Effects of Common Associates on the Selectivity of Recall

by

Melvern James Klingspern

A THESIS

Presented to the Faculty of

The Graduate College in the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Philosophy

Department of Psychology

Under the Supervision of Dr. Katherine E. Baker

Lincoln, Nebraska

May, 1965

TITLE

Effects of Common Associates on the Selectivity of Recall

BY

Melvern James Klingsporn

APPROVED	DATE
Katherine E. Baker	June 3, 1965
William J. Arnold	June 3, 1965
Frank J. Dudek	June 3, 1965
Harry P. Shelley	June 3, 1965
William G. Leavitt	June 3, 1965
Thomas B. Thorson	June 3, 1965

SUPERVISORY COMMITTEE

GRADUATE COLLEGE **UNIVERSITY OF NEBRASKA**

Acknowledgements

I am indebted to Dr. Katherine E. Baker for invaluable assistance in the development and clarification of ideas embodied in this thesis, and for numerous suggestions which immeasureably improved the clarity of the dissertation. Dr. Baker also deserves special thanks for suggestions concerning the development of the procedure for the first experiment, and both she and Dr. John C. Loehlin were helpful in the development of the second experiment.

Dr. Frank J. Dudek and Dr. Harry P. Shelley, who read the next to final draft, deserve credit for offering many valuable suggestions toward clarifying the dissertation.

I would also like to express my appreciation to my wife, Arlene, for assistance in summarizing the data and for typing both the early manuscript and the Appendices for this thesis.

Table of Contents

List of Tables

List of Tables (Continued)

List of Appendices

Introduction

Background and purpose. This study is concerned with whether or not some part of the selectivity of recall is achieved through associations that mutually facilitate each other during recall through converging associations. An attempt is made to establish whether or not such a facilitating process occurs in a controlled laboratory situation in which each of several stimulus inputs share a common associate as well as have unique associates, and the test is a determination of which one is recalled. The results of such a study should also delineate some of the properties of such a facilitating action, and provide for a finer analysis of recall processes.

The importance of selectivity in recall is illustrated by speech and the thought processes speech reflects, and by problem solving activity. Speech and thought proceed via the sequential chaining together of linguistic units (words or phrases) into meaningful comments. This is not to deny the existence of structure or hierarchical associations (Miller, Galanter, and Pribram 1960), but simply asserts that within any such structure at least some of the units are chained together in sequences (Staats and Staats, 1964). The speaker carries with him in his memory all such units used, but recalls the appropriate one in each instance of a linguistic sequence. That is, recall of these units is seen to be selective in that the final utterance is both properly structured gramatically and conveys a meaning which would be lost if one were to randomly substitute nouns for nouns, verbs for verbs, etc, even though this process would preserve the correct gramatical structure. Problem solving activity also exemplifies selectivity of recall since it demands

that the appropriate information be recalled as well as the appropriate operations which when executed, convert this information into a solution. Furthermore, there exists a necessary order to this problem solving process in as much as the different operations must be executed in a definite order if one is to solve the problem. The fact that one typically recalls these operations in the appropriate order implies that recall is selective.

Associationism has in the past experienced difficulty in handling this selective aspect of recall. Original associationistic doctrine has always considered only a single idea or thought to be present in the mind at any given moment. This idea leads to another idea purely through an associative bond or connection. A cursory examination of one's language indicates that each word is associated to many other words inasmuch as each word is preceded and followed in different contexts by many different words. If the dominant or strongest association always determined the subsequent word, then the thought sequence for any person would be rigid and stereotyped, except for changes induced by sensory input. Problem solving, speech and thought would remain inexplicable. To add a random component to the model so that the induced associate occurs only with a definite probability, while relieving the proposed nature of the process of some of its rigidity, does nothing to make it more selective.

In the past various alternative explanations were developed to handle these difficulties. The Wurzburg school developed the concept of "task" and the Gestaltists developed dynamic organizational principles to account for not only the selective nature of recall but the general directive quality of thought. It is hoped that extensions of the project

initiated in the present study will ultimately show how such selectivity of recall can be achieved wholly within the framework of associationistic concepts, an accomplishment which would eliminate some of the need for such extra-associationistic concepts as "task" or "dynamic organization principles". Furthermore, such an accomplishment seems desirable in that it would allow for more formalization than is possible at present with these other conceptualizations. However, the first step is to see if some of the selectivity can be attributed to a relatively simple associationistic principle of convergence.

