Effects of list organization and retrieval cues on children's delayed recall

Suhasini Ramisetty
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EFFECTS OF LIST ORGANIZATION AND RETRIEVAL CUES ON CHILDREN'S DELAYED RECALL

Iowa State University

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Effects of list organization and retrieval cues on children's delayed recall

by

Suhasini Ramisetty

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

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INTRODUCTION

Interest in the study of memory and its development can be traced to the early days of psychology as an experimental discipline (Ornstein, 1978). Renewed interest in children's memory was apparent by the middle '60s, following developments within both experimental and developmental psychology. Research activity in this field began to accelerate by the early 70s and was further stimulated by a symposium on memory development (Flavell, 1971). The increased experimental interest in memory development during the past 15 years seems due in part to the influence of the growing cognitive orientation within experimental psychology (Neisser, 1967). In many respects, the first "modern" studies of children's memory resulted directly from an application of the findings, methods, and theories of experimental psychology to developmental questions. In particular, advances in the organizational analysis of recall, short-term memory, sensory memory, and in models of the memory system all affected the course of developmental research in the 1970s. Interest in cognitive psychology, and especially in the study of the operation of the human memory system (Atkinson & Shiffrin, 1968; Bower, 1972), created a climate which contributed to a substantial amount of research activity with respect to the development of memory in children. Currently, research on children's memory constitutes a major area of inquiry within developmental psychology and it attempts to describe and to explain the developmental changes that occur in memory.
Theoretical Framework

Several themes characterize current approaches to the development of memory in children. A first theme concerns the operation of children's mnemonic strategies (Hagen, Jongeward, & Kail, 1975; Ornstein & Corsale, 1979; Naus & Ornstein, 1983). Many researchers have suggested that the age-related increase in availability of and use of memory strategies during the elementary school years is related to children's improvements in their ability to commit material to memory. With respect to this first theme, the development of organization as a mnemonic strategy has received substantial research attention over the past 10 years (Ornstein & Corsale, 1979). Organization is customarily defined as a structure discovered or imposed upon a set of items by a learner, with this structure facilitating retrieval of items from memory. Organization has generally been thought of as a deliberate and effortful process with age changes being attributed to age differences in strategic functioning (Bjorklund, Ornstein, & Haig, 1977). Organization as a concept has its basis in Gestalt psychology (Postman, 1972), where it was assumed that memory is governed by the laws of perceptual grouping, and that organization is established during initial perception of events in such a way that events are connected by a common relation or property (Bower, 1972).

The classic works of Bruner, Goodnow and Austin (1956), Mandler (1967), Miller (1956), and Tulving (1962b) were significant in the most fundamental sense for their discussions of the adaptive functions of stimulus organization for learning and retention and for the empirical
and theoretical principles they contributed to what we now refer to as the "Organization approach" to memory. This approach has potential appeal to developmentalists with varying theoretical biases, since it employs principles derived from the classic Gestalt and associationistic frameworks, as well as from those based on information-processing conceptions of development (Lange, 1978).

A logically implied assumption which underlies the organization theorist's approach to storage is that stored memories do not exist as isolated, single-unit representations of perceived items or events, but as integrated structures whose contents bear common relationships with one another and/or with higher-order conceptual symbols. The organization approach is a potentially comprehensive and verifiable developmental theory which already has to its credit a good deal of empirical support from studies of recall with children and adults.

Organization in children's memory has been most extensively studied using the free recall task where subjects recall the items freely in any order they wish to. Miller's (1956) utilization hypothesis was applied to the free recall task (Tulving, 1964). Miller (1956) proposed that some "chunking" of information is necessary if recall is to exceed the limits of immediate memory span (Tulving, 1962b).

The second theme in the literature focuses on the role of the permanent memory system or "knowledge base" in influencing the acquisition, retention, and retrieval of information (Chi, 1985; Naus & Ornstein, 1983). Much research has stressed the effects of an individual's prior knowledge on the processing and acquisition of
information. Given that the contents and structure of information available in a knowledge system change markedly with age, it is of particular importance to examine developmentally the linkage between knowledge and memory performance (Ornstein & Naus, 1984). Recently, there have been a number of demonstrations of the influence of the growing knowledge base on age-related changes in memory performance. Major credit for calling attention to this theme must be given to Chi (1977; 1978). She determined that both strategy and knowledge base differences contributed to age changes in memory performance. Piaget and Inhelder (1973) made one of the strongest statements in support of the close linkage between knowledge and memory, by suggesting that memory performance depends on the child's operative level, defined in the context of the Piagetian framework. They argued that a child's ability to remember is influenced by changes in cognitive structures, even to the extent that long-term retention of some materials may actually improve as a function of developmental changes in the understanding of certain fundamental concepts (Ornstein & Naus, 1984).

Mauer, Siegel, Lewis, Kristofferson, Barnes and Levy (1979) attempted to test Piaget's premise that improvements in an operational scheme underlie improvements in memory. They compared the long term memory of two figures, on a series of seriated sticks, which were consistent with the logical operational scheme of seriation, the other a design not related to any hypothesized logical scheme. Were Piaget correct, memory of the sticks would improve as the logical scheme developed, but memory of the design would not. The weight of the
evidence does not support Piaget's position. Improvement in memory was no more common than deterioration of memory and was not closely related to operational change. A similar conclusion can be drawn from studies with three and four year olds (Moscovitch, 1975) and other tasks (Liben, 1974). One possibility is that some general cognitive skill influences all operations plus the retrieval of past experience. This would cause some correlation between any memory and any operation, but not necessarily an exact correspondence, since other factors would influence one ability and not another. There is no evidence for a causal relationship between any one particular operation and any one particular memory skill (Mauer et al., 1979).

A third most important theme in the research on memory development concerns the nature and development of memory retrieval processes. Retrieval is most commonly defined as accessibility to the available information in storage (Ornstein, 1978). Feigenbaum (1961) in his information processing model said that it is useful to draw a distinction between what information or what traits are available in the memory storage and what are accessible. This accessibility to information in storage is called trace utilization which is otherwise known as retrieval (Melton, 1963). Interest in this topic is long-standing, but efforts toward a detailed analysis of retrieval processes and towards theoretical formulations of those retrieval processes have been far more vigorous recently than in the past. The developmental studies indicate that over the years of childhood the individual becomes an increasingly effective information retriever. A developmental increase during childhood has
been observed both in the tendency to spontaneously use readily accessible retrieval cues (Ritter, Kaprove, Fitch, & Flavell, 1973; Kobasigawa, 1974), and in the apparent effectiveness, with which retrieval cues function when they are used (Kobasigawa, 1974; Ashcraft, Kellas, & Keller, 1976).

A prominent and controversial issue in the area of memory development is whether overall recall improvements in childhood are primarily a function of changes in the ability to store a stable trace (Dempster, 1981) or are due primarily to changes in the ability to retrieve information from a stored trace (Chechile & Richman, 1982). The success of recall, broadly speaking, depends on two factors: the amount of organization of the relevant information about the to be remembered items in memory at the time of attempted recall (availability of information), and the nature and number of retrieval cues which provide access to the stored information (accessibility of information) (Mandler, 1967; Tulving & Pearlstone, 1966). Failure to recall a certain item would be interpreted to mean that the trace of the item is no longer available in the memory storage at the time of recall. According to an information-processing model of memory described by Feigenbaum (1961), for instance, forgetting occurs not because information in storage is destroyed, but because learned material becomes "inaccessible in a large and growing association network" (Melton, 1963). Rabinowitz (1984) suggested that many of these differences can be interpreted in terms of differential access to available information. A number of experiments have demonstrated that providing adult subjects with category names as
retrieval cues significantly increased the total number of items accessible for recall as compared with a free-recall condition (e.g., Crouse, 1968; Tulving & Pearlstone, 1966). Younger children's retrieval difficulties may be reduced to a great extent, by the directive-cue procedure when the cues and items are explicitly related during storage (Scribner and Cole, 1972).

Statement of the Problem

One popular form of the storage-retrieval debate has been the investigation of the effects of various types of organization of the to-be-remembered material on children's free recall (Lange, 1978; Ornstein & Corsale, 1979). Specifically, storage-retrieval analyses have been the focus of attempts to identify the mechanisms responsible for developmental differences in the free recall of lists of semantically categorizable items.

A large number of studies has been concerned with the tendency for categorized items to cluster during immediate recall. Most developmental studies found evidence very early development of category knowledge (Nelson, 1973; 1974) and knowledge of hierarchical semantic relationships (Steinberg & Anderson, 1975; Worden, 1974). Although there is compelling evidence to conclude that young children encode individual items in terms of category features, substantial development in terms of category knowledge occurs through the elementary school years.

Semantic relatedness among stimulus items is one variable that affects the recall and clustering values. Several experiments have been
designed to see the effect of the presence of semantic relationship among items. Developmental studies (kindergarten, first, fourth, and seventh grades) by Vaughan (1968) Murphy and Brown (1975) indicated that overall recall increased with age; subjects recalled more words from the categorized lists, and children at all ages showed clustering significantly greater than chance. Drawing upon research by Rosch and colleagues (Rosch, 1975; Mervis, Catlin, & Rosch, 1976) on category structure and typicality (Bjorklund, Thompson, & Ornstein, 1983), Rabinowitz (1984) suggested that children of different ages may differ in the accessibility of categorical information. He found that performance with a semantically related item list was superior to that with unrelated list.

Several attempts have been made to enhance child's sensitivity to the presence of categorical relationships. One such manipulation is to present the to-be-remembered materials in ways that increases the likelihood that the child will notice the categorical nature of the material. "Such blocked" presentation has also been shown to increase both organization of recall and amount recalled even in kindergarteners (Kobasigawa & Wilmhurst, 1973). Age comparisons made by Cole, Frankel, and Sharp (1971) and Moely and Shapiro (1971) showed facilitation of recall and organization through blocking across a wide age range with no differential effects at different ages.

Several investigators have examined the facilitative effects on recall of presenting category cues at the time of recall testing. These retrieval cues provide access to the stored information (accessibility of
information) (Mandler, 1967; Tulving & Pearlstone, 1966) when the availability of relevant information is equal for different groups under specified conditions. Any variation in recall must be attributed to differences in accessibility of the stored information. A number of experiments have demonstrated that providing adult subjects with category names as retrieval cues significantly increases the total number of items accessible for recall as compared with a free recall condition (Crouse, 1968). A developmental increase during childhood has been observed both in the tendency to spontaneously use readily accessible retrieval cues (Kobasigawa, 1974), and in the apparent effectiveness with which retrieval cues function when they are used (Ashcraft, Kellas, & Keller, 1976).

Most developmental studies to date have investigated the effects of semantic relatedness of items and of retrieval cues upon immediate recall. Very few studies have looked at the effects of these factors by studying delayed recall.

The major purpose of the present study is to investigate the age related differences in delayed recall as a function of mode of material presentation (blocked vs random), and of recall condition i.e., the presence or absence of retrieval cues at the time of recall.

