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Clustering by Aphasics in Free Recall

by

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ABSTRACT

In the past two decades we have witnessed a recognition of the sterility of S→R as an explanation of those functions that distinguish man from other animals, and, in addition, we find an increased awareness of the importance of the cognitive processes that mediate between S and R. All cognitive activity, it has been pointed out, involves and is dependent upon the process of categorization and complex cognitive processing--the selection, analysis and coding of pertinent information for storage, retention and retrieval--is dependent on language and memory.

The aphasic's well-known memory deficit plays an important part in his reduced ability to comprehend and communicate. The exact nature of that deficit has yet to be specified. Normals, it has been established, learn to overcome the limitations of memory by the use of organizational techniques. One such widely studied technique is the phenomenon of clustering. It has been observed that, in free recall experiments, normals tend to group, or cluster, the material to be remembered according to the concept inherent in the material. They recall the group and then each item within the group. This chunking increases the amount of material that can be retained and thus serves as an aid in recall.

In this study, two experiments were conducted to determine whether or not aphasics utilize such a technique. In the first, a list of randomized words containing 6 categories with 5 items in each was presented for free recall. Three category words appearing contiguously in recall was considered

a cluster and evidence that the material had been organized.

Results indicated that the majority of aphasics do not use this method. Recall is random, unorganized, and, therefore, low. Since a reduced performance is often attributed to slower functioning, in a second experiment material was presented four time to assess performance over time. This multi-trial experiment used a group of normals and non-aphasic left hemiplegics of similar age, education and socio-economic background as controls.

Although normals consolidated their clusters under conditions specified with a resultant increase in recall, aphasic recall was minimal. Clusters were not consolidated, but were unstable from trial to trial. The performance of the left hemiplegics was always superior to that of the aphasics and inferior to the normals. It appeared that the presence of brain damage resulted in a decrease of clustering and of recall but that this decrease was greater in the presence of aphasia.

A third experiment established that the categories had to some extent been perceived by the aphasic subjects but that they had been unable to utilize this information to aid recall.

A second part of this study examined the possibility that the clustering behavior of aphasics could be remediated. Clustering was examined under a variety of conditions where cues of increasing specificity were offered. Results indicated that while normals demonstrated an ability to benefit from cues, such improvement was not noted for the majority of aphasics.

As always with aphasics, the wide range of performance must be considered. Statistical analysis reveals that the younger, better educated and less severely impaired aphasic has a better prognosis for performance on this task.

General results indicate that the aphasic's reduced functioning is a result of a qualitatively different mode of behavior. Such a difference, it is suggests, reflects a loss of abstract attitude and has, ultimately, an important effect on all higher cognitive functions.

ACKNOWLEDGMENTS

Having at long last reached the moment when it is possible to look back, it is astonishing to realize how many and how varied were the experiences that led to this point; all the arguments, discussions, and sharing with professors and peers; the successes--as well as the failures--with patients who so willingly followed any suggestion. To all who made these experiences possible, my thanks.

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My thanks, also, to all those who participated in the experiments; to Judy Prager and Naomi Soto, who typed--and typed again; and, finally, to my husband, Don, whose belief in me and whose support and comfort in moments of stress made the whole thing possible.

Thought is born through words.
A word devoid of thought is a dead thing,
and a thought unembodied in words remains
a shadow.

L. S. Vygotsky

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Chapter 1

The Problem

The study of memory and cognition, dormant in the first half of this century when behaviorism was the predominant psychological theory, received a new and powerful impetus beginning in the 1950's and continuing to the present day.

The publication of Noam Chomsky's Syntactic Structures in 1957 marked a revolutionary change in the field of linguistics. Before long, psychologists realized that "...the assumptions being abandoned in linguistic theory... bear a suspiciously familiar resemblance to the concept of classical associationism (Deese, 1968, p. 98). The simple relationship between stimulus and response was no longer seen as primary, but rather the importance of the processes that mediate between them was recognized. The coding and recoding of inputs--how signals were sorted out and organized--turned out to be the important secret of the black box (Bruner, Goodnow, & Austin, 1956).

The change in the concept of memory functioning coincided with the revolutionary change in linguistic theory and a similar change in psychology from a behaviorist to a cognitive approach. In all fields, to the degree that the S→R paradigm was abandoned, to that degree did the cognitive activity of the individual assume importance.

Lenneberg (1967) stated that most animals organize their sensory world by a process of categorization. Our

inherent ability to classify and to organize what we learn into a coherent system of knowledge is a basic part of what makes us intelligent beings(Longuet-Higgins, 1973).

Bruner et al (1956) maintained that all cognitive activity involves, and is dependent on, the process of categorization. In man, this process is called concept formation.

While definitions of cognition may vary, there is today general acceptance of the active, participating role of the individual in cognitive functioning. A response is never simply and directly activated by a given stimulus as had been formerly believed, but can only be the result of some kind of active cognitive processing.

As we learn more, and as more and more studies are done, we recognize that our cognitive activity occurs much earlier than had originally been supposed. Perception, once seen as a passive process in which stimuli impinged on the sensory apparatus, is now viewed as an active process of synthesizing or constructing a figure (Neisser, 1967). What we perceive is determined, in this sense, by what we have "decided" to perceive. Or, to put it another way, it is determined by those stimuli to which we have allocated our cognitive resources -- to which we have paid attention. The fact that each person's view of the world is peculiarly his own is an often-stated, not fully appreciated phenomenon. As Treisman (1972) said, "It is difficult to realize that our brains select and thereby create just one of many

possible worlds [p.206]." Tompkins (1962) said it another way. "The world we perceive is a dream we learn to have from a script we have not written. It is neither our capricious construction nor a gift we inherit without work [p.256]."

Numerous studies of selective attention give evidence that some representation in storage must be activated by even unattended sensory input. A decision to ignore can only follow some kind of analysis. Higher level cognitive processes are required for a decision to be made before, or as, input is processed as to which stored representation is pertinent.

The selection of pertinent information, is, of course, merely the first step. The features selected must be analyzed, compared, and coded so that the perceived object can be given its categorical character. Such complex cognitive processing is intimately related to, and dependent on, memory and language.

The essential features having been extracted, material to be processed must be held in STM long enough for an hypothesis to be compared to previously stored information for verification. For such percepts then to make the transition from short-term to long-term memory, they must be coded so as to be included in a system of categories.

While there are presumably purely visual and sensory memories, more complex and certainly more abstract material requires the participation of language for coding into a

stable, available percept. Lantz & Lenneberg (1966) in a study with deaf and hearing children showed that, for example, "The accuracy with which colors could be remembered was significantly correlated with the accuracy with which they could be communicated in the language [p. 58]."

According to Luria (1974) "...it is well known that speech participates directly in the formation of the most complex forms of perception, namely the coding of the perception of colors, shapes and objects into complex 'categories' [p. 235]." He also states "...it is essential to note that human perception is a complex process of coding of the perceived material taking place with the close participation of speech and that human perceptual activity thus never takes place without the direct participation of language p.[230]."

Memory, then, enables us to retain the percepts for the necessary processing while language permits the inclusion of the percept into a system of categories. It is thus only through the close participation of memory and language that that which we perceive can be stored, retained and retrieved for use at a later date.

The importance of the role of memory in the comprehension and storage of words is surpassed only by the complexity of the task with respect to the comprehension of sentences. In spite of enormous gains made over the past several decades, our understanding of how we process and understand sentences is still in its infancy.

One of the most obvious memory requirements is to hold one piece of information in some kind of temporary memory buffer while continuing to process new, incoming information. The temporal nature of the speech signal makes this ability a necessity at every level of speech processing.

Even when dealing with the simplest material--a phrase, a simple affirmative active declarative sentence, for example--our ability to repeat what we have heard varies inversely with the length of the stimulus. More complex sentences, however, prove even more difficult to rehearse and store (Foss & Cairns, 1970). The more that the surface structure distorts the grammatical relationships, the more complex is the processing required and the more short-term memory space is needed to maintain the various elements while the decoding process and synthesis of ideas takes place.

Even greater demands are made on our memory when we must deal with self-embedded sentences. Foss & Cairns (1970) point out that in such sentences as "The lamp that the electrician that the lady hired fixed lit the scene," each noun must be held for the appearance of the appropriate verb. The fact that this is not a task we face frequently in ordinary conversation makes our ability to do it even more remarkable.

In discussing this problem, if we now go on to say, "They also said that..." we not only must make a decision that "they" can not be the electrician or the lady since

"also" implies a previous statement (and we can find no such statement in our memory bank) but we must go back in our memory to find that "they" refers to Foss and Cairns.

Norman (1972b)has said that in many instances the rules of grammar help to reduce the load on short-term memory. For example, the rule against split infinitives means that the number of words we must hold in abeyance until a future word clarifies them is reduced.

However, even grammatical sentences can and do present difficulties. Slobin (1971) states that "It is a frequent phenomenon in language that the selection or understanding of words early in a sentence is determined by words coming later in the sentence [p. 9]." The last sentence in the previous paragraph, for example, although grammatical, presents certain difficulties. In order to know what "is reduced," eleven words must be shunted aside, although they, too, must be processed for the sentence to be meaningful.

The processing, and shunting aside of words for further processing, is demonstrated also in sentences in which the order of events does not follow the linguistic order. "Before you go to work, make sure to make the bed and do the breakfast dishes"--from the moment we hear the word "before" we are alerted that the phrase following it must be processed and put aside in some form of memory buffer until we have heard, processed and assimilated the information as to what we are to do first.

The too-little-understood process by which sentences are comprehended is clearly related and intertwined with

memory process. An analysis of normal memory functioning should aid us in understanding its breakdown in aphasia. By the same token, an understanding of the pathological functioning in aphasia can clarify normal functioning.

Reason for the Study

Part One

The basic and complex relationship between verbal memory and language makes the study of memory particularly relevant to aphasia. The aphasic's well-known memory deficit plays an important role in his reduced ability to comprehend and communicate. It is in precisely those areas where greater demands are made on memory that the aphasic's performance breaks down. His difficulty increased with sentence length. He frequently is unable to remember the referent for a pronoun. A sentence with a qualifying clause could place an additional burden on him. As a result, information in one whole clause may be lost, or information may be taken from each clause and incorrectly combined.

It is sometimes said that the aphasic functions in a manner that is similar to normals, but at a slower rate. Reduced activity and less efficient functioning is attributed to the brain-damaged in general. That the aphasic does process material more slowly appears true also and we acknowledge this fact by reducing our rate of input when presenting information to him. An analysis of aphasic

behavior from a quantitative viewpoint would certainly yield valuable information regarding the amount of material he is able to process. If his reduced efficiency is attributable solely to slower functioning, such analysis would be sufficient. If, however, we accept the cognitive view as presented here with its emphasis on the active, organizing role of the individual, we must ask whether the aphasic is functioning in a different manner as well and whether it is this qualitative difference in the way he processes information that is responsible for the obvious problems he has in storing and recalling verbal material.

This study assumes several general principles set down in the foregoing pages. In brief, they are:

1. Memory is an active cognitive process dependent on and related to language.

2. Organization of material is essential to the storage and retrieval of information from memory.

3. Categorization or concept-formation is a principal method of organization.

4. A true understanding of aphasic behavior can be achieved only through a qualitative analysis of his cognitive functioning. The strategies used in a given task yield information that can not be derived from quantitative results only.

The study has its foundation in these principles and the experiments are designed to yield support for their validity. These principles are examined in terms of clustering in a free recall paradigm.

Deliberate memorization is a cognitive function, less

dependent on the associative processes than on the active organization carried out by the individual. To help an easily-overloaded system cope with the amount of material it must deal with, organization is a basic and essential part. It has been claimed (Baddeley & Patterson, 1971; Mandler, 1967) that the role of organization is so marked that long term memory is not possible without it.

One of the primary forms of organization and one of the most persistent characteristics of free recall data is clustering. First analyzed by Bousfield in 1953, it has proven a most stable organizational strategy used by normals. According to the cognitive view of the memory process (Slamecka, 1972), in list learning, some perception of the list's categorical structure arises during its presentation. Each perceived category is given a label by the subject, which he then stores. It is these labels which serve as the elements of a retrieval plan.

In the first part of this study the behavior of a group of normals, aphasics, and left hemiplegics in the learning and recall of lists of words was examined, and an assessment was made of the use of clustering as an aid to recall. Words from various categories were presented in random order. If on recall they were clustered into appropriate categories the results would support the principle of memory as an active cognitive process. An increase in overall recall combined with an increase in clustering would prove it to be an effective and essential organizational tool.

Normal superiority in clustering in contrast to inferior aphasic performance would indicate that, in this regard at least, the aphasic is performing in a qualitatively different manner, leading to a quantitatively different result. If a number of trials of the same material does not substantially increase aphasic performance, the amount of time required for processing would appear to be less important than the type of processing.

If the mildly impaired aphasic functions closer to the normal while the severely impaired shows greater disparity between his performance and the normals, and if the average aphasic performs at a consistently lower level than the average left hemiplegic, we would have support for the principle that the memory loss in aphasia is related specifically to the loss of language. In general, the brain-damaged show decreased efficiency of performance. If all brain-damaged subjects--both left and right hemiplegics--failed to utilize the clustering strategy to the same degree as normals, such failure could be attributed to brain damage per se. However, if an even greater discrepancy is demonstrated in subjects having lesions in the dominant hemisphere, and if the discrepancy correlates with the degree of aphasic impairment, a relationship between language and the ability to use this strategy is indicated.

Accordingly, the following hypotheses were tested:

1. Normal clustering and its resultant recall will be greater than that of the aphasics.

2. A multi-trial learning experiment will lead to consolidation in normal performance to a greater degree than in aphasic performance.

3. The mildly impaired aphasic will more closely approximate normal performance than will the severe aphasic. In the severely impaired, clustering and, therefore, recall will be minimal.

4. Performance of left hemiplegics will be superior to that of aphasics.

Part Two

One of the problems that besets the student and researcher in aphasia is the great variety in aphasic performance. When dealing with brain damage and, in particular, when dealing with such complex processes as memory, learning, and language, we inevitably find a range in performance. The persistent difficulty in establishing a stable system of classification of aphasics is one result of this problem.

It was anticipated that such a range of performance would be present in our clustering data. A second part of this study, therefore, was designed to examine such differences. Clustering behavior was examined under a variety of conditions. In addition, results were examined to determine any correlation that might exist between the use of clustering and two well known tests of aphasia.

The use of clustering or categorization as an aid to memory is a deliberate cognitive strategy. Failure to use it in a situation that normally calls for it could be

attributed to a) an inability to perform this abstract function, or b) a loss of awareness of the necessity for it.

Goldstein (1943) saw the aphasic's basic problem as the loss of the abstract attitude. If the aphasic is unable to perform the task adequately even when provided with clues or given help, an impairment in the ability to abstract may be implied. However, if he responds to a cue given, we could infer that his basic abstracting ability is intact. What he has lost is an awareness of the necessity for an appropriate cognitive strategy to aid recall.

It seems likely that in this instance we would find performance ranging from the mildly impaired who would use the strategy spontaneously as does the normal, or who would require only the broadest hint to remind him of its use, to the severely impaired whose abstracting ability is so reduced that no amount of help is able to overcome this deficit.

An additional question concerns those aphasics who are able to respond to cues--i.e., whose problem is loss of awareness of the need for the strategy. Having responded to the help given, can the aphasic generalize such knowledge and recognize the need for comparable strategies in new situations.

In this section, therefore, a series of clues of increasing specificity will be given in order to assess the aphasic's ability to utilize them and to generalize what

he has learned to a situation lacking cues.

