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MEMORY AND ORGANIZATIONAL PROCESSES IN CHILDREN OF HIGH AND AVERAGE INTELLECTUAL ABILITY

by

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The purpose of the present study was to investigate organizational processes in the free recall of children having average and high intelligence test scores. If existing IQ tests are in some way assessing individual differences in basic cognitive processes, we should expect to observe differences in the performance of psychometrically determined bright and average children on laboratory tasks designed to study these processes.

Subjects in the study were 88 public-school children, 44 in the third grade and 44 in the fifth grade. Twenty-two children at each grade level had IQ scores greater than 120. Twenty-two children at each grade level had IQ scores between 90 and 109. Equal numbers of males and females were tested at each IQ and grade level.

The children were individually administered four tasks, which were separated by at least two days. The four tasks consisted of a metamemory interview concerning organization and memory, multitrial free recall of unrelated words, multitrial free recall of categorized words, and a sorting task followed by free recall of the sorted words. The metamemory and sorting tasks were presented first and last, respectively; the order of the remaining two tasks was counterbalanced across children.

Bright and average children at each grade level performed equally well on the metamemory tasks. All children overestimated their recall ability. The only difference obtained on the metamemory questions was

the finding that a greater number of bright third graders than of average third graders were able to explain why related words would be easier to remember than unrelated words.

The results of the multitrial free recall tasks and the sorting task indicated that differences in psychometrically-defined intelligence are associated with differences in memory and organizational processes. Across the memory tasks, the bright children consistently showed greater amounts of recall organization than did the average children and consistently recalled more words than did the average children. Even in the sorting task in which the average children were required to achieve organization prior to recall, they did not utilize this organization at recall to the same extent as did the bright children.

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CHAPTER I

INTRODUCTION

A current trend in memory research is to conceptualize mnemonic activity as a conscious goal-oriented process directed toward future recall. During learning and memorization, humans actively and deliberately manipulate information in ways that will potentially facilitate future recall of that information. The study of memory, therefore, ought to be not only the study of recall per se but also a study of the various cognitive strategies which engender recall (Bower, 1970; Mandler, 1967; Meacham, 1972; Tulving, 1962).

The information processing model of memory views the human organism as a cognitive system that receives information from the external environment (input), operates on it (processing), and delivers a response (output). Miller (1956) demonstrated that, at any one time, the capacity of this system to process information is limited to a small number of items (Miller's magic number seven plus or minus two). To account for the obvious fact that human memory is not limited to such a small amount of information, Miller proposed a chunking hypothesis. According to Miller's hypothesis, the span of memory can be increased by grouping individual items into larger "chunks" of information. By recoding individual items into chunks and by recoding small chunks into higher order chunks, the capacity of the memory system increases ad infinitum.

Mandler (1967) pointed out that the organizational mnemonic strategies currently under investigation are equivalent to Miller's notion of chunking and concluded that "organization is absolutely necessary if memory is to exceed the limit of individual items that the system can deal with at any one time" (p. 333). In adult research, Tulving and others (Bousfield, Puff, & Cohen, 1964; Tulving, 1962, 1968) reported positive correlations between amount of organization and number of words recalled across trials and across subjects, an outcome that lends support to the position that recall is dependent on the individual's ability to organize the to-be-remembered items (Mandler, 1967; Miller, 1956). Investigations by Mandler (1967) and by Ornstein, Trabasso, and Johnson-Laird (1974) demonstrated that instructing college students that they were to organize and then recall a list of related words produced no greater recall than simply instructing the subjects to organize the list of words. Ornstein et al. concluded that: "To organize is, to a considerable extent, to remember. Active and consistent categorization is sufficient to yield a relatively high level of recall and additional instructions for recall do not facilitate performance further" (p. 1017). Mandler makes a strong assertion that, "The process of memorization is a process of organization" (p. 333).

In memory research, organization is inferred from consistent discrepancies between order of presentation of a list of words (input) and order of recall (output). In a free recall paradigm, the subject is presented a list of words and is instructed to recall, in any order, as many words as possible. In contrast to a serial recall paradigm, the subject is not required to reproduce the words in the exact order of presentation. Thus, the order in which the subject recalls the words is free to vary from the order of presentation and, therefore, allows the investigation of organizational processes.

Tulving (1968) distinguished between two types of organizational processes. Primary organization refers to consistent discrepancies between the order of input and the order of output that are independent of the subject's prior familiarity with the items. For example, the serial position effect in the free recall of a list of words is indicative of primary organizational processes. During recall of a list of words, regardless of the subject's experiences with the individual items, the order of recall is affected by the position of the word within the list during presentation. Words in the terminal input positions are likely to be recalled before beginning and middle position words are recalled. Secondary organization refers to consistent discrepancies between order of input and order of output resulting from relationships among the items in the list and affected by the subject's intra- and extra-experimental experiences with the items. Secondary organization includes both category clustering and subjective organization. Researchers have developed techniques for quantifying the amount of primary and secondary organization present in a subject's recall protocol (Bousfield & Bousfield, 1966; Frankel & Cole, 1971; Pellegrino, 1971; Robinson, 1966).

Category Clustering

Category clustering refers to the subject's tendency to recall consecutively items from the same category (e.g., animals) despite the fact that items from several different categories (e.g., animals, clothing, food) were presented in a random order. Clustering has been investigated by using a single trial of free recall in which a categorized list is presented once and subjects recall once and by using a multitrial free recall paradigm in which a categorized list is presented two or more times and subjects recall after each presentation. Results of investigations with subjects ranging from kindergarten age through adulthood generally indicate that both total number of words recalled and extent of category clustering in recall increase with increases in chronological age (Cole, Frankel, & Sharp, 1971; Kobasigawa & Middleton, 1972; Nelson, 1969; Rosner, 1971; Yoshimuro, Moely, & Shapiro, 1971). However, Horowitz (1969) found no differences between kindergarten and third-grade children in amount of recall clustering. In a multitrial free recall experiment, Nelson (1969) found significantly greater amounts of category clustering in 8-year-olds as compared to 5-year-olds only in the last two trials of six trials and concluded that single trial free recall may underestimate differences which would appear in later trials. She also reported that the 5-year-olds' performance did not change across trials whereas the 8-year-olds' performance (both number of words recalled and organization) increased across the six trials.

As a measure of secondary organization, category clustering has the disadvantage of reflecting only experimenter-defined organizational structure since the relationships among the items in the list (categorization) are predetermined by the experimenter and since the quantitative measures of clustering take into account only the subject's use of the relationships built into the list by the experimenter. As Mandler (1967) and Tulving (1968) pointed out, measures of category clustering may underestimate the occurrence of organizational processes if (a) the subject fails to recognize the relationships among the items on the list or (b) the subject chooses not to use this experimenter-defined organizational structure as a basis for recall.

Subjective Organization

Subjective organization refers to subjects' tendency to impose their own organizational structure on a list of unrelated words, rather than to subjects' ability to perceive and utilize experimenter-defined organization. When a subject recalls two or more unrelated words together on two consecutive trials, the words are assumed to form a subjective unit of organization for that subject (Tulving, 1962; 1967). Because subjective organization is measured in terms of repetitions of word groupings across trials, the development of subjective organization can only be investigated using a multitrial free recall paradigm.

Studies investigating age differences in subjective organization have yielded conflicting results. Laurence (1966) examined differences in amount of subjective organization in the recall of elementary school children. The children were divided into four groups with mean ages of 5 years, 8 months; 6 years, 9 months; 8 years, 1 month; and 10 years, 6 months. In her study, subjective organization increased across trials in all age groups. However, subjective organization showed no systematic differences with age, despite the fact that total number of words recalled increased significantly with increases in age. Laurence computed a single subjective organization score for the entire block of 16 trials and found this to be positively correlated with mean recall over the 16 trials in the 8- and 10-year-old groups. Shapiro and Moely (1971) obtained similar results with children in grades three (mean age 8.99 years), five (mean age 10.82 years), and seven (mean age 12.98 years). Total number of words recalled increased significantly with increases in chronological age, while increases in subjective organization across ages were only marginally significant; mean recall for the 10 trials and a single subjective organization score for the 10 trials were positively correlated only for subjects in the fifth and seventh grades. Although Tulving (1962) reported significant positive correlations between adult recall and subjective organization, the results of the Laurence (1966) and the Shapiro and Moely (1971) studies indicate that, in young children, total amount of recall may be independent of the amount of subjective organization.

The results of the Laurence and the Shapiro and Moely studies, in regard to their 8-year old subjects, are apparently in conflict. Laurence reported positive correlations between organization and recall with her 8-year olds, whereas Shapiro and Moely obtained positive correlations only with their 10- and 12-year-old subjects. These conflicting results may be at least partially resolved if the population of children used in the two studies is considered. Children in the Laurence study were above average intellectually (mean IQ score = 118) and were enrolled in a special school attached to a university. In the Shapiro and Moely study, children were randomly selected from a public elementary school, and IQ scores probably varied widely within the normal range. It is possible that the IQ differences between the two groups accounted for the conflicting results.

Rosner (1971), using first-, fifth-, and ninth-grade subjects, reported increases in subjective organization across trials in all age groups and significant increases in subjective organization with increases in chronological age. Rosner's findings of parallel increases in subjective organization and total number of words recalled are consistent with the position that increases in recall result from increases in subjective organization. However, the results of the Laurence (1966) and the Shapiro and Moely (1971) studies indicated that improvements in recall with increases in chronological age were accompanied by only minimal increases in subjective organization. Although the types of materials used in these studies varied, there is no evidence that these particular materials should result in differences in subjective organization. The measures of subjective organization in the studies were different; however, these measures have been shown to be positively correlated (Puff & Hyson, 1967).

Although the expected positive relationship between organization (category clustering) and recall of categorized lists of words has been obtained in children as young as 5 years of age, a positive relationship between subjective organization and recall of unrelated lists of words is generally not obtained with younger children. The Shapiro and Moely study reported no correlations between organization and recall in subjects 8 years old and younger. Although Laurence reported positive correlations between organization and recall with 8-year-olds, this outcome may be a function of IQ differences between the two subject populations. Rosner reported parallel age-related increases in subjective organization and recall; however, her failure to compute correlations between amount of organization and recall makes it somewhat difficult to compare her findings with the results of the other studies.

Sorting

Mandler (1967) criticized both category clustering and subjective organization as measures of the organizational structures used by individuals as a basis for recall. Although both of these measures allow investigation of the output phase of free recall, these measures do not allow direct investigation of organization at the time of input nor do they provide direct information concerning the relationship between organizational processes during input and organizational strategies during recall. Mandler (1967) suggested that performance during a multitrial free recall experiment is a result of the efficiency of the initial category system established during input. According to Mandler, the category system is established during the initial trials and is then "filled up" during subsequent trials. Thus, during the initial trials, the subject must establish the most appropriate system of categorization for the entire list. An inefficient category system would prevent organization of all items in the list and would, as a result, hinder recall of some items. According to Mandler, a sorting task reduces the likelihood of an inefficient category system by allowing the subject to organize the entire list of words prior to recall. In a sorting task, all the words in the list are presented simultaneously to the subject and the subject is instructed to sort the words into groups. Sorting trials continue until the subject establishes a stable system of categorization (e.g., meets a criterion such as identical word groupings on two consecutive trials). After reaching the sorting criterion, the subject is asked to recall the list of words. The sorting task, therefore, allows the experimenter to determine whether the category system established by the subject during the input phase (sorting) appears in the output phase (recall). The sorting task has been used to examine organization at input and output for unrelated words and for categorized words and, therefore, may be contrasted to the category clustering and the subjective organization literature, which looks at organization under conditions in which the opportunity to organize is not as optimal as in the sorting task.