The study has the following hypotheses:

1. Main effects:
   a) The study expects to find main effects for mode of presentation, for recall condition, and for time of recall (immediate vs. delayed). Blocked presentation enhances recall over that found with random
presentation, and presence of retrieval cues at the time of recall enhances recall over that found without retrieval cues. These predictions are based on the results of research efforts which attempt to increase the children's sensitivity towards the categorical nature of the to-be-remembered material. For instance, Cole, Frankel, and Sharp (1971) found that at all ages (first, third, and ninth graders) blocked presentation resulted in higher clustering and recall. Hasher and Clifton (1974) and Moely and Shapiro (1971) also showed facilitation of recall and organization through blocking across a wide age range. Perlmutter, Myers, and Sophian (1977) also found that the blocking manipulation increased the number of items recalled.

A number of studies demonstrated that providing category names as retrieval cues significantly increased the total number of items accessible for recall as compared with a free recall condition (Crouse, 1968; Gerjuoy & Spitz, 1966; Kobasigawa, 1974; Ashcraft et al., 1976; Scribner & Cole, 1972; Hall, Murphy, Humphreys, & Wilson, 1979).

b) The study also expects to find a main effect for age. Older children are expected to show higher recall than younger children. Bjorklund (1985) argues that the regular improvements observed in memory organization and recall over the course of the preschool and elementary school years can be attributed to developmental differences in the structure of semantic memory and the ease with which certain types of semantic relationships can be activated. A study by Vaughan (1968) found a linear increase in category clustering by subjects in grades one to seven. Rossi and Rossi (1965) found that both recall and the amount of
clustering increased as a function of age. Bousfield, Cohen, and Whitmarsh (1958) also reported an increase in category organization with increasing age in school children.

c) No main effect of sex is expected. The research studies published to date do not indicate any kind of sex differences in recall performance.

2. The following interaction effects are predicted:

a) A two-way interaction of mode of presentation by recall condition: cued recall with blocked presentation is expected to show higher performance than cued and non-cued recall with random presentation.

Perlmutter et al., (1977) found that the blocking and cueing effects at four and nine years had a large and comparable effects on recall. Yussen (1974) also documented that blocked presentation and providing cues at the time of recall had facilitative effects at age four. Myers and Perlmutter (1978) found that children's retrieval difficulties may be reduced to a great extent by blocking and cueing manipulations.

b) A three-way interaction of mode of presentation by time of recall by retrieval condition is also presented. Cued immediate recall of material presented in blocks will be better than non-cued immediate recall of randomly presented material, and will also be better than cued and noncued delayed recall of blocked and randomly presented material.
REVIEW OF LITERATURE

The research literature on memory development demonstrates convincingly that during the elementary school years children become increasingly proficient at a number of important mnemonic strategies for storing and retrieving information. Substantial developmental changes appear in the use and effectiveness of organizational techniques, in the content and structure of the knowledge base, and in the retrieval of information; in turn these changes are responsible for much of the recall improvement observed over age.

Organization and Recall

Concept of organization

Katona (1940) suggested that organization involves the formation and perception of groupings and of their relations. Organization is a process that establishes or discovers such relations. Mandler (1967) defines organization as follows:

"a set of objects or events are said to be organized when a consistent relation among the members of the set can be specified and, when membership of the objects or events in subsets (groups, concepts, categories, chunks) is stable and identifiable".

Organizational technique as a mnemonic strategy in memory development has been extensively studied during the past decade. A large
number of studies has been concerned with the tendency for categorized items to cluster during recall. This particular line of research was initiated with an experiment by Bousfield and Sedgewick (1944), who found that subjects instructed to produce all the items in a particular language category (such as birds) would cluster subcategories during recall. In 1953, Bousfield initiated a program of research to investigate further the tendency of members of a category to appear contiguously during recall. In the first experiment, subjects were given a randomized list of 60 items consisting of four categories with 15 items per category. Following a single presentation subjects recalled the items and the data showed conclusively that such recall contained clusters of the categories built into the lists (Bousfield, 1953).

**Developmental studies of recall and organization**

Bousfield *et al.* (1958) reported an increase in category organization with increasing age in school children, and a study by Vaughan (1968) found a linear increase in category clustering by subjects in grades one to seven. Rossi and Rossi (1965) have shown that some improvement in recall with a clusterable list is obtained with subjects even younger than the school age subjects. They presented list of 12 pictures to children between two and five years of age. They found that both recall and the amount of clustering increased as a function of age, but even at the youngest level 26 of the 30 two-year-olds clustered above chance level. Thus, children as young as two years can benefit from the presence of categories in free recall lists.
Most of the age changes in the organization of children's recall might not be strategic but could rather be attributed to developmental changes in the structure and the content of the children's conceptual representations. Bjorklund (1985) argues that the regular improvements observed in memory organization over the course of the preschool and elementary school years can most parsimoniously be attributed to developmental differences in the structure of semantic memory and the ease with which certain types of semantic relationships can be activated. Although findings obtained by Laurence (1967) and Nelson (1969) support the notion that the young children might not benefit as much as older children, other studies suggest that young children will use organization when the task is appropriate to their ability level. Tenney (1975) found that kindergarten children's recall was higher for lists of category words than for lists of unrelated words, when lists were made up of words that the child had generated. Goldberg, Perlmutter, and Myers (1974) compared recall of category and unrelated items by children of 29-35 months old. More items and item pairs were recalled correctly from the related sets than from the unrelated sets, indicating that even very young children can take advantage of conceptual groupings as an aid to recall.

Positive correlations have been reported between amount recalled and clustering scores obtained for category organization (Lange & Jackson, 1974; Shultz, Charness, & Berman, 1973). Several investigators have found that the magnitude of correlations between organization measures and amount recalled increases with the age (Moely & Shapiro, 1971). With
development the facilitation of recall through organization becomes increasingly apparent (Moely, 1977).

**Factors influencing organization in recall**

To understand the development of organization in recall it is necessary to consider factors that determine the child's tendency to employ available mnemonic skills in performing memory tests like free recall or sort/recall tasks.

**Semantic knowledge base and organization in recall**

The extent of a child's knowledge base about a particular content area will certainly affect how he or she will process, retain and recall information pertinent to that domain. Children who have a more detailed knowledge for a particular content area than adults have levels of memory performance elevated beyond those of adults (Chi, 1978; Lindberg, 1980). Knowledge of category relations will influence the degree to which children's retrieval is organized (Chechile & Richman, 1982). As category relations become better established in a child's semantic memory, they are apt to be activated in a wider range of contexts, resulting in increased incidences of organization in a child's recall of categorizable material. Bjorklund (1985) argues that when elevated levels of clustering are first seen in development, they are mediated by the relatively automatic activation of semantic memory relations, which in turn lead children to identify an organizational strategy.

Provided that the semantic features of items are processed, developmental changes may still appear in the manner in which such items
are grouped or classified. The structure or "syntax" of the child's semantic categories also must be considered in understanding age differences in recall organization. Moely's (1977) studies involving a variety of different tasks, suggest that hierarchical (i.e., superordinate) conceptual relations develop during the course of the preschool and elementary school years. Some investigators found evidence for very early development of category knowledge (Nelson, 1973; 1974) and knowledge of hierarchical semantic relationships (Steinberg & Anderson, 1975; Worden, 1974). Goldberg et al. (1974) and Rossi and Rossi (1965) showed the earliest use of similarity to either facilitate or organize recall, with children between two and three years of age. A correspondence between developing classification skills and organization in recall was shown by Tomlison-Keasey, Crawford, and Miser (1975), who found that among six year old children those able to perform class inclusion problems were more likely to use category organization in free recall than were non-classifiers of the same age. As Meacham (1972) has suggested, the child must achieve a certain level of capability with classification before this conceptual organization skill will be applied to recall.

Although there is compelling evidence to conclude that young children encode individual items in terms of category features, substantial development in terms of category knowledge occurs through the elementary school years. In a study where children were required to label pictures and to categorize them, Winters and Brzoska (1976) reported regular increases in the number of items reliably categorized by
children from five to fourteen years of age. Northrop (1974) found that a list consisting of easy-to-sort items was better recalled and organized by six year olds and better retained over time, than a list containing items that were relatively difficult to sort into categories.

In summary, there are consistent developmental increases in the ability to use taxonomic relationships, but it appears that the recall of children even as young as two years is affected, at least to a limited extent, by the presence of such relationships. It seems that children not only are sensitive to the semantic aspects of words, but also that they are able to use these aspects to aid recall. As the child grows and his experience with the semantic relationships in language increases, his ability to make effective use of them also increases.

Effects of task manipulations on organization in recall Several investigations of children's memory have been designed to study the linkage between different task manipulations and recall organization. Modifications of the recall task have included variations in (a) the degree of semantic relatedness among stimulus materials to be remembered (b) the mode of presentation of stimuli. Several recent studies have suggested that task factors can influence the deployment of mnemonic techniques, and that under some conditions, young children can show performance typically characteristic of older children (Istomina, 1975). This can be seen in demonstrations that young children's recall is enhanced when the to be remembered materials are presented in an optimally organized fashion (Moely & Shapiro, 1971).
Semantic relatedness or taxonomic frequency is one variable that affects the likelihood that a category will be discovered and used (Mandler, 1967). Semantic relatedness exists when "a set of objects or events have a consistent relation among them that can be specified" (Mandler, 1967). According to Bousfield et al. (1958), when the categories contained items with high taxonomic frequency, the recall and clustering values were significantly greater than for categories with items of low taxonomic frequency.

Several experiments have been designed to see the effect of the presence of semantic relationship among items. To see if the presence of categories in the stimulus list would facilitate children's recall, Vaughan (1968) tested first, fourth, and seventh graders. One list consisted of 16 pictures of objects bearing no particular conceptual relationship to one another. The second list included pictures of four objects from each of four different conceptual categories. Overall recall increased with age; subjects recalled more words from the categorized lists; and children at all ages showed clustering significantly greater than chance. Murphy and Brown (1975) have shown that when presented with highly related items, even kindergarteners showed higher recall when asked to group items into semantically related categories.

Drawing upon research by Rosch and colleagues (Rosch, 1975; Mervis et al., 1976) on category structure and typicality (Bjorklund et al., 1983). Rabinowitz (1984) suggested that children of different ages may
differ in the accessibility of categorical information. He varied the representativeness of category exemplars employed in a free recall task, and the conditions that might affect the obviousness of the category structure. He found that performance with a high-representative list (close taxonomic relationship) was superior to that with a low representative list.

To test the notion that accessibility of information is much easier when the categorical relations exist in the material to be remembered, Bjorklund and Ornstein (1976) conducted an experiment with five and ten year olds. Children were asked to recall each of three sets of materials that varied according to the saliency of list structure. In contrast to a base line condition with unrelated items, two other conditions called for the recall of categorical materials. For both the age groups, recall of the category-typical items was superior to the recall of the category-atypical items. The use of category relationships in recall was clearly influenced by category typicality.

Perlmutter and Myers (1979) reported that the children's memories could be characterized as semantically based. Then research with preschool children (three and a half to four and a half years) indicated that semantically related lists were recalled more number of items than unrelated lists, and clustering was above chance level. Thus, this indicates that even very young children encode items in terms of semantic categories and this facilitates recall.

The semantic relatedness is an important variable that affects the likelihood that a category will be discovered and used. Hence, it is
reasonable to suppose that the discovery and use of highly overlearned categories will produce a more stable organization and therefore better recall than the ad hoc categories a subject may impose on the material (Tulving, 1962a).