We are still in the process of unraveling the way the normal mind functions in attempting to comprehend and retain linguistic information. Any deviation from the normal shown by aphasics increases our understanding of the way his mind functions and, if we see language as central to cognitive processes, gives us the beginning of insight into his thought processes and cognitive functioning in general.

The study of memory is daily revealing to us new information as to how signals are sorted out and organized. Such information as we now possess must be fully comprehended before we can understand any deviation. These questions will be discussed in the following chapter.

Chapter II

The Nature of Memory

Since memory became, once again, a respectable entity, investigations concerning it have proliferated. In the decade from 1960 to 1970, publications in experimental psychology increased by a factor of two and a half, while those dealing with human memory increased sixfold (Tulving & Donaldson, 1972a). At the same time the nature of the study and the experimentation changed to an emphasis on an understanding of how the mind works in registering and storing mnemonic information.

While models of memory vary in concept and terminology, they are all based on three premises: recording, retaining and reviving of an experience. First, some impression of the experience must be made. One of the main requirements of a memory circuit is that the effects of an input must persist after the input itself has ceased (Lindsay & Norman, 1972). To retain a record of the impression, some storage system is an obvious necessity. And, finally, a retrieval system is required if this record is to be returned into consciousness.

The Physiological Process

While there is agreement that an experience must leave an impression, it is far less easy to determine just what that impression might be. Aristotle suggested that some

substance enters the brain and leaves an impression on it as a stylus would on wax. Lashley searched for, but never found, such an engram. "Lashley failed to find any evidence whatsoever that a specific memory is stored in a specific part of the brain" (Lindsay & Norman, 1972, p. 293). Lenneberg (1967) pointed out that surgical removal of a specific percept was not possible. Paul (1967) stated that extensive destruction of the human brain does not lead to memory scotoma, but either to no impairment or quite general impairment.

The alternative to an interpretation in terms of specific traces is interpretation in terms of process (Milner & Teuber, 1968). There appears to be little disagreement today that this process is electrical in operation. Although the exact process is not yet known, there are several ways in which this electrical activity could occur (Lindsay & Norman, 1972). Conceivably a specific cell, or a pattern of specific cells could respond to a particular input. Alternatively, a sequence of neural responses might result. Whatever the specific neural response, there is reasonably good agreement that consolidation must occur and that the permanent storage of information is the result of some chemical or structural change caused by repeated electrical activity. Such changes could be in the neuron itself, in the synaptic junction, or as the result of the growth of new synaptic junctions.

The temporal nature of electrical activity makes a

two-part system inevitable if we are to have any permanent memory record. Whatever the particular pattern of electrical activity, it results in an activity trace which is subject to decay unless consolidation takes place. Those items destined for permanence are consolidated, either through rehearsal or through repetition of the experience. The initial transient activity trace has been called variously "short-term" or "primary" memory. Consolidation would result in the item being placed in "long-term" or "secondary" memory.

The concept of short- and long-term memory is an important part of most major models of memory. For most theorists the bimodal serial position curve is evidence of a two-part system. Tulving (1968) however, feels that the very term "store" or "storage" implies a location where Lashley's engram might be tucked away. He therefore prefers the view that the difference in recall of early, middle, and late items is a reflection of the difference in accessibility. The question of accessibility will be dealt with in a later section. For this review the concept of a two-part system is accepted.

Selective attention, possibly the first step in our cognitive processing, is receiving increased study. The need to process all information on some level has led theorists to postulate a sensory information storage system (SIS) which would hold information for a brief period prior to its decay or to its placement in short-term

memory (STM).

Selective Attention

The human being is, of necessity, attempting at all times to impose some organization on the wealth of information he is continuously receiving through his sense organs. The study of the limitation and selection of incoming information is the study of attention (Norman, 1969).

When we consider the quantity of sensory stimuli impinging on our senses at every moment, it seems obvious that there must be some selection made of those to which we wish to pay attention. A question of equal concern would be how it is possible to make such a judgment unless all the stimuli have undergone some form of processing. A judgment to disregard something as irrelevant can only be made after its relevance has been assessed.

Sperling's study (1960) of iconic memory presented evidence for such processing of all sensory data. Subjects were presented with three rows of three letters each for 5/100 of a second. Typically, when asked to recall them, they were only able to recall four or five and this remained true even if more letters were presented or if exposure duration varied. However, when asked to recall a particular row they were able to do so. Or, when one letter was marked off from the rest, they were able to name it, even when they did not know which letter was going to be marked off until after exposure. The fact that they could do this means

that the whole iconic image must have been present for a brief time. As Lindsay & Norman (1972) point out, the subjects had seen more than they were able to report. In the original experiments apparently, by the time they had processed three or four letters, the others had faded away. Sperling suggested that this material in decaying visual memory is in an unprocessed, precategorical form.

Crowder & Morton (1969) drew a similar conclusion concerning auditorially presented material. The fact that subjects show improvement in recall for the last few items spoken is interpreted by them as evidence that the spoken items are held for several seconds in an "echoic" register or in a raw sensory, precategorical form.
According to Norman (1972[b]).

> "...the evidence for precategorical acoustic storage comes from one form of experiment: the stimulus-suffix experiment. Here, a list is presented to the subject for him to remember and then at the conclusion of that list, an irrelevant item is presented. This latter item, the suffix, is known by the subject to be irrelevant to the experiment, and, ideally, it should be completely ignored by him. The fact that the suffix cannot be ignored leads to the postulate that it must enter memory along with the other items, and the nature of the interference caused by the suffix as the characteristics of both stimulus items and the suffix are varied, leads to the postulated properties of precategorical acoustical store p.[278]."

Baddeley & Patterson (1971) see the role of iconic memory as that of holding visual information long enough for a slower read-out mechanism to use the information to build a more stable image of the visual world, and consider it probable that both iconic and echoic memory are necessary for efficient perception.

Cherry's well-known study (1953) of the cocktail party effect gives evidence of some form of higher level cognitive processing of supposedly unattended material. While shadowing a message in one ear, subjects were still able to note the crude properties--i.e., the sex of the speaker, whether the stimulus was pure tone or speech--of material presented in the unattended ear.

Elaboration of this type of investigation, using dichotically presented material, showed that a subject can hear his own name when it occurs in the unattended ear. According to Norman (1972a) raising the level of pertinence results in lowering the threshold for the sensory input. It has also been shown (Treisman, 1972) that bi-linguals are able to tell when the second, unattended message is a translation of the first. In a study of ambiguity, Garrett (1970) presented an ambiguous sentence in one ear to which the subject's attention was directed and an unambiguous phrase in the unattended ear. In all cases the subjects reacted to the sentence as if it were not ambiguous, thus indicating that the information to the unattended ear had been processed.

Moray (1970) interprets the results of a study by Howath & Ellis as demonstrating that selection is not a peripheral mechanism. A list of names was presented to sleeping subjects. The presentation of the subject's own name caused a change in the EEGs, suggesting that information from a non-attended signal arrives at higher levels of the brain.

Material to which one does attend is, then, apparently placed in a sensory information storage system. This information is subject to such rapid decay that, if it is to be retained, it must be consolidated and put into short-term memory. In SIS we have an image (echoic or iconic) of an event while that which is put into STM is an interpretation of the event (Lindsay & Norman, 1972).

Short-Term Memory

As noted, one of the most important characteristics of short-term memory is its limited capacity. Miller (1956) pointed out that man appears to be biologically capable of holding only seven items, plus or minus two, in such a store. The magical number seven, it appears, is not fortuitous, but a reflection of this memory limitation.

The rapid decay of information in STM was demonstrated in a simple experiment conducted by Peterson & Peterson (1959). Subjects were unable to recall three letters 18 seconds later when they had counted backwards by threes in the 18-second interval.

An equally important characteristic of STM is the low

level of processing. It has been said that only gross sensory information is stored at this stage, while the semantic component is believed to be negligible. However, further examination shows that this is not entirely true. Just as the carefully executed studies of attention described above revealed that some processing was taking place on material that had previously been considered unattended, so here too, the situation is not as simple as it first appears.

It has been shown, for example, that the immediate repetition of a word does not lead to storage of the repeated word (Craik, 1972). This is an example of an active cognitive strategy designed to save space in a limited-capacity system. To adopt such a strategy, something more than gross sensory information must have been extracted. In addition, our ability to recognize our own name in the experiments just cited clearly points to some semantic processing. In the attention studies referred to earlier, sensory information appears to have been extracted even though it may have been lost subsequently. Therefore, while the semantic component may not be an important part of the STM processing, it is apparent that it does play some role.

The processing of the acoustic components remains primary in STM, however. There is evidence that verbal items are held in STM in terms of their sounds and not their meaning(Baddeley & Patterson, 1971; Craik, 1972). In a number of studies, notably Conrad (1964), acoustic confusion errors, where the errors made in recalling visually presented

letters sounded alike, were interpreted as supporting this concept.

Corcoran (1968) hypothesized an acoustic element in visual search when he found his subjects were more apt to miss an "e", unpronounced as in "late," than the pronounced "e" in "let." In addition, the finding that visual items are better retained at a slower rate whereas auditory items show a slight improvement at fast rates suggests that the visual information requires an extra step for translation into a form suitable for storage (Craik, 1971).

Another characteristic of STM is that the low level of processing results in an unstable trace. For information to be retained, further consolidation must occur. Rehearsal or repetition of the experience is necessary and rehearsal schemes seem to operate primarily in STM (Bjork, 1972). It would be in STM that a choice is made as to which items to eliminate and which to rehearse and maintain. According to Norman (1969) rehearsal prolongs the time an item can remain in STM and also increases the likelihood of the item entering long-term memory (LTM). Atkinson & Shiffrin (1968) conclude that rehearsal time increases the strength of the item, and, according to Jacoby (1973), the amount of information transferred from STM to LTM is said to be a direct function of the number of rehearsals.

STM traces decay in 30 seconds, as is shown by the fact that the recency effect is no longer present if recall is delayed 20 - 30 seconds (Warrington, 1971). Rehearsal

serves to prevent decay and the critical factor appears to be the time made available for perceptual processing.

Walter (1973) summarized the results of considerable research as showing: 1) Manipulation of acoustic similarity had a deleterious effect on a short list of letters whereas semantic and graphic similarity had little effect. 2) Intrusions were acoustically related to presented letters and 3) acoustic similarity had a strong effect at small retention intervals while semantic similarity had a strong effect at large intervals.

While rehearsal can maintain an item in STM and facilitate entry into LTM, the major identified cause of decrement in STM is interference due to some intervening activity. According to this theory, time itself doesn't cause anything (Deese & Hulse, 1967). The mere passage of time is not the reason information is lost. The loss is due to interference caused by the events that occur in the time interval.

Long-Term Memory

As opposed to STM, long-term memory is a system characterized by unlimited capacity and a high level of processing, where encoding is based on meaning and where decay is decreased or eliminated (Shiffrin & Atkinson, 1969).

The two basic processes that operate in LTM are storage and retrieval. Material must get in, and it must be possible to get it out. Organization underlies both processes.

There is an intimate relationship between storage and

retrieval. We store new incoming information in terms of our past knowledge and experience. It would not be possible to find things in memory unless newly learned material were interrelated and integrated with old.

Storage in LTM is, therefore, a problem-solving task. It must be determined how the to-be-learned material is, or can be organized, and then how this organization is related to already stored material. Those memory units that serve to identify and provide a name or meaning to which new information can be related are concepts. A concept is, therefore, a node or cluster of information in memory which corresponds to an object or idea that can be named or described (Rumelhart, Lindsay, & Norman, 1972).

According to Vygotsky (1962),

> "Concepts do not lie in the child's mind like peas in a bag, without any bonds between them. If that were the case no intellectual operation requiring co-ordination of thoughts would be possible, nor any general conception of the world. Not even separate concepts as such could exist: their very nature presupposes a system [p. 110]."

Central to any memory system, then, are these nodes or clusters of information and the relations among them.

New material must enter that system. The use of the word "storage" for this process is somewhat misleading, implying, as it does, a little black box. The word "coding" or "encoding" more accurately reflects what occurs. Coding is a cognitive process, a "...select alteration and/or

addition to the information in STS as a result of the search of LTS" (Atkinson & Shiffrin, 1968, p. 115). This is an example of the efficiency of the central nervous system. We don't merely store the information we receive, but we change, consolidate and categorize it. The code represents information, rather than being it (Johnson, 1972).

This recoding of information into another form which is easier to remember can take several forms. Reduction recoding reduces the amount of information by transforming it through a hierarchy of levels from letters and words to grammar and semantics (Baddeley & Patterson, 1971). Symbols can be substituted for lengthier material or an abstract or summary can be made and memorized. Such substitution codes can then be used to regenerate a form of the original. Elaboration coding adds to the material, making it easier to remember. The fact that, in this instance, longer material is easier to remember is additional proof of the fact that the number of chunks of information we can hold in memory is not as important for efficiency as the amount of information in those chunks.

Since almost all words have for us a multiplicity of associations, it seems reasonable to suppose that we encode them in different ways at the same time. According to the coding redundancy hypothesis (Paivio, 1971), memory increases directly with the number of alternative codes available to it. If, for example, we see a picture of a bird and encode it simply as "bird," only that word will aid in recall. On

the other hand, if we encode "bird--yellow--canary--lays eggs, etc." we open many retrieval routes. Multiple encoding provides additional retrieval routes and is, therefore, an effective strategy for coding material to ensure its eventual retrieval.

Another important characteristic of LTM is that meaning is the most important principle. Norman (1969) refers to a Broadbent experiment that demonstrates this. When a series of numbers was presented to both ears, subjects organized recall by ear, giving the number from one ear first and then those presented to the other ear. When the stimulus was words, however, as other experimentors showed, and when the words were broken up--half a word being presented to one ear and half to the other--subjects united the two halves to recall the word. Meaning was more important than the physical sensory analysis.

The importance of semantic encoding is shown also by the release from proactive inhibition paradigm. When a series of words having similar attributes is presented for recall over a number of trials, proactive inhibition results in a decline in performance. A release from the proactive inhibition, and a consequent improvement in recall, is the result of a shift to a new class of psychologically differentiated material. In particular, a change in the semantic context--a shift, for example, from words to numbers--obtains a release from P.I. The subject is "...particularly reactive to semantic attributes of words, mildly reactive to the

method of their physical presentation and essentially impervious to their syntactical characteristics" (Wickens, 1973, p. 213).

To recapitulate: as opposed to STM with its limited capacity, its low level of processing, where sensory acoustic information is gathered in the main and where rapid decay is the result of an unstable trace, LTM is unlimited in capacity and is characterized by a high level of processing where encoding is via the meaning or name. Consolidation of the trace by rehearsal results in the decrease or elimination of decay.

We stated earlier that memory is the recording, retaining and reviving or an experience, or retrieval. The foregoing is an attempt to discuss those requirements in terms of a broad, general model of memory as a process. In sum, they are:

Recording: The response to the stimulus is electrical activity. A sensory information store (SIS) holds information only long enough for a decision regarding its pertinence to be made. The electrical activity for pertinent information must be reinforced by rehearsal or repetition of the event. Such processing results in its placement in STM where, in the main, it is coded according to its sensory information.

Retention: Material to be retained permanently is coded according to meaning and thus enters LTM from which it is presumably never lost.

Retrieval: The way in which it is encoded, and the adequacy of the encoding process, determine if revival is possible and, at the same time, provide the path that must be followed for such retrieval. Probably the greatest problem we have in the memory process is in coding information in a form that is sufficiently appropriate that it can be matched against existing information and can be recalled when needed.