Terminology, conceptualization, and assumptions. The descriptive terminology to be utilized henceforth and certain preliminary assumptions which seem warranted can now be presented, both as a basis for suggesting a conceptual model and to delineate more clearly the ongoing processes presumed to be occurring during selective recall. The ultimate goal, which is to develop a full scale associationistic model for cognitive behavior, will require many studies. However, the following analysis together with the results of this study are considered necessary to the foundation for a properly substantiated proposal for a complete model. Consequently only general notions about the model itself will be developed here, leaving more refined notions to evolve from the findings of the experiment.

In this study reference will be made to two different types of memory, to units or elements remembered and/or given as sensory input, and to a "preassociate complex".

By immediate memory, symbolized as immem, is meant the temporary storage of information. "Attention span" and "span of apprehension"

are descriptive phrases used in the past to refer to this type of retention of currently operating stimulus inputs. By permanent memory, permem, is meant the permanent storage of information which is available for retrieval but which is not currently functioning in cognitive processes. Items are stored in permem through a process of learning. According to the present conceptualization, items are induced in immem either through sensory input or by being recalled from permem. This makes immem a somewhat broader notion than the processes responsible for the span of apprehension for sensory inputs, but the assumption of a fairly set capacity is retained. Thus immem is conceived of having present at any one time a set number of elements consisting either of representations of sensory inputs or of representations of associates to sensory inputs as they are called forth from permem.

Some or all of the items in immem may be engaged in the recall process. All such items so engaged will be called the "preassociate complex". This study is primarily concerned with the nature of the role of such a preassociate complex in determining recall.

The basic argument of how selectivity of recall can be achieved within associationism can now be presented. The argument goes as follows: The retrieval processes for various associates to the units of the preassociate complex occur simultaneously rather than sequentially. Several of the units of the preassociate complex may have a common associate as well as several relatively unique associates. That is, the different units that go to make up the preassociate complex may have been in the past separately associated to the same item, a

common associate, and furthermore, each of these preassociate units likely has been associated to items which are not associates to any of the other preassociate units, unique associates. The case considered involves a preassociate complex composed of several units, which units share some associates stored in permem and which units each have some unique associates stored in permem. In such a case, recall of the common associate may be facilitated in the sense that it now becomes more probable to be the first recalled. The retrieval of an associate common to two units in the preassociate complex speeds up that recall process and allows that associate to be recalled earlier than it would if either of its preassociate units were separately effecting recall. It should be noted that such a formulation allows for some randomness in the item recalled, while at the same time making it more probable that the recalled unit will be appropriate to a larger context than just the immediately given stimulus input.

The variability in the item retrieved would stem from the variability inherent in separate retrieval processes. The appropriateness to the larger context would stem from the separate aspects of the larger context combining in the preassociate complex to facilitate the retrieval of any associate that is common to several of those aspects.

At least lip service must be given to difficulties in the atomistic position implied. The elements to be associated are considered as units, and as possessing individual characteristics which persevere across time. However, these "atoms" may be such that they combine to form complexes, or "molecules" with properties not derivable from properties of the "atoms" alone. These complexes may then behave as units

later. This is to say, the type of atomism espoused is one that allows but does not require a subsequent mental chemistry.

Buhler (Humphrey, 1948) once wrote that thought is an irreducible fact of experience. This fact was arrived at through careful and persistent introspective sessions. He found that thought could not be reduced to other thoughts. However, if an element is postulated which is not a thought but which can be combined with other elements to form thoughts, then one can accept Buhler's fact and still reduce thought to some basic atoms. Such atoms may not be directly accessible to experience. To develop such a position, one would have to ascribe logical properties to such atoms, which properties would eventually be manifest in verbal descriptions of thoughts or other forms of overt behavior. Such a procedure is recognized as a possibility, but would involve difficulties beyond the scope of this paper. The position taken here will be simply that certain frequently used inputs will also behave as units. Letters of the alphabet and numerals, for example, taken at face value, seem to be rather simple structures and will be treated as units.