Mode of presentation of semantically related items Cofer, Bruce, and Reicher (1966) and others have shown that adults' recall and use of category organization can be increased by presenting all items from a given category in succession. Several attempts have been made to enhance children's sensitivity to the presence of categorical relationships. One such manipulation is to present the to-be-remembered materials in ways that increases the likelihood that the child will notice the categorical nature of the material. For instance, Cole et al. (1971) contrasted recall of lists in which all of the exemplars of a given category were presented together, in blocked fashion, with lists in which category exemplars were distributed randomly throughout the list. Children tested were first, third, and ninth graders, and at all ages, blocked presentation resulted in higher clustering and recall. Moely (1968) also found similar results. Such "blocked" presentation has also been shown to increase both organization of recall and amount recalled in kindergarteners (Kobasigawa & Orr, 1973; Kobasigawa & Wilmhurst, 1973). Blocking may facilitate recall by increasing the likelihood that the child will discover the category structure of the list (Furth & Milgram, 1973; Hasher & Clifton, 1974). Blocked presentation relative to random order of presentation typically increases the average number of items recalled from each category accessed in recall (Moely, 1968).
Age comparisons made by Cole et al. (1971), Moely (1968), and Moely and Shapiro (1971) showed facilitation of recall and organization through blocking across a wide age range, with no differential effects at different ages. However, several other investigations have reported results consistent with the notion that blocking will have greater effects at higher developmental levels. Yoshimura, Moely, and Shapiro (1971) compared four and nine year olds on recall of multiple lists over several days, and found that blocking of sets of three related items, successively presented, increased organization only for the older group. Furth and Milgram (1973) found that grouping of related items during successive presentation increased recall and organization for children 9 and 12 years of age, but not for four and six year olds. Similar developmental differences in the effects of blocking on recall were noted by Kobasigawa and Middleton (1972).

Perlmutter et al. (1977) designed a recall study to evaluate blocking effects. The blocking effect was significant in the constrained recall condition where children were asked to recall items from specific categories, compared to free recall. Furthermore, although the blocking effect was stronger for older children, the age x blocking interaction was not statistically significant. The rather minimal blocking effect obtained in their study suggests that blocking is not terribly helpful to children as young as four years. This suggestion is strengthened by the work of other investigators, who also found minimal or non-existent blocking effects for young children. Although Moely and Shapiro (1971) found blocking facilitating recall children as young as three, Furth and
Milgram (1973), Yoshimura et al. (1971), and Yussen, Kunen, and Buss (1975) all reported that blocked serial presentation facilitated recall of children of nine years or older but did not affect the recall of four year olds. Blocking appears to be helpful to children as young as three or four years of age when presentation conditions are appropriate to the child's abilities. Use of small categories and use of simultaneous presentation of all items from a category aided four- and six-year-olds in the use of blocked presentation (Furth & Milgram, 1973). Similarly, use of small categories and/or simultaneous presentation may account for the positive effects of blocking shown with young children in studies by Moely (1968), Moely and Shapiro (1971), Kobasigawa and Orr (1973), and Kobasigawa and Wilmhurst (1973).

Training organizational skills

Given the young child's limited benefit from most of the manipulations described here, and his or her ability to infer that organization is a useful tool for recall (Moynahan, 1973; Wellman, Drozdal, Flavell, Salatas, & Ritter, 1975), several investigators have been concerned with the effects on recall of procedures that deliberately teach the child to organize. Many training studies have demonstrated that young children who do not spontaneously employ mnemonic strategies can be taught to use them to some extent and that greater recall typically results from these manipulations (Lange, 1978; Ornstein & Corsale, 1979). Moely, Olson, Halwes, and Flavell (1969) showed that teaching of an organizational strategy was effective with kindergarten
and first grade children. In another study, Moely and Jeffrey (1974) investigated the extent to which training effects would occur with first graders. Children were told that grouping items by category was a useful technique for recall, and were given practice at grouping and recalling items in category sets on a preliminary list. Children who were given organization training recalled more number of items than those who had received no suggestions about organization during practice trials. Clustering during recall was somewhat higher following such training.

Sort/recall procedures are usually used to train young children to spontaneously use organization as a mnemonic strategy in recall. Both Moely and Jeffrey (1974) and Rosner (1971) found that children who had been instructed in the use of organization showed greater ability to sort items into sets in a sorting task given after recall was obtained. This improvement in sorting-task performance indicates that suggestions about organization do increase children's awareness of item relationships, even though the child may not be able to effectively employ the technique to organize recall. Application of the grouping technique to recall was easier for first graders when items were members of common conceptual categories (Moely & Jeffrey, 1974) than when items were unrelated pictures (Rosner, 1971).

Young children appear to have information in memory which is not spontaneously used to aid recall. They have knowledge of taxonomic categories, yet they often fail to demonstrate above-chance clustering in recall (Kobasigawa & Middleton, 1972). It seems possible that the positive effects of mnemonic training observed in the above experiments
and elsewhere (Liberty & Ornstein, 1973; Moely et al., 1969; Rosner, 1971) may simply result from prompting children to use knowledge which they already have in permanent memory. These findings suggest that changes in input organization may contribute to developmental improvements in memorization.

Effects of Retrieval Cues on Recall

Several investigators have examined the facilitative effects on recall of presenting category cues at the time of recall testing. Studies with adults (Cohen, 1966; Tulving & Pearlstone, 1966) have indicated that most of the variance in forgetting a categorized list is attributable to forgetting category labels or cues rather than to forgetting items within categories. For example, Cohen (1966) demonstrated that if one item is recalled from a category, then there is a high probability that the subject will recall a stable number of other items from that category, independent of list length and number of categories present (within limits). A number of experiments have demonstrated that providing adult subjects with category names as retrieval cues significantly increases the total number of items accessible for recall as compared with a free recall condition (e.g., Crouse, 1968; Tulving & Pearlstone, 1966). Because access to a category is such a critical factor it seems reasonable to expect that supplying category labels at recall, given that these labels were stored with the items at the time of acquisition, will increase the amount recalled.
Developmental changes in cue utilization

Those few developmental studies published to date indicate that over the years of childhood the individual becomes an increasingly effective information retriever. A developmental increase during childhood has been observed both in the tendency to spontaneously use readily accessible retrieval cues (Ritter et al., 1973; Kobasigawa, 1974), and in the apparent effectiveness, with which retrieval cues function when they are used (Kobasigawa, 1974; Ashcraft et al., 1976; Scribner & Cole, 1972). The important role of retrieval cues in children's recall of categorized items was reported by Gerjuoy and Spitz (1966) and by Moely (1968) with children of seven and ten years of age. Kobasigawa (1974) conducted a study with children in grades one, three, and six, to see the effect of a pre-experimental associative relationships between target items and the cues on recall. The cues were paired with their target items during study. One group recalled without the cues at the time of recall. In the non-directive cue condition, the cues were made accessible during recall, but without instructions for their use. In a third condition, the directive cue condition, the children were given the cues with explicit instructions for their use. The number of children using the cues in the non-directive cue condition, and the mean recall of those children, increased with age. Scribner and Cole (1972) examined recall of categorizable items for children in grades two, four, and six using category labels as cues. There were two recall conditions, one in which the category names were presented at the beginning of the recall period and a second that closely resembles Kobasigawa's directive cue
condition. In both conditions recall increased with age, leading the authors to conclude that retrieval processes become increasingly effective with age.

Hall et al. (1979) were concerned with possible age differences in the ability to use cues for recall when cues could access all target items equally. In their study the cues were pre-experimentally associated with the targets at known levels that were equivalent across age and the cues were not presented with the targets during study. Findings indicated a superiority for the older children in the use of experimenter-provided cues to assist retrieval. In those studies in which categorized word lists were studied and the category labels were supplied as extra list cues, the resulting superior recall of the older children may simply reflect greater pre-experimental learning about the category label-target relationship by the older children. Likewise, when the cue and the target are studied together the superior recall of the older children may reflect greater learning about the cue-target relationship, not more effective retrieval operations. Even when the target is studied by itself if the study conditions are identical for the older and younger children, the older children will almost certainly learn more than the younger children.

**Effect of cue presentation time**

Several studies have been designed where the time of cue presentation is manipulated to see when a retrieval cue is most effective to enhance recall. An earlier study with adults by Tulving &
Pearlstone (1966) provided an experimental demonstration of the relationship between time of cue presentation and recall. The subjects were presented with lists of words which they had to memorize. At input the words were accompanied by the names of conceptual categories of which the words were members. When these category names were given to subjects at output as retrieval cues, subjects recalled more words than when no experimentally manipulated retrieval cues were present at output. This finding demonstrates that retrieval might depend on the completeness of reinstatement at the time of output of the stimulating conditions present at the time of input (Melton, 1963).

Similarly, the important role of retrieval cues in children's recall of categorized items was reported by Gerjuoy and Spitz (1966) with retarded children and by Moely (1968) with children of seven and 10 years of age. They used directive cueing procedures at the time of recall. These readily accessible retrieval cues enhanced recall.

Given that a retrieval cue is effective if it is present both at input and at output, is it equally effective if it is provided to subjects only at the time of attempted recall of the to be remembered word? It is conceivable that a pre-experimental associative bond between the cue and the word is sufficient to make the retrieval cue effective at the time of recall. On the other hand, it may be necessary that information about the relation of the retrieval cue to the TBR item be specifically stored at the time of the input of the TBR item. Tulving and Osler (1968) suggested that while the meaningfulness of the connection between the cue and the TBR word, meaningfulness obviously
being determined by subjects pre-experimental knowledge of the language, may be a necessary condition for the effectiveness of retrieval cues, it does not seem to be a sufficient condition.

In Gerjuoy and Spitz (1966) and Moely (1968) studies with seven and 10 years old children, pre-experimental associations were established between to-be-recalled items and cues during input. Accessible to these cues at the time of recall facilitated the amount recalled even by younger children.

The overall pattern of the data reported is completely consistent in showing that whenever the cues accompanied the TBR items at input their presence at output facilitated recall, and whenever they were absent at input their presence at output did not serve any useful purpose. In fact, the presence of cues only at output, or the changing of cues from input to output appeared to interfere with recall of the TBR words. The important finding is the lack of recall facilitation by cues presented to subjects for the first time at the time of recall. This finding, in conjunction with the finding of Tulving and Osler (1968) that the same cues were quite effective with eight graders when presented at both input and output, suggests that specific retrieval cues facilitate recall if and only if the information about them and about their relation to the TBR items is stored at the same time as the information about the membership of the words in a given list. Tulving and Osler (1968) offered this suggestion as the main conclusion of their study. This conclusion may appear to be inconsistent with the results of experiments (e.g., Bilodeau & Blick, 1965; Fox, Blick, & Bilodeau, 1964; Lloyd, 1964).
in which retrieval cues have been provided to subjects only at the time of recall and which have showed such retrieval cues to facilitate recall. The inconsistency disappears, however, if it is remembered that appropriate categorical coding of input words may take place even if the experimenter does not explicitly suggest to subjects how he or she is to code the TBR items, that is, what additional information he/she has to store with the TBR item, at the time of input. If the TBR word is bulb, to use an example given by Bilodeau and Blick (1965), at least some subjects are quite likely to think of it as something to do with light. If "light" is then presented by experimenter as a retrieval cue, it is effective for those subjects in the same way as it would have been if it had been presented together with bulb at input. Thus, if the experimenter leaves the subjects free to code the input subjectively, or lets the subjects make their own differential responses to stimuli (Postman, Adams, & Phillips, 1955), the effectiveness of specific retrieval cues provided by experimenter at output presumably depends on the extent of the overlap between the cues and such subjective coding responses that have occurred at input.