The sorting task seems particularly useful in investigating the role of organization in young children's memory. Since all words in the list are presented simultaneously, and since a sorting criterion must be met, each child is allowed to establish a stable system of categorization according to his own criteria and is required to incorporate all words in the list; therefore, occurrence of an organizational scheme at input is equated across subjects of different ages (Lange & Jackson, 1974). Thus, age differences in the extent to which this organizational structure appears in recall would reflect the extent to which organization mediates recall and would not be interpreted as an inability to organize, as might be the case with serial presentation of a list of words.

With college students, Mandler (1967) reported a significant relationship between number of categories established during sorting and subsequent recall of a list of unrelated words. Increases in the number of categories established in the sorting phase (up to a maximum of 7) resulted in increases in total number of words recalled. In addition, subjects tended to cluster together in recall items from the same sorting groups. This tendency increased as the number of sorting categories and, consequently, number of words recalled increased. Mandler and Stevens (1967) found no relationship between the number of sorting categories and number of words recalled in children aged 7 through 13 years. Worden (1974), however, using a categorized list of words, reported a direct relationship between number of sorting categories and number of words recalled in first, third, and fifth graders. As the number of categories increased from two to six, the total number of words recalled increased at all age levels. Worden's results also indicated that children at all age levels clustered items in recall according to the categories established during sorting. The six-category subjects clustered items into the same six categories during recall, whereas the two-category subjects clustered items into the two larger categories.

There is some evidence that young children sort words into a greater number of categories than is considered optimal for adults and that children's categories are smaller, more fragmented, and often constructed according to different criteria than those of adults (Lange & Hultsch, 1971; Liberty & Ornstein, 1973). A sorting task, therefore, may be a more sensitive measure of children's organizational ability because it allows each child to organize according to his or her own criteria (Lange & Jackson, 1974). Hagen et al. (1975) suggested that the stable category systems established by young children are inefficient schemes for improving recall. Even when young children are given an optimal opportunity to organize lists of words at input, i.e., stable sorting is required, they fail to make maximum use of organization during recall (Lange & Jackson, 1974).

Age-Related Differences in Criteria for Categorization

Research previously reviewed generally showed that the amount of category clustering in recall increases with age. This change, according to Denney and Ziobrowski (1972), does not reflect an improvement in the ability to organize but rather the acquisition of more adult-like criteria for organization. Reviewing findings from a variety of research areas, including memory clustering, free classification, word associations, and word definitions, Denney (1974) concluded that, between the ages of 6 and 9 years, there is a general transition from categorization according to complementary criteria (i.e., items share some interrelationship based on the subject's intra- or extra-experimental experiences with items) to categorization according to similarity criteria (i.e., items are similar either perceptually or functionally). Denney hypothesized that, although "complementary items are grouped naturally in time and space" (p. 48), external pressures from the formal educational environment result in the child's focusing on similarity relations. Consistent with Denney's conclusion is the finding that, while college students clustered more than first graders when presented with a list composed of word pairs of similar meaning (e.g., ocean-sea), first graders clustered more than college students when presented with a list of complementary word pairs (e.g., pipe-tobacco) (Denney & Ziobrowski, 1972).

Results of an investigation (Lange & Jackson, 1974) of developmental changes in categorization criteria, using a sorting task, do not support the 6- to 9-year old range as a period of transition from complementary to similarity criteria. Lange and Jackson (1974) chose four categories with instances that could be sorted within or across taxonomic categories. Sorting rationales were scored as descriptive (reference to some observable aspect of the items), functional-contextual (reference to a functional or contextual interdependence; complementary according to Denney's analysis), or class-inclusion (reference to membership in the same generic class; similarity according to Denney's analysis). Subjects were first-, fourth-, seventh-, and tenth-grade children and college students. Lange and Jackson hypothesized a gradual developmental increase in the use of class-inclusion rationales and a corresponding decrease in descriptive and functional-contextual rationales. However, their results revealed a large percentage of functional-contextual rationales in the first and fourth graders and a significant decrease in class-inclusion responses between the first and fourth grades. Beyond the fourth grade, their hypothesis was supported. Significant positive correlations were obtained between clustering scores and number of items recalled, and Lange and Jackson (1974) concluded that the observed correlation coefficents " . . . suggest that personal schemes of item organization appearing in recall seem to mediate the recall achievements of school children of all ages" (p. 1065).

Metamemory about Organization

The term metamemory was coined by Kreutzer, Leonard, and Flavell (1975) to refer to children's verbalizable knowledge about memory and

and memory-related processes. Earlier, it was stated that during memory tasks humans actively and deliberately organize information in ways which facilitate recall. As previously cited research has shown, this deliberate use of organizational strategies occurs less frequently in younger children. Moely and Jeffrey (1969), however, showed that young children can be trained successfully to use organizational strategies in memory tasks, although the effects of training dissipate rapidly. As Hagen et al. (1975) indicated, it seems paradoxical that, although young children can be induced to use organizational strategies through training, they do not do so spontaneously during memory tasks. Recently, greater emphasis has been placed on the role of metamemory as a possible explanation for this finding. Several researchers (Flavell, Friedrichs, & Hoyt, 1970; Hagen, Jongeward, & Kail, 1975; Kreutzer, Leonard, & Flavell, 1975; Meachem, 1972) suggest that children can only engage in appropriate organizational strategies after they have come aware of the fact that (a) remembering requires active participation in the memorization process, (b) their own memory abilities are limited, and (c) they can increase their memorization capacity by engaging in organizational strategies.

There is some evidence that children's awareness that they must be active participants in the memorization process may be related to chronological age. Appel, Cooper, McCarrell, Sims-Knight, Yussen, and Flavell (1972) instructed 4-, 7-, and 11-year old children to either "look at" or "remember" a set of 15 pictures. Following remember instructions, the 11-year-olds rehearsed more during the study period and clustered more during recall than they did following the look at instructions. The two types of instructions produced no differential behavior in the 4- and 7-year olds. These children seemed unaware that remembering required anything more than looking. Appel et al. concluded that "memorizing and perceiving are functionally undifferentiated for the young child, with deliberate memorization only gradually emerging as a separate and distinctive form of cognitive encounter with external stimuli . . ." (p. 1396).

A child's awareness that his or her own memory ability is limited also seems to increase with age. Research (Flavell, Friedrichs, & Hoyt, 1970; Yussen & Levy, 1975) with children from nursery school through fourth grade has found that children at all ages overestimated their actual span of memory but that the difference between predicted and actual memory spans was smaller in the older subjects.

The development of children's knowledge that categorization has a facilitative effect on recall seems to occur during the elementary school years. Moynahan (1973) asked first-, third-, and fifth-grade children whether categorized or uncategorized word lists would be easier to remember and then asked them to recall the categorized and uncategorized lists. The third and fifth graders chose categorized lists as easier to remember more often than first graders. Analysis of the actual recall protocols indicated that categorization facilitated recall at all age levels. Thus, despite the fact that categorization resulted in increases in recall for first graders, they seemed unaware of this facilitative effect.

Tenny (1975) presented kindergarten, third-, and sixth-grade children a key word and asked them either (a) to free associate (b) to construct a list of words that would be easy to remember with the key word, or (c) to construct a list of words belonging to the same taxonomic category as the key word. Although the kindergarten children were able to generate words by taxonomic category when instructed to do so, they revealed no deliberate use of this organizational strategy when constructing their lists of "easy to remember" words. With increases in age, children began to utilize taxonomic category as a strategy for constructing their "easy to remember" lists. Although third graders varied in their use of taxonomic category as a strategy for constructing their easy to remember lists, the sixth graders made almost exclusive use of this strategy.

Additional information concerning children's knowledge of the facilitative effects of organization was obtained by Kreutzer et al. (1975) who interviewed extensively kindergarteners and first, third, and fifth graders. In one task, the children were presented a list of words and asked whether it would be easier to memorize the list of words by "brute force" or by incorporating the words into a story. There was an increasing tendency for the older subjects to judge the story condition as being easier to remember, and there was a sharp increase between first and third grade in the ability to give verbal rationales indicating an awareness that imposing some sort of organizational structure on a list of words would facilitate recall.

In another task, the children were asked which of two sets of pictures would be easier to remember. One set of pictures contained five items from the taxonomic category of animals (conceptually related) and the other set was composed of five unrelated items, all of which were colored green (perceptually related). Kreutzer et al. hypothesized an increase in conceptual choices and a decrease in perceptual choices with increases in age. Although this hypothesis was supported in the kindergarten through third-grade children, the developmental trend was reversed for the fifth-grade subjects. According to Kreutzer et al., many of the children at all age levels ignored the color green in choosing between the two lists. Instead, they argued that the individual items in the perceptual set were highly familiar to them and therefore easy to remember. Kreutzer et al. suggested that categorization was not a salient cue since the category of animals is quite large and the items in the perceptual set were apparently easy to remember. In still another task, subjects were presented two lists of words, each of which was comprised of associated word pairs. In the "Opposites" list, word pairs were comprised of opposite words (e.g., boy-girl). In the "Arbitrary" list, word pairs were comprised of a proper name and some arbitrarily chosen physical activity (e.g., John-sit). As predicted, there was an increasing tendency for older subjects to choose the "Opposites" list as easier to remember.

In summary, children's knowledge of memory phenomena seems to develop through the elementary school years, becoming fairly well established by the sixth grade. By 11 years of age, memorization has emerged into a distinct set of cognitive activities (Appel et al., 1970). Children seem unaware of any limitations of their own memory ability until fourth grade, when they are able to predict their memory span with more accuracy (Flavell et al., 1970; Yussen & Levy, 1975). Knowledge of the facilitative effects of categorization also seems to be well established by sixth grade and may show a transition from child to adult strategies of categorization during the third grade (Yussen, 1975).

The age trends obtained in the Kreutzer et al. interview study may be an artifact of the instructions given to the children during each task. Kreutzer et al. found that third- and fifth-grade children were significantly better than kindergarten and first-grade children at verbalizing knowledge of organizational strategies. However, problems in interpreting their data arise when the instructions given to the children are considered. During the Conceptual-Perceptual task, the experimenter presented two sets of pictures and labeled the sets for the subject (i.e., "These are green things, and these are animals"). Similarly, in the Opposites-Arbitrary task, the differences in the two lists were made quite salient for the children (i.e., "These words are opposites . . . and these words are people and things they might do."). Labeling the categories for the children may have resulted in an overestimation of the younger children's knowledge of the beneficial effects of organization.

Organizational Processes and Intelligence

Memory tasks are generally included in standardized intelligence tests. For example, the Wechsler Intelligence Scale for Children includes a Digit Span subtest and the Stanford-Binet Intelligence Scale includes memory for details of a short story, memory for a series of commands, and memory for designs. Hagen et al. (1975) concluded that: "Memory . . . has been used as a measure of the development of intelligence for over 50 years, because it exhibits clear and reliable developmental properties over a wide age span and because it appears to be related to accepted criteria of cognitive ability" (p. 59).