A possible error engendered by this position is as follows: if the association of two structures or ideas is between the atoms that compose them, then a given number of acquisition trials for pairs varying in number of atoms could well result in varying degrees of learning. However, if the different structures are of the same degree of complexity, little harm is foreseen in treating them as units. What variation in complexity that remains can be considered to have its effects randomly distributed across the experimental material.

It is also necessary to make explicit certain general assumptions to be utilized, using historical precedent or empirical phenomena to support them.

A. Probably the oldest theory in psychology, dating back at least to Aristotle, is that of associationism. Element a becomes associated to element b via their contiguous presentation (or through the contiguous presentation of a with some mediating principles, e.g. oppositeness). That is, the two elements or units are functionally connected in the sense that following this association a now has the power to "bring to mind" b. Since this writer knows of no alternative to the general notion, it will be assumed to be adequate to describe the process whereby one unit achieves the potential to call up another unit. The present proposal is, in fact, neutral as to the laws or mechanisms responsible for the acquisition of associations, and is merely accepting the fact of association.

B. Furthermore, the potential condition of several units being simultaneously present in immem is a warranted assumption. By this is meant nothing more than the fact that a sequential input of several items can be immediately recalled, or a simultaneous input of several items can be immediately reconstructed, by S. This ability has been demonstrated sufficiently often to accept it without hesitation. Clearly, however, the capacity is not limitless. Sequences exceeding certain lengths cannot be recalled (Miller, 1956).

C. It will be assumed that any unit may have more than one associate existing in permem. This assumption receives empirical support from the fact that a S is able to give more than one associate

to a given stimulus word. In fact, the variability of response to a given stimulus word has often caused the psychologist embarrassment. It will further be assumed that practice at associating A with units b, c, ... will be a sufficient condition to induce the state of having multiple associates. This assumption receives general support from the studies by Estes & Straughan (1954), among others, wherein more than one response to a given situation is positively reinforced with the result that both or all responses so reinforced do occur for a given S. Since in these cases the probability of the occurrence of a given response is roughly proportional to the percent of times that that response is reinforced, it seems tentatively possible to determine or equate the strength of any association through the appropriate variation of practice conditions.

Test for facilitation. The general nature of an empirical test for facilitation in recall may now be stated. Suppose that unit A is associated with units x and y and unit B is associated with units y and z, where the strength of the association between any pair is roughly the same. That is, suppose these units and their associates are committed to permem. Then if an input exists such that both units A and B are present simultaneously in immem, one might anticipate various response outputs depending on the operating characteristics of the recall process. Of immediate interest will be whether or not the common associate of both A and B will be recalled more often than the other associates, i.e. whether or not some facilitation of y will occur. Thus if the response y occurs one third of the time (i.e. as often as x and z) no facilitation can be said to have occurred and the basic concept of this

study has received no support. In general, if the input sequence has r associates, then the probability value 1/r will be the baseline which must be exceeded to demonstrate facilitation. In the next section two different types of facilitation will be explored, along with the empirical evidence which would support one or the other type of process. A detailed analysis of the possible operating characteristics of the recall process, and the outcomes implied by each follows.

Detailed analysis of the recall process. Several aspects of the recall process will be considered with different possible operating characteristics for each. Of primary interest is the aspect of the relation between recall processes for different inputs. If two input units share a common associate and if their respective recall processes are active simultaneously, the joint activity may have a facilitating effect over and above what would be expected from their separate independent activities. That is, two notions of facilitation are to be considered. The notion of separate independent activity leads to a base line prediction for the probability of the recall of any associate which is indicative of facilitation, i.e. greater than 1/r as above. The notion of convergent activity involves an effect of facilitation over and above what would obtain from separate independent activity. Thus, the effect of any convergent process will be made manifest in empirically obtained proportions of common associates that are significantly greater than their expected values under the independent activity assumption. Further, the effects of such a convergent activity in the recall process differs depending upon the operating characteristics assumed concerning certain other aspects of the recall process. That

is, predicted differences in facilitation will also depend upon certain other operating characteristics. These operating characteristics will be examined before considering further how the different notions of facilitation would effect the recall process.