Experimental manipulation of cues at the time of the presentation of TBR items simply restricts the ways in which various subjects code the input and thus provides the experimenter with greater control over what is stored, but the underlying mechanisms are probably the same in both cases. Regardless of whether the subject codes the TBR items subjectively or follows the suggestions for coding given by the experimenter in the form of input cues, a retrieval cue is effective only
if the information about it and its relation to the TBR item is stored at the same time with the TBR items. This conclusion is quite consistent with the principle that retrieval depends upon the completeness of reinstatement of original stimuli at the time of recall (Melton, 1963).

**Blocking and cueing effects**

Perlmutter et al. (1977) designed a study to evaluate blocking and category cueing effects. Two lists were presented in a blocked order with adjacently presented items from the same conceptual category, and two in a random order. On one unblocked and one blocked list, a free recall procedure was used and was followed by category cueing. On other unblocked and blocked lists, a constrained recall procedure was used in which the children were immediately asked to recall items from specific categories. Recall prior to cueing in the free recall testing condition (free recall) was compared to recall in the constrained recall testing condition (constrained recall), and in the other analysis recall after cueing in the free-recall condition (cued recall) was compared to constrained recall. Both analyses indicated that older children recalled more in all conditions. Although the magnitude of the effect was not very large, the blocking manipulation increased recall, and the effect was significant in the free-constrained condition. Providing category cues at the time of recall, either by cueing after free recall or constraining recall, had a large and comparable effect at both ages (9 and 4 years); that is, it resulted in higher recall than a simple free-recall procedure. Williams and Goulet (1975) observed similar
facilitative effects of constraining at age 4, and Yussen et al. (1975) found constraining to be effective in four year olds, although this was only true when items were blocked by category at presentation. It seems, therefore, that at this age children may encode items according to known categories but are unlikely to generate and use category cues to provide access to their memory stores under recall demands (Myers & Perlmutter, 1978). It may be concluded that younger children's retrieval difficulties may to a great extent be reduced by blocking and cueing manipulations.

In conclusion, on the basis of the research reviewed above, it is clear that the changes in performance with age are a result of developmental changes both in semantic knowledge and in the ability to device and carry out appropriate strategies for remembering. A fairly consistent finding in the research reviewed is the tendency for task manipulations to show an interaction with age level, such that older children are more able than younger children to profit by the presence of the category name, blocking of items in presentation, use of a recall strategy induced through constrained recall or with instructions, and possibly, practice with the task. It appears that a certain level of semantic development needs to be attained before the child can be induced to organize through these manipulations.
METHODOLOGY

Subjects

The subjects for the study were 192 elementary school children consisting of 96 second and 96 fourth graders, with 48 boys and girls from each grade. The second graders ranged in age between 7 to 8 years (mean=7.3) and the fourth graders between 9 to 11 years (mean=9.3). All children were from predominantly white middle-class farm families in the Midwest. Class teachers' assistance was used to contact parents through parental consent forms to allow their child to participate in the study. Subject selection was based on parental consent and child's willingness to participate at the time of testing.

Design

The experimental design was a 2 x 2 x 2 x 2 x 2 factorial design with repeated measures on one factor. The independent variables were grade (2), sex (2), mode of presentation (2), recall condition (2), and time of recall (2) which was the repeated factor.

Mode of presentation refers to how to-be-remembered items were presented. When the items belonging to the same semantic category were presented adjacently, the mode of presentation was called blocked presentation. When the related items were presented randomly in such a way that no two items of the same semantic category were presented adjacently, the mode of presentation was called random presentation.

Recall condition refers to whether retrieval cues were present (cued
The time of recall factor involved immediate recall, that is, recalling items after item presentation, while delayed recall was recall of items 24 hours after input presentation. No item presentation took place at Time 2.

Materials

A series of 20 pictures of common objects was prepared. These pictures consisted of four objects from five categories. The objects were represented by attractive picture cards (4" x 4") of simple line drawings. These objects were selected from Battig and Montague (1969) category norms for verbal items in 56 categories, based on familiarity at second and fourth grade levels.

Furthermore, class teachers were consulted to indicate whether the children were familiar with the items selected for the study. A pilot study was conducted with ten children to see whether they could recognize the item pictures and cues. The pictures selected for the study were, in the transportation category: car, truck, jeep, and bus; in the clothing category: jacket, shorts, T-shirt, and dress; in the food category: bread, cake, carrot, and milk; in the furniture category: table lamp, couch, bed, and chair; and in the tools category: saw, nail, pliers, and hammer.

Pictures of associated concepts were used as retrieval cues. A retrieval cue can be defined as something, e.g., a label or a picture, externally present which helps to retrieve information from memory. In
this study pictorial representations which are closely associated with each category were used as cues. The pictures selected as retrieval cues were: for the transportation category, road at Time 1 and tire at Time 2 (new cue); for clothing category, hanger at Time 1 and iron at Time 2 (new cue); for food category, refrigerator at Time 1 and Stove at Time 2 (new cue); for furniture category, empty room at Time 1 and house at Time 2 (new cue); and for tools category, tool box at Time 1 and wood work bench at Time 2 (new cue). These were also attractive picture (4" x 4") cards made up of line drawings.

Procedure

The experimenter was introduced to the children by their class teacher. Each child was escorted by the experimenter from the class room to the testing place. Subjects were tested individually in a separate, quiet room for a 8 to 10 minute period twice. Assignment of the subjects to the several conditions in the study was random, with the constraint that the groups would be equal in terms of number of boys and girls. At the first testing time, each pictured item was presented to all subjects in all conditions at a 5-second rate. In the related blocked condition the items belonging to the same category were presented successively and in the related random condition, the items were presented in such a way that no two items belonging to the same category were presented successively. The experimenter showed the item and asked the child to name the item to make sure that the child was familiar with the item. Immediately after all the items were presented, the subjects in both
blocked and random conditions were asked to count numbers from 1 to 10 to avoid any possible rehearsal which would affect recall performance.

Subjects were not given any kind of instructions that they had to recall the items after the presentation. This way the children were not cued to engage in relevant activities in preparation for recall. According to Appel, Cooper, Yussen, and Flavell (1972), children are sensitive to instructions and they behave differently when instructed to memorize items and when told simply to look at them. Children are aware of the need to engage in relevant activities as a preparation for recall.

Immediately after children counted the numbers from 1 to 10, they were asked to recall the items. A tape recorder was used to record the recall.

In the cued recall condition at time 1 the retrieval cues were given to the child at the time of recall after the 20 items were presented. Five cue cards were given to the subject and the following instructions were given:

"Please go through these five cards and see if they can help you to remember the pictures I just showed you. You can use them in any way or order you want to."

The items were recorded as the subject recalled them. When no item was emitted for a period of 15 seconds the child was encouraged to try to remember additional items by looking at the cues. After a second pause of 15 seconds, the recall period was terminated.

In the non-cued condition, after the items were presented, children were asked to count numbers from 1 to 10 and then free recall was
requested. No retrieval cues were presented at the time of recall. The same time limits were followed as in the case of cued recall.

There was a 20- to 27-hour time gap between the first and second testing time. There was no presentation at the second time of the to be recalled items.

Under cued recall at time 2, half of the subjects in the cued recall condition at time 1 were shown the same retrieval cues as used at time 1 and asked to recall the items shown the previous day. The remaining half were shown a new cue and were asked to recall the items. The same time limits for recalling were followed as during the first testing time.

Children in the no-cue condition were not presented with any cues, but were asked to recall the items shown the previous day. Again the same time limits for recalling were followed.

Scoring

The tape-recorded protocols were transferred onto scoring sheets (see Appendix B) and the following dependent measures were computed:

1. Total number of items correctly recalled [Item Recall (Rw)]. The maximum score range possible is 0-20 since there are twenty items in the list.

2. The number of categories from which at least one item was recalled [Category Recall (Re)] and the score range possible is 0-5 since there are five categories in the list.

3. The mean number of items recalled per category [Within category recall (Rw/c)]. It is the ratio of the number of words recalled to the
number of categories recalled. This measure can be referred to as "Mean word recall per category" (Cohen, 1966). The maximum possible mean score is 4 since there are four items in each category.

4. Time taken is measured in minutes from the time the recall period started and ending with two fifteen second pauses.

5. Total number of category repetitions are measured by the number of times a category item follows an item from the same category. The maximum possible number of repetitions are 15 (i.e., total number of items - total number of categories 20 - 5 = 15).

6. Organization in recall. To estimate the clustering in recall protocols, an adjusted ratio of clustering (ARC) score was calculated. The ARC measure was recommended by Roenker, Thompson, and Brown (1971). For each subject in the clustering conditions, the expected repetitions E(R) in each category were compared with the corresponding obtained repetitions 0(R) for each category. The amount of clustering is obtained by deducting (for each subject) his E(R) scores from his 0(R) scores. These deviation scores (O(R) - E(R) differences) comprise the 'clustering scores' which could be used in the data analyses. Perfect clustering is set at an ARC score of one, chance clustering is set at zero, and negative values present clustering less than expected by chance. The ARC score represents the proportion of actual category repetitions above chance for any given recall protocol. Hence, the ARC score is invariant with respect to factors unrelated to relative amount of clustering.
The computational formula for the ARC score is as follows:

\[ \text{ARG} = \frac{O(R) - E(R)}{\max R - E(R)} \]

- \( O(R) \) = total number of observed category repetitions (i.e., the number of times a category item follows an item from the same category).
- \( \max R \) = maximum possible number of category repetitions.
- \( E(R) \) = expected (chance) number of category repetitions.

It should be noted that

\[ \max R = N - K \]

where \( N \) = total number of items recalled and \( K \) = number of categories represented in the recall protocol. And

\[ E(R) = \frac{\sum n_i^2}{N} - 1 \]

where \( n_i \) = number of items recalled from category \( i \) and \( N \) is as before (Bousfield and Bousfield, 1966).
RESULTS

A 2 (grade) x 2 (sex) x 2 (mode of presentation) x 2 (time of recall) x 2 (recall condition) analysis of variance with repeated measures on the time of recall factor was performed for each of the six dependent measures. For each dependent variable the ANOVA tables are presented in Appendix C; the tables provide the degrees of freedom, the sums of squares, the mean squares, and the resulting F values for significant main and interaction effects only.

Item Recall

The mean number of items correctly recalled in the four conditions for each of the two recall times at each grade level is presented in Table 1, together with the standard deviations.

