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ABSTRACT

Three measures of verbal input organization (category clustering, associative clustering, and subjective organization) were employed to compare the performances of 30 normal and 30 educable mentally retarded (EMR) elementary school males of equal chronological age on various free recall learning tasks. Subjects were given 12 successive trials on each of five stimulus lists. Findings indicated that EMR children demonstrated less category clustering and recall than normal boys on the categorized list, and less associative clustering and recall than normal boys on a stimulus list composed of high associative paradigmatic noun pairs. EMR subjects demonstrated significantly less recall than normal boys on stimulus lists composed of either low associative paradigmatic or low associative syntagmatic word pairs. Investigators focused on M. Semmel's model of the language behavior of EMR children as a guide. Reviewed was the literature on the major psychological theories attempting to explain the organizational processes involved in learning and memory, on category clustering in free recall, on associative clustering in free recall, on subjective organization in free recall, and on clustering studies of children. (Author/GW)

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OF NORMAL AND RETARDED CHILDREN

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This study investigated organizational strategies of educable mentally retarded (EMR) and normal boys in processing verbal input. The investigators focussed on Semmel's (1967, 1969) model of language behavior of EMR children as a guide. The performances of two groups of 30 normal and EMR boys of equal CA were compared on various free recall learning tasks. Three separate measures of input organization were employed: category clustering, associative clustering, and subjective organization. Subjects were presented with five stimulus lists, each composed of 12 words. One list contained 12 words from four conceptual categories. The remaining lists each contained six word pairs, and differed in the degree of associative strength and in the grammatical form-class of their items. Subjects were given 12 successive trials on each list. The findings indicated that EMR boys demonstrated less category clustering and recall than normal boys on the categorized list. EMR boys also demonstrated less associative clustering and recall than normal boys on a stimulus list composed of high-associative paradigmatic noun pairs. The difference in recall between the groups on a stimulus list composed of high-associative syntagmatic word pairs was significantly less than the difference in recall on a list composed of high-associative paradigmatic noun pairs. EMR boys demonstrated significantly less recall than normal boys on stimulus lists composed of either low-associative paradigmatic or low-associative syntagmatic word pairs. Implications of the findings for theory in mental retardation, and for their possible educational relevance in grouping, training strategies, and teaching reading to retarded children were discussed.

THEORETICAL ORIENTATION

One of the more striking defining characteristics of mentally retarded (MR) children is their inferior performance compared to non-retarded children on tasks involving language and cognitive behaviors. A major criterion for labeling a child mentally retarded is his performance on standard tests of intelligence and academic performance which both load heavily on language and cognitive factors. To the worker concerned with helping MR children experience a measure of success in a competitive society, a knowledge of why this distinction occurs may suggest methods for overcoming deficits in these areas.

Various theories have been proposed which attempt to explain the behavioral inadequacies of retarded children. Some focus on motivational and emotional factors (Zigler, 1966), deficits in attention (Zeaman & House, 1963; Semmel, 1965), or short-term memory (Ellis, 1963, 1970) and problems in verbal mediation (Luria, 1963), among others. Recent work in information theory suggests a more extensive explanation of the learning difficulties of educable mentally retarded (EMR) children in relation to the learning process in general. Information theorists deal primarily with the ability of an individual in selecting, processing, storing, and retrieving relevant information. Investigators have stressed the limited capacity of the human information processing system, and the importance of organization of stimulus input in order to maximize the amount of relevant information one is able to receive, process, and remember (Broadbent, 1958; Bruner, Goodnow, & Austin, 1956; Bruner, Oliver, & Greenfield, 1966; Mandler, 1967a & b; Miller, 1956;

Tulving, 1962, 1966). Current views appear to characterize the child as an "active" learner who possesses a repertory of organizational processes from which he must select those that are appropriate to the particular learning situation. Hence, human memory is essentially an active process of organization imposed on the stimulus input by the learner. In fact, organization is not only correlated with memory but is a necessary condition for successful memory (Bruner et al., 1966; Mandler, 1967b). The strain on memory capacity can be reduced through recoding, or input organizational strategies, which combine individual units, or "bits" of information into a fewer number of hierarchically organized categories, or "chunks" (Bruner et al., 1956, 1966; Mandler, 1967b; Miller, 1956). It follows, therefore, that the study of memory provides an efficient means of evaluating the organizational strategies employed by a learner when processing verbal input.

