recall of the TBR words.

In a subsequent study, Tulving and Osler (1968) investigated the effect of using words that are only weakly associated with the TBR words as cues. Ss were presented with twenty-four TBR words under nineteen different conditions; the different conditions were based on various combinations of cue presentation. Some of the conditions which are considered relevant to the present study are as follows: TBR words were presented and recalled in the absence of cues; TBR words were presented and recalled in the presence of the same cue; and TBR words were presented and recalled in the presence of different cues. The results indicate that the use of cues which are only weakly associated with the TBR words does facilitate recall; cued recall was approximately seventy percent higher than noncued recall. When a different cue was presented in the output phase than was presented in the input phase, even though it was equally related, recall was not facilitated.

In another study, Earhard (1967a) investigated the effect of cued recall upon clustering. Her experiment consisted of two conditions. In one condition, all the words began with the same letter, and in the other condition all the words began with a different letter. In the cued condition, the Ss were informed of the alphabetic nature of the list. Her findings indicated that cued recall for categorized

lists was effective only when fewer than six or seven items per category were presented.

The von Restorff Effect. Though clustering has not been concerned with this particular variable, it is here considered because of its relevance to the present study. The von Restorff effect is simply the tendency of Ss to recall an item due to its "perceptual uniqueness" in the context of other items. That this effect will facilitate recall is reflected in a statement by Deese, and Hulse (1967), "It has been known for a long time that a unique item in an otherwise homogeneous series of items will be learned more rapidly [p. 290]." An example of the von Restorff effect would be the condition in which a series of nonsense syllables are presented in context with a single meaningful word. In the present study the von Restorff effect was considered relevant because it mediated a cued recall situation as previously discussed.

Purpose of the Study

The purpose of the present study was suggested by Tulving in a recent article (1968). Specifically, the purpose of the study was to investigate the effect of item distance (ID), which is defined as the absolute number of words separating a single item from the other items of the category, upon clustering of the removed item. The categorized items were presented in blocked fashion, and the single

item was removed from the other items of the cluster: zero words, five words, ten words, or twenty words. The effect of a second independent variable, inter-item associative strength (IIAS), was studied so that each ID was studied at each of three levels of IIAS: High, Low, and Zero.

The literature on clustering suggests that clustering increases as IIAS increases (Deese, 1959). In the present study an interaction is expected between the two independent variables, ID and IIAS, such that in the High IIAS condition greater clustering of the removed word will occur, with the effect of ID being negligible; and in the Low IIAS condition ID will affect clustering of the removed word so that as ID increases, clustering of the removed word will decrease. In the Zero IIAS condition insignificant clustering of the removed word is expected.

Hypotheses

In keeping with the theories presented in this section, and the purpose of this study, the following hypotheses are made:

(1) It is hypothesized that the probability of the removed word being recalled contiguously with another word from the category cluster will be significantly greater in the High inter-item associative strength conditions.

(2) It is hypothesized that the probability of the removed word being recalled contiguously with another word from the category cluster will increase as item distance decreases in the Low inter-item associative strength conditions.

Method

Design and Subjects

The study involved four IDs (zero, five, ten, and twenty) X three levels of IIAS (High, Low, and Zero). Ss were assigned to each of the twelve conditions of the experiment in blocks of twelve, with one S per experimental condition per block. The running order of conditions within each block was determined by a table of random numbers. Assignment to conditions was on the basis of the Ss' order of appearance in the laboratory. Ss were run individually. The Ss (N=240) consisted of students taking courses in psychology at North Texas State University.

Lists

Words were selected by two methods. To begin with, thirty-four of the words were randomly selected, and they were believed to be unrelated to the other words of the lists in the sense that no single item was given as a free associate to any other item according to the Minnesota Word Association Norms (Palermo and Jenkins, 1964). However, a possible artifact occurred which will be discussed later. The purpose of these thirty-four words was to serve as buffer items (the category cluster was imbedded within these thirty-four words), and at the same time to allow for the independent variable, ID, to be investigated. Since six-word category clusters were used, during any single input phase there were

forty words presented. By utilizing relatively long lists of forty words each, the effect of isolating an item from the category proper could be studied at different significant distances. These thirty-four random words were used in all the lists of the experiment.