The analysis of variance with repeated measures on the time of recall factor yielded significant main effects for time, F(1,181) = 31.22, p<.0001, for grade, F(1,181) = 28.99, p<.001, for mode of presentation, F(1,181) = 10.03, p<.001, and for recall condition, F(1,181) = 34.33, p<.0001. Sex did not have a significant main effect. The following significant interaction effects were found: time by grade, F(1,181) = 4.87, p<.05, time by recall condition, F(1,181) = 28.81, p<.0001, and time by grade by recall condition, F(1,181) = 6.87, p<.01 (Figure 1). Mode of presentation condition did not interact significantly with any other variables, nor did sex.

Because of the significant 3-way interaction between time, grade,
Table 1. Mean number of items recalled by second and fourth grade children at time 1 and time 2 in each condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Grade 2</th>
<th></th>
<th>Grade 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>11.37</td>
<td>2.31</td>
<td>12.21</td>
<td>2.43</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>9.37</td>
<td>2.56</td>
<td>11.71</td>
<td>2.67</td>
</tr>
<tr>
<td>Random x cued</td>
<td>10.33</td>
<td>1.97</td>
<td>11.37</td>
<td>1.86</td>
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<tr>
<td>Random x non-cued</td>
<td>9.08</td>
<td>2.06</td>
<td>10.62</td>
<td>2.22</td>
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</table>

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<thead>
<tr>
<th>Condition</th>
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</thead>
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<tr>
<td>Blocked x cued</td>
<td>10.87</td>
<td>2.89</td>
<td>13.00</td>
<td>3.20</td>
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<tr>
<td>Blocked x non-cued</td>
<td>7.91</td>
<td>3.29</td>
<td>10.41</td>
<td>2.97</td>
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<tr>
<td>Random x cued</td>
<td>9.29</td>
<td>2.11</td>
<td>11.95</td>
<td>2.59</td>
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<tr>
<td>Random x non-cued</td>
<td>7.37</td>
<td>2.12</td>
<td>8.50</td>
<td>2.13</td>
</tr>
</tbody>
</table>

aN = 24 in each condition.

and recall condition, separate 2(grade) x 2(recall condition) ANOVAS were run for each time of recall. At time 1, grade, F(1,188) = 18.37, p<.0001, and recall condition, F(1,188) = 11.63, p< .001 had significant main effects. At time 2, significant main effects were also found for grade, F(1,188) = 27.77, p< .0001 and for recall condition, F(1,188) = 46.72, p<.0001. No interaction effects were found either at time 1 or time 2.

Mean Category Recall

The mean category recall scores together with standard deviations for each of the two grades in the four conditions at time 1 and time 2
Figure 1. Time by grade by recall condition effect on mean item recall
Table 2. Mean category recall by second and fourth grade children at time 1 and time 2 in each condition

<table>
<thead>
<tr>
<th>Conditiona</th>
<th>Grade 2</th>
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<th></th>
<th>Grade 4</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
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<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>4.63</td>
<td>0.65</td>
<td>4.83</td>
<td>0.38</td>
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<tr>
<td>Blocked x non-cued</td>
<td>3.92</td>
<td>0.83</td>
<td>4.30</td>
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<tr>
<td>Random x cued</td>
<td>4.71</td>
<td>0.46</td>
<td>4.83</td>
<td>0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>4.00</td>
<td>0.72</td>
<td>4.50</td>
<td>0.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>4.63</td>
<td>0.77</td>
<td>4.87</td>
<td>0.34</td>
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<tr>
<td>Blocked x non-cued</td>
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<td>0.83</td>
<td>3.83</td>
<td>0.87</td>
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<tr>
<td>Random x cued</td>
<td>4.75</td>
<td>0.44</td>
<td>4.87</td>
<td>0.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>3.50</td>
<td>0.72</td>
<td>4.04</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aN = 24 in each condition.

are presented in Table 2. The analysis of variance of the data showed significant main effects for time, \( F(1,181) = 19.06, p<.0001 \), for grade, \( F(1,181) = 16.77, p<.0001 \), and for recall condition, \( F(1,181) = 116.29, p<.0001 \). Sex and mode of presentation did not have main effects. A significant interaction effect of time by recall condition, \( F(1,181) = 24.90, p<.0001 \) was found (Figure 2). Grade, sex, and mode of presentation did not have any significant interaction effects with other variables. The time by recall condition interaction effect was further analyzed by two separate one-way (recall condition) ANOVAS, one for each of the two times of recall. The analysis showed a significant main
Figure 2. Time by recall condition effect on mean category recall
effect for recall condition, $F(1,190) = 41.58, p<.0001$ at time 1 and also at time 2, $F(1,190) = 121.74, p<.0001$.

Within-Category Recall

Mean items recalled within category together with standard deviations are indicated in Table 3.

The analysis of variance of the data indicated significant main effects for time, $F(1,181) = 33.06, p<.0001$, for grade, $F(1,181) = 28.81, p<.0001$, for mode of presentation, $F(1,181) = 10.29, p<.001$, and for recall condition, $F(1,181) = 34.16, p<.0001$. No significant main effect for sex was found. Significant interaction effects for time by recall

Table 3. Mean items recalled within category by second and fourth grade children at time 1 and time 2 in each condition

<table>
<thead>
<tr>
<th>Conditiona</th>
<th>Grade 2</th>
<th></th>
<th>Grade 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Time 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>2.26</td>
<td>0.47</td>
<td>2.44</td>
<td>0.49</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>1.87</td>
<td>0.49</td>
<td>2.34</td>
<td>0.53</td>
</tr>
<tr>
<td>Random x cued</td>
<td>2.04</td>
<td>0.39</td>
<td>2.27</td>
<td>0.37</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>1.82</td>
<td>0.41</td>
<td>2.12</td>
<td>0.46</td>
</tr>
<tr>
<td>Time 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>2.17</td>
<td>0.58</td>
<td>2.58</td>
<td>0.62</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>1.57</td>
<td>0.66</td>
<td>2.06</td>
<td>0.58</td>
</tr>
<tr>
<td>Random x cued</td>
<td>1.86</td>
<td>0.42</td>
<td>2.37</td>
<td>0.53</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>1.47</td>
<td>0.41</td>
<td>1.69</td>
<td>0.41</td>
</tr>
</tbody>
</table>

aN = 24 in each condition.
Figure 3. Time by grade by recall condition effect on mean within category recall
condition, $F(1,181) = 29.95, p< .0001$ and time by grade by recall condition, $F(1,181) = 5.55, p<.01$ (Figure 3) were found. Mode of presentation and sex did not have significant interaction effects with any other variables.

The significant interaction effects led to two separate 2(grade) x 2(recall condition) ANOVAS, one for each time of recall. Significant main effects were found for grade, $F(1,188) = 19.53, p<.0001$ and for recall condition, $F(1,188) = 10.83, p<.001$ at time 1, and for grade, $F(1,188) = 27.76, p<.0001$ and for recall condition, $F(1,188) = 47.69, p<.0001$ at time 2. No significant interaction effects were found either at time 1 or time 2.

Recall Time

Mean time taken to recall in all the conditions is indicated in Table 4, together with standard deviations.

The ANOVA results showed a main effect only for recall condition, $F(1,181) = 41.34, p<.0001$. Significant interaction effects for time by grade, $F(1,181) = 8.54, p<.01$ and time by grade by mode of presentation, $F(1,181) = 7.83, p<.01$ (Figure 4) were found.

The significant 3-way interaction effect was further analyzed by two 2(grade) x 2(mode of presentation) ANOVAS for each of the two times of recall. The ANOVA's results showed a significant main effect for grade, $F(1,188) = 5.28, p<.05$ at time 2, with no significant interaction effects at either time.
Figure 4. Time by grade by recall condition effect on mean recall time
Table 4. Mean time (minutes) taken to recall by second and fourth grade children at time 1 and time 2 in each condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Grade 2</th>
<th></th>
<th>Grade 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Time 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>3.18</td>
<td>0.40</td>
<td>3.28</td>
<td>0.54</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>2.58</td>
<td>0.349</td>
<td>2.44</td>
<td>0.37</td>
</tr>
<tr>
<td>Random x cued</td>
<td>3.19</td>
<td>0.32</td>
<td>3.32</td>
<td>0.44</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>2.51</td>
<td>0.33</td>
<td>2.53</td>
<td>0.32</td>
</tr>
<tr>
<td>Time 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>3.22</td>
<td>0.39</td>
<td>3.17</td>
<td>0.59</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>2.42</td>
<td>0.43</td>
<td>2.40</td>
<td>0.34</td>
</tr>
<tr>
<td>Random x cued</td>
<td>3.29</td>
<td>0.36</td>
<td>3.08</td>
<td>0.54</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>3.06</td>
<td>0.32</td>
<td>2.31</td>
<td>0.47</td>
</tr>
</tbody>
</table>

aN = 24 in each condition.

Number of Category Repetitions

The mean number of category repetitions together with the standard deviations are presented in Table 5.

The analysis of variance yielded significant main effects for grade, F(1,181) = 12.65, p<.001, for mode of presentation, F(1,181) = 24.44, p<.0001, and for recall condition, F(1,181) = 19.97, p<.0001. No significant main effect for sex and time of recall were found.

Significant interaction effects of time by grade, F(1,181) = 11.01, p<.001, time by recall condition, F(1,181) = 11.44, p<.001, and time by grade by recall condition, F(1,181) = 4.39, p<.05 (Figure 5) were found. Mode of presentation and sex did not have significant interaction effects.
Figure 5. Time by grade by recall condition effect on mean category repetitions
Table 5. Mean number of category repetitions in recall protocols by second and fourth grade children at time 1 and time 2 in each condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Grade 2</th>
<th></th>
<th>Grade 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>5.33</td>
<td>2.18</td>
<td>5.46</td>
<td>2.93</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>3.83</td>
<td>2.14</td>
<td>5.21</td>
<td>2.08</td>
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<tr>
<td>Random x cued</td>
<td>3.50</td>
<td>2.04</td>
<td>3.83</td>
<td>2.37</td>
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<tr>
<td>Random x non-cued</td>
<td>3.04</td>
<td>1.88</td>
<td>3.12</td>
<td>2.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Time 1</th>
<th></th>
<th>Time 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>5.21</td>
<td>2.52</td>
<td>6.92</td>
<td>3.55</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>3.25</td>
<td>2.23</td>
<td>4.92</td>
<td>1.88</td>
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<tr>
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<td>3.54</td>
<td>1.61</td>
<td>5.79</td>
<td>2.83</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>2.70</td>
<td>1.48</td>
<td>3.29</td>
<td>1.76</td>
</tr>
</tbody>
</table>

\(N = 24\) in each condition.

with any other variables.

Separate 2(grade) x 2(recall condition) ANOVAs were run for time 1 and time 2 of recall. Significant main effects for recall condition at time 1, \(F(1,190) = 4.66, p<.05\) and for grade, \(F(1,190) = 17.49, p<.0001\) and recall condition, \(F(1,190) = 25.00, p<.0001\) at time 2 were found. No significant interaction effects were found either at time 1 or time 2.