Generally, memory ability (as measured by total number of words recalled) increases as measured intellectual ability increases. This trend has been demonstrated in studies comparing low, average, and bright age-matched children (Fagen, 1972; Wachs, 1969). Investigations of organizational strategies, however, have been restricted largely to comparisons of retarded and normal children. After reviewing numerous studies comparing normals and retardates, Belmont and Butterfield (1969) concluded that, as age and intellectual ability increase, memory capacity increases as a function of more active acquisition strategies and more efficient retrieval strategies. Consistent with this conclusion is a recent finding that third-grade "normal" children clustered items from the same category in recall significantly more than 15-year-old retarded children matched for mental age (Zupnick & Forrester, 1972).

Three studies with children having IQ scores in the normal range have examined the possible relationship between intelligence and use of organizational strategies. In an organizational training study with normal 6- and 7-year-olds, Moely and Jeffrey (1974) reported significant positive correlations between intelligence quotient scores on the Peabody Picture Vocabulary Test and number of words recalled. In addition, they reported significant positive correlations between IQ scores and number of categories represented in recall. However, correlations between IQ scores and the various quantitative measures of organization were not significant. Apparently, even though the more intelligent subjects were able to recall more categories (an outcome indicating that they recognized the structure of the list), they did not tend to cluster items from the same category together in recall. Although Moely and Jeffrey investigated order of presentation as a possible organizational strategy and also investigated the nature of idiosyncratic organizational strategies, they reported no correlations between tendency to use the alternative strategies and intelligence. The Moely and Jeffrey study does provide some support for the notion that use of organizational strategies is related to intelligence. Although Moely and Jeffrey de-emphasized the fact that IQ was related to number of categories represented in recall, research with adults and children (Mandler, 1967; Worden, 1974) has indicated that total number of words recalled is a direct function of the number of categories utilized by subjects. Mandler (1967) demonstrated that adults recalled a constant number of items from each category in a list of words and that increases in total number of words recalled was a result of remembering additional categories, not remembering more items per category.

Additional evidence of a relationship between intelligence and organization was provided in a study by Rossi and Wittrock (1971). Rossi and Wittrock reported that clustering showed a positive linear trend with intelligence in children with mental ages of 2 through 5. Interpretation of these results is difficult, however, since both mental age and intelligence were based on scores on the Peabody Picture Vocabulary Test and the chronological ages of the subjects were not reported.

Laurence (1966) reported that IQ and subjective organization were not correlated in her 5- through 10-year-old subjects. Earlier it was pointed out that Laurence described all her subjects as being above average. She reported a mean IQ score of 118 but did not report the range of variability. It is possible that the range of IQ scores in her subject population was restricted, therefore, reducing the likelihood of obtaining positive correlations between IQ and subjective organization.

There has been no methodologically sound, systematic attempt to investigate the use of organizational strategies in children of high intelligence (as measured by standardized tests). The only systematic research concerning high verbal ability and use of organizational strategies was conducted with college students. Hunt, Frost, and Lunneborg (1975) investigated differences between high- and low-verbal college freshmen on a variety of memory tasks. Their results indicated that high-verbal freshmen clustered less than low-verbal freshmen during random presentation of a list of categorized words. There was a nonsignificant tendency for the high-verbal subjects to recall words serially, and this tendency for serial recall was evident on other memory tasks. Hunt et al. hypothesized that low-verbal subjects were forced to rely on categorization as a basis for recall because of an inability to utilize temporal coding; they implied that organizational strategies are resorted to by individuals with poor temporal memories. Since Hunt et al. used a single trial of free recall, results of a multitrial free recall experiment may show that high-verbal subjects attempt to use serial recall initially but change to a clustering strategy on later trials.

Purpose of the Present Study

Because of the ability of IQ tests to discriminate among individuals and to accurately predict an individual's performance in the academic environment (Hagen, 1975), intelligence testing has occupied a position of primary importance in educational settings since its conception by Binet and Simon in the early 1900s. The purpose of intelligence testing as conceptualized by Binet was to identify children who needed special remedial education to facilitate optimal progress in an educational environment (Tyler, 1976). However, as Kennedy (1973) pointed out, the concept of IQ scores was so universally accepted that the intelligence test took on explanatory power such that a child's poor academic performance was seen as being the result of a low IQ score.

During the past decade, the use of intelligence test scores as explanatory factors has come under much attack. As Hunt (Hunt, Frost, & Lunneborg, 1975; Hunt & Lansman, 1975) indicated, intelligence test scores do not specify the underlying cognitive processes that explain how intellectual performance occurs. Perfetti (1976) views IQ test scores as "merely prestigious intervening observations" and advocates that psychologists and educationalists "focus on the real functional relationship of interest, between basic ability and school achievement . . ." (p. 292). Thus, a person's poor grade in school should not be viewed as being a function of a low IQ score, but rather the IQ score and the school performance should be regarded as reflections of basic cognitive processes. Discovery of the basic cognitive processes underlying intellectual behavior should lead to the discovery of ways to improve them (Perfetti, 1976) or to the discovery of ways to modify educational tasks to match the cognitive abilities of different individuals (Resnick, 1976).

In the past, there has been little contact between the activity of psychometricians who construct intelligence tests and the activity of experimental psychologists who have generated vast amounts of data concerning cognitive processes. Currently much emphasis is being placed on the need for a strong cooperative effort by experimental psychologists and psychometricians to identify the types of basic cognitive processes that are involved in intelligent performance (Hunt, 1975; Resnick, 1976). Hopefully, this would lead to ". . . the analysis of intellectual performance for the purpose of creating more effective educational settings for the development of intellectual behavior" (Estes, 1976, p. 302).

If existing IQ tests are in some way tapping individual differences in the basic cognitive processes studied by experimental psychologists, we should expect to observe differences in the performance of psychometrically bright and average children on laboratory tasks designed to study these processes. That is, higher levels of measured intelligence should reflect more efficient strategies of processing information. Hunt (1975) suggested that the psychometricians develop assessment techniques which would replace "the relativistic definition of intelligence with a definition in terms of information processing" (p. 89). An information-processing approach to intelligence would focus on the potentially modifiable cognitive strategies that individuals use to process input rather than on descriptions of the relative amounts of "intelligence" possessed by individuals. Since intelligence tests often involve memory tests and since memory processes, especially organizational processes, are occupying a central place in current information processing approaches to cognition, a fruitful area to begin to search for relationships between measured IQ and underlying cognitive processes may be in the area of organization and memory.

The purpose of the present study was to provide a systematic investigation of the relationship between higher levels of intellectual ability (as measured by standardized IQ tests) and performance on laboratory tasks designed to assess children's use of organizational strategies. In the literature that was reviewed earlier there was evidence that children's knowledge concerning and use of organizational strategies show marked changes during the third through sixth grades. Therefore, third graders who are approximately the age at which this change begins and fifth graders who are in this period of change but are not at the age when the knowledge and use of organizational strategies is well established were selected for the study. At both age levels, children of high intellectual ability and children of average intellectual ability participated. The children's knowledge and use of organizational strategies were investigated during several experimental tasks: (a) an informal metamemory interview designed to assess the children's verbalizable knowledge of the facilitative effects of organization on recall (b) multitrial free recall of categorized words (c) multitrial free recall of unrelated words, and (d) a sorting task, followed by free recall.

CHAPTER II

METHOD

Subjects

Subjects were 88 children from the Greensboro City Schools, Greensboro, North Carolina. Children were selected from the third and fifth grades, 44 children at each grade level. The children were divided into two groups on the basis of their scores on the California Test of Basic Skills, a group administered intelligence test given to all children in the Greensboro City Schools at the beginning of the third grade. Within each grade level, 22 children had IQ scores greater than 120. The mean IQ score for the bright third-grade children was 126 (range = 120 to 135). The mean IQ score for the bright fifth-grade children was 125.5 (range = 121 to 139). The remaining 22 children at each grade level had IQ scores between 90 and 109. The mean IQ score for the third grade and fifth grade children respectively were 99 and 101. To assure that the two groups represented two distinct levels of measured intelligence, individuals with IQ scores in the intervening range (110 to 119) were excluded.

Experimenters

The children were tested by the author, two male graduate students, and one female and one male undergraduate psychology student. The graduate and undergraduate students were trained to administer the experimental tasks by the author.

Procedure

Each experimenter administered only one of the experimental tasks. Each child participated in four 15- to 20-minute sessions. During each session, the children completed a different task, and only one experimental task was presented on any given day. Children completed the four tasks in not less than one week and not more than two weeks. In order to assess each child's knowledge of organizational mnemonic strategies prior to exposure to organizational memory tasks, the metamemory interview was administered first to all children. The order of administration of multitrial free recall of unrelated words and multitrial free recall of categorizable words was counterbalanced across the children at each grade level. The sorting task is considered to be a more optimal situation for organization to occur and, therefore, to avoid biasing the children toward looking for organizational structure in the word lists of the other tasks, the sorting task was presented last to all children. The tasks that were administered to all children are described below.

Metamemory interview. Each child was asked a series of questions designed to assess the subject's awareness of his or her own memorization ability and his awareness of the role of organizational processes in memory. The questions were adapted from Kreutzer et al. (1975). The Memory Ability question was administered first to all children. The order of presentation of the other metamemory tasks was counterbalanced across children at each grade level. The metamemory tasks followed the format of an informal interview. If a child did not understand or failed to answer a question, the experimenter repeated the question and, if necessary, rephrased the question for the child, with the restriction that the experimenter provided no additional information other than the information given in the basic instructions. Six raters, unfamiliar with the purpose of the study, judged the quality of the children's responses to the metamemory tasks. Two different raters judged each task. Raters had no knowledge of each child's age, sex, or intelligence level. Raters were given written instructions which included a brief statement of the purpose of the task, a copy of the instructions to the children, and specific criteria for rating the responses.

Memory Ability. The experimenter said to each child: "Sometimes I forget things. Do you forget? (Child answered.) Do you remember things well -- are you a good rememberer? (Child answered.) For example, if I showed you 24 words to look at and remember, how many do you think you would remember?" (Child answered.)

Story-List. The materials consisted of seven index cards with one word printed on each card. The seven words were: bed, tie, shoes, table, dog, hat, car. During the list presentation of the words, the experimenter said to each child: "The other day I showed these words to other boys and girls your age." The experimenter then placed the cards on the table in a random order, reading each word as it was placed on the table. The experimenter said: "I asked one girl to learn them so that she could tell me what they were later when she couldn't see them anymore." During the story presentation of the words, the experimenter said to each child: "I showed the same words to another girl, but also told her a story about the words." The experimenter read the following story, placing each word on the table as it was mentioned:

> A man gets up out of bed, and gets dressed, putting on his best tie and shoes. Then he sits down at the table for breakfast. After breakfast he takes his dog for a walk. Then he puts on his hat and gets into his car and drives to work.

After reading the story, the experimenter said to each child: "I told the girl who heard this story that she was supposed to learn the words so she could tell me what they were later when she couldn't see the words. She didn't have to tell me the story, just the words. Do you think the story made it easier or harder for the girl to remember the words?" (Child answered.) "Why?" (Child answered.)

Half of the children at each grade level heard the list presentation first and half of the children at each grade level heard the story presentation first (with appropriate modification of instructions). Raters classified the children's responses on a four-point scale using the following criteria:

Ratings of 0 giving the wrong answer by stating that the story made it harder for the girl to remember the words

1 giving the correct answer but without referring to the story in the explanation of why the story made it easier (example: "It just is.")

2 giving the correct answer plus a statement referring to the cue value of the story (example: "If you remember the story you can remember the words.")

3 giving the correct answer plus a statement about the value of context as a clue for remembering a word, i.e., the story makes words related (example: "Each part of the story give you a hint about the word to remember.")