There were three different six word category clusters used. The category clusters were selected on the basis of IIAS. In selecting the words comprising the three category clusters, use was made of lists constructed for an earlier experiment by Deese (1959). In his experiment, Deese constructed fifteen-word categories using words from the Minnesota Word Association Norms. His categorized lists were based on three levels of IIAS: High, Low, and Zero. The present experiment utilized both his IIAS levels and portions of his stimulus words. Deese used eighteen fifteen-word lists which were further broken down into six conceptual categories: butterfly, slow, music, whistle, command, and chair. Within each category three lists were constructed based on the three previously mentioned levels of IIAS. The current experiment used portions of the three lists which comprised the conceptual category command in Deese's experiment; six words were selected from each of the three lists. Table 1 shows the thirty-four random words and three category clusters that were used. There was only one category cluster used in each list.

In order to study the independent variable, ID, four

TABLE 1

LIST OF RANDOM AND CATEGORY CLUSTER WORDS*

High Inter-item Associative Strength			
0 Words Away	5 Words Away	10 Words Away	20 Words Away
Salt	Salt	Salt	Salt
White	White	White	White
Find	Find	Find	Find
Thirsty	Thirsty	Thirsty	Thirsty
Cheese	Cheese	Cheese	Cheese
Now	Now	Now	Now
Citizen	Citizen	Citizen	Citizen
Command	Command	Command	Command
General	General	General	General
Attention	Attention	Attention	Attention
Officer	Officer	Officer	Officer
Soldier	Soldier	Soldier	Soldier
Army	Long	Long	Long
Long	Scissors	Scissors	Scissors
Scissors	Justice	Justice	Justice
Justice	Guns	Guns	Guns
Guns	Sickness	Sickness	Sickness
Sickness	Army	Deep	Deep
Deep	Deep	Cars	Cars
Cars	Cars	Music	Music
Music	Music	From	From
From	From	Heavy	Heavy
Heavy	Heavy	Army	Chair
Chair	Chair	Chair	Although
Although	Although	Although	Wish
Wish	Wish	Wish	Him
Him	Him	Him	Earth
Earth	Earth	Earth	Younger
Younger	Younger	Younger	Afraid
Afraid	Afraid	Afraid	Easier
Easier	Easier	Easier	Bath
Bath	Bath	Bath	Anger
Anger	Anger	Anger	Army
Jump	Jump	Jump	Jump
Doors	Doors	Doors	Doors
Mutton	Mutton	Mutton	Mutton
Tobacco	Tobacco	Tobacco	Tobacco
Dogs	Dogs	Dogs	Dogs
Priest	Priest	Priest	Priest
Fruit	Fruit	Fruit	Fruit

*Underlined words denote category cluster items.

TABLE 1--continued

Low Inter-item Associative Strength			
0 Words Away	5 Words Away	10 Words Away	20 Words Away
Salt	Salt	Salt	Salt
White	White	White	White
Find	Find	Find	Find
Thirsty	Thirsty	Thirsty	Thirsty
Cheese	Cheese	Cheese	Cheese
Now	Now	Now	Now
Citizen	Citizen	Citizen	Citizen
Command	Command	Command	Command
Head	Head	Head	Head
Direct	Direct	Direct	Direct
Sword	Sword	Sword	Sword
Firm	Firm	Firm	Firm
Change	Long	Long	Long
Long	Scissors	Scissors	Scissors
Scissors	Justice	Justice	Justice
Justice	Guns	Guns	Guns
Guns	Sickness	Sickness	Sickness
Sickness	Change	Deep	Deep
Deep	Deep	Cars	Cars
Cars	Cars	Music	Music
Music	Music	From	From
From	From	Heavy	Heavy
Heavy	Heavy	Change	Chair
Chair	Chair	Chair	Although
Although	Although	Although	Wish
Wish	Wish	Wish	Him
Him	Him	Him	Earth
Earth	Earth	Earth	Younger
Younger	Younger	Younger	Afraid
Afraid	Afraid	Afraid	Easier
Easier	Easier	Easier	Bath
Bath	Bath	Bath	Anger
Anger	Anger	Anger	Change
Jump	Jump	Jump	Jump
Doors	Doors	Doors	Doors
Mutton	Mutton	Mutton	Mutton
Tobacco	Tobacco	Tobacco	Tobacco
Dogs	Dogs	Dogs	Dogs
Priest	Priest	Priest	Priest
Fruit	Fruit	Fruit	Fruit