Memory is an inherent part of all of life. A human being without a memory is a vegetable (Baddeley & Patterson, 1971). There are inevitably many kinds of memory and many different ways of studying them. Each kind has, of course, its own specifics. The general model outlined above, it is believed, can serve as a base in studying all of them.

Language and Memory

In the attempt to understand human behavior, the studies of language behavior are perhaps the most significant. Because it is precisely our ability to use language that differentiates us from other animals, an understanding of such abilities can contribute in a major way to our understanding of human functioning.

The way we process and use language is at the same time the most complex of our human endeavors and that which is most likely to be revealing about what makes us human. "There is nothing either more characteristically human, or more psychologically significant than language..."(Deese & Hulse, 1967, p. 250).

To determine if a sentence has been comprehended, some action or activity is required of the subject that would demonstrate comprehension. The ability to follow directions is frequently accepted as evidence of comprehension. In a task such as that used in The Token Test (DeRenzi & Vignolo, 1962), where attention to every word is required (e.g., "Touch the small green square and the large yellow circle"), ability to perform the task accurately is considered a demonstration of comprehension. For more complex material, however, the subject is required to demonstrate what he remembers of what he has heard--through word-by-word repetition of the stimulus sentence, recognition of its syntactic form, etc. It must be recognized, however, that there can be rote recall without comprehension and that a sentence can be comprehended even though its syntax may be forgotten. In such cases, the basic concern is less with the memorial process as such than with its use as a means of assessing comprehension. This is not to say that we can not learn something about the memory process from the study of sentences, but rather that the studies are primarily concerned with comprehension. As Fillenbaum (1973) says, "The interest has <u>not</u> been in the ways in which syntactic factors might influence memorial processes or performance, but in the yield of memorial tasks as revealing something about syntactic structures... [p. 1]."

Since sentences are not the sum of words chained together, the study of individual words cannot help to clarify our understanding of how we comprehend sentences.

Bever (1968) states "...we cannot hope to learn to understand verbal behavior by studying experimental manipulation of words...[p. 478]." However, the study of single words can contribute greatly to our understanding of the way in which memory works and is thus the basis for most models of memory. It is therefore the major subject of this paper.

While the study of sentence comprehension lends itself less well to the development of models of memory, it has contributed important information concerning the general process, as we hope to show. Only through a study of sentence processing can we hope to understand the demands made on our memory by language.

Only through such study can we separate and clarify the roles of syntax and semantics. A brief discussion of the current status of our understanding of sentence comprehension is, therefore, essential.

The Sentence

Our understanding of the way in which we process sentences has undergone many changes. The concept that the meaning of a sentence was found in its deep structure led to experimentation designed to determine how deep structure was understood and meaning thereby extracted. The focus in these early studies was on the effect of syntactic variables. At a later stage, the emphasis shifted to semantic aspects.

While these early studies presented evidence for the facilitating effect of syntax on our ability to recall and

repeat sentences, more recent work emphasizes that the memory representation of a sentence is primarily semantic rather than syntactic (Barclay, 1973). According to Clark (1969) determination of deep structure is necessary for comprehension of a sentence, but memory is represented by a complex of semantic features.

The importance of meaning over syntax in sentence memory was shown in a study by Sachs (1967) which presented evidence that the memory for meaning is preserved over time while the memory for specific wording is lost. In a paragraph read to subjects, she variously changed the test sentence from active to passive, changed the word order and changed the meaning. Its position in the paragraph was also changed in order to assess performance when there was a time difference between stimulus and response.

When the interval between stimulus and response was brief, subjects were able to judge correctly 90% of the time whether the new sentence presented was the same one they heard before. At longer retention intervals, correct judgment dropped to 55-65% for all formal and voice changes. However, even at the longer intervals, subjects were correct in detecting semantic change 80% of the time.

It would appear from these results that the original form of the sentence is stored only long enough for comprehension. The specific wording then fades and it is the meaning that is stored.

As has been pointed out (Deese, 1968), in ordinary

language it is always the case that a very different string of words would do as well as the one actually recalled. In such everyday use of language it is the paraphrase of ideas that is important, not the exact sequence of words.

Bransford & Franks (1971) carried our understanding of this process one step further. In their study, four simple sentences could be combined to encompass two, three or four ideas. The subject initially was presented with some simple sentences, some where two ideas were combined, and some, three. At the time of test he was shown the above, plus some fours, which were the sum of information contained in all the sentences. He was asked to say which sentence he heard before and to indicate his confidence in this judgment. Subjects' highest positive recognition rate was for the fours--the sentences they had never heard but which expressed the complete semantic information in the various sentences. Their confidence rating decreased as the information in the sentence decreased, being lowest at the original simple sentence level.

So it appears we not only lose the syntactic form while retaining the meaning, but we take the information contained in these semantically related sentences and integrate them into a more easily remembered whole. "In general, subjects did not store representations of particular sentences. Individual sentences lost their unique status in memory in favor of a more wholistic representation of semantic events" (Bransford, Barclay, & Franks, 1972,

p. 206). These authors suggest an alternative to the interpretive approach in which "...a semantically interpreted deep structure is assumed to provide a sufficient characterization of what is stored." Their experiments look at the question of whether sentence memory is a function of the input only or of the semantic descriptions that the input suggests. In their view, a sentence is viewed as "...information which subjects can use to construct semantic descriptions of situations."

The Bransford, Barclay & Franks (1972) experiments contrasted the interpretive versus the constructuve approach to sentence memory by means of sentences from which additional information was implicit or inferable. Subjects heard the sentences 1) "Three turtles rested beside a floating log, and a fish swam beneath them," and 2) "Three turtles rested on a floating log, and a fish swam beneath them." On a subsequent recognition task they were able to state correctly that 3) "Three turtles rested beside a floating log, and a fish swam beneath it." had not appeared, but they were unable to determine whether 4) "Three turtles rested on a floating log, and a fish swam beneath it." had appeared. While sentence 3) can not be inferred from sentence 1), sentence 4) can be inferred from sentence 2). In the entire study, it was only those sentences that had a potential inference that subjects were unable to judge correctly.

Further studies (Barclay, 1973; Bransford et al., 1972) achieved the same results concerning inferences

drawn, not from single sentences, but from sets of semantically related sentences.

Fillenbaum (1973) sums up the current status of this aspect of our understanding of how sentences are remembered in the following manner: "If memory is not for sentences but for knowledge based on the information in sentences as this interacts with pre-existent knowledge, then just as verbatim models for sentence memory are irrelevant, just as syntactically based models appear to be inappropriate, so semantically based accounts may prove to be incomplete and insufficient insofar as they restrict themselves to the explicit meanings specifically embodied in particular sentences. If input information is conflated with pre-existent knowledge, then we shall need a theory of semantic memory which deals with the way in which cognitive schemata are achieved, stored, modified, and accessed p.[72]."

Ultimately it is the way we process and thereby comprehend sentences that we want to understand and the studies discussed above, along with many others not mentioned here, do much to increase that understanding. It is through the study of individual words, however, that we can learn about the processes involved in memory and the variables that affect that process.

A sentence is not a string of words. Until recently, however, the word was the unit most frequently studied because of the naive assumption that it played the key

role in the perception of spoken and written language. Later studies have revealed that processing is on many levels--phonetic, linguistic--which may differ in size and between which there is extensive interaction (Lehiste, 1972). Just as individual words must be understood for a sentence to be comprehended, so, too, comprehension of the sentence determines how a word is understood in context. Our memory for sentences is different from our memory for a list of words but a complete model for memory must account for both.

The Word

The particular way in which the word is studied varies according to the theoretical framework believed to determine verbal behavior. The three major methods of such study were serial learning, paired associate learning and free recall.

As the gap between empirical findings and theory widened and as the restrictions and inadequacies of S-R theory in general were revealed, the particular paradigms developed in that conceptual framework (serial learning and paired associate learning) were re-examined and re-assessed.

The inadequacies of S-R theory led Bever, Fodor & Garrett (1968) to conclude that certain human abilities were beyond the limit of what could be explained by an associative learning principle. "...any behavior that can be characterized by associative principles can ipso facto be characterized by the more powerful models...associative

rules are simply special cases of the rules employed by more powerful theories [p. 258]."

According to Young (1968), serial learning is a poor method of studying the processes underlying verbal behavior and only has advantages if we are specifically studying those processes involved in serial learning itself. Similarly, Battig (1968) states with respect to paired associate learning that "...general S-R behavior theory has provided researchers in PA learning with an oversimplified set of concepts grossly inadequate to handle the complexities of the learning processes involved therein..." and further, "PA learning research convincingly demonstrates the processes and phenomena involved to be exceedingly complex and, therefore, subsumable only under a general behavior theory which itself is of a high order of complexity [p. 166]."

Studies of serial learning and paired associate learning were supplanted in importance by the free recall paradigm as S-R theory was abandoned in favor of a cognitive approach to verbal learning and, indeed, the utilization of free recall appears to have developed "...not just in isolation, but almost in defiance of the traditional S-R models of behavior (Tulving, 1968, p. 32)." The emphasis on the active, participating role of the individual in memory functioning set forth in the foregoing sections makes the use of free recall most appropriate.

Free Recall

In an historical note, Tulving (1968) tells us that free recall is the descendent of the method of retained members which was named, but not used by Ebbinghaus. Subjects were presented a collection of items for subsequent recall and the order of such recall was not specified by the experimenter.

Although the method was used by early experimenters for the study of a variety of problems and the manipulation of numerous variables, it sank into oblivion in part as a result of Ebbinghaus' negative verdict as to its usefulness. "...for Ebbinghaus the study of memory was synonymous with the study of acquisition and retention of associations among items [p. 4]."

As "free recall," the method is once again respectable and is providing reliable empirical data of a kind that can not be explained by theories based on some form of rote learning. The fact that the subject is not constrained in any way by the experimenter in his recall of the stimulus provides us with an opportunity to see exactly what he does do in this situation. If he is not compelled to order his output to match the order of input, what order will he adopt? If he is not trained to remember a word because it has previously been paired with another, what mnemonic device will he use to aid his recall?

Organization

One of the most important findings from the analysis of free recall data is that the subject in this situation will use organization as a means of enhancing recall. It seems obvious that since the memory system can only deal with a limited number of items at any given time, organization is necessary to overcome such limitations. For many theorists, however, the major problem in memory lies not in storage, but in our ability to retrieve material from long-term memory. If long-term memory is viewed as a system unlimited in capacity from which nothing is ever lost, then it cannot contain a random collection of facts; rather, the information must be interrelated and structured and new material must be organized and integrated with the old or it would never be possible for us to find anything (Lindsay & Norman, 1972). While there is some dispute about the extent to which organization affects storage, there is general agreement about its importance in retrieval and there are many who believe that long-term memory is not possible without it (Baddeley & Patterson, 1971; Mandler, 1967).

There can be many types of memory. It can be episodic in which information about episodes and events is stored in terms solely of its perceptible properties. Here the reference is always autobiographical. Or it can be semantic memory, the memory necessary for the use of language. In contrast to episodic memory, in semantic

memory one registers the cognitive referents for input signals rather than their perceptible properties. Reliance on semantic memory enables one to know something he has not learned, to make inferences or generalizations (Tulving, 1972a). Memory can, of course, be many combinations of the above.

The way in which it is organized can be a reflection of these different kinds of memory. As stated above, the free recall paradigm lends itself particularly well to the study of such organization and within that framework the concept of a "primary" and "secondary" form of organization adds to the clarity.

In his analysis of the "Theoretical Issues in Free Recall," Tulving (1968) defined primary organization as "...consistent discrepancies between input and output orders that are independent of the subject's prior familiarity with a set of input items [p. 15]." Examples of primary organization, so defined, are the primacy and recency effects.

Recall of a list of words tends to result in a u-shaped curve, recall for words at the beginning and the end of the list being superior to the middle words regardless of the characteristics of the list, the specific meanings, or semantic relations. The serial position curves are the reverse of one another in serial recall and free recall, being greatest at the end in free recall (Deese & Hulse, 1967).

In free recall, the strength of the words early in the list is attributed, in part, to the small amounts of proactive inhibition to which they are subjected and to the possibility that they are rehearsed while the middle items are being presented, thus being strengthened at the expense of the middle items (Tulving, 1968). The recency effect--the greater recall of the final items--is believed to represent output from STM.

In secondary organization the output is "...governed by semantic or phonetic relations among items or by the subject's prior, extra-experimental or intra-experimental acquaintance with the items constituting a list (Tulving, 1968, p. 16)."

Clustering

The main example of such secondary organization is the phenomenon of clustering. First described by Bousfield in 1953, clustering has been called one of the most persistent characteristics of free recall data and has even been demonstrated in children from two to three. Subjects, when given a list to recall, tend to cluster those words that fall in the same category. Retrieval is thus simplified. We recall the category name, and then the items within that category.

The clustering of items for free recall is an illustration of the more general cognitive process of categorization. The universality of this strategy is shown in a

study by Roberts (1968) where, after ten trials of free recall of a list of words, subjects were asked to list the strategies or mnemonics they used. Those used by any one subject ranged from 1 to 7, with a mean of 2.84. However, 96% said one strategy used was to group on the basis of a common aspect.

There are many ways in which material can be organized. Organization is choice. Which "common aspect" is chosen certainly affects recall. It has been shown, for example, that categorical can exceed alphabetical clustering, even when both first letter cues and blocked presentation are provided to maximize the latter (Lauer & Battig, 1972).

In many of the free recall experiments, the material is organized by the experimenter and the subject has only to discover the list's inherent organization and cluster accordingly. Another form of organization is called an "adopted chunk." In this instance, an uninterrupted sequence in output will correspond to a similar input sequence (Tulving, 1968)

In addition, there can be subject-determined organization, or what Tulving (1962) refers to as subjective organization (S-Org). Several trials are required to establish subjective organization, as it is based on consistency of output over several trials. Since organization can be determined by "...the subject's prior... acquaintance with the items...," S-Org. may not always be identical with E-Org.

It has been shown that after a constant amount of study, the number of chunks recalled from unrelated lists was the same as for categorized lists, although the category chunks contained a larger number of units. The number of chunks thus appears to reflect mnemonic capacity (Cohen, 1963; Postman, 1972).

Category clustering lends itself particularly well to study and analysis. Cohen (1966) discusses some of the very striking results achieved when subjects are given categorized word lists for free recall. In the first place, they recall a large proportion of the words, in some cases as high as 60% of a 72-word list. Second, although the words are presented in random order, a high degree of organization--or clustering--is evidenced on recall. And, finally, while the number of words recalled exceeds what has been accepted as the span of immediate memory (Miller, 1956), the number of categories recalled seems to be relatively fixed.

The "Some-or-None" behavior Cohen describes is one of the more stable characteristics of free recall. Either subjects don't recall any words of a given category, or the number of words they do recall is remarkably consistent, and this is true regardless of category size. This mean-word-recall per category appears to be invariant with respect to list length, rate of presentation, or serial position. The recall of categories, however, is dependent on serial position.

Postman (1972) found that on initial recall, subjects attempt to recall serially and the tendency to recall terminal items is strong. However, with repeated exposure, the imposition of structure increases and this tactic is abandoned as the subject shifts his attention to semantic relations among items. Another important Cohen finding is that for both exhaustive (North, East, South, West, for example) and non-exhaustive categories, the probability of recalling only one word was small, .05 for the exhaustive categories and less than .10 for the non-exhaustive.

The fact of clustering and its facilitating effect on recall is accepted. The explanations for it, however, reflect the association versus organization dispute. The associationists believe that the organization is based on direct associative relations among items. Organization theorists believe that the response is based on mediation. Words are grouped, according to this view, not because one word arouses another as in association, but because one word arouses a general concept to which other words belong. For example, the word "dog" arouses the superordinate concept of "animal" thus providing access to the category and to a stable number of items within that category. The fact that for very few categories only one item is recalled is evidence that entry into the category is the important action.