Related-Unrelated. The materials in this task were two sets of words, nine words in each set. One set contained the following words: eye, nose, teeth, ear, hair, chin, neck, cheeks, lips. Since these items belong to the same taxonomic category (parts of the head), they were considered to be conceptually related. The second set contained the following words: mitten, chair, bottle, bus, pocketbook, candle, pot, tree, wagon. Since there is no obvious relationship among the items, they were considered to be unrelated. The two sets of words were placed on the table in front of the child in two horizontal rows, one row being placed directly above the other row. Each set constituted a row. The upper-lower position of the two sets of words was counterbalanced across children at each grade level. The experimenter then said to each child: "Here are two sets of words. These are one set (the experimenter pointed to upper row) and these are another set (experimenter pointed to lower row). If you had to learn these words so that you could say them when I took them away, which would be easier? Point to the set you think would be easier to remember. Why would that set be easier to remember?" (Child answered.) Raters classified the children's responses on a four-point scale using the following criteria:

Ratings of 0 giving the wrong answer by stating that the unrelated list was easier to remember

1 giving the correct answer but without referring to the categorized nature of the related list (example: "They are littler words.")

2 giving the correct answer plus a statement that the related list are all parts of the body or face

3 giving the correct answer plus a statement indicating that words in the same category are related and therefore easier to remember (example: "They are all on your face. All you have to do is think of your face and you automatically know the words.")

Opposites-Arbitrary. Materials consisted of two lists of word pairs. The arbitrary list consisted of people's first names randomly paired with physical actions: Mary-walk, Charley-jump, Joe-climb, Ann-sit. The opposites list consisted of word pairs that were opposites or complements: boy-girl, hard-easy, cry-laugh, black-white.

A practice set of three word-pairs (box-pen, apple-cat, tree-cup) was used initially to familiarize the children with a paired-associate task. For the practice set, each word pair and each initial word of each pair was printed on individual index cards. Word-pairs in the practice set were presented to each child in a series of study-test trials. During the study period each word pair was presented to each child for three seconds, while the experimenter read the word pair to the subject. During the test period, each initial word of each pair was read to the child by the experimenter and the child was asked to give the other word in the pair within 5 seconds. One study period and one test period constituted a study-test trial. Study-test trials continued with the practice word pairs until the child achieved perfect recall during one trial.

Following one perfect recall of the practice word pairs, the experimenter proceeded to the experimental task with the following instructions: "Here are two longer lists of words that you could learn in the same way." Two vertical columns of index cards were placed on the table in front of the child. One column consisted of word pairs in the arbitrary list. The other column consisted of word pairs in the opposites list. The order of word pairs within each column was varied randomly across children. Left-right position of the arbitrary list column and the opposites list column was counterbalanced across children at each level.

The experimenter read the word pairs in each list to the children. The children were allowed to study the two lists for 20 seconds and were then asked: "Do you think one of these lists of word pairs would be easier for you to learn and remember? Point to the list that you think would be easier for you to remember." (Child answered.) "Why?" (Child answered.) Raters classified the children's responses on a four-point scale using the following criteria:

Ratings of 0 giving the wrong answer by stating that the arbitrary list was easier to remember

1 giving the correct answer without reference to the opposite nature of the word pairs (example: "They are easier words.")

2 giving the correct answer plus a statement that the opposites list is easier because they are opposites

3 giving the correct answer plus a statement indicating that if you see a word you automatically know its opposite

Multitrial free recall of unrelated words. The unrelated word list consisted of 24 common words chosen by the author so that no obvious relationships existed among the words. The following words comprised the unrelated word list: egg, fence, game, grass, joke, king, lake, map, nail, rope, window, store, song, truck, air, book, wall, pipe, heart, box, moon, watch, year, rose. Each word was printed on an individual index card for presentation to the children.

The 24-word list was presented to the children during ten study-test trials. A different random order of the 24 words was used during each of the ten trials, with the restriction that no word occupied the same serial position on more than one trial and no word was preceded or followed by the same word on more than one trial. All children received the same ten predetermined random orders of the list.

The child was seated at a small table opposite the experimenter. The experimenter administered the list with the following instructions:

> Listen carefully and I will tell you what we are going to do. Do you have a good memory? Do you remember things that you see and hear? I am going to show you some words. Each time I show you a word I want you to look carefully at the word while I read it to you. When I have shown you all of the words I have in my hand, I want you to tell me all of the words you can remember. You don't have to remember the words in the same order I showed them to you. Remember them in any order you want to.

Each word was exposed for 3 seconds. Following presentation of the 24-word list, the children were asked to recall as many of the words as possible in a 90-second recall period. Following each study-test trial, the experimenter said to the child:

> You did very well remembering the words I showed you. Now, lets do it again. Look carefully at each word as I read it to you. When I have shown you all the words, I want you to tell me all the words you remember in any order you want to.

Multitrial free recall of categorized words. The categorized word list consisted of 24 common nouns representing six instances each of four different taxonomic categories. The following categories and category items comprise the categorized word list: (a) fruit: grapes, peach, banana, cherry, apple, lemon (b) clothing: coat, socks, hat, dress, pants, sweater (c) animals: dog, cow, pig, mouse, horse, sheep (d) furniture: chair, desk, lamp, couch, bed, rug. Each word was printed on an individual index card for presentation to the children.

The 24 words of the categorized word list were presented to the children during six study-test trials. A different random order of the 24 words was used during each of the six trials, with the constraint that no two words from the same category occurred consecutively on any trial and no word occupied the same serial position on more than one trial.

Each child was seated at a small table opposite the experimenter. The 24-word categorized list was presented to the children with the following instructions:

> Listen and I will tell you what we are going to do, I am going to show you some words. Each time I show you a word I want you to look carefully at the word while I read it to you. When I have shown you all the words I

> have in my hand, I want you to tell me all the words you remember. You don't have to remember them in the order I show them to you. Remember them in any order you want to.

Each word was exposed for 3 seconds. Following presentation of the 24-word list, the children were asked to recall as many of the words as possible in a 90-second recall period. Following each study-test trial, the experimenter said to the child:

> You did very well remembering the words I showed you. Now, let's do it again. Look carefully at each word as I read it to you. When I have shown you all the words I have in my hand, I want you to tell me all the words you remember, in any order you want to.

Immediately following the last study-test trial, the children were asked to sort the words into categories. Instructions to each child were as follows:

> Now, I am going to give you all of the words and I want you to put all of the words that go best together in a group. As you put each word in a group, I want you to tell me why you put that word in that group.

<u>Sorting task</u>. Materials for this task consisted of 24 common words, six instances of each of four broadly defined categories. The items were selected for their suitability for sorting within and across categories. The categories and the category items were: (a) <u>people</u>: <u>Indian</u>, <u>woman</u>, <u>man</u>, <u>farmer</u>, <u>boy</u>, <u>girl</u> (b) <u>vehicles</u>: <u>stagecoach</u>, <u>bus</u>, <u>car</u>, <u>boat</u>, <u>tractor</u>, <u>bicycle</u> (c) <u>places to live</u>: <u>apartment</u>, <u>teepee</u>, <u>house</u>, <u>cabin</u>, <u>barn</u>, <u>tent</u> (d) <u>tools</u>: <u>knife</u>, <u>scissors</u>, <u>axe</u>, <u>rake</u>, <u>hammer</u>, <u>pencil</u>.

Each word was printed on an individual index card. The experimenter placed the words on the table in front of the children in a random order. As the experimenter placed each word on the table, he or she read the word to the child. Following presentation of the 24 words, the experimenter said to the child:

> I am interested in how children remember the things they see and hear. Before I take these words away and ask you to remember which ones you saw, I want you to put the words in different groups. The words that go together best should go in the same group. Think carefully about the groups you are making so that you can remember which groups you made if I ask you to do it again. Each time you place a word in a group, I want you to tell me why it belongs in that group. You can make as many groups as you want and can change your groups around and make new groups if you like. After you make your groups a few times I will take the words away and ask you to remember as many of the words as you can.

The order of the words on the first trial was a predetermined random order and was identical for all children. On the first trial, after the experimenter read the 24 words to the children, the children were given 30 seconds to study the words before sorting the words into groups. When the child had finished sorting the words into groups, the words were shuffled and placed in a random order on the table. The child was, again, asked to sort the words into groups. Sorting trials continued until the child reached a criterion of identical sorting on two consecutive sorting trials. When the child reached criterion, the words were covered, and the child was asked to recall as many words as possible in a 90-second recall interval.

CHAPTER III

RESULTS

Metamemory

Memory Ability. The Memory Ability task required the children to predict the number of words they could recall if they were presented a list of 24 words. The children's estimates were compared to the actual number of words they recalled on Trial 1 of the categorized and unrelated lists by means of separate 2(grade) x 2(intelligence) x 2(sex) x 2(predicted versus actual recall) analyses of variance (all statistical analyses can be found in Appendix A). For the categorized list, the main effect of predicted versus actual recall was significant. Predicted recall (M = 13.23) was significantly greater than actual recall on Trial 1 of the categorized list (M = 8.01).

The mean number of words predicted and the mean number of words actually recalled on Trial 1 of the unrelated list as a function of grade and sex are presented in Table 1. For the unrelated list, the main effect of predicted versus actual recall, F (1,80) = 96.53, $p < .01$, and the interaction of grade, sex, and predicted versus actual recall, F (1,80) = 4.16, $p < .05$, were significant. Multiple comparisons using a Newman-Keuls statistic performed on the interaction showed that predicted recall for fifth-grade males was greater than predicted recall for fifth-grade females, $p < .05$. The mean number

Table 1

Mean Number of Words Predicted and Mean Number of Words Actually Recalled on Trial 1 of the Unrelated List as a Function of Grade and Sex

Group	Predicted and actual recall	
	Mean number of words predicted	Mean number of words recalled
Third grade		
Male	13.14	6.77
Female	13.18	5.91
Fifth grade		
Male	14.86	7.73
Female	11.73	8.64

of words predicted and the mean number of words actually recalled on Trial 1 of the unrelated list as a function of intelligence and sex are presented in Table 2. The interaction of intelligence, sex, and predicted versus actual recall was significant, F (1,80) = 4.01, $p < .05$. Multiple comparisons using the Neuman-Keuls statistic performed on the interaction indicated that predicted recall for bright males was greater than predicted recall for bright females.

Story-List. In the Story-List task children were asked to state whether the story facilitated recall of a list of words and to provide a rationale for their responses. Table 3 shows the number of children in each group who stated that the story facilitated recall. A 2(grade) x 2(response) chi-square analysis indicated that an equivalent number of children at each grade level stated that the story facilitated recall. Separate 2(intelligence) x 2(response) chi-square analyses indicated that an equivalent number of bright and average children at each grade level stated that the story facilitated recall.