TABLE 1--continued

Zero Inter-item Associative Strength			
0 Words Away	5 Words Away	10 Words Away	20 Words Away
Salt	Salt	Salt	Salt
White	White	White	White
Find	Find	Find	Find
Thirsty	Thirsty	Thirsty	Thirsty
Cheese	Cheese	Cheese	Cheese
Now	Now	Now	Now
Citizen	Citizen	Citizen	Citizen
Command	Command	Command	Command
Oven	Oven	Oven	Oven
Fight	Fight	Fight	Fight
Shed	Shed	Shed	Shed
Class	Class	Class	Class
Add	Long	Long	Long
Long	Scissors	Scissors	Scissors
Scissors	Justice	Justice	Justice
Justice	Guns	Guns	Guns
Guns	Sickness	Sickness	Sickness
Sickness	Add	Deep	Deep
Deep	Deep	Cars	Cars
Cars	Cars	Music	Music
Music	Music	From	From
From	From	Heavy	Heavy
Heavy	Heavy	Add	Chair
Chair	Chair	Chair	Although
Although	Although	Although	Wish
Wish	Wish	Wish	Him
Him	Him	Him	Earth
Earth	Earth	Earth	Younger
Younger	Younger	Younger	Afraid
Afraid	Afraid	Afraid	Easier
Easier	Fasier	Easier	Bath
Bath	Bath	Bath	Anger
Anger	Anger	Anger	Add
Jump	Jump	Jump	Jump
Doors	Doors	Doors	Doors
Mutton	Mutton	Mutton	Mutton
Tobacco	Tobacco	Tobacco	Tobacco
Dogs	Dogs	Dogs	Dogs
Priest	Priest	Priest	Priest
Fruit	Fruit	Fruit	Fruit

distances which the single item was removed from the category proper were selected. Distances were the following: zero words away, in which all the items of the category were presented contiguously; five words away, in which five of the category items were presented contiguously (hereafter identified as the category proper) and five buffer words intervened between the removed word and the category proper; ten words away, in which ten buffer words intervened between the removed word and the category proper; and twenty words away, in which twenty buffer words intervened between the removed word and the category proper. These four ID conditions were presented at each of the three IIAS levels. Attention is called to a possible artifact in the experiment, which is discussed below. It is noted here because of the influence it may have had on the interpretation of ID effects.

A possible artifact occurred in that one of the thirty-four buffer words, GUNS, was discovered to be related to the six words of the category cluster. Inclusion of the word was accidental, and it was not realized that it was strongly associated to the cluster words until the end of data collection. Since it is an associate to the six words of the category cluster according to the Minnesota Word Association Norms (Palermo and Jenkins, 1964), it was designated as an additional category member. Because this alteration was necessary, the nature of the lists was changed in two ways: the four distances, as originally conceived, were changed

in light of the position in the list of the new category member; and the ratio of category to buffer words was changed from 6:34 to 7:33.

As a consequence the ID for each condition was recalculated in the following manner: the number of words intervening between the removed word and each word of the category was totaled and then divided by the number of category items, minus one, to yield an average distance. Since the word GUNS was always three words away from the last word of the category proper, the revised distances were consistent throughout. The following example will serve to illustrate the method used to arrive at the revised IDs: in the five words away condition, the number of words which intervene between the removed word and the category members are one, five, six, seven, eight and nine, which, when totaled and averaged, yield a distance measure of 6.00. Therefore, the revised IDs are as follows: zero words away becomes 2.17 words away; five words away becomes 6.00 words away; ten words away becomes 11.00 words away; and twenty words away becomes 21.00 words away. Even though the actual IDs do not correspond to those intended they will continue to be identified by their original values, i.e., zero, five, ten and twenty words away.

Apparatus

The words comprising the twelve lists were all presented through a Wollensak 3M tape recorder (model number 1520).