Mechanical repetition by itself has no effect on recall (Tulving, 1966). Higher order units must be formed

if recall is to be increased. Multi-trials provide increased study time which means items can be organized into larger units. According to Bousfield & Cohen (1953), the fact that the number of recalled words increases could be attributed solely to the formation of larger clusters.

"The most impressive experimental evidence for the effects of organization on retrieval per se comes from studies of cuing. In the recall of categorized lists, supplying the names of the categories at the time of test enhances recall" (Postman, 1972, p. 12).

A series of experiments by Slamecka (1972) demonstrated that item cuing did not increase the extent to which a given category's contents could be retrieved and gains were attributed to increased recall of categories, not increased access to items within categories. Slamecka drew the following conclusions from his results:

a) Item-cuing was effective only when some categories could not be recalled unaided.

b) the magnitude of the cuing effect was a positive function of the number of categories in the list.

c) the effect operated by facilitating access to additional categories.

d) item-cuing did not increase the proportion of items recalled per recalled category.

e) proportion recalled under cued conditions was unaffected by the number of cues per category.

He concluded that

> "The theoretical conclusion which we feel justified in drawing from these findings

> is that they are more consistent with a basically cognitive account of the memorization of categorized material ...The fact that cuing had no power to enhance retrieval of specific items from a recalled category is patently contrary to an associative prediction, and instead suggests that a cue's contribution was terminated once access to the category-unit was achieved [p. 330]."

Additional support for the concept that clustering is based on organization rather than association comes from the studies dealing with part-list learning prior to whole-list learning. Results of these studies are particularly striking, possibly because they are counter-intuitive. In the Tulving (1966) experiment, one group of subjects learned 18 words prior to being exposed to the whole list containing these 18, plus 18 new words. A control group was given an irrelevant 18-word list. The group with prior learning had higher recall scores on the early trials but then part-learning seemed to retard memorization and they were passed by the control group. The same experiment was repeated with shorter lists and greater prior part-list learning with the same results.

One explanation for these findings is that the particular organization that the subject uses in the prior-part-list learning may not be appropriate for learning the whole list. If that were so, the material would need to be reorganized and this could conceivably retard learning. If practice and repetition were more important than organization, one would expect increased recall for the

group with the prior learning. It has been pointed out, however, that "prior part-list learning can facilitate subsequent whole-list learning if the lists are designed in such a way that List 1 organization is 'appropriate' to List 2 learning" (Wood, 1972, p. 55).

The retrieval process is, of course, central to any study of memory. As we stated earlier, retrieval is intimately related to storage. How an item is stored reflects what kind of material can interfere with it, and what kind of cues can be effective in retrieving it.

It is important that a distinction be made between material which is available and that which is accessible. Tulving & Pearlstone (1966) presented to subjects lists of words belonging to different categories, and the category name. Recall was superior under conditions of cued recall (presenting the category name as cue). This was strong support for the idea that material may be stored and, therefore, available. It may, however, be inaccessible unless the appropriate cue is provided.

These findings have been replicated and extended in other studies and have led to the formulation of the "encoding specificity hypothesis" which states that

> "...no cue, however, strongly associated with the TBR (to-be-remembered) item or otherwise related to it, can be effective unless the TBR item is specifically encoded with respect to that cue at the time of storage" (Thomson & Tulving, 1970, p. 255).

It should be pointed out, however, that such a cue does not necessarily have to be presented by the experimenter. In general, a subject who recognizes the categorical nature of the list will encode the specific item and its superordinate and thus will not require the presentation of a cue.

Aphasia and Memory

The new and powerful impetus that the study of memory has had in the past few years has only recently been reflected in the field of aphasia. It is well known that memory deficiencies accompany aphasia, but their exact nature has not been described in terms of our new knowledge of memory functioning. According to Luria (1971), "Memory disturbance associated with local brain lesions are often mentioned but seldom described carefully...[p. 367]."

The remarkable gains that have been made in our understanding of how the human mind works in processing new information, integrating it with old, and making it available when needed have come about as a result, in the main, of studies with normals. However, as is generally true, a great deal about the normal memorial process can be learned as well from the study of its growth and development from childhood and from its breakdown and disintegration in pathology.

Luria (1971) discusses two types of memory disorders. One is a general disorder which is modality non-specific,

and which, in severe cases, can cause massive memory derangement. An example of this general type is found in Korsakoff patients whose memory deficits have been the subject of considerable research in the past few years (Butters, Lewis, Cermak, & Goodglass, 1973; Cermak, Butters, & Goodglass, 1971). The second type of disorder he refers to as a partial, modality-specific disorder, and it is here, of course, that we find the aphasic. This type of disorder has, in our opinion, received even less detailed examination.

Luria makes an important distinction between these two groups. According to his findings, the memory disorder in the group with a general deficit is the result of interference. The disordered brain is unable to retain information learned if it is required to cope with new, incoming information. He found no deficit following what he termed a "free interval" after testing but did find a marked disturbance when the interval was filled with some interfering activity.

In the group with the modality-specific deficit, however, a disturbance was found even following the "free interval." Such patients would show the negative results of interfering activity but would also demonstrate a modality-specific deficit following free intervals. Those with temporal lesions, for example, where the acoustic modality was specifically affected, could retain figures after a "free interval," but were not able to recall auditorially

presented words. In this instance, the memory deficit is interpreted as due not only to interference effects but also to a primary instability and easy decay of traces within a specific modality. Others, to be discussed below, have found a primary disturbance in one modality but instability and loss in other spheres as well.

Such a distinction is important in helping us to understand not only the normal memorial process but the exact nature of the breakdown in aphasia. The study of normal memory is important to psychologists and students generally because of the central role it plays in all cognitive processes--or in all those processes that make us specifically human. For the speech pathologist, the delineation of the exact nature of the breakdown of the process is essential for planning of rehabilitative therapy.

In the earlier section of this study we have attempted to make clear the difference in the approach to memory processing that was a result of the release from behaviorist thinking which occurred in the 1950's. The central point made concerned the active role of the individual. Memory is not something one has. Memory is something one does. To go back to Bartlett (1932), memory is reconstructive. And it is man who does the reconstruction.

What kind of reconstruction can we have if the man who does the reconstructing is aphasic? The aphasic has lost the use of certain sections of his brain. As a

consequence, he has lost some ability to function symbolically. Can one who has lost this ability, function in the same manner as one who has not? In aphasia, the functioning of the human brain is deranged. Not only is its functioning disordered, but the disorder affects particularly and specifically the highest cognitive function we know--language.

Memory is a process and we cannot understand the aphasic if we don't examine him from the point of view of how his functioning follows or differs from normal processing.

Considering the important role that memory plays in language processing and considering the well-known aphasic deficit in memory, it is surprising that we know of no study designed to examine this deficit in a particular and specific form, as it relates to aphasia. In most studies of which we are aware, either the memory deficit or the aphasic component is peripheral to the subject under study. In some cases, the experiment is designed basically to examine the functioning of the left vs. the right hemisphere, or of the different hemispheric lobes. In these cases, the presence or absence of aphasia is not always specified, or may be an afterthought to the main concern of the study. In other instances, the way the aphasic performs is a central concern, but the means of testing this performance is via some cognitive function which may or may not be memory related.

Another problem we face in attempting to deal with these questions is the depth and breadth of the question asked. It is many years since Goldstein (1948) described

the aphasic impairment as the loss of the abstract attitude. He was quite clearly discussing a qualitatively different performance on the part of the aphasic. Unfortunately, the findings since then have been divided, sometimes supporting the position and sometimes offering no validation for its support.

One study which presented data in support of Goldstein's main contention was conducted by De Renzi, Faglioni, Savoiardo, & Vignolo in 1966. Earlier studies had found a worse performance on Weigl's Sorting Test by left brain damaged than right, but when the subgroups within the left hemisphere were examined, the aphasic performance was not significantly worse. De Renzi suggested that possibly the way the study was conducted might have contributed to these results. In their study, a modified version of Weigl's test was given to normals, right brain damaged, left brain damaged who were non-aphasic, and to left brain damaged aphasics to assess the influence of cerebral damage, of the hemispheric side of the lesion, and of aphasia.

Their results indicate that Weigl's test is specifically sensitive to the presence of aphasia and is quite insensitive to brain damage per se. The aphasics' mean scores fell to half the mean of the other groups. Their findings thus gave strong support to Goldstein's belief in the close relationship between aphasia and an impairment of abstract thinking.

A number of other studies, although not addressing themselves specifically to this question, have presented evidence of qualitatively different functioning on the part of aphasics. Several did not.

Tikofsky & Reynolds (1962) found aphasics merely slower in performing a modification of Grant's Wisconsin Card Sorting Task. Shewan & Bennett (1974) found the same pattern of errors by aphasics and normals in a task requiring selection from a group of an ambiguous figure previously seen.

Carson, Carson, & Tikofsky (1968) studied the learning capabilities of aphasics and found that they generated learning curves similar to normals. They concluded that the aphasic functioned more slowly but demonstrated a similar pattern of functioning.

One study which examined aphasic functioning particularly from the point of view of processing was conducted by Swinney & Taylor (1971). A nonverbal short-term memory task was administered to normals and aphasics. Response latencies were noted as subjects indicated whether a given item was "in" or "out" of the stimulus list. Normals showed similar latencies for both "in" and "out" functions, indicating an exhaustive search had been made before responding. Aphasics, on the contrary, took twice as long for the "out" function as for the "in." This suggests a self terminating search which stops when the item is found.

"In" responses would thus have shorter latencies since they would be found, on the average, half way through the list.

Specifically, they found that

> "...aphasics performed a slow, self-terminating search of memory for a recognition task while normals performed a faster, but exhaustive serial search of memory. Thus, an hypothesis of aphasic short-term memory which recognizes only quantitative differences between aphasic and non-aphasic adults appears to be insufficient [p. 584]."

The results of their study, they feel, raises "...serious questions concerning the validity of the hypothesis suggested by Carson et al. (1968) that aphasics differ from non-aphasics in a quantitative, but not a qualitative manner [p. 587]."

The fact that aphasics have difficulty in naming colors is known and is not surprising. A surprising finding (De Renzi, Faglioni, Scotti, & Spinnler, 1972) is that aphasics were significantly more impaired than any other brain damaged group in their ability to color in outlined drawings of objects having specific characteristic colors (i.e., a yellow banana, a red strawberry, etc.). This failure occurred in spite of the fact that the subject had both elements before him--the drawing and a group of 30 colored pencils from which he only had to select the one that matched the drawing. De Renzi concludes

> "The inability of aphasics to call the representation of colours to mind is viewed as an aspect of a more general disorder of conceptualization associated with but not directly dependent on the language derangement [p. 304]."

Teuber & Weinstein (1956) assessed the ability to discover hidden figures after cerebral lesions. Performance of all brain injured was inferior to controls. However, within the brain damaged subgroups, those with visual field defects, epilepsy, or somatosensory defects were not more impaired than those without such defects. Aphasic performance, however, was significantly worse. In an earlier study (Weinstein, Teuber, Ghent, & Semmes, 1955) aphasics had been found inferior on a conditional reaction task (choose a triangle rather than a circle when both appear on a horizontally striped background and a circle rather than a triangle when the stripes are vertical).

Both of these tasks are memory dependent and the aphasic's ability to perform them may therefore reflect his memory impairment. According to Teuber & Weinstein (1956),

> "The severe impairment of aphasics on hidden figures...does not encourage interpretations of the aphasias as specific losses of associations or engrams for linguistic patterns.... Instead, our observations support the view that an important aspect of aphasia is defective organization or selection of material (linguistic as well as non-linguistic).... [p. 376]."

The question of quantity vs. quality is clearly an important one and one that, in some form or another, has been discussed by most of the major aphasiologists. Has the aphasic merely lost the words, or is there a loss of some higher cognitive functioning as well? Quantity, of course, becomes quality, and our most severe aphasics would demonstrate this. In the somewhat less impaired, can we see the same pattern?

Until very recently our understanding of normal memory functioning was limited. Our newly gained insight provides an opportunity to compare the performance of normals and aphasics on this basic cognitive task and, it is hoped, to shed some further light on this controversial and important question.

The present study is an attempt to look further into the manner of aphasic memory functioning as it relates to normal functioning. Since the role of organization is now viewed by many as an essential part of the memory process and since one method of organization, clustering, has been such a ubiquitous finding, the aphasic's use of that strategy was the subject of this study.

Chapter 3

Methodological Considerations

Organization, now viewed by many as an essential part of the memory process, can take many forms. One ubiquitous method used by normals is clustering and, accordingly, it has been widely studied. In order to assess aphasic organizational ability and at the same time determine whether or not they use the strategies employed by normals, an analysis of their use of clustering was deemed most appropriate. For many years the free recall paradigm was used by memory students because of its potential for providing a variety of information (Tulving, 1968). This is especially true with regard to the kind of mental organization that is demonstrated in clustering. When no constraints are placed on the manner of recall, we learn whether or not the subject attempts reorganization of material to aid his recall and we learn also about his level of success.

Subjects

When attempting to analyze a cognitive skill such as the ability to use an appropriate strategy for the most successful performance of a given task, it is especially important to equate the subjects being compared along some basic lines. The college student can differ from the person who achieved a grade school or a high school education in more ways than the number of years of education. College students are more likely to be the children of those with a college

education. Not only is the past different, but the present and the future as well. Such differences in the milieu in which one has lived, is living now and can reasonably hope to live, will almost certainly affect cognitive functioning.

Much of the normative data on memory processing and, especially, clustering, was secured from a college population. In the original experiment conducted here (Chapter 4, Experiment 1) these data in the literature were accepted and used as the basis for comparison. It was decided, however, that more could be learned from comparing subjects of a similar educational level and background. Accordingly, in those experiments where comparisons were being made of the performance of aphasics, left hemiplegics and normals, all subjects were equated for years of schooling and all were selected from the population found in the Veterans Administration (VA) Hospital in Manhattan.

A cerebro-vascular accident (CVA), which is the most frequent cause of the aphasia found in the subjects used, entails a long and costly hospitalization and post-hospital care. One does find occasionally, as a result, patients whose socio-economic level is higher than the norm for a VA hospital. In general, however, it is a more homogeneous group than one is likely to find elsewhere and so comparisons of normals, aphasics and right hemiplegics from this group should prove most instructive.

Most cognitive functions, including memory, show a decline with age. A study of residents of an old age home showed that the percentage of subjects with memory loss increased from decade to decade (Kral, 1969). To control for the factor of age, subjects in this study were equated for age as well as education.

In summary, clustering performance of aphasics on a free recall memory task is compared to normal and left hemiplegic subjects equated for age, years of education, and socio-economic background.

Stimuli

Organization can be subjective (Tulving, 1968) or elicited by the experimenter by means of the composition of the list to be recalled. Subjective organization has the disadvantage of requiring a number of trials for it to be established whereas experimenter-defined organization can be evaluated in a single trial as well as over several trials. Accordingly, lists were constructed which had an inherent organization determined by the experimenter.

The most frequently used method of grouping, or clustering, is on the basis of some common aspect (Roberts, 1968). Words that are highly regarded as being members of a particular category lend themselves well to organization. To select the words used in this study, both normals and aphasics were asked on an informal basis to name as many

items as they could which belonged to a particular category. The resultant lists had many similarities. When asked to give instances of fruit, for example, a majority named apple or orange. Whenever possible, these most frequently named category members were used. On a few occasions less frequently named items were selected in order to equate the lists for general frequency of occurrence (Carroll, et al., 1971) but on no occasion was a word used that had not been contributed by an aphasic.