The children's rationales were rated according to the four-point scale described previously. Interrater reliability was calculated by dividing the number of agreements by the number of agreements plus disagreements. Interrater reliability for the Story-List task was .78. Inspection of the interrater agreement data revealed that discrepancies in ratings occurred most frequently between ratings of 2 and 3, indicating that the raters apparently had difficulty discriminating a 2- from a 3-point answer. Therefore, a two-point scale was utilized in the analyses. A rating of 1 indicated that the child's rationale

Table 2

Mean Number of Words Predicted and Mean Number of Words Actually Recalled on Trial 1 of the Unrelated List as a Function of Intelligence and Sex

Group	Predicted and actual recall	
	Mean number of words predicted	Mean number of words recalled
Bright		
Male	14.59	7.27
Female	11.36	8.05
Average		
Male	13.41	7.23
Female	13.55	6.50

Table 3

Number of Children Stating that the Story Facilitated Recall as a Function of Grade and Intelligence

Group	Number of children: Story facilitated recall	Number of children: Story did not facilitate recall
Third grade		
Bright	18	4
Average	16	6
Fifth grade		
Bright	15	7
Average	20	2

showed no awareness of the cue value of the story. A rating of 2 or 3 indicated that the child's rationale showed at least minimal awareness of the cue value of the story. Ratings of 0 were omitted from the analyses because that rating represented an incorrect answer. Table 4 shows the number of 1-point and 2- or 3-point ratings for children in each group. Results of Fisher Exact Tests indicated that, at the third grade level, more bright children gave 2- or 3-point rationales than average children (p = .027). At the fifth grade level, an equivalent number of bright and average children gave 2- or 3-point rationales.

Related-Unrelated. In the Related-Unrelated task children were asked to state whether a list of related words or a list of unrelated words would be easier to remember and to give a rationale for their responses. Table 5 shows the number of children in each group who stated that the related list would be easier to remember. A 2(grade) x 2(response) chi-square analyses indicated that an equivalent number of children at each grade level stated that the related list would be easier. Separate 2(intelligence) x 2(response) chi-square analyses indicated that an equivalent number of bright and average children at each grade level stated that the related list would be easier.

The children's rationales for the Related-Unrelated task were rated according to the four-point scale described previously. Interrater reliability was calculated by dividing the number of agreements by the number of agreements plus disagreements. Interrater reliability for the Related-Unrelated task was .92. As in the Story-List task,

Table 4

Number of 1-point and 2- or 3-point Ratings
on the Story-List Task as a function of
Grade and Intelligence

	Rating of rationales	
Group	1	2 or 3
Third grade		
Bright	1	17
Average	6	10
Fifth grade		
Bright	1	14
Average	1	18

Table 5

Number of Children Stating that the Related List was Easier to Remember as a Function of Grade and Intelligence

Group	Number of children: Related list easier	Number of children: Related list not easier
Third grade		
Bright	21	1
Average	20	2
Fifth grade		
Bright	21	1
Average	22	0

discrepancies in ratings occurred most frequently between ratings of 2 and 3, indicating that it was apparently difficult for raters to discriminate a 2- from a 3-point rationale. Therefore, a two-point scale was utilized in the analyses. A rating of 1 indicated that the child's answer showed no awareness of the fact that the words were related. A rating of 2 or 3 indicated that the child's rationale showed at least minimal awareness that words in the same category are easier to remember. Ratings of 0 were omitted from the analyses because that rating represented an incorrect answer. Table 6 shows the number of 1-point and 2- or 3-point ratings for children in each group. A 2(intelligence) x 2(ratings) chi-square analysis indicated that, at the third grade level, more bright children gave 2- or 3-point rationales than average children, $\chi = 4.65(1)$, $p < .05$. At the fifth grade level, an equivalent number of bright and average children gave 2- or 3-point rationales.

Opposites-Arbitrary. In the Opposites-Arbitrary task children were asked whether a list of opposite word pairs or a list of unrelated word pairs would be easier to remember and to give a rationale for their responses. Table 7 shows the number of children at each grade level who stated that the opposites list would be easier to remember. A 2(grade) x 2(response) chi-square analysis indicated that an equivalent number of children at each grade level stated that the opposits list would be easier. Separate 2(intelligence) x 2(response) chi-square analyses indicated that an equivalent number of bright and average children at each grade level stated that the opposites list would be easier.

Table 6

Number of 1-point and 2- or 3-point Ratings on the Related-Unrelated Task as a Function of Grade and Intelligence

	Rating of rationales	
Group	1	2 or 3
Third grade		
Bright	2	20
Average	8	12
Fifth grade		
Bright	1	19
Average	6	16

Table 7

Number of Children Stating that the Opposite List was Easier to Remember as a Function of Grade and Intelligence

Group	Number of Children	
	Opposites list easier	Opposites list not easier
Third grade		
Bright	20	2
Average	17	5
Fifth grade		
Bright	20	2
Average	20	2

The children's rationales for the Opposites-Arbitrary task were rated according to the four-point scale described previously. Interrater reliability was calculated by dividing the number of agreements by the number of agreements plus disagreements. Interrater reliability for the Opposites-Arbitrary task was .91. As in the Story-List and the Related-Unrelated tasks, discrepancies in ratings occurred most frequently between ratings of 2 and 3, indicating that it was apparently difficult for raters to discriminate a 2- from a 3-point rationale. Therefore, a two-point scale was utilized in the analyses. A rating of 1 indicated that the child's answer showed no awareness of the fact that the words in the word pairs were opposites. A rating of 2 or 3 indicated at least minimal awareness that words that are opposites are easier to remember. Ratings of 0 were omitted from the analyses because that rating represented an incorrect answer. Table 8 shows the number of 1-point and 2- or 3-point rationales for children in each group. Separate Fisher Exact Tests indicated that an equivalent number of bright and average children at each grade level gave 2- or 3-point rationales.

In summary, bright and average children at each grade level performed equally as well on the metamemory tasks. More bright third graders gave 2- or 3-point rationales than did average third graders on the Story-List and the Related-Unrelated tasks. All children overestimated their recall ability as compared to their actual recall on Trial 1 of the categorized and unrelated lists.

Table 8

Number of 1-point and 2- or 3-point Ratings on the Opposites-Arbitrary Task as a Function of Grade and Intelligence

	Rating of rationales	
Group	1	2 or 3
Third grade		
Bright	0	19
Average	0	12
Fifth grade		
Bright	0	20
Average	0	17

<u>Multitrial Free Recall of Unrelated Words</u>

During this task, a list of 24 unrelated words was presented to the children during 10 study-test trials. Analyses were performed on the number of words recalled on each trial and on the amount of subjective organization on adjacent pairs of trials.

<u>Number of words recalled</u>. Table 9 shows the mean number of words recalled as a function of intelligence and trials. A 2(grade) x 2(intelligence) x 2(sex) x 10(trials) analyses of variance, with repeated measures on the last factor, was performed. A significant main effect of grade was obtained, F (1,80) = 10.63, $p < .01$, with fifth-grade children (M = 13.47) recalling more words than third-grade children (M = 11.58). A significant intelligence x trials interaction was obtained, F (9.720) = 3.51, $p < .01$. Multiple comparisons using a Newman-Keuls statistic were performed on the interaction. The results indicated that bright children recalled more words than average children on all trials except Trial 1, $p < .05$.

<u>Subjective organization</u>. For all children, Bousfield and Bousfield's (1966) observed (O) minus expected (E) intertrial repetition (ITR) measure was used to assess the amount of subjective organization on adjacent pairs of trials. This measure of subjective organization reflects the extent to which pairs of words are outputted by the children in adjacent positions on adjacent pairs of trials. A 2(grade) x 2(intelligence) x 2(sex) x 10(trials) analysis of variance, with repeated measures on the last factor, was performed. A significant main effect of intelligence, F (1,80) = 4.56, $p < .05$, indicated that

Table 9

Mean Number of Words Recalled on the Unrelat[illegible] as a Function of Intelligence and Trials

Intelligence group	1	2	[illegible]	[illegible]	[illegible]	[illegible]	7	8	9	10
Bright	7.43	10.54	11.[illegible]	[illegible]	[illegible]	[illegible]	15.48	15.89	16.25	16.70
Average	6.79	9.00	10.23	[illegible]	[illegible]	[illegible]9	12.30	13.04	13.23	13.54

Table 9

Mean Number of Words Recalled on the Unrelated List as a Function of Intelligence and Trials

	Trial									
Intelligence group	1	2	3	4	5	6	7	8	9	10
Bright	7.43	10.54	11.93	12.98	14.52	15.25	15.48	15.89	16.25	16.70
Average	6.79	9.00	10.23	10.73	11.75	12.89	12.30	13.04	13.23	13.54

bright children ($\underline{M}$ = .62) showed more subjective organization than average children ($\underline{M}$ = .39). A significant main effect of trials was also obtained, $\underline{F}$ (8,640) = 5.99, $\underline{p} < .01$. Mean subjective organization scores on Trials 2 through 10 were .13, .29, .19, .45, .63, .68, .69, and .82, respectively. A Newman-Keuls post hoc analysis performed on the nine adjacent pairs of trials indicated that subjective organization was greater on Trials 6, 7, 8, 9, and 10 as compared to that obtained on Trials 2 and 4; subjective organization obtained on Trial 10 was greater than that obtained on Trial 3, $\underline{p} < .05$.

Correlations between subjective organization and number of words recalled. Pearson correlation coefficients were calculated between mean number of words recalled on each trial and subjective organization on each pair of adjacent trials. As indicated in Table 10, significant positive correlations were obtained between recall on each trial and subjective organization on each pair of adjacent trials, with the exception of nonsignificant correlations between recall on Trial 3 and subjective organization on Trial 3 and recall on Trial 4 and subjective organization on Trial 4.

In summary, bright children used more subjective organization and recalled more words than did average children. Although nonsignificant differences in subjective organization were obtained between third and fifth graders, fifth-grade children recalled more words.

Multitrial Free Recall of Categorized Words

During this task a list of 24 common nouns representing six instances of four different taxonomic categories were presented to the

Table 10

Correlations Between Recall and Subjective Organization as a Function of Trials

	Trial								
	2	3	4	5	6	7	8	9	10
Pearson Correlation Coefficients	.26**	-.007	.05	.35***	.33***	.40***	.42***	.25**	.33**

** $p < .01$
*** $p < .001$

children in six study-test trials. Analyses were performed on the number of words recalled on each trial and the amount of category clustering on each trial.

Number of words recalled. A 2(grade) x 2(intelligence) x 2(sex) x 6(trials) analysis of variance, with repeated measures on the last factor, was performed. Significant main effects of grade, $F\ (1,80) = 10.55$, $p < .01$, intelligence, $F\ (1,80) = 19.78$, $p < .01$, and trials, $F\ (5,400) = 129.06$, $p < .01$, were obtained. Fifth-grade children ($M = 13.32$) recalled more words than third-grade children ($M = 11.50$), and bright children ($M = 13.67$) recalled more words than average children ($M = 11.17$). A Newman-Keuls analysis performed on the trials effect indicated that the mean number of words recalled increased on each trial, $p < .05$. Mean number of words recalled on Trials 1 through 6 were 8.02, 11.27, 12.39, 13.32, 14.23, and 15.27, respectively.

Category clustering. Category clustering refers to the tendency to recall consecutively words from the same category despite the fact that the words are presented in a random order. For all children, Bousfield and Bousfield's (1966) observed (O) minus expected (E) stimulus category repetition (SCR) measure was used to assess the amount of category clustering on each trial. This measure reflects the extent to which the children recalled pairs of words from the same taxonomic category in adjacent output positions. Table 11 shows the mean category clustering scores as a function of grade and trials. A 2(grade) x 2(intelligence) x 2(sex) x 6(trials) analysis of variance, with repeated measures on the last factor, was performed.

Table 11

Mean Category Clustering Scores as a Function of Grade and Trials

	Trial					
Grade	1	2	3	4	5	6
Third grade	.28	.44	1.47	1.16	1.80	2.48
Fifth grade	.56	1.03	2.05	3.00	3.61	4.06

Significant main effects of grade, F (1,80) = 7.31, $p < .01$, intelligence, F (1,80) = 8.76, $p < .01$, and trials, F (5,400) = 30.86, $p < .01$, were obtained. A significant grade x trials interaction, F (5,400) = 3.14, $p < .01$, was also obtained. Multiple comparisons using a Neuman-Keuls statistic performed on the grade x trials interaction indicated that fifth-grade children clustered more than third-grade children on Trials 4, 5, and 6, $p < .05$. Nonsignificant differences in clustering were found on Trials 1, 2, and 3.