It was necessary for each S to recall the removed word in order to study ID. Therefore, a technique was introduced to satisfy this requirement. An electric light bulb was flashed quickly on and off to signal the presentation of the removed word. The light flash occurred during the interval separating the removed word and the word presented immediately before the removed word. Each S was instructed to be sure to remember the word immediately following the light flash, in order to insure its recall in the output phase. The apparatus used to signal presentation of the removed word consisted of an electric light bulb attached to a wooden box. The wooden box was nineteen and one half inches long, twelve inches wide, and eight and one half inches deep. The light was attached at the center of the base of the box and was placed in a position facing the S. The light was operated by a string which was concealed from the S in order to prevent any distraction to the S.

Procedure

Upon reporting to the experimental situation, each S was given the following instructions:

> Soon you will be presented with a long list of words. You are to listen carefully and try to remember each word. I will let you know when the last word has been presented. At that time, begin writing as many of the words as you can remember. You may recall the words in any order you wish. At some point during the presentation of the list, a light will flash on and off one time. Please try your best to remember the word which follows immediately after the light flash.

> On your desk you will find a sheet of paper. Please fill up the left column of the paper first. When I turn on the tape recorder you will hear a tone, and five seconds later the first word will be presented. Remember, it makes no difference in what order you recall the words. Are there any questions?

At this point, if there were no questions, the experiment began. It required about five minutes to collect the data on each S.

The words were spoken in a monotone voice, and were presented to the Ss in a single input phase and were recalled in a single output phase. The rate of presentation was three seconds per word, which is consistent with past experimental work dealing with clustering (Bousfield, 1953; Bousfield, Cohen and Whitmarsh, 1958). In all conditions of the experiment, the category proper preceded the removed word in the list.

Results

Because of the failure of several Ss to recall either the removed word or any other word from the category cluster in the Low and Zero IIAS conditions, the original primary purpose of the experiment, investigating three IIAS levels X four IDs as they affected clustering of the removed word, had to be abandoned. It was decided that a two-dimensional analysis of variance with unequal cell frequencies was inappropriate since the unequal cell frequencies varied systematically with IIAS. However, all of the Ss in the High IIAS

condition recalled the removed word and at least one other word from the category cluster, making investigation of the effect of ID on clustering of the removed word in the High IIAS condition possible with a simple analysis of variance. Clustering of the removed word is defined as recalling the removed word contiguously with any other word from the cluster. An inspection of Table 2 shows that significant

TABLE 2

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR CLUSTERING OF THE REMOVED WORD

Source of Variation	df	Mean Square	F
Between Methods	3	18.35	2.44
Experimental Error	76	7.51	

results were not obtained, $F(3,76)=2.74$, $p>.05$. The means and standard deviations are presented in Table 3.

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR CLUSTERING OF THE REMOVED WORD

	ID			
	0	5	10	20
		High IIAS		
Mean	2.40	3.05	.95	2.90
SD	2.74	3.29	1.53	2.79

A number of other measures for which data for all Ss and conditions of the experiment were available were also analyzed: clustering of the categorized items, number of cluster words recalled, and the total number of words recalled. The effect of ID and IIAS upon each of these three dependent variables was analyzed in a separate three (IIAS) X four (ID) analysis of variance.

Clustering of the Categorized Items

Clustering of the designated cluster items (RR) was determined by the number of category clusters that occurred. For example, if COMMAND, ARMY, and GENERAL are recalled contiguously, COMMAND and ARMY is one cluster, and ARMY and GENERAL is another cluster. The summary of the analysis of variance of the RR data is presented in Table 4, and the means and standard deviations are presented in Table 5. The analysis of variance indicates that there was a significant effect due to ID, $F(3,228)=2.60$, $p<.05$. IIAS also produced a significant effect on RR, $F(2,228)=4.61$, $p<.01$. The interaction effect was not significant, $F(6,228)=2.10$, $p>.05$.