Both normals and aphasics have greater difficulty in comprehension and naming of low frequency words (Spreen, 1968). As Schuell (1965) has pointed out, aphasic errors tend to increase as word frequency decreases. The use of words of high frequency should, therefore, facilitate recall and organization. Lists were equated for frequency of occurrence to ensure an equal opportunity for recall among all lists and for recall of all categories within lists.

As has been pointed out, Miller (1956) defined the magical number seven as the biological capacity of the short-term memory system and proposed that Ss recode information into higher-order units or chunks, thus reducing the amount of information to be recalled. The important fact is that the seven items can be seven single words, seven categories with multiple entries, general concepts, etc. In this study the magical number has not been exceeded. Two of the lists contain six categories and have five items

in each; one has three categories with five items, and four have four categories with seven items in each. In all cases the list exceeds the short-term memory span. However, if recall is organized by category, the normal span is not exceeded, nor is it for within-category items.

According to Posner (1973),

> "In recalling categorized lists, the limitation tends to be the number of categories which can be represented in the recall rather than the number of words. Some studies indicate that subjects will recall items from three to seven categories and that each category may contain from three to seven items allowing recall of twenty-five or more items from a single, efficiently organized list [p.35]."

Theoretically, if a category is entered, i.e., if a code unit is recalled, then all the information it represents should be available for recall. According to Johnson (1972), in free recall, normal Ss seem to handle chunks of six and seven elements without trouble.

Serial position effect, in which recall is high for the words at the beginning and at the end of a list is a well-documented phenomenon (Murdock, 1962). The primacy effect, or recall of words early in the list,is believed to occur because such words are subject to relatively small amounts of proactive inhibition. An alternative, or additional, explanation is that memory traces for these early words are strengthened by rehearsal. Entering an essentially free STM

system, initial words can be rehearsed as incoming information is being processed. Such rehearsal, it is maintained, strengthens the trace of earlier items at the expense of middle items. The recency effect, or recall of terminal items, occurs, it is felt, because of their earlier recall, that is, there is a shorter time interval between learning the item and its recall (Tulving, 1968).

In order that such increased recall of initial and final words should not confound the results, three buffer words were added to the beginning and three to the end of each list. These words were equated for frequency of occurrence but were not instances of the categories used. With such words eliminated, an increase in recall could be attributed to the degree of organization of the list. In the fourth experiment of the study (Chapter 5) there are several experimental conditions in which the category name is presented as a cue at the time of presentation. In these cases no buffer words were used since the lack of a category label in a situation where all other words were labelled might make them even more salient.

To recapitulate, the lists used were experimenter-defined and composed of high-frequency words named by aphasics as being members of particular categories. Neither the category items nor the number of categories exceeds what is considered the normal span. In addition, buffer words which are not counted in recall are added to control for serial position effects. All of the word lists employed

in this study are reproduced in the appendices at the end of this dissertation.

Procedures

1. Multi-modality stimulation

Wepman (1961) who regards aphasia as modality-specific and Schuell et al (1965) who consider the deficit to be multi-modal define the extreme positions on this question. In this study, based on the literature as well as clinical experience, the Schuell position was accepted. Just as all modalities are affected, input in more than one modality is found beneficial. Accordingly, all stimuli in this study are presented both aurally and visually so that the subject gets maximum benefit from the presentation of the stimuli.

2. Cuing

In a "cuing" situation, the subject is provided with a word as a cue to aid his recall. Such experiments provide invaluable information about the availability of information as opposed to its accessibility (Tulving and Pearlstone, 1966). Supplying individual category items has not been found to help the subject name new instances (Wallace, 1970). Conversely, presentation of the name of the category does enhance recall.

The ability to retrieve items from memory is generally considered a more central problem in aphasia than their initial storage. In Experiments 1 and 2 (Chapter 4), after a subject's unaided recall had been recorded, he was

supplied the category names and following this cue any additional words were recorded to give further information about items which might have been in storage but which proved inaccessible without the aid of a cue.

A somewhat different use of cues was made in Experiment 4 (Chapter 5). Results in Chapter 4 raised the question of whether a cue would be effective as a reminder to cluster or ineffective because the subject would be unable to utilize it. In Experiment 4, therefore, there is basically one experiment with six conditions. A clustering baseline is established by presenting a list for recall with no cue given. In the next three conditions, cues of increasing specificity are presented. The fourth condition is used to assess generalization with no cues provided. Finally, the original "baseline" list is presented again with maximum cues.

3. Additional performance information

It has been noted that the only thing aphasics have in common is their disordered communicative ability. Variability of performance from subject to subject is a common finding. In an attempt to account for some of this variability, test scores of The Minnesota Test for Differential Diagnosis of Aphasia (Schuell, 1965) and the verbal portion of the Porch Index of Communicative Ability (Porch, 1967) were considered in analyzing data. Clustering scores were correlated with scores on these two

tests of aphasia in order to assess the effect of severity of aphasia.

4. Special scoring conventions

Unlike normals, in free recall tasks, aphasic subjects occasionally perseverate, i.e., repeat a stimulus word they have already uttered, or intrude, i.e., produce a response which was not part of the stimulus set. To cope with these anomalies, the following conventions were established:

a. Repetitions and intrusions were not counted in final recall totals.

b. If a word was repeated, it was not necessarily the first instance that was counted, but rather the instance which contributed to the higher clustering score.

c. If an intrusion occurred to items of the same category, the intruded word was considered to have destroyed the cluster.

The following two chapters present the data for this study. The first defines the phenomenon of failure to cluster by aphasics and the second describes attempts to remediate aphasic clustering behavior.

Chapter 4

Initial Experiments: Defining the Phenomenon

The present study was undertaken to ascertain whether aphasics utilize the clustering strategy employed by normals for the retention of verbally presented material and for its subsequent retrieval. The presence of a clustering strategy was assumed to be evidence of effective organization for retrieval which should enhance recall and the use of the clustering strategy would imply an active role on the part of the aphasic in organizing the material with which he must deal.

Grouping words into integrated units facilitates recall and is a strategy most frequently utilized by normals. Evidence for such grouping is displayed in the recall pattern which tends to be a burst from a cluster, a pause, and then a burst from another cluster, suggesting that the subjects search for groups.

According to most memory theorists material that has been placed in long-term memory (LTM) is never lost. The problem lies in the ability to retrieve such material when necessary. Storage and retrieval are thus inextricably bound since information must be encoded or categorized in a suitable form to facilitate retrieval.

For this study, free recall of lists of words was

selected as the means of analysis. The presence of clustering would be considered effective organization for retrieval and, it is believed, should lead to increased recall. On the other hand, a minimal clustering, or a lack of clustering altogether, would be indicative of an absent or inefficient coding system and should adversely affect recall.

In addition, it was hypothesized that if the presentation of a cue for recall, i.e., a category name, enabled a subject to add new words to his recall list, we would have evidence that the word had indeed been perceived and encoded as a member of a category. In that case, one would conclude that processes had not decayed or been lost in short-term memory, but had made the transition from short-term memory to storage in long-term memory. The central problem would not then be in encoding or storage of material but in a failure in the retrieval process.

Experiment 1

Procedures

Subjects were 10 aphasic out-patients being seen for post-hospital care and 2 aphasic in-patients currently being seen at the Veterans Administration Hospital in New York City. Their aphasic difficulty ranged from severe to mild. Those whose specific deficit precluded their comprehension of auditorially presented material were excluded from the study, as were those whose expressive language was too inadequate for them to fulfill the

required task.

Two lists of 36 words each were constructed.

1. List A consisted of six categories--fruit, vegetables, animals, clothing, furniture, and means of transportation--with five items in each.

A control list, List B, was composed of words having no relation to each other or to any word on List A. Words on this list matched those of List A in frequency of occurrence (Carroll, Davies, & Richman, 1971), and had the same first phoneme. Both lists contained the same number of syllables. Lists A and B are reproduced in Appendix A.

The words were recorded by a female speaker on a Wollensak recorder at 3-second intervals. Each word was also typed on a 3 x 5 card in capital letters.

Subjects were told that they would hear two lists of words. At the end of the first list, they would be asked to recall as many words as they could, in any order. The second list would then be presented for recall in the same manner. All subjects were seen individually. As the word was spoken on the tape recorder, the card with the typed word was placed in front of the subject. It was covered by each succeeding card. Immediately following the last word presented, the subject was asked to name any words he recalled.

The experimenter was familiar with all subjects and she occasionally judged that the subject remembered a

particular word although he was unable to say it--i.e., unable at the moment to say the word "table," he pointed to a table, or wrote the first letter. In all such cases, his reaction when the experimenter said the word for him was sufficient for her to conclude that the word had indeed been the one for which he was searching. Since this was a test of memory, not naming ability, such words were added to the recall list and considered correct. This occurred rarely.

2. At the end of the recall period, the subject was shown a paper on which each of the six category names had been written, with an indication that five items belonged under each. It was explained to him that the list he had just heard had contained such groups and he was asked if that information helped him recall any additional words. Additional time was allowed for recall. All words--new and old--were noted.

3. List B was presented for recall. Procedure was identical to that for List A except that no cued recall was given.

Results

Results for each subject are listed in Table 1 in descending order of success. Overall recall for List A ranged from a low of 3 to a high of 16, with a mean of 7.4. List B recall ranged from 0 to 6, with a mean of 3.1.

When a criterion of two was used to form a cluster, all but one subject formed at least one cluster. However,

Table 1

Results of Experiment 1

Subjects	Items recalled List A	Items recalled List B	N° of clusters criterion of 3	N° of clusters criterion of 2	N° of words added with cued recall
AN	15	6	3	6	7
JR	16	6	1	3	9
HF	9	4	0	2	6
LK	8	2	0	1	2
SK	7	4	0	1	0
HS	7	1	1	1	5
DC	7	4	0	2	1
RM	7	6	0	0	1
LW	4	0	0	1	3
LS	3	0	0	1	2
WJ	3	1	0	1	0
RS	3	4	0	1	6

since this performance might be due to reasons other than organization, results using a criterion of three were also examined. Only three subjects formed such clusters, and two of the three had the highest recall on both List A and List B.

When a cue for recall of List A was given, in all but two cases additional items were recalled. Added recall, in this case, ranged from 0 to 9, with a mean of 3.5

Recall of List B fell for the group as a whole, (Wilcoxon T = 1.5, p .01). List A, with its inherent organization, was better recalled by all subjects, including those who were not aware of it consciously or did not appear to use its organizational possibilities. The superiority of List A with respect to List B shows that the presence of categories is effective in influencing the performance.

Discussion

In general, these results support the cognitive approach to memory processing. Organization--in this instance, clustering--is a strong aid to recall. While the aphasics vary in their use of this strategy, the majority appear to use it minimally. Recall suffered thereby, and their performance can be said to be both quantitatively (lower recall) and qualitatively (lacking in organization) different from that attributed to normals in the literature.

With regard to the second hypothesis that added recall with cuing would be indicative of categorical storage in long-term memory, the following can be noted:

For the group as a whole, 42 additional words, or a mean of 3.5, were recalled when a cue was provided. Only two of the 12 subjects were not aided by this procedure. These 42 additional words represent an amount slightly less than half of the original 89 recalled. The hypothesis is thus supported. However, the fact that self-cuing was not utilized leads to the conclusion that the aphasic's coding and search techniques are inefficient. Material is placed in long-term memory and is, therefore, available, but because of weak storage or inefficient retrieval techniques, is inaccessible (Tulving & Pearlstone, 1966).

This inability to utilize organizational strategies could possibly be considered a result of the aphasic's slower functioning. It might be felt that a single learning trial does not give him enough time to perceive the categorical nature of the list and decide on an appropriate strategy. It has been demonstrated with normals that multitrial learning leads to an increase in organization. Clusters are consolidated. More categories are recalled and more items within those categories. This leads to an overall increase in recall (Bower, Lesgold & Tieman, 1969; Cohen, 1966). If a similar result could be shown for aphasics, it would be support for the position that the aphasic is merely functioning more slowly and that given enough time and trials, his performance will be similar to that of normals. Lack of such increase in organization

and consolidation would point to a difference in the quality of the aphasic behavior.

For this experiment it was decided to utilize a normal control group matched as closely as possible to the aphasics with respect to age and education. This step was necessitated by the fact that most of the normative data on clustering in the literature had been established with a college-age population. Accordingly, ten normal subjects were chosen from the same V.A. hospital as the aphasics, this insuring, we felt, a degree of homogeneity with respect to general background and socio-economic level. The only exception to this is one normal subject who is the mother of an aphasic subject brought in to balance a female aphasic.

In addition, a group of ten left hemiplegics was tested since it was felt that the use of such a group would reveal whether any deficit in the use of organizational stragegy was the result of brain damage per se, or was specifically related to aphasia.

Table 2 summarizes the age and years of education of the three groups.

Experiment 2

Procedures

A total of 35 subjects was used, ten normals and ten left hemiplegics as described above, and 15 aphasic subjects, nine of whom had participated in the previous study three months before.

Table 2

Subjects for Experiment 2

Group	Education	Age
Aphasics		
Mean	10.5	56.6
Range	(8 - 14)	(32 - 82)
Left Hemiplegics		
Mean	9.5	61.9
Range	(5 - 16)	(42 - 84)
Normals		
Mean	11.0	58.8
Range	(8 - 13)	(41 - 84)

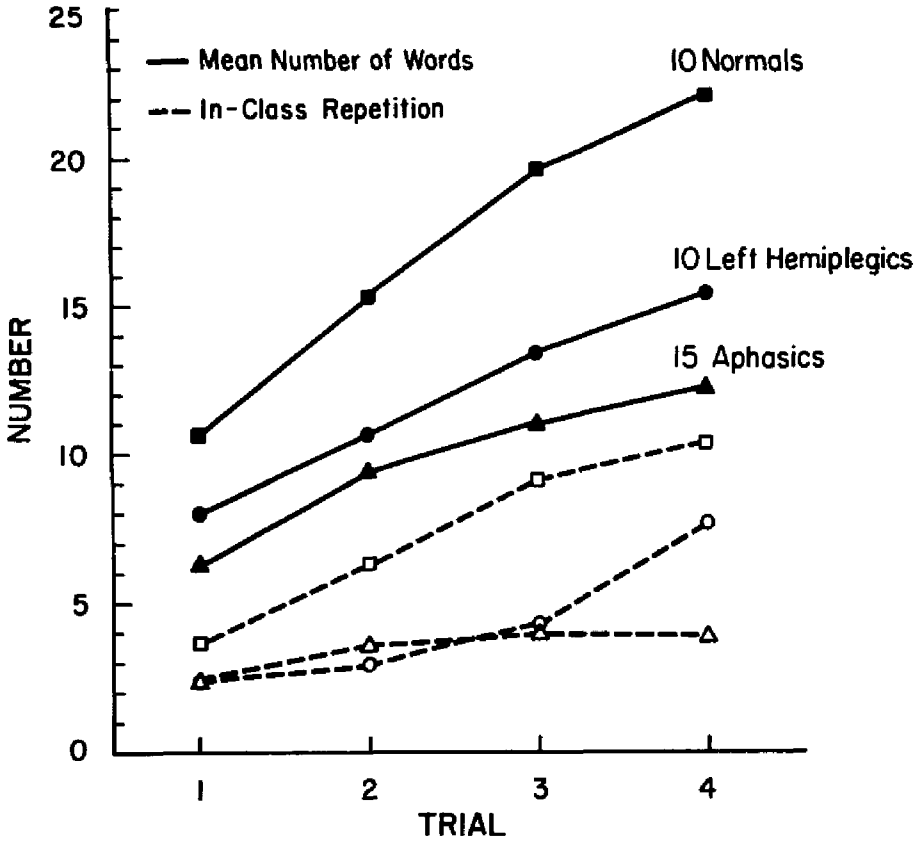
A list of 34 words was used. The list differed completely from the two used in the previous experiment. There were four categories of seven words each--sports, professions, dwellings, and weather. The category lists had essentially identical numbers of syllables (14) and mean word frequencies (49.3--Carroll et al., 1971). The 28 words were arranged in random order and were enclosed by a triad of buffer words at each end of the list. This word list is reproduced in Appendix B.