Mean category clustering scores as a function of intelligence and trials are presented in Table 12. The intelligence x trials interaction was also significant, F (4,400) = 2.89, $p < .05$. Multiple comparisons using a Neuman-Keuls statistic performed on the intelligence x trials interaction showed that bright children clustered significantly more than average children on all trials with the exception of Trial 1, $p < .05$.

Correlation between category clustering and mean number of words recalled. Pearson correlation coefficients were calculated between the amount of category clustering on each trial and the number of words recalled on each trial. Significant positive correlations were obtained between recall on each trial and amount of category clustering on each trial. Correlations between category clustering and recall on Trials 1 through 6 were .47, .51, .61, .59, .56, and .62, respectively.

Although fifth-grade children recalled more words than third-grade children on every trial, they clustered more than third-grade children only on the last three trials. Bright children recalled more words than average children and clustered more than average children on all trials except Trial 1.

Table 12

Mean Category Clustering Scores as a Function

of Intelligence and Trials

	Trial					
Group	1	2	3	4	5	6
Bright	.58	1.15	2.40	2.57	3.53	4.40
Average	.26	.32	1.12	1.59	1.88	2.14

Sorting Task

During the sorting task children were asked to sort a list of 24 words into stable groups and were then asked to recall the 24 words. Analyses were performed on the number of trials to criterion, number of sorting categories utilized at criterion, number of words recalled, and amount of category clustering in recall.

Number of trials to criterion. Criterion on the sorting task was defined as identical sortings on two consecutive sorting trials. Separate 2(grade) x 2(intelligence) x 2(sex) analyses of variance were performed on the number of trials required by the children to reach criterion and the amount of time required to reach criterion. The number of trials which the children took to reach criterion did not differ among the groups. In contrast, analysis of the time taken to reach criterion indicated main effects of grade, F (1,80) = 11.40, $p < .01$, and intelligence, F (1,80) = 8.66, $p < .01$. Third-grade children took longer to reach criterion (M = 6.74 minutes) than fifth-grade children (M = 4.12 minutes), and average children took longer to reach criterion (M = 6.57 minutes) than bright children (M = 4.29 minutes).

Number of sorting categories utilized. A 2(grade) x 2(intelligence) x 2(sex) analysis of variance was performed on the number of sorting categories established at criterion. A significant main effect of intelligence was obtained, F (1,80) = 4.84, $p < .05$. Bright children used fewer sorting categories (M = 4.93) than average children (M = 5.89).

Category clustering in recall. Category clustering in the sorting task was defined as the tendency for children to recall words consecutively from the categories they established at criterion. Each child's own sorting categories were used as the basis for evaluating clustering during recall. Bousfield and Bousfield's (1966) observed (O) minus expected (E) stimulus category repetition (SCR) measure was used to assess the children's tendency to recall in adjacent output positions pairs of words which they had placed in the same category during the criterion trial of the sorting task. A significant main effect of intelligence was obtained, F (1,80) = 10.63, $p < .01$. Bright children (M = 8.10) clustered more than average children (M = 5.82) during recall.

Number of words recalled. A 2(grade) x 2(intelligence) x 2(sex) analysis of variance was performed on the number of words recalled. A significant main effect of intelligence was obtained, F (1,80) = 19.56, $p < .01$, with bright children recalling more words (M = 18.75) than average children (M = 16.59).

Quality of children's sorting categories. Table 13 shows the number of children in each group who sorted the words into the four experimenter-defined categories built into the list. Separate chi-square analyses indicated than an equivalent number of children in each group sorted the words into the four experimenter-defined categories built into the list.

Table 13

Number of Children Sorting the Words Into the Four Experimenter-Defined Categories as a Function of Grade and Intelligence

	Number of children	
Group	Sorted into experimenter-defined categories	Did not sort into experimenter-defined categories
Third grade		
Bright	7	15
Average	5	17
Fifth grade		
Bright	12	10
Average	6	16

CHAPTER IV

DISCUSSION

The present study systematically investigated the relationship between intellectual ability (as measured by standarized IQ tests) and performance on laboratory tasks designed to assess children's use of organizational strategies in memory. Third- and fifth-grade bright and average children participated in the study. Children's knowledge of and use of organizational strategies were investigated during several experimental tasks: (a) an informal metamemory interview designed to assess the children's verbalizable knowledge of the facilitative effects of organization on recall (b) multitrial free recall of categorized words (c) multitrial free recall of unrelated words and (d) a sorting task followed by free recall. The results are discussed separately for each experimental task.

Metamemory

The results of the Memory Ability task indicated that third- and fifth-grade children overestimated their actual span of memory, with fifth-grade children being no more accurate than third-grade children in their predictions. These results are consistent with research by Flavell, Friedrichs, and Hoyt (1970) who found that fourth graders were as inaccurate as second graders at predicting their span of memory. Although preschool children are less accurate than elementary school children at predicting their own memorization ability (Flavell, Friedrichs, & Hoyt, 1970; Yussen & Levy, 1975), it appears that the accuracy of children's predictions does not increase significantly during the elementary school years. In the present study, bright children at each grade level were no more accurate at predicting their own memorization ability than were average children. Thus, IQ does not appear to be related to children's awareness of their memory limitations.

The Story-List, Related-Unrelated, and Opposites-Arbitrary tasks were designed to assess children's verbalizable knowledge of the role of organizational processes in memory. Consistent results were obtained across the three tasks. On each task, third- and fifth-grade children did not differ in their ability to choose the mnemonically organized list on each task as easier to remember or in their ability to verbalize their knowledge of the facilitative effects of organization on memory. These results are generally consistent with previous research by Kreutzer et al. (1975) and Moynahan (1973).

.Bright and average fifth-grade children did not differ in their ability to choose the organized lists as easier to remember or in their ability to verbalize their knowledge of the facilitative effects of organization. At the third grade level, the majority of bright and average children chose the organized lists as easier to remember on each task, a result suggesting that both groups were aware of the facilitative effects of organization on memory. The third-grade bright children, however, were able to verbalize adequately their knowledge of the role of organizational processes in memory more often than were the third-grade average children. Tenny (1975) suggested that third grade may be a transition period in children's knowledge of the facilitative effects of organization on recall. The present study lends support to the hypothesis that third grade is a transition period but suggests that the transition during third grade is a transition in children's ability to verbalize their knowledge of the role of organizational processes during memorization rather than in their awareness that organization facilitates recall.

Multitrial Free Recall of Unrelated Words

The major focus of this study was to investigate systematically differences in the performance of children with high intellectual ability as compared to children of average intellectual ability. The results indicated that bright children used more subjective organization than average children and recalled more words than average children on all trials except Trial 1. Initial recall performance was equivalent for bright and average children. Rosner (1971) collapsed the data of her high and average ability children because of nonsignificant differences in their performance on Trial 1. The results of the present study indicated that differences between bright and average children may not become apparent until after Trial 1. Rosner may have masked differences between her bright and average subjects by collapsing the data on subsequent trials.

The results of the present study are in conflict with research by Laurence (1966) who found that IQ and subjective organization were not correlated in her five- through ten-year-old subjects. As noted previously, the range of IQ scores in Laurence's study was possibly restricted, therefore reducing the likelihood of obtaining a relationship between IQ and extent of subjective organization. In the present study, an attempt was made to assure that the bright and average children represented two distinct levels of measured intelligence. The fact that bright children in the present study used more subjective organization than average children suggests that Laurence may have obtained correlations between subjective organization and intelligence if the range of her IQ scores had been extended to include children in the average range of intellectual ability.

In the present study, fifth-grade children recalled more words than third-grade children despite the fact that subjective organization showed no systematic increase with increases in chronological age. The results of this study and previous studies investigating changes in subjective organization and recall through the elementary school years (Laurence, 1966; Shapiro & Moely, 1971) suggest that subjective organization is not the mechanism primarily responsible for older children's increased memory performance. Positive correlations obtained between subjective organization and recall indicate that subjective organization contributes to the recall performance of young children. A causal relationship, however, seems unlikely because subjective organization does not follow an expected developmental trend "of an increase in mean value through the childhood years . . ." (Laurence, 1966, p. 398). Rather, subjective organization appears to be only one of the processes that occur during memorization by young children.

Multitrial Free Recall of Categorized Words

The present study represents the only systematic attempt to investigate differences between high and average ability children in the extent of category clustering in recall. The results indicated that bright children recalled more words than average children and clustered more than average children on every trial except Trial 1. For the bright children both number of words recalled and category clustering showed a parallel increase across the six trials. For the average children, however, the number of words recalled increased across the six trials, while clustering seemed to asymptote on trials 4, 5, and 6.

The fact that the average children continued to recall more words on the last three trials without parallel increases in the extent of category clustering suggests that perhaps they were utilizing an alternative strategy which resulted in increasingly greater recall on the later trials. Although category clustering is an efficient mnemonic strategy that contributes to increased memory performance, it appears to be only one of the strategies available to children during multitrial free recall of a categorized list.

Consistent with previous research (Cole, Frankel, & Sharpe, 1971; Kobasigawa & Middleton, 1972; Nelson, 1969; Rosner, 1971; Yoshimuro, Moely & Shapiro, 1971), the results of the present study indicated that fifth-grade children recalled more words than third-grade children across the six trials. For both third- and fifth-grade children the rate of increase in recall remained fairly consistent across trials, with fifth-grade children simply recalling more words than third-grade children on each trial. Fifth-grade children clustered more than third-grade children only on the last three of the six trials. For both third- and fifth-grade children, initial category clustering was quite low. However, the extent of category clustering increased at a higher rate for the fifth graders than for the third graders, with the differences in rate of increase becoming more pronounced on later trials.

Previous research with adults and children (Mandler, 1967; Worden, 1974) indicated that in multitrial free recall of categorized words, increases in number of words recalled are a direct function of increases in the number of categories represented in recall. In the present study, the number of categories recalled on Trial 1 for all groups was at least 3.5 out of 4, a result indicating that all children may have immediately recognized the experimenter-defined relationships among the items. Because of ceiling effects for number of categories represented in recall, for children in all groups, increases in mean number of words recalled across the six trials was a result of recalling more words per category.

Sorting Task

The sorting task allows individuals to incorporate all words in a list into a stable system of categorization according to their own criteria for organization prior to recall. Therefore, differences in the extent of organization in recall would reflect differences in the extent to which organization mediates recall and would not be confounded by differences in ability to organize during input.

Equating the occurrence of a stable organizational scheme prior to recall via the sorting manipulation did not eliminate the IQ-related differences in recall and recall organization obtained during the multitrial free recall tasks. Although the average children were required to establish a stable category system according to their own criteria prior to recall, they did not utilize this organization at recall to the same extent as did the bright children. The bright children established fewer categories at criterion than the average children. These findings are in direct conflict with previous research with adults and children (Mandler, 1967; Worden, 1974) indicating that increases in recall are a direct function of increases in the number of categories utilized. The fact that the bright children recalled more words than the average children, despite the fact that the former group established fewer categories at criterion, further substantiates the bright children's greater ability to utilize organization to facilitate recall.