Clustering in Recall

Because the number of items correctly recalled at the two grade levels was different, a relative measure of clustering was also used as a
dependent variable, in addition to the number of category repetitions measure. Number of category repetitions is just a raw score; a better clustering index would be a chance adjusted score. An adjusted ratio of clustering (ARC) index was recommended by Roenker et al. (1971). The ARC score represents the proportion of actual category repetitions above chance to the total possible category repetitions above chance for any given recall protocol. Hence, the ARC score is invariant with respect to factors unrelated to relative amount of clustering. Category repetitions, or the number of times that items from the same category are recalled together, are used as the index of organization for this measure. Mean ARC scores in all the conditions together with standard

<table>
<thead>
<tr>
<th>Condition</th>
<th>Grade 2 Mean</th>
<th>Grade 2 Std. Dev.</th>
<th>Grade 4 Mean</th>
<th>Grade 4 Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 1</td>
<td></td>
<td>Time 2</td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>0.74</td>
<td>0.30</td>
<td>0.59</td>
<td>0.39</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>0.55</td>
<td>0.50</td>
<td>0.58</td>
<td>0.24</td>
</tr>
<tr>
<td>Random x cued</td>
<td>0.45</td>
<td>0.34</td>
<td>0.39</td>
<td>0.41</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>0.36</td>
<td>0.47</td>
<td>0.29</td>
<td>0.39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Grade 2 Mean</th>
<th>Grade 2 Std. Dev.</th>
<th>Grade 4 Mean</th>
<th>Grade 4 Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 2</td>
<td></td>
<td>Time 2</td>
<td></td>
</tr>
<tr>
<td>Blocked x cued</td>
<td>0.78</td>
<td>0.23</td>
<td>0.78</td>
<td>0.30</td>
</tr>
<tr>
<td>Blocked x non-cued</td>
<td>0.47</td>
<td>0.58</td>
<td>0.63</td>
<td>0.29</td>
</tr>
<tr>
<td>Random x cued</td>
<td>0.71</td>
<td>0.33</td>
<td>0.70</td>
<td>0.34</td>
</tr>
<tr>
<td>Random x non-cued</td>
<td>0.47</td>
<td>0.54</td>
<td>0.62</td>
<td>0.39</td>
</tr>
</tbody>
</table>

\(N = 24\) in each condition.
Figure 6. Grade by sex effect on mean ARC score
Figure 7. Time by sex by mode of presentation effect on mean ARC score
deviations are indicated in Table 6.

The ANOVA results revealed significant main effects for time, $F(1,177) = 21.18, p<.0001$, for mode of presentation, $F(1,177) = 10.08, p<.001$, and for recall condition, $F(1,177) = 10.07, p<.001$. Sex and grade did not have significant main effects. Significant interaction effects for time by mode of presentation, $F(1,177) = 10.22, p<.001$, for grade by sex, $F(1,177) = 4.27, p<.05$ (Figure 6), and for time by sex by mode of presentation, $F(1,177) = 4.86, p<.05$ (Figure 7) were found. Recall condition did not interact significantly with any other variables. The grade by sex interaction effect was further analyzed by a one-way (grade) ANOVA for the boys and girls separately for each of the two times of recall. A main effect for grade, $F(1,94) = 4.41, p<.05$ was found for boys at time 1. The significant 3-way interaction effect was further analyzed by separate 2(sex) by 2(mode of presentation) ANOVAS for each of the two times of recall. These results indicated a significant main effect for mode of presentation, $F(1,188) = 19.34, p<.0001$ and a significant interaction effect of mode of presentation by sex, $F(1,188) = 4.70, p<.05$ at time 1. No significant main or interaction effects were found at time 2.

Type of Cue

To see the effect of an old versus a new cue at time 2, t-tests were run. None of the t values were significant. There was no significant difference in item recall in the presence of the old versus a new cue, $F(47) = 1.36, p>.30$, no difference in total category-recall, $F(47) =$
1.79, $p > .05$, in within-category recall, $F(47) = 1.32$, $p > .35$, in total number of repetitions, $F(47) = 1.40$, $p > .25$, in recall time $F(47) = 1.05$, $p > .86$, and in clustering, $F(47) = 1.25$, $p > .45$. 
DISCUSSION

Item Recall

For the dependent variable of number of items recalled, main effects were found for the following factors: time, grade, mode of presentation, and recall condition. The mean number of items recalled during immediate recall was significantly higher ($\bar{X} = 10.76$) than the mean number of items recalled during delayed recall ($\bar{X} = 9.91$). The fourth graders recalled more items ($\bar{X} = 11.23$) than the second graders ($\bar{X} = 9.45$). Blocked presentation enhanced item recall ($\bar{X} = 10.86$) compared to random presentation ($\bar{X} = 9.82$), and the presence of a retrieval cue improved item recall ($\bar{X} = 11.27$) significantly over item recall without a retrieval cue ($\bar{X} = 9.37$).

However, the main effects for time, grade, and recall condition are qualified by the presence of interaction effects between time and grade, time and recall condition, and time by grade by recall condition. This latter three-way interaction indicates differential effects of time and recall condition for the second and fourth graders. In the non-cued retrieval conditions, both the fourth graders and second graders recalled more items during immediate ($\bar{X} = 11.16$ and $\bar{X} = 9.23$, respectively) as compared to delayed recall ($\bar{X} = 9.45$ and $\bar{X} = 7.64$, respectively). However, in the cued retrieval conditions, the second graders recalled more items during immediate ($\bar{X} = 10.85$) than during delayed recall ($\bar{X} = 10.08$), while the fourth graders recalled more items in delayed recall ($\bar{X} = 12.48$) than during immediate recall ($\bar{X} = 11.79$).
Separate ANOVAS for each time of recall indicated main effects of grade and recall condition both during immediate and delayed recall. The older children recalled more items than the younger children. At both time 1 and time 2, the fourth graders ($\bar{X}$ at time 1 = 11.48 and time 2 = 10.97) had a higher mean item recall than the second graders ($\bar{X}$ at time 1 = 10.03 and time 2 = 8.86). The greater item recall by the fourth graders than the second graders support the findings by Bousfield et al. (1958) and Vaughan (1968) of an increase in the amount recalled with increasing age. The presence of a retrieval cue enhanced mean item recall both during immediate and delayed recall. At both times cued recall ($\bar{X}$ at time 1 = 11.32 and time 2 = 11.23) was better than non-cued recall ($\bar{X}$ at time 1 = 10.20 and time 2 = 8.55). The findings of a facilitative effect of a retrieval cue on item recall are in agreement with the results of studies by Kobasigawa (1974) and Tulving and Pearlstone (1966).

The results of an overall main effect of mode of presentation is consistent with the results of the studies by Cole et al. (1971) and Kobasigawa and Wilmhurst (1973) in which blocked presentation has been shown to increase both organization of item recall and number of items recalled. Blocking most likely facilitated recall by increasing the likelihood that the children discovered the category structure of the list (Hasher and Clifton, 1974). The lack of a main effect of sex is also in agreement with other studies, e.g., Kobasigawa (1974) and Vaughan (1968) who found that the boys and girls did not differ in their recall performance.
Category Recall

For the dependent variable of number of categories recalled, main effects were found for time, grade, and recall condition but not for sex and mode of presentation. Number of categories recalled during immediate recall ($\bar{X} = 4.46$) was higher than during delayed recall ($\bar{X} = 4.24$), was higher for the fourth graders ($\bar{X} = 4.51$) than for the second graders ($\bar{X} = 4.20$), and was higher in the cued recall condition ($\bar{X} = 4.76$) than in the non-cued condition ($\bar{X} = 3.94$).

However, in addition to the main effects of time and recall condition, there was a significant ordinal interaction effect between time and recall condition. In the non-cued condition, there was a decrease in mean category recall from time 1 ($\bar{X} = 4.18$) to time 2 ($\bar{X} = 3.71$) while in the cued condition category recall was nearly the same ($\bar{X}$ at time 1 = 4.75 and $\bar{X}$ at time 2 = 4.78). Similar results were noted by Kobasigawa (1977).

The finding of a main effect of age is similar to the findings of studies by Moely and Shapiro (1971) and Moely (1977). The finding of the main effect for recall condition is also supported by the studies of Crouse (1968), Ritter et al. (1973), and Kobasigawa (1974) where a developmental increase during childhood has been observed both in the tendency to spontaneously use readily accessible retrieval cues and in the apparent effectiveness with which retrieval cues function when they are used.

In contrast to the findings with number of items recalled, mode of presentation did not have a significant main or interaction effect with
number of categories recalled. However, the variable mode of presentation pertains to items, not categories.

Separate one-way analyses of variance for recall condition during immediate and delayed recall indicated that cued recall significantly increased the number of categories recalled at both times, as was also the case with item recall.

**Within-Category Recall**

For the dependent variable of within-category recall, it was found that recall was better at time 1 ($\bar{X} = 2.14$) than at time 2 ($\bar{X} = 1.97$), that fourth graders had a higher score ($\bar{X} = 2.29$) than the second graders ($\bar{X} = 1.99$), that blocked presentation enhanced within-category recall ($\bar{X} = 2.23$) over random presentation ($\bar{X} = 1.95$), and that the presence of a retrieval cue enhanced ($\bar{X} = 2.25$) within-category recall over non-cued recall ($\bar{X} = 1.87$). Each of the variables of time, grade, and recall condition was involved in significant interaction effects, namely, a two-way interaction of time by recall condition, and a three-way interaction effect of time by grade by recall condition. The three-way interaction indicates differential effects of time and recall condition for the second and fourth graders. In the non-cued retrieval conditions, both the second and fourth graders recalled more items during immediate ($\bar{X}$ for second graders = 1.84 and $\bar{X}$ for fourth graders = 2.23) as compared to delayed recall ($\bar{X}$ for second graders = 1.52 and $\bar{X}$ for fourth graders = 1.87). However, in the cued retrieval conditions, the second graders had higher mean within-category recall during immediate ($\bar{X} = 2.15$) than
during delayed recall ($\bar{X} = 2.01$), while the fourth graders recalled more items within-category in delayed recall ($\bar{X} = 2.48$) than during immediate recall ($\bar{X} = 2.35$), a finding similar to the one with item recall.

Separate ANOVAS for each time of the recall indicated main effects of grade and recall condition both during immediate and delayed recall. Older children had higher mean within-category recall both during immediate ($\bar{X} = 2.30$) and delayed ($\bar{X} = 2.17$) recall compared to the younger children ($\bar{X} = 1.99$ for immediate and $\bar{X} = 1.76$ for delayed recall). This is consistent with the results of the study by Vaughan (1968) and Bjorklund (1985). The presence of a retrieval cue enhanced mean within-category recall both during immediate ($\bar{X} = 2.25$) and delayed recall ($\bar{X} = 2.24$) compared to non-cued immediate ($\bar{X} = 2.03$) and delayed ($\bar{X} = 1.70$) recall. The findings of the facilitative effect of the retrieval cues are reflective of the findings of the studies of Cohen (1966), Moely (1968), and Kobasigawa (1974) who found that providing subjects with category names as retrieval cues significantly increased the total number of items within a category accessible for recall as compared with a free recall condition.

The result of an overall main effect for mode of presentation is consistent with the findings of Furth and Milgram (1973) and Yoshimura et al. (1971) who found that blocking of items showed facilitation of within-category recall and organization across a wide age range. Several other investigations have reported results consistent with the notion that blocking will have greater effects at higher developmental levels (Yoshimura et al., 1971)
Recall Time

The main effect of recall condition indicated that recall time was faster in the non-cued condition ($\bar{X} = 2.48$ min) than in the cued condition ($\bar{X} = 3.22$ min). Recall time is relative to the amount recalled. Overall recall under cued condition was greater so accordingly the total recall time taken is likely to be longer.