The recall process is here considered as occurring by means of associations of discrete input units in immem to other units in permem and recall is considered to have taken place when the associate in question has been retrieved from permem and is therefore available for report. By listing the possible operating characteristics that might be assumed under each of several aspects of the recall process, one may arrive at an assumed set of combinations of operating characteristics for the recall process. Then under each such combination, the expected value of the recall of any associate can be considered. These different predicted expected values will in some cases allow for a discrimination between the different combinations of operating characteristics.

The sorts of aspects to be considered, are revealed in the following questions: (1) How many retrieval processes will be active simultaneously for a given stimulus item present in immem when that item has a number of associates stored in permem? (2) How many different stimulus items can be employed simultaneously in the retrieval of their separate associates? (3) If two or more stimulus items are simultaneously involved in the retrieval of a common associate, what type of facilitation will occur, if any?

Consider first the question concerning the number of retrieval processes that can be active simultaneously for each input unit. The possibilities to be considered are as follows: a) Only one associate

of any input unit can be in the active process of being recalled at any given time. Thus, if input unit A has associated to it units x and y in permem, the process of recalling unit x would prevent the initiation of the process of the recall of unit y and vice-versa. That is, the retrieval of unit x has to terminate before the retrieval of unit y can begin. b) Two or more associates of any input unit can be in the process of being recalled simultaneously.

Consider next the question concerning the number of input units that can be involved in recall together. The possibilities to be considered are as follows: a) Only one of the input units can be actively recalling its associates at any given time. Thus if A, B and C are input units, the activation of the process or recall of A's associates would prevent the initiation of the recall process for B's units and C's units, etc. b) Exactly two of the input units can be actively engaged in the process of retrieving their associates at any given time. c) Three or more of the input units can be actively retrieving their associates at any given time.

Finally consider the question of facilitation. The possibility of no facilitation has already been discussed. The set/s of operating characteristics that predict no facilitation will hereafter be referred to as the null facilitation model (NFM). The possibility of facilitation requires that two types be considered, independent facilitation and convergent facilitation. This aspect of recall is considered the most interesting and thus will be developed in more detail.

In the independent facilitation model (IFM) facilitation would result between input items A and B sharing a common associate, x, if

the recall process of x initiated and sustained through A occurred separately, simultaneously and without interaction with the recall process of x initiated and sustained through B. In this case, the probability of the recall of x, P(x), would be given by the proportion of all the associates of A and B that are x's. It should perhaps be pointed out that under the assumption of equal strength of associations, this independent activity would result in recall probabilities identical to those that would be obtained if one were randomly selecting associates from a population in which each input contributed all its associates. In this case, however, several associates are identical and thus the common associates have a higher probability of being recalled.

If the separate recall processes occurring simultaneously interact, or converge in such a fashion that their joint activity increases the probability of the recall of their common associate over and above the increase which would result from independent facilitation, then convergent facilitation will be said to have occurred. The set/s of operating characteristics that predict convergent facilitation will hereafter be referred to as the convergent facilitation model (CFM). Again it will be noted that independent facilitation provides a base line above which the effects of convergent facilitation may be detected.

By considering these three aspects of the recall process one may form 18 different combinations of operating characteristics. These 18 combinations together with the arguments generating predictions therefrom are shown in tabular form in Appendix A. The paradigm shown in Fig. 1 represents the experimental situation proposed for the present study and is elaborated in Appendix A. The capital letters represent

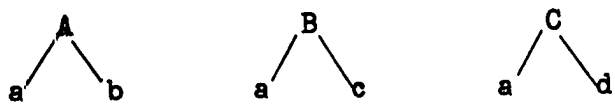

Fig. 1. Paradigm representing hypothetical condition of stored associations for experiment proposed. Capital letters represent stimulus items given as sensory input; small case letters represent associates stored in permem; bonds represent which stimuli have been associated with which responses.

stimulus items, the small letters represent response associates, and the connecting lines represent the associations between the two. The 18 combinations shown in the cells in Appendix A are essentially 18 working hypotheses. Due to the nature of (1) the data to be gathered and (2) the type of experiment proposed (see Appendix A) only five of these combinations predict different results. The strategy of this study is to attempt to eliminate some of these working hypotheses.