Equating the occurrence of a stable organizational scheme prior to recall via the sorting mechanism eliminated the age-related differences in recall organization obtained during the multitrial free recall tasks. When the younger children were required to establish an organizational scheme according to their own criteria, they were able to use their system of categorization as a basis for recall as well as the older children. Because age differences in recall were also eliminated during the sorting task, the category schemes established by the younger children were as efficient in improving recall as those of the older children. The lack of age differences in extent of recall organization after the sorting task may indicate that age differences in organization obtained during the multitrial free recall tasks are an artifact of the serial method of presentation and that multitrial free recall paradigms underestimate young children's ability to utilize organizational strategies to mediate recall.

Concluding Remarks

The results of the present study indicate that differences in psychometrically defined intelligence are associated with differences in organizational processes and recall. Across the memory tasks used in the present study, bright children showed consistently greater amounts of organization during recall and consistently greater recall. Strongest support for the position that differences in measured intelligence may reflect differences in organizational processes comes from the fact that IQ differences in recall and extent of recall organization were obtained in the sorting task. Under conditions considered to be optimal for the occurrence of organization at recall, average children did not exhibit recall organization to the same extent as did the bright children. These results are particularly interesting in light of the fact that the sorting task eliminated age differences in recall and organization.

The identification of organization and memory differences associated with different levels of measured intelligence provides more precise information about the type of basic cognitive processes that underly intellectual ability. As Perfetti (1976) cautioned, however, the intent is not to add to the prestige of the intelligence test by providing construct validation. The author agrees with Perfetti that "IQ tests are merely prestigious intervening observations . . ." (p. 292) about an individual's ability relative to other individuals. The present research will hopefully encourage the development of other tests of basic cognitive processes so that children can be described in terms of their ability within psychologically important dimensions of cognitive processing. Tests of basic cognitive processes such as organization seem to have more positive implications for improvement than do existing tests of verbal and quantitative abilities. In addition, tests of basic cognitive processes may provide clues for modifying educational tasks and instructions so that the educational environment matches and optimizes the basic cognitive skills of students.

Future research should be directed toward investigation of the potential usefulness of teaching children to use organization as a strategy during memorization. Previous research in this area (Moely & Jeffrey, 1974; Moely, Olson, Halwes, & Flavell, 1969; Neimark, Slotnick, & Ulrich, 1971) has shown that young children can be taught to use organizational strategies to improve recall if training includes explicit instructions to group items together and to use the groups in recall. As Flavell (1970) pointed out, the organizational startegies are generally not maintained outside of the teaching session and do not appear without specific prompts (Moely, Olson, Halwes, & Flavell, 1969). The lack of generalization, however, may be the result of the brevity of the training procedures utilized. Future research should examine the effectiveness of establishing extended training programs, possibly as part of a child's school curriculum. The goal of such a program would be to develop and strengthen the use of organizational strategies for learning in children who would not typically use these strategies.

The results of the present study should be replicated at different chronological ages. Hunt, Frost, and Lunneborg (1975) found that high-verbal freshmen clustered less than low-verbal freshmen during a single trial of free recall of a categorized list. The results of the present study, using multitrial free recall, are in conflict with these results. Future research should examine the difference in clustering performance of bright and average ability subjects from early childhood through old age, utilizing a multitrial free recall paradigm. Future research should also examine differences in the extent of subjective organization in recall of subjects from elementary school through old age, using multitrial free recall. An interesting question would be whether the differences in the performance of bright and average children on the sorting task would be maintained across different chronological ages.

CHAPTER V

SUMMARY

The purpose of the present study was to investigate organizational processes in the free recall of children having average and high intelligence test scores. If existing IQ tests are in some way assessing individual differences in basic cognitive processes, we should expect to observe differences in the performance of psychometrically determined bright and average children on laboratory tasks designed to study these processes.

Subjects in the study were 88 public-school children, 44 in the third grade and 44 in the fifth grade. Twenty-two children at each grade level had IQ scores greater than 120. Twenty-two children at each grade level had IQ scores between 90 and 109. Equal numbers of males and females were tested at each IQ and grade level.

The children were individually administered four tasks, which were separated by at least two days. The four tasks consisted of a metamemory interview concerning organization and memory, multitrial free recall of unrelated words, multitrial free recall of categorized words, and a sorting task followed by free recall of the sorted words. The metamemory and sorting tasks were presented first and last, respectively; the order of the remaining two tasks was counterbalanced across children.

Bright and average children at each grade level performed equally well on the metamemory tasks. All children overestimated their recall ability. The only difference obtained on the metamemory questions was the finding that a greater number of bright third graders than of average third graders were able to explain why related words would be easier to remember than unrelated words.

The results of the multitrial free recall tasks and the sorting task indicated that differences in psychometrically-defined intelligence are associated with differences in memory and organizational processes. Across the memory tasks, the bright children consistently showed greater amounts of recall organization than did the average children and consistently recalled more words than did the average children. Even in the sorting task in which the average children were required to achieve organization prior to recall, they did not utilize this organization at recall to the same extent as did the bright children.

BIBLIOGRAPHY

Appel, L. F., Cooper, R. G., McCarrell, N., Sims-Knight, J., Yussen, S. R., & Flavell, J. H. The development of the distinction between perceiving and memorizing. Child Development, 1972, 43, 1365-1381.

Belmont, J. M., & Butterfield, E. C. The relationship of short-term memory to development and intelligence. In L. P. Lipsett & H. W. Reese (Eds.), Advances in Child Development and Behavior, 4. New York: Academic Press, 1969.

Bousfield, W. A., Puff, C. R., & Cowen, T. M. The development of constancies in sequential organization during repeated free recall. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 489-495.

Bower, G. H. Organizational factors in memory. Cognitive Psychology, 1970, 1, 18-46.

Cole, N., Frankel, R., & Sharpe, D. Development of free recall learning in children. Developmental Psychology, 1971, 4, 109-123.

Denney, N. W. Evidence for developmental changes in categorization criteria for children and adults. Human Development, 1974, 17, 41-53.

Denney, N. W., & Ziobrowski, N. Developmental changes in clustering criteria. Journal of Child Psychology, 1972, 13, 275-282.

Estes, W. K. Intelligence and cognitive psychology. In L. E. Resnick (Ed.), The Nature of Intelligence. New York: John Wiley & Sons, 1976.

Fagan, J. F., III. Rehearsal and free recall in children of superior and average intelligence. Psychonomic Science, 1972, 28, 352-354.

Flavell, J. H., Friedrichs, A. G., & Hoyt, I. D. Developmental changes in memorization processes. Cognitive Psychology, 1970, 1, 324-340.

Frankel, F., & Cole, M. Measures of category clustering in free recall. Psychological Bulletin, 1971, 76, 39-44.

Hagen, J. W., Joneward, R. H., Jr., & Kail, R. V., Jr. Cognitive perspectives on the development of memory. In L. P. Lipsett & H. W. Reese (Eds.), Advances in Child Development and Behavior. New York: Academic Press, 1975.

Horowitz, A. B. Effects of stimulus presentation modes on children's recall and clustering. Psychonomic Science, 1969, 14, 297-298.

Hunt, E., Frost, N., & Lunneborg, D. Individual differences in cognition: a new approach to intelligence. In G. H. Bower (Ed.), The Psychology of Learning and Motivation, 7. New York: Academic Press, 1973.

Hunt, E., & Lansman, M. Cognitive theory applied to individual differences. In W. E. Estes (Ed.), Handbook of Learning and Cognitive Processes, 1. New Jersey: Laurence Earlbaum Associates, 1975.

Kennedy, Wallace A. Intelligence and Economics: A confounded relationship. New Jersey: General Learning Press, 1973.

Kobasigawa, A., & Middleton, D. B. Free recall of categorized items by children at three grade levels. Child Development, 1972, 43, 1067-1072.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. An interview study of children's knowledge about memory. Monographs of the Society for Research in Child Development, 1975, 40.

Lange, G. W., & Hultsch, D. F. The development of free classification and free recall in children. Developmental Psychology, 1970, 3, 408.

Lange, G. W., & Jackson, P. Personal organization in children's free recall. Child Development, 1974, 45, 1060-1067.

Laurence, M. W. Age differences in performance and subjective organization in free-recall learning of pictorial material. Canadian Journal of Psychology, 1966, 20, 169-186.

Mandler, G. Organization and memory. In K. W. Spence & J. T. Spence (Eds.), The Psychology of Learning and Motivation, 1. New York: Academic Press, 1967.

Mandler, G., & Stephens, D. The development of free and constrained conceptualization and subsequent verbal memory. Journal of Experimental Child Psychology, 1967, 5, 86-93.

Meacham, J. A. The development of memory abilities in the individual and society. Human Development, 1972, 15, 205-228.

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

Moely, B. E., & Jeffrey, W. E. The effect of organization training on children's free recall of category items. Child Development, 1974, 45, 135-143.

Moynahan, E. D. The development of knowledge concerning the effect of categorization upon free recall. Child Development, 1973, 44, 238-346.

Nelson, K. J. The organization of free recall by young children. Journal of Experimental Child Psychology, 1969, 8, 284-295.

Ornstein, P. A., Trabasso, T., & Johnson-Laird, P. N. To organize is to remember: the effects of instructions to organize and to recall. Journal of Experimental Psychology, 1974, 103, 1014-1018.

Pellegrino, J. W. A general measure of organization in free recall for variable unit size and internal consistency. Behavior Research Methodology and Instrumentation, 1971, 3, 241-246.

Perfetti, C. A. Language comprehension and the deverbalization of intelligence. In L. E. Resnick (Ed.), The Nature of Intelligence. New York: John Wiley & Sons, 1976.

Puff, C. R., & Hyson, S. P. An empirical comparison of two measures of intertrial organization in free recall. Psychonomic Science, 1967, 9, 329-330.

Resnick, L. B. Introduction: Changing concepts of intelligence. In L. B. Resnick (Ed.), The Nature of Intelligence. New York: John Wiley & Son, 1976.

Robinson, J. A. Category clustering in free recall. Journal of Psychology, 1966, 62, 279-285.

Rosner, S. R. The effects of rehearsal and chunking instructions on children's multitrial free recall. Journal of Experimental Child Psychology, 1971, 11, 93-105.

Rossi, E. L., & Wittrock, M. C. Developmental shifts in verbal recall between mental ages 2 and 5. Child Development, 1971, 42, 33-338.

Shapiro, S. I., & Moely, B. E. Free recall, subjective organization and learning to learn at 3 age levels. Psychonomic Science, 1971, 23, 189-191.

Tenney, Y. H. The child's conception of organization and recall. Journal of Experimental Child Psychology, 1975, 19, 110-114.

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

Tulving, E. Theoretical issues in free recall. In T. R. Dixon & D. L. Horton (Eds.), Verbal Behavior and General Behavior Theory. New Jersey: Prentice-Hall, 1968.

Tyler, L. E. The intelligence test -- an evolving concept. In L. E. Resnick (Ed.), The Nature of Intelligence. New York: John Wiley & Sons, 1976.

Wachs, T. D. Free-recall learning in children as a function of chronological age, intelligence, and motivational orientation. Child Development, 1969, 40, 577-589.

Webb, R. A. Concrete and formal operations in very bright 6- to 11-year olds. Human Development, 1974, 17, 292-300.

Worden, P. E. The development of the category-recall function under three retrieval conditions. Child Development, 1974, 45, 1054-1059.

Yoshimuro, E. K., Moely, B. E., & Shapiro, W. I. The influence of age and presentation order upon children's free recall and learning to learn. Psychonomic Science, 1972, 26, 188-190.