The variable of mode of presentation was found to interact significantly with time and grade. This three-way interaction resulted from the fact that in the blocked condition the second graders' recall time did not vary greatly from time 1 ($\bar{X} = 3.08$ min) to time 2 ($\bar{X} = 3.02$ min), while the fourth graders' recall time varied from time 1 ($\bar{X} = 3.06$ min) to time 2 ($\bar{X} = 2.58$ min). Furthermore, for the random condition, the second graders performed slightly faster at time 1 ($\bar{X} = 3.05$ min) than time 2 ($\bar{X} = 3.17$ min), while the fourth graders recalled faster at time 2 ($\bar{X} = 2.49$ min) than at time 1 ($\bar{X} = 3.12$ min).

Separate ANOVAS for immediate and delayed recall showed a significant main effect for grade during delayed recall. The second graders spent more time ($\bar{X} = 3.09$ min) than the fourth graders ($\bar{X} = 2.54$ min).

Number of Category Repetitions

For the dependent variable of number of category repetitions main effects were found for grade, mode of presentation, and recall condition. The fourth graders had a higher mean category repetition score ($\bar{X} = 4.82$) than the second graders ($\bar{X} = 3.86$). Blocked presentation enhanced number
of category repetitions ($\bar{X} = 5.02$) over random presentation ($\bar{X} = 3.60$) and the presence of a retrieval cue improved category repetitions ($\bar{X} = 4.98$) significantly over category repetitions without a retrieval cue ($\bar{X} = 3.67$).

However, the main effects for grade and recall condition are qualified by the interaction effects between time by grade, time by recall condition, and time by grade by recall condition. Mode of presentation and sex were not involved in any interaction effects.

The three-way interaction indicates differential effects of time and recall condition for the second and fourth graders. In the non-cued retrieval conditions, both the fourth and second graders had a higher mean category repetition score during the immediate ($\bar{X} = 4.17$ and 3.44, respectively) as compared to the delayed recall time ($\bar{X} = 4.11$ and 2.97, respectively). However, in the cued retrieval conditions, the second graders had more category repetitions during immediate ($\bar{X} = 4.42$) than during delayed recall ($\bar{X} = 4.37$), while the fourth graders had more category repetitions in delayed recall ($\bar{X} = 6.35$) than during immediate recall ($\bar{X} = 4.64$).

Separate ANOVAS for each time of recall indicated main effects for recall condition at time 1 and for grade and recall condition at time 2. At both time 1 and time 2 the number of category repetitions was higher in the presence of a retrieval cue ($\bar{X} = 4.53$ at time 1 and 5.36 at time 2) than in its absence ($\bar{X} = 3.80$ and 3.53, respectively). These findings of a main effect of recall condition at each time of recall are consistent with the findings by Bilodeau and Blick (1965), Lloyd (1964),
and Kobasigawa and Wilmhurst (1973) where retrieval cues provided at the time of recall facilitated recall. Grade did not have a main effect during immediate recall.

**Clustering in Recall (ARC)**

For the dependent variable of clustering in recall (ARC) main effects were found for time, for mode of presentation, and for recall condition. The mean ARC score during immediate recall ($\bar{X} = 0.67$) was higher than during delayed recall ($\bar{X} = 0.63$). Blocked presentation enhanced the ARC score ($\bar{X} = 0.64$) over the ARC score in the random presentation ($\bar{X} = 0.49$), and the presence of a retrieval cue facilitated clustering ($\bar{X} = 0.64$) compared to non-cued recall ($\bar{X} = 0.49$). Sex and grade did not have significant main effects. The findings of the main effects of mode of presentation and the presence of a retrieval cue are consistent with the findings of the studies by Kobasigawa (1974) and Lange and Jackson (1974).

However, the main effects for time and mode of presentation are qualified by the presence of interaction effects between time by mode of presentation, grade by sex, and time by sex by mode of presentation. The interaction between grade and sex was due to the fact that the boys in the second grade ($\bar{X} = 0.60$) and the girls in the fourth grade ($\bar{X} = 0.64$) had higher ARC scores as compared to the boys in the fourth grade ($\bar{X} = 0.51$) and the girls in the second grade ($\bar{X} = 0.53$). The three-way interaction effect indicates that time and mode of presentation impact boys and girls differently. This finding is inconsistent with the
literature on children's recall, in that almost all studies do not report significant main and/or interaction effects involving sex (Vaughan, 1968; Kobasigawa, 1974; Ornstein, Naus, & Liberty, 1975).

Separate ANOVAs for each time of the recall indicated a significant main effect of mode of presentation and a significant interaction effect of mode of presentation by sex at time 1. Blocked presentation facilitated more clustering ($\bar{X} = 0.62$) than random presentation ($\bar{X} = 0.37$) during immediate recall.

**Type of Cue**

The overall pattern of the data showed no significant effects of the old retrieval cue versus a new retrieval cue at time 2. The new cue seems to be as effective as the old cue at time 2. In contrast, Tulving and Osler (1968) reported that whenever the cues accompanied the TBR words at input, their presence at output facilitated recall, and whenever they were absent at input, their presence at output did not serve any useful purpose. In fact, the presence of cues only at output, or the changing of cues from input to output appeared to interfere with recall of the items. This conclusion appears to be inconsistent with the result of this and other studies (e.g., Bilodeau & Blick, 1965, Lloyd, 1964).
SUMMARY

It was predicted that older children would perform better on various dependent measures than younger children, that blocked presentation would increase recall performance over random presentation, that the presence of a retrieval cue would facilitate recall, and that boys would not differ significantly from girls on various performance measures. Furthermore it was hypothesized that the presence of a retrieval cue in combination with blocked presentation would significantly increase recall performance over that found with cued and non-cued recall in random presentation. Finally, the occurrence of a three-way interaction of mode of presentation by time of recall by retrieval condition was predicted: cued immediate recall of blocked material will be better than non-cued immediate recall of randomly presented material, and will also be better than cued and non-cued delayed recall of blocked and randomly presented material.

For all the six dependent measures, main effects were found for time, grade, and recall condition. For item recall, category recall, and ARC score, mode of presentation had a main effect. Sex did not have a main effect on any of the dependent measures. The results of these main effects met the expectations of the study that the performance of fourth graders is higher than that of second graders, that the blocked presentation enhances recall, that the presence of a retrieval cue facilitates greater recall, and that girls and boys would not differ.

These main effects, however, were qualified by interaction effects,
most frequently a three-way disordinal interaction between time, grade, and recall condition. Further analysis of this interaction effect indicated that for item recall, within-category recall, and number of category repetitions, non-cued recall performance during immediate recall was better than during delayed recall for both second and fourth graders, however, the fourth graders showed greater performance in delayed recall on the cued condition while the second graders performed better in immediate recall on the cued condition.

Even though there was no significant main effect of sex present for any of these dependent measures, a three-way interaction of time by sex by mode of presentation was found for the clustering in recall. This finding was neither predicted nor is it found in the literature.

No significant difference in the effect of an old versus a new retrieval cue at time 2 was found, indicating that the new cues were as effective as old cues.

The organization of material, blocked versus randomly presented, seems to affect recall performance primarily by making the desired information more accessible in an otherwise limited retrieval system.

On the whole, these results suggest that major developmental shifts in recall learning are localized in both the storage and learning components of children's memory. Semantic organization, mode of material presentation, and conditions of recall tend to affect both younger and older children's recall. These factors, in turn, appear to interact in a rather complex fashion with age changes in children's storage and retrieval abilities (Howe, Brainerd, & Kingma, 1985).
Implications for Future Research

A fairly consistent finding in this study as well as other recall research is the tendency for task manipulations to show an interaction with age level, such that older children are more able than younger children to profit by the presence of the cues and blocking of items in presentation. It appears that a certain level of semantic development needs to be attained before the child can be induced to organize through these manipulations. Better ways of specifying the child's level of conceptual knowledge are needed so that interactions of age with task manipulations may be understood more clearly. Most variations or methods of item presentation that have been used with children are based on findings in research with adults, so that it is reasonable that they should be more effective with older children who are closer to the adult in mnemonic capabilities. Rather than trying to shape the child to the adult model through teaching, it may be more useful, in terms of understanding development and assisting the child's learning in other situations, to design tasks so as to maximize the child's opportunity to use available skills. In addition, the investigation of motivational variables involved in the production deficiency of young children would be of interest in further delineating young children's capabilities.

Children process and encode greater numbers of to-be-recalled stimuli with increasing age in ways that do not appear to be manifested in the order of their recall output. Future investigators can pursue this apparent limitation of developmental organization. Future research is needed to find out better assessments of output organization and
better specification of the underlying source and unit of such organization. This would give a better understanding of relationship between recall improvements and systematic improvements in organization. We can proceed with the reasoning that organization serves as only one of the several control processes that in combination account for age changes in the amount of recall. Future research should pursue these issues intensively in developmental research.

Continued research on the effects of the knowledge base should provide a more complete account of children's memory than currently available. Research on long-term developmental effects of the knowledge base on memory strategies should facilitate an understanding of the memory processing mechanisms. Studies which would examine these issues should be longitudinal in scope, but even cross-sectional research that explores the interrelationships between strategies and knowledge will facilitate an understanding of the development of memory in children globally.

Limitations of the Investigation

This study is a cross sectional study attempting to look at the developmental aspects of memory and recall. This cross sectional nature of the study is a limitation in that intra individual changes over time in mnemonic functioning can not be traced directly. Children from Iowa families (Midwest) comprised the sample for the present investigation. A further limitation, therefore, is the generalizability of the findings as this sample is not representative of the general population.
One of the major concerns of category clustering procedures is that the categories the experimenter decides to represent in the list may not constitute an optimal organization for all subjects. This issue is particularly important from the standpoint of interpreting developmental trends in retrieval organization, since there is ample evidence that the properties of younger children's classificatory behavior differs markedly from those of older children (Annett, 1959; Goldman & Levine, 1963; Lange & Hultsch, 1970; Liberty & Ornstein, 1973; Saltz & Sigel, 1967; Saltz, Soller, & Sigel, 1972).

Furthermore, the items and the cues were selected depending on supposed familiarity of the items at second and fourth grade levels. This poses a methodological problem in that the recall differences might be due to list characteristics, such as cohesiveness of items or number of items in each category. It would be well to use more than one exemplar of each list type, to be sure that differences shown are not specific to the lists used or attributable to factors other than those of interest.

Another important issue in cued recall is that of the presentation of an appropriate category name or an appropriate associated concept as a retrieval cue. The presence of retrieval cues at the time of recall may not lead to greater recall than that in the absence of retrieval cues, because the particular cues selected by the experimenter may not trigger the retrieval of items from those particular categories.

The study employed a category clustering procedure (ARC score) to measure organization in recall protocols. One reservation concerning
clustering analyses should be mentioned however. Because recall levels of two different age groups might not be comparable, it is difficult to compare the amount of organization present in protocols produced. The relative measure of clustering employed made it possible to determine whether the obtained recall was organized. However, clustering measures like this are not entirely satisfactory for addressing differences in the degree of organization of different levels of recall; when recall is very low, clustering scores may be distorted. The comparably measured clustering of two age groups could thus reflect inappropriately high assessments of clustering in the extremely limited outputs of younger subjects. The clustering analyses are therefore judged somewhat limited in sensitivity for detecting developmental change in organization of very young children's memories (Perlmutter & Myers, 1979).