The presentation was the same as in the previous experiment. Subjects were told they would hear a single list repeated four times with a period for recall at the end of each presentation. Cued recall, which the subject had not been told would occur, followed the last recall period as it had in the first experiment.

Results

Multi-trial performances for the three groups of subjects are presented in Figure 1, wherein we observe a steady increase in words recalled on each succeeding trial. Additionally, Figure 1 displays the course of a commonly used index of clustering defined as In-Class Repetitions (ICRs). For this index, a subject is credited with an ICR each time a succeeding word comes from the same category as its predecessor, except that no credit is given to the first word of a cluster to correct for adventitious pairings (Shuell, 1969). In this experiment, an unattainably perfect

Figure 1: Two indices of performance by three groups on the multi-trial learning task.


25
20
15
10
5
0
NUMBER
Mean Number of Words
In-Class Repetition
10 Normals
10 Left Hemiplegics
15 Aphasics
1
2
3
4
TRIAL

performance would be to recall all 28 words in four successive clusters of seven words each, thereby achieving an ICR score of 24.

When the three groups are compared on the basis of total words recalled, there appears to be simple quantitative differences among them--normals best, aphasics worst--except that on succeeding trials, normals added words at a faster rate than either brain-damaged group. When compared on the basis of ICRs, a qualitative difference emerges, in that only the aphasic subjects failed to show a substantial improvement in clustering between the first and fourth trials. The difference between the two brain-damaged groups was assessed by comparing their fourth trial clustering performances in the following way: for each S, a ratio of his ICRs to total words was constructed in order to correct for the increasing probability of ICRs with increased words. This operation yielded a median ratio of 0.333 for the left hemiplegics and 0.286 for the aphasics. The distribution of ratios were then compared by means of the Mann-Whitney Test (Siegel, 1956), yielding a U of 15 ($p < .01$). Thus we confirm that even when their performances are adjusted for the opportunity of clustering, the aphasics cluster less frequently than the left hemiplegics.

A similar result is obtained when the three groups are compared on cued recall. In this task, with the

category names supplied, all normals recalled at least one word from each category, and only two of the left hemiplegics missed a single category each. In the aphasic group, only eight Ss recalled words in all four categories, the seven others missing from one to three categories each.

That the aphasics are functioning in a manner different from both the normals and the left hemiplegics seems evident. The question still remains, however, as to just where the breakdown occurs. A third experiment was conducted to look more closely at this question.

Experiment 3

Procedures

Subjects were 14 aphasics, eight of whom had participated in Experiments 1 or 2.

A list of 15 words containing three categories (fruit, clothing, means of transportation) with five words in each category was randomized and presented to the subjects. This list is reproduced in Appendix C.

Presentation was the same as in the previous two experiments. Before the list was presented, subjects were told to try to remember the words because immediately at the conclusion of the list, a second list would be presented. This list would contain all the words they had just heard, plus some additional new words. Their task was to indicate whether or not they thought the word in the second list had appeared on the original list.

The second list contained, in addition to the original 15 words, three new words for each of the three categories plus nine neutral words, for a total of 33 words. Words were equated for frequency and number of syllables.

Our hypothesis was that if the subject had perceived the categorized nature of this list, his errors would reflect this fact. For example, if he had noted that five of the words were fruit, he would be more likely to err in thinking that he had heard the word "pear" or "peach" before than that he had heard "parade" or "park."

Results

The 14 subjects made a total of 104 incorrect judgments, as follows:

1) Words that appeared on the original list but were not recognized: 57 errors.
2) Neutral words judged to have appeared on the original list: 16 errors.
3) New words from the same categories as the original words, judged to have appeared on the original list: 31 errors.

Since neutral words and new category words were equally represented on the list, the excess of the latter over the former can be taken as evidence of support for our hypothesis. Indeed when the difference scores for each S were examined by means of the Wilcoxon signed-ranks test (Siegel, 1956), a T of 5 was computed ($p = <.01$).

Discussion

Our results lend support to the view that, with respect to memory processes, aphasics function in a manner qualitatively different from that of normals. It is not just that recall is less, but that the aphasic does not use the normal strategy of clustering as a means of overcoming the limitations of memory and its vulnerability. This is so in spite of the fact that he seems on some level aware of the fact that the items in the list fall into categories.

In the first experiment, the lists were equated for frequency of occurrence, number of syllables, initial phoneme and manner of presentation, and yet 11 of the 12 subjects had superior recall on List A, the list containing six categories (see Table 1). The group as a whole recalled 22% of the words possible on List A, whereas they only recalled 10% of the words possible on List B. It would appear that the superior recall of List A must be due to the only apparent difference in the two lists--the presence of categories. For the presence of categories to have had any effect, it must have been noted by the subjects to some extent. And yet the clustering of such items to facilitate recall was minimal.

Experiment 3, the recognition experiment, gave further support to the idea that the categorized nature of the list had been perceived by the subjects. In this instance, of

the words that subjects wrongly thought they had heard before, 65% were members of the same categories. Subjects must have had some sense, however vague, that the list contained fruit or clothing, for example, for them to mistakenly feel 65% of the time that a particular fruit or item of clothing had been heard before. Retrieval, or the accessibility of available items, thus appears to be a major problem for the aphasics. On the other hand, the possibility of inefficient coding techniques cannot be eliminated since one quarter of the original list was not recognized. If there was an awareness that categories were present, individual items had not been strongly encoded as members of such categories.

When Experiment 1 was conducted, the normative data as cited in the literature was accepted for comparison. In Experiment 2, the multi-trial experiment, normal data as well as data from non-aphasic right brain-damaged subjects was gathered from a population with similar age, education and socio-economic background. This experiment thus made it possible to assess aphasic use of the clustering strategy vis-a-vis normal and left hemiplegic controls. The four trials enabled us to compare the aphasic's performance with those control groups when his slower functioning would not be a deterrent.

The contrast is, of course, greatest between the aphasics and the normal controls. That the normals

recalled more words initially is not surprising. However, it is of interest to note that, having started with a substantially higher rate of recall, the normals were able to add 41% more words while the aphasic increase was only 22%. If the aphasics' problem had only been that they were functioning more slowly, the four trials would have provided them with the opportunity to catch up, or at least bring their performance in line with the normals. Actually, the difference between the two was greater on trial 4.

The ability of normals to recall 79% of the words presented by trial 4 can be attributed to the marked increase in clustering as shown by ICR. This increase is a reflection of the consolidation of the clusters. Whereas two or three words from a category might form a cluster on trial 1, by trial 4, the most frequent normal pattern was fewer and larger clusters.

In every instance the performance of the left hemiplegic group lies between that of the aphasics and the normals. The ability to recall a list of words as well as the ability to call on an appropriate strategy as an aid appears to be affected by brain damage. A much greater deficit is apparent, however, when there is loss of language. On the first two trials the left hemiplegics' use of clustering was slightly less than that of the aphasics. However, while the aphasic clustering rate

began to decelerate and was less on trial 4, the left hemiplegics' rose rapidly on trials 3 and 4.

Results of this study support the findings of numerous studies of clustering by normals which demonstrate the validity of this technique as an aid to recall. In addition, they give support to our hypothesis that the inferior recall by aphasics can be attributed to the fact that this strategy is not normally used by them.

Deliberate memorization is an active, cognitive process and normals develop and use various strategies to help an easily-overloaded memory system cope with material presented to them. The need for such an active role apparently must be reawakened in the aphasic patient. Aphasics differ in the extent of the damage suffered and in their residual abilities. A multi-stage experiment, described in the next chapter, was conducted to determine if the aphasic could be trained to use the facilitating strategies of normals and to evaluate the characteristics that distinguish those who can benefit from such training from those who appear unable to utilize a strategy even when it is supplied to them.

Chapter 5

Experiment Four: Can Clustering Behavior be Remediated?

The experiments described in the previous chapter established some facts and raised new questions. In verbal recall, the aphasics did not cluster to the degree that normals did, and additional time did not improve their performance. In addition, aphasics clustered less than brain-injured patients without aphasia. Why doesn't the aphasic cluster? Is he unable to do so, or has he merely forgotten the utility of such a strategy? Could he be trained to cluster, and how specific must such training be? These are the issues dealt with in this chapter.

In order to obtain specific information that would make it possible to deal with these questions, the aphasics were given lists to recall accompanied by cues of varying specificity.

Procedure

Ss in this experiment were 20 male aphasics and ten normals drawn from the same population as was described in the previous chapter. Four of the aphasics had participated in one or another of the preceding experiments but, since a year had passed between those studies and the present one, this degree of subject-overlap was not considered relevant.

Mean age and educational level for this group were 53.1 and 11.5 years respectively. The normals included four female relatives of patients in the study and six V.A. inpatients whose mean age and educational levels were 48.4 and 12.1. The data obtained from the normals was helpful in establishing the validity of the cues.

All Ss were exposed to the following six conditions:

Baseline 1: The procedure utilized for List A in Experiment 1 was replicated--i.e., a list with buffers was presented, each spoken item accompanied by a file card showing the word in written form.

Cue 1: The category name was added to the stimulus card. The aurally presented stimuli were accompanied by the usual 3 x 5 card. In this case, however, in addition to the stimulus word which was centered and in lower case, the category name was supplied typed in upper case, enclosed in a box to emphasize it, and placed below and to the right of the stimulus. No attention was drawn to this in any way.

Cue 2: Stimulus cards as in Cue 1 were presented and, in addition, Ss were urged to group words that seemed to belong together as that would aid recall.

Cue 3: Stimulus cards were as in Baseline 1, but, on presentation, Ss were required to sort Stimuli into an array headed by category names.

Posttest: General procedure for Baseline 1 was replicated, but a new list was used.

Baseline 2: Procedure for Baseline 1 was replicated using the original list. Prior to presentation Ss were told the category name and instructed to attempt to cluster accordingly.

The nature of the lists and the cuing conditions described above are summarized in Table 3. All Ss performed all 6 conditions in a single session.

Results

Performance for the two groups are presented in Figure 2. Unsurprisingly, it is observed that the normals retrieve more words than the aphasics in every experimental condition, and that for both groups there is a rough proportionality between ICRs and total words.

Differences between the groups emerge when the various conditions are intercompared. For the normals, each of the three cue conditions yielded more ICRs than the Baseline 1 condition: Wilcoxon T's for Cues 1, 2, and 3 were 0, 1, and 0 respectively, all of which differences are highly significant ($p<.01$). When the same comparison is made for the aphasics, none of the cue conditions yields significantly higher ICRs than on Baseline 1 ($T=3$, $p<.01$) while the aphasics actually regress somewhat below Baseline 1, ($T= -72$) although not significantly.

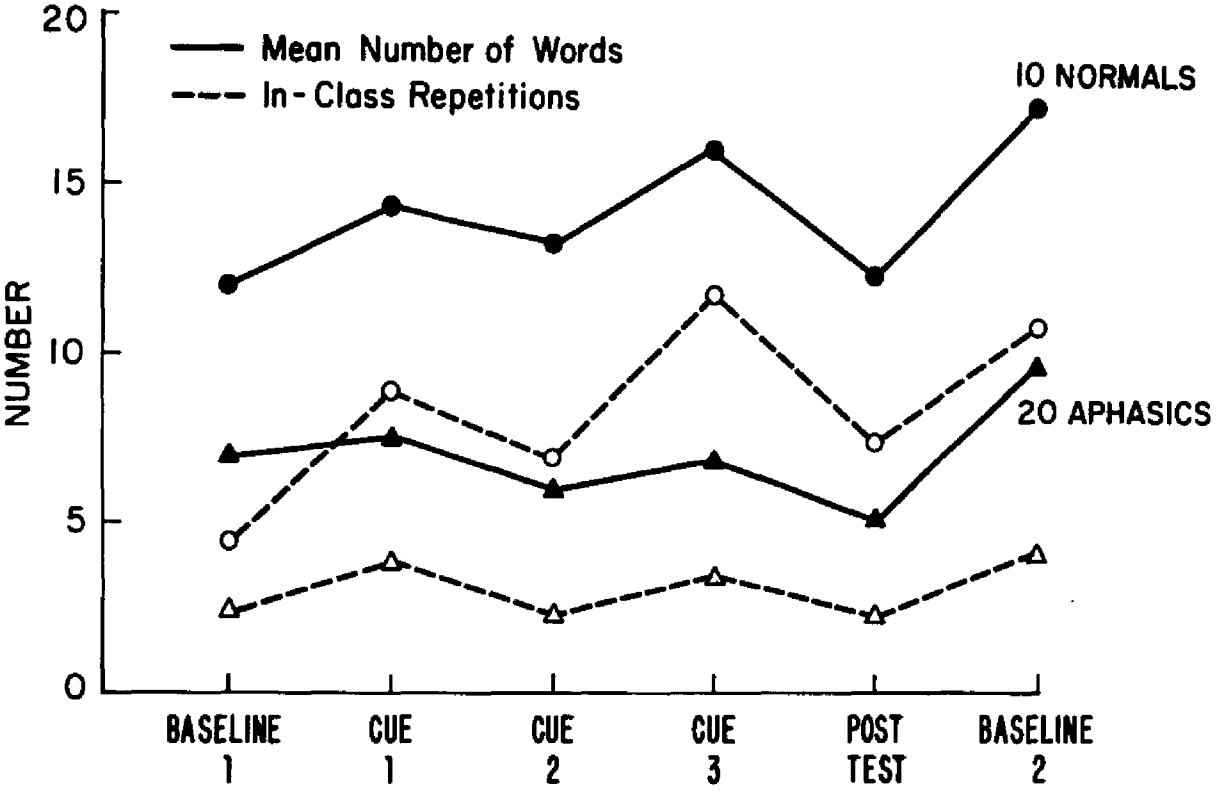
Both groups perform better on Baseline 2 than on Baseline 1, but the differences in magnitude are substantial. Whereas the normals gained an average of 5.1 words and 6.3 ICRs the aphasics gained only 1.7 words and 1.7 ICR's. Indeed, whereas $T=0$ ($p<.01$) for both the normal comparisons, $T=52$ ($p<.05$) for aphasic words and $T=29$ ($p<.05$) for aphasic ICRs.

Table 3

Design for Experiment Four

Condition	Composition of List	Cue
Baseline 1 (List A, Appendix A)	5 items each of: Fruit Vegetables Animals Clothing Furniture Transportation Plus buffer items	None
Cue 1 (Appendix D)	7 items each of: Metals Relatives Flowers Musical Instruments	Stimulus cards contain category names
Cue 2 (Appendix E)	7 items each of: Body Parts Trees Insects Fish	Stimulus cards contain category names; Ss urged to put similar words together
Cue 3 (Appendix F)	7 items each of: Bodies of water Tools Jewels Birds	Stimulus cards must be sorted under category names which are provided
Posttest (Appendix G)	5 items each of Sports Professions Dwellings Weather Colors States plus buffer items	None
Baseline 2	Same as Baseline 1	Ss told category name and urged to cluster

Figure 2: Two indices of performance by two groups in different experimental conditions.