TABLE 4

SUMMARY OF ANALYSIS OF VARIANCE FOR RR

Source of Variation	df	MS	F
A (ID)	3	1.83	2.86**
B (IIAS)	2	46.38	72.16**
AB	6	.94	1.47
Within Cells	228	.64	

TABLE 5

MEANS AND STANDARD DEVIATIONS FOR RR

	ID			
	0	5	10	20
		High IIAS		
Mean	1.20	1.30	2.10	1.75
SD	1.02	1.00	.94	1.26
		Low IIAS		
Mean	.20	.25	.30	.30
SD	.68	.54	.64	.46
		Zero IIAS		
Mean	.20	.30	.40	.30
SD	.40	.64	.73	.51

A Newman-Keuls test was done to determine which ID treatment means were significantly different. The Newman-Keuls test indicated that a significant difference, $p<.05$, was obtained only between the zero words away ($\bar{X}=10.67$) and ten words away ($\bar{X}=18.67$) conditions. A second Newman-Keuls test indicated that significant differences, $p<.01$, existed between the High IIAS condition ($\bar{X}=31.75$) and both the Low ($\bar{X}=5.25$) and Zero ($\bar{X}=5.50$) IIAS conditions, while the difference between the Low and Zero IIAS conditions was not significant.

Number of Cluster Words Recalled

The number of designated cluster items recalled (NC) was also analyzed in a three X four analysis of variance. The summary of the analysis of variance of the NC data is

presented in Table 6, and the means and standard deviations in Table 7. As can be seen in Table 6, the only significant effect was due to IIAS, $F(2,228)=4.61$, $p<.01$. Neither the effect of ID, $F(3,228)=2.60$, $p>.05$, nor the interaction

TABLE 6

SUMMARY OF ANALYSIS OF VARIANCE FOR NC

Source of Variation	df	MS	F
A (ID)	3	1.60	1.38
B (IIAS)	2	48.66	41.95**
AB	6	1.37	1.18
Within Cells	228	1.16	

TABLE 7

MEANS AND STANDARD DEVIATIONS FOR NC

	ID			
	0	5	10	20
		High IIAS		
Mean	3.50	3.45	4.00	4.00
SD	1.07	1.02	1.00	1.18
		Low IIAS		
Mean	2.15	2.40	2.25	2.65
SD	.91	.58	1.48	.91
		Zero IIAS		
Mean	2.20	2.60	2.70	2.15
SD	.98	1.02	1.27	.96

effect, $F(6,228)=2.10$, $p<.05$, was significant. A Newman-Keuls test indicated that a significant difference, $p<.01$,

occurred between the High ($\bar{X}$=74.75) and Low ($\bar{X}$=47.25), and High and Zero ($\bar{X}$=48.28) IIAS conditions, while the difference between the Low and Zero IIAS conditions was not significant.

Total Number of Words Recalled

The total number of words recalled (R) was also analyzed in a three X four analysis of variance. The summary of the analysis of variance of the R data is presented in Table 8, and the means and standard deviations are shown in Table 9. The analysis of variance indicates that neither ID, $F(3,228)=2.60$, $p>.05$, nor IIAS, $F(2,228)=3.00$, $p>.05$, nor the interaction between ID and IIAS, $F(6,228)=2.10$, $p>.05$, was significant. A summary of the above detailed results is presented in Table 10.

TABLE 8

SUMMARY OF ANALYSIS OF VARIANCE FOR R

Source of Variation	df	MS	F
A	3	11.44	.87
B	2	35.29	2.69
AB	6	19.71	1.50
Within Cells	228	13.14	

TABLE 9

MEANS AND STANDARD DEVIATIONS FOR R

	ID			
	0	5	10	20
		High IIAS		
Mean	14.60	12.45	13.10	11.85
SD	3.72	2.77	3.56	3.40
		Low IIAS		
Mean	11.15	11.85	11.60	12.15
SD	3.09	3.15	3.79	3.97
		Zero IIAS		
Mean	12.55	13.3	11.05	11.70
SD	4.19	3.95	2.96	3.59

TABLE 10

SUMMARY OF RESULTS

Clustering of the Removed Word	
Independent Variable	Level of Significance
ID	Nonsignificant
Ratio of Repetition	
Independent Variable	Level of Significance
ID	.05
IIAS	.01
Interaction	Nonsignificant
Number of Cluster Words Recalled	
Independent Variable	Level of Significance
ID	Nonsignificant
IIAS	.01
Interaction	Nonsignificant
Total Number of Words Recalled	
Independent Variable	Level of Significance
ID	Nonsignificant
IIAS	Nonsignificant
Interaction	Nonsignificant

Discussion

The results indicate that, at least in the High IIAS condition, ID did not significantly affect clustering of the removed word. However, ID was found to affect RR, and IIAS was found to affect both RR and NC.