A further potential limitation of these measures is that their focus is restricted to pairs of items recalled adjacently and in the same directional sequence over successive trials. For subjects who organize a list into higher-order units and recall items in reverse order from trial to trial, or one or two positions removed from the item(s) they were paired with on the preceding trial, the standard subjective organization measure will underestimate organization at recall. Also, these traditional clustering measures cannot be used with studies using unrelated stimuli.
REFERENCES


ACKNOWLEDGMENTS

I am most grateful to those whose help and encouragement motivated me towards the completion of this final requirement for my Ph.D. degree.

In particular, I would like to express my deepest gratitude to Dr. Jacques Lempers, my major professor, for his unwavering support, patience, and expertise not only during the planning, execution, and writing of this study, but also throughout my graduate program.

To Dr. Frederick Lorenz, I extend my special thanks for consultation and assistance in working out design problems and the statistical analysis of my data.

For their numerous suggestions and generous cooperation, I wish to express my appreciation to my committee members, Dr. Dianne Draper, Dr. Samuel Clark, and Dr. Lloyd Avant.

A special note of thanks is extended to the school personnel, parents, and children for their hospitality, cooperation, and willingness to participate in the study.

I am deeply grateful to Manuel Cerrato who provided me financial support, and the soil research lab personnel for their encouragement.

The support of friends also have been of grateful encouragement to me during my graduate work. My special gratitude to Armin Mikler for his moral support. Thanks also go out to Greg Binford for his help and to Jane Yeomans for excellent typing and valuable assistance.

To my mother, father, sisters, brother, and daughter, a very special debt of gratitude for their support, interest, and encouragement. You
are the best family one can ever ask for. Without your faith in me, this phase of my life would never have become a reality.
APPENDIX A: CONSENT FORMS
1. **Title of project (please type):**

   Long term effects of list organization and retrieval cues on children's free recall.

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are properly protected. Additions to or changes in procedures affecting the subjects after the project has been approved will be submitted to the committee for review.

   **RAMISETTY SUHASINI**

   Typed Name of Principal Investigator

   4163 Buchanan Hall

   Campus Address

   **4-4073**

   Campus Telephone

3. **Signatures of others (if any)**

   **5/3/86**

   Relationship to Principal Investigator

   Major professor

4. **ATTACH an additional page(s) (A) describing your proposed research and (B) the subjects to be used, (C) indicating any risks or discomforts to the subjects, and (D) covering any topics checked below. CHECK all boxes applicable.**

   - Medical clearance necessary before subjects can participate
   - Samples (blood, tissue, etc.) from subjects
   - Administration of substances (foods, drugs, etc.) to subjects
   - Physical exercise or conditioning for subjects
   - Deception of subjects
   - Subjects under 14 years of age and/or
   - Subjects 14-17 years of age
   - Subjects in institutions
   - Research must be approved by another institution or agency

5. **ATTACH an example of the material to be used to obtain informed consent and CHECK which type will be used.**

   - Signed informed consent will be obtained.
   - Modified informed consent will be obtained.

6. **Anticipated date on which subjects will be first contacted:**

   **4 15 1986**

   **Anticipated date for last contact with subjects:**

   **8 15 1986**

7. **If Applicable: Anticipated date on which audio or visual tapes will be erased and/or identifiers will be removed from completed survey instruments:**

   **Month Day Year**

8. **Signature of Head or Chairperson**

   **Date**

   **Department or Administrative Unit**

   **3-31-86**

   **Chairman**

9. **Decision of the University Committee on the Use of Human Subjects In Research:**

   - Project Approved
   - Project not approved
   - No action required

   **George G. Karas**

   **Date**

   **Signature of Committee Chairperson**
Dear Superintendent,

Memory development and recall improvements in childhood has received much attention over the last decade. A number of studies have looked at the effects of various types of organization of the to-be-remembered material on children's recall. It is usually assumed that the use of organization increases the amount of information stored and retrieved. A developmental increase during childhood has been observed both in the tendency to spontaneously use readily accessible retrieval cues, and in the apparent effectiveness with which retrieval cues function when used for semantically related information. Knowledge in these areas would certainly help parents and teachers to help young children to memorize class material and improve their recall. I would like to study the long term effects of material organization and retrieval cues on children's recall for my doctoral dissertation.

I have designed a study that actually involves children of the second and fourth grade in different experimental conditions dealing with recall of picture items. Each child is tested twice for 15 minutes each time, at Time 1 and after 24 hrs time interval at Time 2.

I request your permission for your students to participate in this study. The procedure of this study has been reviewed by Iowa State University's committee on the use of human subjects in research to assure that the study will not cause harm to any child. All information will be kept confidential. No child or parents will be identified by name in the final research reports. No child will be forced to be involved if he/she does not want to participate, and the child can withdraw at any time if he/she is not interested.

If you are interested, a copy of the research summary will be sent to you after the study is completed.

Your cooperation is very much appreciated. I will be happy to respond to any questions or concerns that you have about this study. Please feel free to contact me (294-4073 or 294-5144, message) or my major professor Dr. Jacques Lempers (294-4565).

Thank you in advance for your consideration and help. Looking forward to hear from you.

Sincerely,

(Suhasini Ramisetty)  
Graduate Student

Jacques Lempers, Ph.D  
Professor, Child Dev.
Dear Parents,

I am a graduate student in the Child Development department at Iowa State University. I am presently working on my doctoral dissertation under the direction of Dr. J. Lempers. I am interested in studying children's memory skills under different conditions of information input. In order to obtain information in this area, I hope to administer a test which involves recall of items. Children will be tested twice, first at Time 1 and after 24 hrs time gap at Time 2. It takes approximately 15 minutes to administer the test at one time.

All information will be kept confidential. I would greatly appreciate your help in this project allowing your child to participate. Please fill in the consent form below and return to the concerned class teacher.

I will be happy to answer any questions concerning this project. Please feel free to call me at 294-4073 (Home) or leave a message at 294-5144.

Thank you for your cooperation.

Sincerely,

(Suhasini Ramisetty)
Graduate Student

Approved by

(Dr. J. Lempers)
Professor, Child Development

Concerning Suhasini's research project

I am/am not willing to let my child participate.

Child's name : ___________________________ Grade : _________

Parent's signature : ___________________________ Date: __________

School : ___________________________
DEPARTMENT OF CHILD DEVELOPMENT
IOWA STATE UNIVERSITY
INFORMED SCHOOL CONSENT

I, __________________________ do voluntarily cooperate and give
(Principal's name) permission for our school's __________________ participation
(Name of the school) in the "Long term effects of list organization and retrieval cues on
children's recall" study being conducted by Suhasini Ramisetty of
Iowa State University. I understand that all information is kept
confidential, and children are free to withdraw at any time.

(Principal's Signature) (Date)

(Name of the school and Address) (Tel#)

Please return this form to me in the self addressed and stamped
envelope as soon as possible. Thank you very much for your help.
APPENDIX B: SCORING SHEETS
SCORING SHEET
(NO CUE) 88
(BLOCKED)

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ITEMS RECALLED:

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</tbody>
</table>

TOTAL

No. of categories recalled:
- Time 1:
- Time 2:

No. of items within category:
- Fo C To Fu Tr

Time 1
- ARC Score:
- RR Score:

Time 2
SCORING SHEET
(NO CUE) 89
(RANDOM)

NAME : 
AGE : 
SEX : 
IQ : 
GRADE : 
SCHOOL : 
DATE OF BIRTH :

ITEMS RECALLED :

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<th>TIME 1</th>
<th>TIME 2</th>
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</table>

TOTAL

No. of categories recalled :
Time 1 :
Time 2 :

No. of items within category
Fo  C  To  Fu  Tr

ARC Score :
Time 1
Time 2

RR Score :
# SCORING SHEET

**NAME**: \\
**AGE**: \\
**SEX**: \\
**IQ**: \\

**GRADE**: \\
**SCHOOL**: \\
**DATE OF BIRTH**: \\

**ITEMS RECALLED**:

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**TOTAL**

No. of categories recalled:  
Time 1:  
Time 2:  

No. of items within category:  
Fo C To Fu Tr  

<table>
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<th>TIME 1</th>
<th>Time taken</th>
<th>TIME 2</th>
<th>Old Cue</th>
<th>New Cue</th>
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**No. of categories recalled**:  
**Time taken**  
**No. of items within category**  

**ARC Score**  
**RR Score**
SCORING SHEET
(RANDOM)

ID# ____________

NAME :  
AGE :  
SEX :  
IQ :  
GRADE :  
SCHOOL :  
DATE OF BIRTH :  

ITEMS RECALLED :

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<tr>
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<th>NEW CUE</th>
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TOTAL

<table>
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<th>No. of categories recalled :</th>
<th>Time taken :</th>
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<tbody>
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<td>Time 1 :</td>
</tr>
<tr>
<td>Time 2 :</td>
<td>Time 2 : Old cue New cue</td>
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</tbody>
</table>

<table>
<thead>
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<th>No. of items within category:</th>
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</thead>
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<tr>
<td>Fo</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Time 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 2</td>
<td></td>
</tr>
</tbody>
</table>

ARC Score :  
RR Score :  
Table 1. ANOVA table for item recall

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<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>PR&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between subjects:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>1</td>
<td>301.04</td>
<td>301.04</td>
<td>28.99</td>
<td>0.0001</td>
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<tr>
<td>Mode of presentation</td>
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<td>104.16</td>
<td>104.16</td>
<td>10.03</td>
<td>0.0018</td>
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<tr>
<td>Recall condition</td>
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<td>356.51</td>
<td>356.51</td>
<td>34.33</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>181</td>
<td>1879.74</td>
<td>10.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within subjects:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>1</td>
<td>68.34</td>
<td>68.34</td>
<td>31.22</td>
<td>0.0001</td>
</tr>
<tr>
<td>Time * Grade</td>
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<td>10.66</td>
<td>10.66</td>
<td>4.87</td>
<td>0.0285</td>
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<tr>
<td>Time * Recall condition</td>
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<td>61.76</td>
<td>61.76</td>
<td>28.21</td>
<td>0.0001</td>
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<td>15.04</td>
<td>15.04</td>
<td>6.87</td>
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<td>Error (Time)</td>
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<td>396.19</td>
<td>2.18</td>
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</table>

Table 2. ANOVA table for mean category recall

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<th>MS</th>
<th>F</th>
<th>PR&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between subjects:</strong></td>
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<td></td>
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<tr>
<td>Grade</td>
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<td>9.38</td>
<td>9.38</td>
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<td>116.29</td>
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<td>Error</td>
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<td>Time</td>
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Table 3. ANOVA table for within-category recall

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<td><strong>Within subjects:</strong></td>
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<tr>
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<td>2.87</td>
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Table 4. ANOVA table for recall time

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<th>MS</th>
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Table 5. ANOVA table for number of category repetitions

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Table 6. ANOVA table for clustering in recall

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