20
15
10
5
0
NUMBER
Mean Number of Words
In-Class Repetitions
10 NORMALS
20 APHASICS
BASELINE 1
CUE 1
CUE 2
CUE 3
POST TEST
BASELINE 2

When individual performances are examined we observe profound differences among the aphasic subjects. For example, in the ICR comparison just cited, 12 patients improved between Baseline 1 and 2; 3 patients remained unchanged, while 5 actually worsened. A vivid demonstration of the range of performances may be obtained by summing, for each patient, his ICR scores over each of the 6 experimental conditions. When this is done we find the best five patients achieved scores of 55, 50, 43, 24 and 23 ICRs respectively. Conversely, the sum for the five lowest patients were 1, 1, 4, 4, and 5 ICRs respectively. In an effort to account for this enormously wide range of performance two test scores readily available for each patient were correlated with the sum ICR scores. One of them, the Verbal section of the Porch Index of Communicative Ability (Porch, 1967) yielded a rank difference correlation of $r_s = 0.378$ ($p < .05$). The other correland was the percentage correct score on the Minnesota Test for the Differential Diagnosis of Aphasia (Schuell, 1965). The rank difference correlation between the MTDDA scores and the sum ICR scores was an astonishingly high $r_s = .705$ ($p < .01$).

Discussion

The greater recall of normals based on superior clustering is demonstrated again in this experiment and reinforces the findings of the experiments reported in Chapter 4. In spite of initially higher recall and higher ICRs, normals were able in every instance to benefit from the cues provided.

The normal's increased recall when cued could be attributed to their being made aware of a process which, in all likelihood, had been carried out without their conscious awareness. Such awareness, brought about by the presence of cues, apparently serves to increase the efficiency with which the process is conducted. The increased recall of Posttest items (in which no cue was given) over Baseline 1 could reflect then a result of the set which had been created in the three previous conditions.

No such results are found for the aphasics. Just as in Experiment 3 additional time was not helpful, in Experiment 4 we find that the aphasic does not significantly improve his clustering ability even when the method of organization is indicated to him. If he had forgotten the importance of using a strategy, the cues should have served as a reminder and, even if it took more time for him to realize that helpful information was being given, by the time of the Posttest an increase rather than a regression would be expected. The results thus point to an inability to cluster. It is possible, of course, that the presentation of three cues in a single session does not constitute training and that the subjects might benefit from training which extended over a longer period of time. The relatively flat learning curve, however, does not predict strong results.

All of the above conclusions must be qualified when we examine individual performances. As always, aphasics' performance covers a wide range from near normal, or in the low-normal range, to grossly inadequate. The extent to which training can be beneficial bears a relationship to initial performance. This fact, plus the high correlation between ICRs and the MTDDA provide a means of predicting performance in a clustering task, and the ability to make such predictions has important therapeutic considerations.

These considerations as well as conclusions and inferences drawn from all the experiments reported will be discussed in the following chapter.

Chapter 6

Discussion

General results of this study demonstrated again the effectiveness of the clustering strategy in facilitating recall. Organization of material is essential if material which exceeds in quantity the biological capacity of short-term memory is to be remembered. In free recall, organization most often takes the form of grouping or clustering of items according to some common attribute. On a single trial of new material the benefits of clustering can be seen as increased recall accompanies an increase of clustering. A more dramatic demonstration is given in the multi-trial situation. The opportunity to hear the same list repeated a number of times permits the consolidation of the original groups. Larger clusters are formed as new words are added so that by a fourth trial, for example, recall consists of entry into a category and reading off all the instances of the category remembered before proceeding to the next category.

Studies cited in the literature presented evidence that the use of the clustering strategy in free recall was a widespread phenomenon among young college-educated subjects. Results of this study have shown that it is a technique used as well by the older non-college-educated subject typical of that found in the V.A. hospitals.

They also show that its use is lessened to some extent by any brain damage and, more significantly, that brain damage accompanied by aphasia has a markedly negative effect.

The left hemiplegics (L.H.) used in this study showed what appears to be a general slowing down, or the less efficient functioning so often attributed to aphasics. Whereas the normals clustered on the first trial and then added and consolidated on each succeeding trial, the left hemiplegics showed a steady, low rate of clustering for the first three trials. On the fourth trial, however, the amount of clustering increased sharply. It would appear that the L.H.s required a greater amount of time and more familiarity with the material for them to recognize and use the categories in the list. Once that recognition takes place, however, the categories are formed into clusters for recall. If we extrapolate from the curve for the mean number of words and the related ICR curve (Fig. 1), we may predict that normals would approach 100% recall by trial five or six. Similarly, for the L.H.s, after the recognition of categories in the third trial one may predict a steady increase in ICR and in words recalled.

The same expectation can not be assumed for the aphasic subjects. For the first three trials their ICRs equal that achieved by the L.H.s. The learning curve, however, remains flat. There is no evidence that the aphasics had the kind of insight from trial 3 to trial 4 that the L.H.s

appear to have had. In fact, aphasic recall on trial 4 shows a slight decline. It is interesting also that in spite of similar ICRs on the early trials, aphasics' mean recall was always below that the the L.H.s.

Results of the experiments conducted in this study give a picture of performance in a series of different conditions and permit a comparison of normal and aphasic performance. It can be seen that normals cluster spontaneously and then use additional trials to add to clusters already formed. In addition, they use cues provided to enhance their ability to organize recall. If the aphasic functions in the same manner as normals but with reduced efficiency, or at a slower rate, both additional time and cues should benefit him and bring his performance more in line with that of the normals. In fact, however, it can be seen that neither additional trials nor the presence of cues benefit him. Recall on trial 4 is remarkably similar to that of trial 1.

It has been emphasized many times that performance must be evaluated by an analysis of the quality of errors rather than the simple counting of numbers. How a given result is achieved can provide more information than a quantitative score. Aphasic scores in the experiments here consistently fall below that of left hemiplegics and normal controls. If we did not analyze further we could easily conclude that the difference between the groups is

quantitative. It is only when we examine the method of recall that we see that the quantitative score is the result of a qualitatively different performance. That qualitatively different functioning appears to occur at the time of original storage or encoding of material as well as at time of retrieval.

Clustering is an act of deliberate memorization. And deliberate memorization is a learned cognitive strategy. As Flavell (1971) pointed out, young children do perceive, do assimilate new information and do recall past information. They do not, however, attempt to do it consciously and deliberately. Young children, he found, did not show a difference in results when they were asked to memorize something as opposed to when they merely looked at the material for the same length of time. Superior recall of the memorized material, indicating a difference in processing, only occurred in older children who were more developed cognitively. If the awareness of the need for a cognitive strategy is a result of cognitive growth, lack of such awareness can only be attributed to cognitive loss. The aphasic's failure to use this strategy--or his inability to do so--is an indication of a disorder in cognitive functioning.

Deliberate memorization, according to Flavell, is planful, intentional, goal-directed, furture-oriented behavior. Having recognized the need for a strategy when material to-be-remembered exceeds the memory span, one must choose an appropriate one and abstract the information

necessary for its organization. Deliberate memorization must begin with heightened attention to the incoming stimuli and processing in depth of material to be remembered.

According to Posner (1973) "...the most crucial time for the retention of information is the moment at which the information is received. The way in which information is organized and filed at that moment governs the uses for which it will be most readily available in later thinking [p. 30]". Studies dealing with the release from proactive interference in which there is a tendency for recall to increase following a switch in stimuli from digits to letters, for example, or a switch of semantic categories, demonstrate that stimuli are encoded according to meaning at input. The classifications, and the hierarchy of classifications formed at input, determine the limits to which the material is accessible for retrieval.

The plan to cluster according to categories can only be made when enough of the list has been heard so that the relationship among the various words is clear. The more fully the word is encoded when first heard, the more varied the cues that will elicit its recall. Encoding and processing material on many levels will facilitate recall when the mode or organization required in a particular task becomes clear.

That normals in this study have encoded the individual words according to their category membership is shown by the fact that entrance into a specific category--that is,

recall of at least one member of that category, is in 78% of the cases followed by several other members of the same group. It is rare that only a single category entry will be recalled. Each item recalled represents not itself but its superordinate, the category name. This, then is the principle of recall of some-or-none, as discussed by Cohen (1966).

This is not true of aphasic recall. Thirty-two per cent of the time recall of a single item ends there and does not serve as the door opening into the category. Each item is recalled singly, sometimes calling forth another highly associated word, but rarely providing entry to the category. And this is so despite the fact that results of the earlier studies showed some awareness of the categories on the part of the aphasics. Recall of the categorized list in the original experiment was superior to that of the control list, indicating that the presence of categories had some effect on recall. Presentation of the category name at the time of recall elicited some additional recall by most subjects, although in the majority of cases only the barest fraction of the category was tapped. The aphasics do not seem able, however, to convert that minimal awareness into "goal-directed, future-oriented behavior". The aphasic appears to have lost the ability to use the information that he has. The gathering of information is important only if we know what to do with it.

Once again we see the critical distinction between the passive reception of information and its active processing. The act of categorizing is so basic a part of human development that the superior recall of List A may be just a reflection of that lifelong activity. For a true difference, the knowledge of the presence of categories must be put to use in an active way. The presence of categories points out the road to the most appropriate strategy. The decision to go down that road must be actively undertaken.

To deliberately memorize means to formulate a plan or strategy for recall. Not only must the plan selected by appropriate for maximum recall, but inappropriate strategies must be discarded as more information exposes their weakness or leads to a different strategy. Implied in this view is the ability to hold pieces of information in memory while processing new, incoming material. The ability to stand off from the material, abstracting information and weighing alternatives is a basic requirement. Such abilities appear beyond the scope of the average aphasic.

To the extent that these lost skills involve the capacity to abstract, the results of this study can be viewed as offering a measure of support for Goldstein's view of aphasia as an impairment of the abstract attitude (1948). Perhaps the majority of aphasics do not use the cognitive strategy used by normals because they are unable to assume the abstract attitude required for its performance. Neither time nor cues can be of sufficient help to overcome this loss, associated with a loss

of language. It does not appear to be true of the left hemiplegics and the extent of the problem is highly correlated with the extent of the language deficit.

His memory deficit is a severe loss to the aphasic. It is strange and difficult to understand that the Broca's aphasic who often can only achieve a pointing span of two is still capable of relatively good comprehension--even, it is sometimes claimed--near perfect comprehension. The redundancy of our language is certainly helpful to him and he is able to follow general conversation. It quickly becomes apparent, however, that while simple conversation can be followed, subtleties are lost and comprehension diminishes as complexity increases. The aphasic who appears to be capable of following a conversation and who laughs appropriately when something funny occurs, looks blank when he hears the punch line of a joke. It is not sufficient that we be able to hold any given amount of material in memory. We must be able to act on it as well--making inferences, juggling concepts, finding ambiguities.

The deficit becomes even more apparent when we examine the aphasic's reading ability. Even the mildly impaired complain of their reading problems. Reading rate is drastically reduced because of the necessity to go back and review what has already been read--and already forgotten. While they can comprehend individual pieces of information--far better, in many cases, than one would anticipate-- it is difficult for them to follow a story of any length or

complexity or to carry out instructions composed of several parts. Even more frequent is an inability to draw inferences from what is read.

To retain facts heard or read requires holding several isolated bits of information in an active memory system. Even this is beyond the capability of the more severely impaired, but many aphasics can retain information well enough to be able to recall a given number of facts. To draw inferences or to extract a theme from facts heard requires a higher level of cognitive processing--a cognitive processing requiring the use of memories, their reorganization and combination with new information.

The results of these studies permit us to draw conclusions concerning certain specific hypotheses and enable us to state directly that aphasics do not use the clustering strategy of normals; that, in the main, they are unable to use cues provided to help them adopt this strategy; and that this disability is related to the loss of language, being more severe in aphasia than in cases of brain injury without aphasia and correlating with the severity of the aphasic impairment. The results also, while not providing direct answers, permit us to draw inferences concerning other, broader questions. These allow speculation concerning some immediate and some more far-reaching effects of such disabilities. It is with these inferences that this section will be concerned.

As has already been pointed out, the most obvious inference is that the inability to cluster is an inability to assume the prerequisite abstract attitude, and is a manifestation of a qualitatively different mode of behavior. Such a difference in behavior was seen by Goldstein (1948) as a central deficit in aphasia. While there has been great resistance to this concept, a number of studies have given support to the general concept of a different mode of behavior, and others have specifically pointed to an impaired ability to abstract.

It is possible that the resistance to Goldstein's formulation is because acceptance of the idea of aphasia as a loss of an ability to abstract implies a deficit in thinking ability and this is something one would rather not find in people who appear to know what they want to say but are merely unable to find the specific words.

Let us assume for the moment that the aphasic has lost some ability to abstract and that he is functioning in a qualitatively different manner. He has certainly done so with respect to the tasks in the study presented here. De Renzi et al., (1966) found such a loss on performance of Weigl's Sorting Task. And other studies have brought out aphasic difficulty with tasks that present no problem for normals--i.e., associating color to form (De Renzi et al., 1972); recognizing meaningful sounds (Spinnler and Vignolo, 1966); discovering hidden figures (Teuber and Weinstein, 1956).

Swinney and Taylor (1971) found a difference in search tactics. It was demonstrated that aphasics do not verbally encode visual material as normals do (Goodglass, Denes & Calderon, 1974).

What can we infer from such an altered mode of behavior and an impaired ability to abstract? For many centuries philosophers have been attempting to understand the nature of human thinking and to elucidate its requirements, and, as Posner makes clear in his review of the history of memory and thought in Cognition: an Introduction (1973), the ability to abstract is a central requirement. Aristotle emphasized the importance of abstraction, induction and deduction. Abelard described the mind as capable of abstracting universal qualities, attending to one aspect of an object, ignoring other aspects and thus isolating aspects which relate to differing objects. For John Locke, fundamental mental acts were perception, retention, distinguishing, comparison and composition.

All attempts to understand the psychology of thought processes must be concerned with how information is represented in memory structures and, more importantly, the mental operations performed upon these memory structures (Posner, 1973). One such operation is the assignment of a verbal label which permits information to be abstracted, represented in a memory structure and acted upon.

"Human culture, social behavior and thinking could

not exist as we know them in the absence of language..." (Slobin, 1971, p. 98).

"All authors who have been concerned with the study of thinking have realized the importance of memory," (Posner, 1973, p. 15).

"...it is quite impossible in human adults to separate thinking from language behavior," (Cameron, 1944, p. 51).

"Thought is not merely expressed in words, it comes into existence through them." (Vygotsky, 1962, p. 125).

If memory, language and thought are inextricably related and intertwined, what then of the person who has lost the particular and specific ability of verbal memory? If language is affected, how would it be possible, in view of the above, for thought to be untouched? Can the aphasic be said to have lost the word without having lost the thought? According to Vygotsky, "A word without meaning is an empty sound; meaning, therefore, is a criterion of 'word,' its indispensable component...the meaning of every word is a generalization or a concept. And since generalization and concepts are undeniably acts of thought, we may regard meaning as a phenomenon of thinking" [p. 120].

What do we lose if we lose the ability to abstract? According to Goldstein (1944) it is the abstract attitude that enables us to:

1. Assume a mental set voluntarily.

2. Shift voluntarily from one aspect to another.

3. Keep in mind simultaneously various aspects.
4. Grasp essentials of a given whole--break up a given whole into parts and isolate them voluntarily.
5. To generalize: to abstract common properties; to plan ahead ideationally; to assume an attitude toward the merely possible; to think and perform symbolically.
6. To detach our ego from the outer world.