Actually, one could also discriminate between the various types of convergent activity considered in Appendix A by retaining the basic design of the experiment but simply altering the particular combination of associates with respect to both the number of associates that are duplicates and the number of times a given associate is duplicated. But since, it was not feasible to include in the present study the situational changes necessary to make these comparisons, only the different probabilities implied by the null, independent and convergent models need be considered. Even though the present experiment is primarily concerned with the possible nature of facilitation which obtains between the common or shared associations depicted in Fig. 1, it is interesting to note that questions concerning the number of input units and the number of associations that can be simultaneously activated are relevant to the problem of facilitation. Without the simultaneous activation of

at least two of the associations of each of at least two input units, neither evidence for convergent activity nor for the null model would be possible in the present study.

The present study was designed to establish certain conditions depicted by the paradigm shown in Fig. 1. These conditions, referred to as the side conditions of the study, were necessary to establish before the models could be tested. It has already been pointed out that unless the simultaneous activation of different retrieval processes from different stimulus inputs are effected, the hypothetical convergent facilitation is not possible. Simultaneous activity of different retrieval processes may not be possible because of the operating characteristics of the model (see Appendix A) or because the S did not form associations from the inputs to different items. This completion of the learning of all associates is one of the side conditions not adequately achieved in Experiment I, which failure led to the design and execution of Experiment II.

A second side condition necessary to establish before simultaneous activity of different retrieval processes from different input units is possible is that the several input items are established in immem before the recall process begins. Although it is a simple matter to present different stimuli to S simultaneously, S may only attend to a single stimulus and consequently fail to establish in immem the three input units shown in Fig. 1. For example, if S only attends to one stimulus item, thus in effect only achieving a single unit, then his response output would be the same under each of the operating characteristics of the recall process which are considered in this study.

A third side condition which should be met is that the strengths of all associations be equal. Failure to meet this side condition would result in alterations in the predicted probabilities of recall rather than an elimination of facilitation per se. However, since a discrimination between the different models depends upon the estimated probabilities of recall, a failure to meet this side condition would confound the results. If the experiment to be presented successfully establishes these side conditions, then the results should indicate which of the three models most closely mirrors the recall process.

The overview of the plan of the study is as follows: Each S learned two associates, letters, to each of several stimulus items, numbers. Each of three of these stimulus items shared a common associate with the other two, as well as having one unique associate. In a later test situation these three stimulus items were presented simultaneously along with the instructions to report the first letter recalled. The proportion of common and unique responses obtained could then be compared with the value predicted by the models.

If the proportion of responses obtained that are common associates were to be significantly greater than 1/2, this would be support for the CFM. If the proportion of responses obtained that are common associates were to be roughly 1/2, this result would be support for the IFM. If roughly 1/4 of the obtained responses are common associates, the null facilitation model would be considered the most adequate predictor.

Method for Experiment I

Subjects

The Ss were 359 men and women students, largely from sociology and psychology classes at the University of Nebraska and at Nebraska Wesleyan University. For the most part, instructors volunteered their entire classes to serve as groups of Ss for this experiment and other groups were made up of Ss who volunteered themselves. Of these 359 Ss, 52 were discarded for not following instructions or for simply not responding on the tests. The remaining 307 Ss came from 18 groups which varied in size from 6 to 36.

Procedure

The experiment was done in three parts carried out in a single 45 minute group session. The purpose of each part can be understood by reference to the model in Fig. 1 presented earlier.

Acquisition phase. The purpose of the acquisition phase of the experiment was to establish two associations of equal strength to each of six different stimulus items. To accomplish this, Ss were given nine practice trials during which time they were supposed to learn all associations. On the basis of a pilot study it was thought that nine trials would be sufficient for a majority of the Ss to learn all items, and furthermore more trials were not feasible within a 50 minute class period. Numerals from one to nine constituted the stimulus items and fourteen letters of the alphabet constituted the response items for these associations. The choice of stimulus material was made in order to minimize acquisition time by using material with which Ss were