Of the four IDs (zero, five, ten and twenty words away), the only significant difference between ID treatment means was found to exist between zero and ten words away, with the ten words away condition producing significantly superior RR. This effect of ID on RR was due primarily to the High IIAS condition. The effect of ID on RR may be explicable by noting that the removed word appears to function as a cue which facilitates RR. The ability of cueing to effectively facilitate recall has been demonstrated in earlier work (Tulving and Pearlstone, 1966; Tulving and Osler, 1968). Tulving et al presented Ss with a related cue word at the beginning of the output phase. Their results indicated that the Ss who were presented with a cue word produced significantly greater recall than the Ss who were not presented with a cue word. In regards to RR, it seems feasible to contend that, especially in the High IIAS condition, the Ss were reminded of the categorized nature of the lists by the presentation of the cue (removed) word. The removed word perhaps served to activate a superordinate cluster name, resulting in superior recall of the items belonging to the cluster.

It appears that there is an optimal distance for a removed word to facilitate RR. The present results indicate that this distance is somewhere around six words away. An inspection of the structure of the experimental lists will reveal that there are, essentially, three ID conditions: the removed word is very close to another cluster word, the removed word is moderately close to another cluster word, or the removed word is far away from another cluster word. In the zero and five words away conditions, the removed word is either zero or one word away from another cluster word (due to the position of the word GUNS). In the ten words away condition, the removed word is six words away from another cluster word. In the twenty words away condition, the removed word is sixteen words away from another cluster word.

The following tentative explanation is offered in an attempt to account for the superior RR produced by the moderately close ID condition. In the twenty words away condition, the sixteen intervening words are beyond the average human memory span (Miller, 1956). Therefore, the Ss in the twenty words away condition may have experienced more difficulty in recognizing the relation between the removed item and the temporally distant other cluster items than the Ss in the ten words away condition. In the zero and five words away conditions, since the removed word was presented very close to the other cluster words, the Ss may

have switched their attention, expecting another cluster of words to be presented. In the ten words away condition, the six words that set the removed word off from the nearest cluster word provide enough of a gap to give the removed item a unique emphasis. Whatever is the cause of this phenomenon, however, the results indicate that a related word can serve effectively as a cue for the recall of a cluster in the input phase as well as in the output phase.

The effect of High IIAS upon RR and NC closely replicate earlier results obtained by Deese (1959). In his experiment, however, Deese obtained significantly greater recall for Low IIAS over Zero IIAS. In the present experiment a significant difference was not obtained between Low and Zero IIAS. This result is probably due to the fact that, in the present experiment, only seven of forty words are related in each list, while in Deese's experiment all of the fifteen words in each list were related.

Neither ID nor IIAS significantly affected R. That IIAS did not significantly affect R is a surprising result in the light of past experimental work. Deese (1959) found that IIAS correlated .88 with recall. This result may also be due to the fact that only seven of forty words were related in the lists of the present experiment, while all of the fifteen words of Deese's lists were related. Miller (1956) hypothesized that Ss can recall only a limited number of units, and that an increase in recall over successive

trials reflects the increasing size of each individual unit. In the High IIAS lists, the seven categorized items should have been processed as a single unit. Had this phenomenon occurred, the Ss in the High IIAS condition should have recalled more words than the Ss in the Low or Zero IIAS conditions. This is true since the seven categorized items in the High IIAS condition should have been processed as a single unit, while the seven designated category items in the Zero IIAS condition should have been processed as seven units. Thus, the High IIAS condition should have provided a reduction in the mnemonic load for the Ss since they were required to remember fewer chunks than in the Zero or Low IIAS conditions. There is, however, no evidence of any such facilitating factor operative in the present study. Remembering items was apparently just as difficult when the list had a High IIAS cluster in it as when a Low or Zero IIAS cluster was contained in it.

In summary, the present study was designed to investigate the effect of removing a cluster item, during the input phase, upon the clustering of the removed word during the output phase. Four different distances the word was removed (ID) were studied at three levels of inter-item associative strength (IIAS). Since a number of the Ss failed to remember items from the cluster, the effect of ID on clustering of the removed word could only be studied in the High IIAS condition.