Yussen, S. R., & Levy, V. M. Developmental changes in predicting one's own span of short-term memory. Journal of Experimental Child Psychology, 1975, 19, 502-508.

Zupnick, J. J., & Forrester, W. E. Effects of semantic and acoustic relatedness on free recall in normal children and retardates. Psychonomic Science, 1972, 26, 188-190.

Appendix A

Table 1

Analysis of Variance for Estimated and Actual Recall on Trial One of the Unrelated Word List

Source	SS	df	MS	F
Grade	43.00	1	43.00	2.50
Intelligence	.96	1	.96	0.05
Sex	25.50	1	25.50	1.48
Predicted vs. Actual Recall	1566.05	1	1566.05	96.53**
Group x Intelligence	9.55	1	9.55	0.56
Group x Sex	5.46	1	5.46	0.31
Intelligence x Sex	9.55	1	9.55	0.55
Grade x Predicted vs. Actual Recall	31.95	1	31.95	1.97
Intelligence x Predicted vs. Actual Recall	18.45	1	18.45	1.13
Sex x Predicted vs. Actual Recall	27.05	1	27.05	1.66

Appendix A

Table 1
(Contd.)

Source	SS	df	MS	F
Grade x Intelligence x Sex	19.77	1	19.77	1.15
Grade x Intelligence x Predicted vs. Actual Recall	12.55	1	12.55	0.77
Grade x Sex x Predicted vs. Actual Recall	67.50	1	67.50	4.16*
Intelligence x Sex x Predicted vs. Actual Recall	65.05	1	65.05	4.01*
Subjects (Grade x Intelligence x Sex)	1373.17	80	17.16	

Appendix A

Table 1
(Contd.)

Source	SS	df	MS	F
Group x Intelligence x Sex x Predicted vs. Actual Recall	.96	1	.96	.05
Subjects x Predicted vs. Actual Recall (Grade x Intelligence x Sex)	1297.79	80	16.22	

$*p < .05$
$**p < .01$

Appendix A

Table 2

Analysis of Variance for Estimated and Actual Recall on Trial One of the Categorized Word List

Source	SS	df	MS	F
Grade	28.64	1	28.64	1.51
Intelligence	13.64	1	13.64	.72
Sex	6.96	1	6.96	0.36
Predicted vs. Actual Recall	1197.05	1	1197.05	79.10**
Grade x Intelligence	10.50	1	10.50	0.55
Grade x Sex	18.46	1	18.46	0.97
Intelligence x Sex	35.46	1	35.46	1.87
Grade x Predicted vs. Actual Recall	19.77	1	19.77	1.30
Intelligence x Predicted vs. Actual Recall	49.14	1	49.14	3.24*
Sex x Predicted vs. Actual Recall	57.95	1	57.95	3.83*

Appendix A

Table 2
(Contd.)

Source	SS	df	MS	F
Grade x Intelligence x Sex	25.50	1	25.50	1.35
Grade x Intelligence x Predicted vs. Actual Recall	11.50	1	11.50	0.76
Grade x Sex x Predicted vs. Actual Recall	39.14	1	39.14	2.58
Intelligence x Sex x Predicted vs. Actual Recall	27.05	1	27.05	1.78
Subjects (Grade x Intelligence x Sex)	1509.80	80	18.87	

Appendix A

Table 2
(Contd.)

Source	SS	df	MS	F
Grade x Intelligence x Sex x Predicted vs. Actual Recall	0.14	1	0.14	.01
Subjects x Predicted vs. Actual Recall (Grade x Intelligence x Sex)	1210.65	80	15.13	

$*p < .05$
$**p < .01$

Appendix A

Table 3

Analysis of Variance for the Number of Words Recalled

During Multitrial Free Recall of Unrelated Words

Source	SS	df	MS	F
Grade	788.51	1	788.51	10.63**
Intelligence	1217.30	1	1217.30	16.41**
Sex	.32	1	.32	0.01
Trials	5224.18	9	580.46	133.86**
Grade x Intelligence	5.10	1	5.10	0.07
Grade x Sex	21.95	1	21.95	0.29
Intelligence x Sex	.55	1	.55	.01
Grade x Trials	30.66	9	3.40	.78
Intelligence x Trials	137.01	9	15.23	3.51**
Sex x Trials	41.30	9	4.58	1.05

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Table 3
(Contd.)

Source	SS	df	MS	F
Grade x Intelligence x Sex	166.69	1	166.69	2.24
Grade x Intelligence x Trials	21.34	9	2.37	0.54
Grade x Sex x Trials	44.55	9	4.95	1.14
Intelligence x Sex x Trials	37.65	9	4.18	.96
Subjects (Grade x Intelligence x Sex)	5932.96	80	74.16	
Grade x Intelligence x Sex x Trials	45.28	9	5.03	1.16
Subjects x Trials (Grade x Intelligence x Sex)	3121.97	720	4.33	

**$p < .01$

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Table 4

Analysis of Variance for Subjective Organization During Multitrial Free Recall of Unrelated Words

Source	SS	df	MS	F
Grade	5.73	1	5.73	2.39
Intelligence	10.99	1	10.99	4.55*
Sex	4.01	1	4.01	1.66
Trials	42.39	8	5.29	5.99**
Grade x Intelligence	.15	1	.15	.06
Grade x Sex	.29	1	.29	.12
Intelligence x Sex	.32	1	.32	.01
Grade x Trials	2.86	8	.35	.40
Intelligence x Trials	8.78	8	1.09	1.24
Sex x Trials	5.24	8	.65	.74

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Table 4
(Contd.)

Source	SS	df	MS	F
Grade x Intelligence x Sex	7.09	1	7.09	2.93
Grade x Intelligence x Trials	3.83	8	.47	.54
Grade x Sex x Trials	2.19	8	.27	.31
Intelligence x Sex x Trials	5.33	8	.66	.75
Subjects (Grade x Intelligence x Sex)	193.07	80	241.	
Grade x Intelligence x Sex x Trials	7.86	8	.98	1.11
Subjects x Trials (Grade x Intelligence x Sex)	565.78	640	.88	

*$p < .05$
**$p < .01$

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Table 5

Analysis of Variance for the Number of Words Recalled

During Multitrial Free Recall of Categorized Words

Source	SS	df	MS	F
Grade	440.01	1	440.01	10.54**
Intelligence	825.00	1	825.00	19.77**
Sex	38.18	1	38.18	.91
Trials	2892.05	5	578.41	129.06**
Grade x Intelligence	19.70	1	19.70	.47
Grade x Sex	13.36	1	13.36	.32
Intelligence x Sex	.68	1	.68	.01
Grade x Trials	11.03	5	2.20	.49
Intelligence x Trials	44.08	5	8.81	1.96

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Table 5

(Contd.)

Source	SS	df	MS	F
Sex x Trials	13.76	5	2.75	.61
Grade x Intelligence x Sex	64.12	1	64.12	1.53
Grade x Intelligence x Trials	15.51	5	3.10	.69
Grade x Sex x Trials	15.00	5	3.00	.66
Intelligence x Sex x Trials	10.78	5	2.15	.48
Subjects (Grade x Intelligence x Sex)	3337.16	80	41.71	
Grade x Intelligence x Sex x Trials	24.70	5	4.94	1.10
Subjects x Trials (Grade x Intelligence x Sex)	1792.63	400	4.48	

$^{**}p < .01$

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Table 6

Analysis of Variance for Category Clustering During

Multitrial Free Recall of Categorized Words

Source	SS	df	MS	F
Grade	163.59	1	163.59	7.31**
Intelligence	196.05	1	196.05	8.76**
Sex	20.02	1	20.26	0.89
Trials	535.97	5	107.19	30.86**
Grade x Intelligence	8.07	1	8.07	.36
Grade x Sex	2.80	1	2.80	.12
Intelligence x Sex	5.83	1	5.83	.26
Grade x Trials	54.47	5	10.89	3.13**
Intelligence x Trials	50.18	5	50.18	2.88**
Sex x Trials	11.25	5	2.25	.64
Grade x Intelligence x Sex	.14	1	.14	.01

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Table 6
(Contd.)

Source	SS	df	MS	F
Grade x Intelligence x Trials	14.31	5	2.86	.82
Grade x Sex x Trials	29.97	5	5.99	1.72
Intelligence x Sex x Trials	8.19	5	1.63	.47
Subjects (Grade x Intelligence x Sex)	1789.93	80	22.37	
Grade x Intelligence x Sex x Trials	11.74	5	2.34	.67
Subjects x Trials (Grade x Intelligence x Sex)	1389.41	400	3.47	

*$p < .05$
**$p < .01$

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Table 7

Analysis of Variance for the Number of Trials to Criterion on the Sorting Task

Source	SS	df	MS	F
Grade	1.63	1	1.63	.62
Intelligence	6.54	1	6.54	2.50
Sex	.72	1	.72	.27
Grade x Intelligence	1.13	1	1.13	.43
Grade x Sex	2.22	1	2.22	.85
Intelligence x Sex	2.22	1	2.22	.85
Grade x Intelligence x Sex	.18	1	.18	.06
Subjects (Grade x Intelligence x Sex)	209.27	80	2.61	

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Table 8

Analysis of Variance for the Number of Categories Utilized at Criterion on the Sorting Task

Source	SS	df	MS	F
Grade	.40	1	.40	.09
Intelligence	20.04	1	20.04	4.83*
Sex	.18	1	.18	.04
Grade x Intelligence	2.90	1	2.90	.70
Grade x Sex	7.68	1	7.68	1.85
Intelligence x Sex	.40	1	.40	.09
Grade x Intelligence x Sex	.18	1	.18	.04
Subjects (Grade x Intelligence x Sex)	331.44	80	4.14	

*$p < .05$

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Table 9

Analysis of Variance for Category Clustering During Free Recall on the Sorting Task

Source	SS	df	MS	F
Grade	22.70	1	22.70	2.39
Intelligence	113.99	1	113.99	10.62**
Sex	13.18	1	13.18	1.22
Grade x Intelligence	.13	1	.13	.01
Grade x Sex	43.68	1	43.68	4.07
Intelligence x Sex	5.66	1	5.66	.52
Grade x Intelligence x Sex	.218	1	2.18	.02
Subjects (Grade x Intelligence x Sex)	858.00	80	10.72	

**$p < .01$

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Table 10

Analysis of Variance for the Number of Words Recalled following Criterion on the Sorting Task

Source	SS	df	MS	F
Grade	12.37	1	12.37	1.15
Intelligence	102.55	1	102.55	9.55**
Sex	9.55	1	9.55	.89
Grade x Intelligence	3.28	1	3.28	.30
Grade x Sex	.28	1	.28	.02
Intelligence x Sex	2.55	1	2.55	.23
Grade x Intelligence x Sex	.284	1	.284	.02
Subjects (Grade x Intelligence x Sex)	858.52	80	10.73	

$^{**}p < .01$

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Table 11

Analysis of Variance of Time to Criterion

on the Sorting Task

Source	SS	df	MS	F
Grade	151.71	1	151.71	11.40**
Intelligence	114.81	1	114.81	8.65**
Sex	10.10	1	10.10	.76
Grade x Intelligence	6.60	1	6.60	.49
Grade x Sex	11.40	1	11.40	.86
Intelligence x Sex	12.42	1	12.42	.93
Grade x Intelligence x Sex	.22	1	.22	.01
Subjects (Grade x Intelligence x Sex)	1060.69	80	13.25	

**$p < .01$