Thought is concept formation. "In genuine concept formation, it is equally important to unite and to separate: synthesis must be combined with analysis" (Vygotsky, 1962, p. 76). Such analysis and synthesis requires the ability to abstract. Goldstein (1944) points out further "...the process of disintegration in the direction of concrete behavior does not prevent the arousal of ideas and thoughts; what it actually affects and modifies is the way of manipulating and operating them [p.20]."

In the study presented here, aphasics proved unable to memorize lists of words because they were unable to make the size of the list manipulable by abstracting common elements from the words and uniting them appropriately into superordinate categories. One is not frequently called on to memorize lists of words. One is, however, constantly required to abstract, to analyze and synthesize.

In terms of comprehension, Luria (1973) points out essential conditions for the decoding of narrative speech. The first is retention of all elements of the expression in the speech memory; then the simultaneous synthesis of its elements, surveying and forming simultaneous logical schemes. This process, he points out, is not necessary for the simple communication of events but is essential for an understanding of complex-logical-grammatical relationships. The final and most important condition is the active analysis of the most significant elements of the speech. The aphasic about whom it is frequently said "He understands everything" does not, in fact, understand all the complex logical-grammatical relationships to which Luria refers, but rather derives the general meaning from some of the verbal elements together with cues from context and intonation.

In terms of production of speech the ability to abstract is required if one is to formulate a plan or theme for speech. To answer a simple question requires merely finding the appropriate words. To make a voluntary statement means that one must abstract a theme and hold it in memory while synthesizing its various elements.

Many aphasics, when asked to describe a picture and tell what is happening, are unable to perform at all, or, at best, can name isolated elements in the picture. For example, if asked to describe a picture of a boy breaking a stick, the aphasic does not know where to begin. He is

able to answer a series of questions, such as who are we talking about, what is he doing, and what is he doing it to. He is then frequently able to put it all together in a sentence and say "The boy is breaking a stick." Not always, but often, he can then describe a picture of a boy raking leaves. If, however, in a real life situation, he wants to tell you that his wife is drinking a cup of coffee, or that he wants to go to the bathroom, he appears unable to formulate the required theme or plan and so does not know how to begin. Luria (1963) calls such a deficit a "disintegration of internal dynamic conceptual patterns." It is described here on a sentence level. It is even more apparent in the aphasic who can understand a story, can answer questions about it, but is incapable of organizing his thoughts to enable him to tell what the story is about.

Comprehension and evaluation of spoken language are affected by the verbal memory loss. So, too, the thought process must inevitably be affected. Language is not only a means of human social communication but it is a tool for intellectual activity and also a method of regulating or organizing human mental processes "...a method of formulating decisions and drawing conclusions...a mechanism of intellectual activity--a method for use in operation of abstraction and generalization and a basis for categorical thinking." (Luria, 1973, p. 307).

Results of this study as well as the study of search tactics by aphasics analyzed by Swinney and Taylor (1971) are evidence that the quantitatively inferior results

achieved are the result of qualitatively different functioning. General observation points to a loss of strategies in aphasia. Further research is required to uncover other specific modes of behavior in which the aphasic may not be following the normal pattern but an altered, less effective strategy.

What might such therapy be, and who are the subjects likely to benefit from it? some implications with respect to the latter question may be drawn from a closer inspection of the high correlation found in Experiment 4 between MTDDA scores and sum ICRs. Figure 3 presents a scatterplot of the relationship where, adjacent to each point, the age of the patient has been annotated.[1] As can be seen

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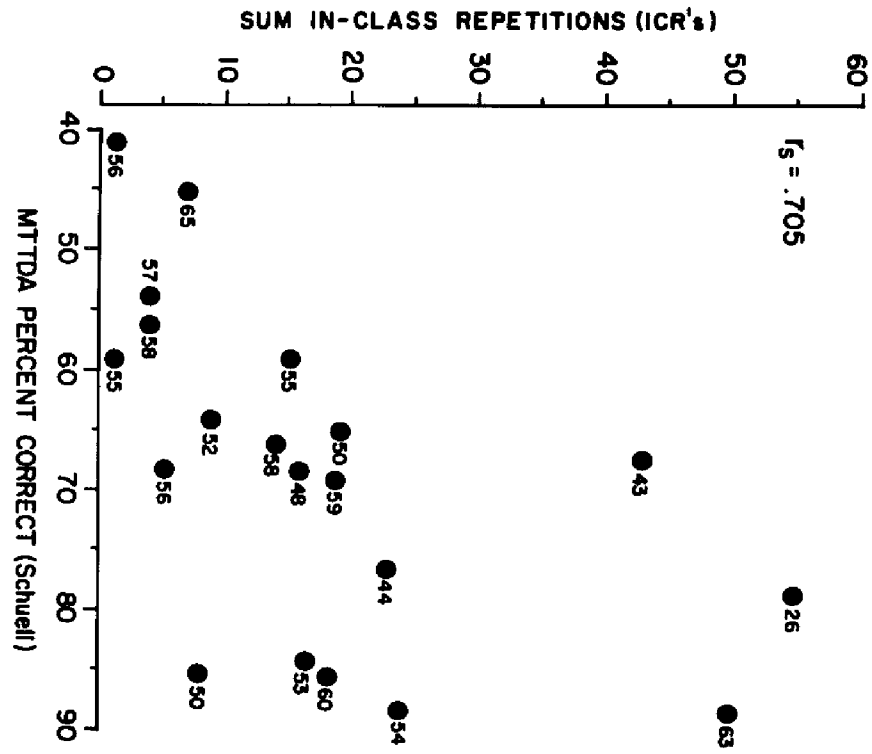
1 Future students of clustering behavior in aphasics may be interested to learn that slightly higher correlations emerge between certain subtests of the MTDDA and ICR scores than reported here for the MTDDA total score. Specifically, when only purely productive tasks are considered (Section C, subtests 5 through 15) r_s with ICR scores rises to .738. When only comprehension tasks are considered (Section A, subtests 1 through 7) r_s with ICR scores rises to .790. Unfortunately, no means yet exist to test the significance of differences between rank-difference correlation coefficients. Thus, considering the many subscores upon which it is based, the MTDDA total score would appear to be the best estimator of the relationship between severity of aphasia and capacity to cluster in free recall.

Figure 3: Scatter plot of MTDDA scores (percent correct) vs. Sum ICR scores in Experiment 4. Numbers on the graph indicate the age of each patient.


SUM IN-CLASS REPETITIONS (ICR's)
0
10
20
30
40
50
60
r_s = .705
MTTDA PERCENT CORRECT (Schuell)
40
50
60
70
80
90
56
65
57
58
55
55
52
56
58
48
50
59
43
44
26
50
53
60
54
63

17 of the 20 Ss achieved ICR scores below 30 and those data lead to the conclusion that if a patient has a Schuell score in which less than 60% of the items are correct and if he is over 50 years old, it is probably fruitless to attempt training in cognitive strategies. For such patients, goals of therapy might be minimal with an emphasis on utilizing such communicative skills that remain rather than focusing on higher level cognitive activities.

Of the three subjects who scored over 30 ICR, 2 are below age 50. The performance of the third subject, the 63 year old, is surprisingly good considering his age. It is important to note, however, that this subject's major aphasic problem is phonemic paraphasia and his inability to repeat words and phrases lowers his Schuell scores considerably. On all other meaures, his impairment would be considered minimal and would explain his high score.

For those patients with Schuell scores above 60% correct, then, training in cognitive strategies is worth attempting especially if the patient is young. The extent of the benefits of such training, however, remains unclear.

We have been discussing an altered mode of behavior and the conclusion is inevitable that an alteration in behavior requires an alteration in therapy approaches. If we were dealing with a quantitatively inferior performance, the emphasis might be on additional processing time. In such cases, drill and repetition would be the major therapeutic

approach. The implication is that all systems are operating normally but at a vastly reduced rate. Additional time and familiarity with the material should result in gains bringing performance more in line with normal behavior. In the one study here using left hemiplegics without aphasia such an assessment seemed apropos. One could infer from the results of the multi-trial experiment that additional time would be of value to them. Not so the aphasics. In this case it is the actual mode of behavior that requires alteration and only therapy directed toward a change in behavioral strategies seems warranted.

Luria (1963) describes the restoration of function after brain injury as the "radical re-organization of the destroyed activity," and he describes how a complex human activity, such as speech, can be transferred to the level of conscious action and subsequent automatization. The performance of any high level cognitive task is dependent on analysis and synthesis or precisely on the ability causing the aphasic difficulty.

One type of therapy might then be directed toward making the aphasic aware on a very conscious level of just what such analysis and synthesis entails. For the brain injured, therapy may mean laboriously breaking down or analyzing processes and then, just as laboriously putting them together, or synthesizing, them. The patient who could say "The boy is breaking the stick" only in response to questions, must be taught to ask himself "who is doing

what to whom." For less impaired patients, Luria described "transition formulae"--words or phrases, such as "however," "although," "after," etc., that subjects used to help them compose the plan necessary for a narration.

To learn at age 50 or thereabouts to formulate a sentence by making oneself aware of all its elements seems a monumental task and the day when such a process could become automatic might be far in the future. And yet it seems to be one possible path open to the aphasic. There are surely others as well.

It has frequently been said that no two aphasics are alike. Like snowflakes, each is different. But in one respect they are alike. They will never stop working to regain their speech. They alone know the magnitude of their loss.

Appendix A

Lists Used in Experiment 1

List A		List B	
date	- Buffer	distant	- Buffer
condition	- "	conversation	- "
ranch	- "	ruler	- "
banana	Fr	gentlemen	
car	T	scale	
grapes	Fr	clothes	
radio	F	cake	
bus	T	peace	
shirt	C	tree	
table	F	bag	
subway	T	pans	
lion	A	balloon	
orange	Fr	camera	
cow	A	alphabet	
train	T	oceans	
hat	C	city	
cabbage	V	tail	
cat	A	ring	
bed	F	tack	
potato	V	tanks	
sock	C	hole	
pear	Fr	patients	
dog	A	schoolhouse	
tomato	V	secret	
sofa	F	palace	
beans	V	baby	
tiger	A	log	
apple	Fr	desert	
pants	C	beaches	
chair	F	ants	
airplane	T	scene	
shoes	C	camp	
peas	V	scent	
degree	- Buffer	dollar	- Buffer
construction	- "	complex	- "
environment	- "	evidence	- "
Overall Freq.: 55.3		Overall Freq.: 52.1	

Fruit (Fr)	- Frequency 52.0
Vegetable (V)	- Frequency 51.2
Clothing (C)	- Frequency 54.8
Animal (A)	- Frequency 57.8
Transportation (T)	- Frequency 57.4
Furniture (F)	- Frequency 58.3

Appendix B

List Used in Experiment 2

cliff	- Buffer
lens	- "
rolls	- "
football	Sp
doctor	P
adobe	D
sleet	W
dentist	P
basketball	Sp
policeman	P
hockey	Sp
engineer	P
boxing	Sp
cabin	D
hurricane	W
trailer	D
nurse	P
tent	D
jeweler	P
coop	D
tennis	Sp
lightning	W
wigwam	D
sandstorm	W
track	Sp
thunder	W
wrestling	Sp
apartment	D
rain	W
lawyer	P
tornado	W
lid	- Buffer
cash	- "
rats	- "

Overall Frequency - 50.1

Sports (Sp)	- Frequency 49.2
Professions (P)	- Frequency 49.1
Dwellings (D)	- Frequency 49.1
Weather (W)	- Frequency 49.5

Appendix C

Lists Used in Experiment 3

List presented for free recall

grape	Fr
taxi	T
pants	C
walking	T
cherry	Fr
airplane	T
hat	C
pineapple	Fr
jacket	C
banana	Fr
shirt	C
car	T
shoes	C
helicopter	T
apple	Fr

Overall Frequency - 53.5

Fruit (Fr)	Frequency 51.1
Transportation (T)	Frequency 55.7
Clothing (C)	Frequency 55.4

List presented for recognition

peach	Fr - new
sword	neutral
apple	Fr
helicopter	T
shoes	C
bus	T - new
shirt	C
jars	neutral
walking	T
tear	neutral
park	neutral
teacher	neutral
banana	Fr
train	T - new
coat	C - new
over	neutral
pear	Fr - new
tie	C - new
bags	neutral
car	T
jacket	C
pineapple	Fr
subway	T - new
parade	neutral
airplane	T
cash	neutral
taxi	T
hat	C
orange	Fr - new
pants	C
cherry	Fr
socks	C - new
grape	Fr

Overall Frequency - 53.0

Fruit (Fr)	Frequency 50.8
Transportation (T)	Frequency 55.0
Clothing (C)	Frequency 54.8
Neutral	Frequency 53.0

Appendix D

List Used in Experiment 4 - Cue 1

harp	- Mu
aunt	R
piano	Mu
sunflower	Fl
drum	Mu
brother	R
iron	M
sister	R
lead	M
daffodil	Fl
gold	M
daisies	Fl
son	R
tulip	Fl
horn	Mu
copper	M
wife	R
lily	Fl
grandfather	R
violin	Mu
tin	M
organ	Mu
uncle	R
lilac	Fl
steel	M
guitar	Mu
silver	M
rose	Fl

Overall Frequency - 52.9

Metals (M)	- Frequency 59.0
Relatives (R)	- Frequency 57.2
Music (Mu)	- Frequency 50.6
Flowers (Fl)	- Frequency 45.0

Appendix E

List Used in Experiment 4 - Cue 2

nose	- B
neck	B
bass	Fi
arm	B
birch	Tr
grasshopper	I
evergreen	Tr
crab	Fi
ear	B
maple	Tr
shrimp	Fi
mosquito	I
clam	Fi
worm	I
feet	B
bee	I
pine	Tr
shark	Fi
oak	Tr
beetle	I
salmon	Fi
fly	I
mouth	B
trout	Fi
elm	Tr
starfish	Fi
palm	Tr
leg	B
ants	I

Overall Frequency - 53.0

Body Parts (B) - Frequency 59.9
Trees (Tr) - Frequency 49.9
Insects (I) - Frequency 52.4
Fish (Fi) - Frequency 49.8

Appendix F

List Used in Experiment 4 - Cue 3

river	- Wa
crow	Bi
drill	To
stream	Wa
hammer	To
sapphire	J
sea	Wa
geese	Bi
ocean	Wa
owl	Bi
emeralds	J
lakes	Wa
diamond	J
saw	To
pond	Wa
jade	J
spring	Wa
pigeon	Bi
rubies	J
ax	To
opal	J
robin	Bi
nails	To
parrot	Bi
pearls	J
wrench	To
hawk	Bi
hatchet	To

Overall Frequency - 51.4

Water (Wa) - Frequency 60.4
Tools (To) - Frequency 51.7
Jewels (J) - Frequency 43.8
Birds (Bi) - Frequency 49.9

Appendix G

List Used in Experiment 4 - Posttest

cliff	- Buffer
lens	- "
rolls	- "
purple	Co
policeman	P
Oregon	St
cabin	D
Florida	St
apartment	D
doctor	P
baseball	Sp
tent	D
blue	Co
tornado	W
teacher	P
football	Sp
hurricane	W
nurse	P
Massachusetts	St
tennis	Sp
Virginia	St
home	D
Alaska	St
swimming	Sp
rain	W
beige	Co
trailer	D
thunder	W
pink	Co
basketball	Sp
engineer	P
brown	Co
lightning	W
lid	- Buffer
cash	- "
rats	- "

Overall Frequency - 54.4

Professions (P)	- Frequency 54.7
Sports (Sp)	- Frequency 54.8
Dwellings (D)	- Frequency 56.8
Weather (W)	- Frequency 52.7
Colors (Co)	- Frequency 53.6
States (St)	- Frequency 53.9

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