A simple analysis of variance indicated that the effect of ID was not significant.

Three X four analyses of variance were also performed on each of three other dependent variables: clustering of the categorized items (RR), recall of the categorized items (NC), and the total number of words recalled (R). For the dependent variable, R, neither ID, IIAS, nor their interaction produced a significant effect. The effect of IIAS on both RR and NC was significant, while ID significantly affected only RR. The effect of IIAS on RR and NC closely duplicate results obtained in earlier experimental work. The effect of ID on RR appears to be an instance of facilitation by a cue in the input phase. Previous experimental work indicates that a cue word presented in the output phase facilitates recall. Possible reasons for the obtained results have been discussed.

References

Adams, Jack A., Human Memory. New York: McGraw Hill Book Company, 1967.

Bousfield, W. A., The occurrence of clustering in the recall of randomly arranged associates. Journal of General Psychology, 1953, 49, 229-240.

Bousfield, W. A., Cohen, B. H., and Whitmarsh, G. A., Associative clustering in the recall of words of different taxonomic frequencies of occurrence. Psychological Reports, 1958, 4, 39-44.

Bousfield, W. A., and Sedgewick. An analysis of sequences of restricted associative responses. Journal of General Psychology, 1944, 30, 149-165.

Bousfield, W. A., Steward, J. R., and Cowan, T. M. The use of free associational norms for the prediction of clustering. Journal of General Psychology, 1964, 70, 205-214.

Cofer, Charles N. On some factors in the organizational characteristics of free recall. American Psychologist, 1965, 20, 261-272.

Cofer, Charles N. Does conceptual organization influence the amount retained in immediate free recall? In B. Kleinmuntz (Ed.), Concepts and the structure of memory. New York: John Wiley and Sons, 1967, 181-214.

Dallett, K. M., Number of categories and category information in free recall. Journal of Experimental Psychology, 1964, 66, 1-12.

Deese, J. Influence of inter-item associative strength upon immediate free recall. Psychological Reports, 1959, 5, 305-312.

Deese, J., and Hulse, S. H., The psychology of learning. New York: McGraw-Hill, 1967.

Earhard, M., Cued recall and free recall as a function of the number of items per cue. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 257-263. (a)

Ebbinghaus, H., Memory: A contribution to experimental psychology. (Trans. by Ruger and Bussenius.) New York: Teachers College Press, 1913.

Hebb, D. O., The organization of behavior. New York: John Wiley and Sons, 1949.

Jenkins, J. J., and Russell, W. A. Associative clustering during recall. Journal of Abnormal and Social Psychology, 1952, 47, 818-821.

Kent, G. H., and Rosanoff, A. J., A study of association in insanity. American Journal of Insanity, 1910, 67, 37-96, 317-390.

Miller, G. A., The magical number seven, plus or minus two: Some limits on our capacity to process information, Psychological Review, 1956, 63, 81-97.

Murdock, B. B., Jr., The serial position effect of free recall. Journal of Experimental Psychology, 1962, 64, 482-488.

Palermo, David S., and Jenkins, James J., Word association norms. Minneapolis: University of Minnesota Press, 1964.

Puff, C. R., Clustering as a function of the sequential organization of stimulus word lists. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 503-506.

Shuell, Thomas J., Clustering and organization in free recall. Psychological bulletin, 1969, 72, 353-374.

Thorndike, E. L., and Lorge, I., The teachers word book of 30,000 words. New York: Columbia University, Teachers College, 1944.

Tulving, E., Subjective organization in free recall of "unrelated" words. Psychological Review, 1962, 69, 344-354.

Tulving, E., Theoretical issues in free recall. In T. R. Dixon and D. L. Horton (Eds.), Verbal behavior and general behavior theory. Englewood Cliffs, N. J.: Prentice-Hall, 1968.

Tulving, E., and Osler, S., Effectiveness of retrieval cues in memory for words. Journal of Experimental Psychology, 1968, 77, 593-601.

Tulving, E., and Pearlstone, Z., Availability versus accessibility of information in memory for words. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 381-391.

Underwood, B. J., The representativeness of rote verbal learning. In A. W. Melton (Ed.), Categories of human learning. New York: Academic, 1964.