Considering the important role of recoding in learning and memory, it is possible that the short-term memory (STM) deficit displayed by MR children may be due to faulty or inefficient organization of stimulus input. Indeed, this position is supported by Spitz (1966), who maintains that the slower learning performance of MR children may be due to a particular deficit in the organization or grouping of the material to be learned. He contends that "the question is not whether or not retardates group or organize materials, but rather under what conditions, in what manner, and how efficiently they display this capacity [p. 36]."

Viewing the problem of mental retardation within the context of language deficit, the authors have hypothesized a qualitative difference in the organizational strategies used by EMR and normal children in processing verbal materials (Semmel, 1967). In the authors' view, EMR children use primarily "sequential-associative" strategies in processing language, while "hierarchical" and "sequential-associative" strategies seem to be synchronized in normal children. Of the two, sequential-associative strategies are relatively more primitive since they develop as the child experiences associations between linguistic units in a language environment. Hierarchical-grammatical and semantic strategies are more abstract, frequently taking the form of rules governing the permissible relationships between linguistic units. Because the generality of such strategies makes them more powerful tools for generating and processing language, they are probably related to more proficient language behavior than are sequential-associative strategies.

The authors propose that in addition to providing evidence for a qualitative difference between the organizational strategies of EMR and nonretarded children, previous work suggests that EMR children probably have the ability to recode linguistic units into hierarchical categories. Unlike nonretarded children who tend to avail themselves naturally of this competence, EMR children have no such strong tendencies. They are, therefore, more dependent on simple associative cues between linguistic units than on constructive organizational strategies in processing verbal stimuli (Semmel, Lifson, & Sitko, 1967; Semmel, Sitko, & Semmel, 1968). The following section focuses on a review of studies which were significant in the formulation of this view.

Several investigators (Brown & Berko, 1960; Entwisle, 1966b; Entwisle, Forsyth, & Muuss, 1964; Ervin, 1961) have demonstrated that as young children develop linguistically, there is a progressive change in the nature of their free word-associations (W-As) somewhere between the ages of six and eight years. These investigators found that children's W-As shift from "syntagmatic" or sequential associates (e.g., dog-bark, red-apple) to associations falling within the same grammatical form-class as the stimulus--"paradigmatic" associates (e.g., dog-cat, red-black). According to Semmel (1967), syntagmatic associates can be regarded as indications of a sequential organizational strategy, since they are associates "where the stimulus and response are likely to occur in contiguous relationships within a language context (i.e., the red apple) (Semmel, 1967, pp. 40-41)." White (1965) found that the paradigmatic shift in children's W-As was one of many cognitive changes in the learning behavior of five- to seven-year old children.

The appearance of predominantly paradigmatic responses in children's W-As was suggested by Brown and Berko (1960) as evidence for an increasing grammatical development (i.e., competence) in the language behavior of children. On the other hand, McNeill (1966) rejected this notion contending that implicit grammatical rules, which are presumed to be the basis of paradigmatic association, are actually mastered by children at least three years before they demonstrate the paradigmatic shift. McNeill posited a "semantic" explanation for the shift phenomenon. He contended that the paradigmatic shift "results from adding sufficient numbers of features so that the minimal contrast for any word will always be within the boundaries of the word's major grammatical class [McNeill, 1966, p. 556]." Entwisle (1966a) and Anderson and Beh (1968) reported considerable data which are consistent with McNeill's position. Anderson and Beh suggested that the paradigmatic shift not only represents the acquisition of a tendency to match semantic markers in recall, but also accompanies an increase in storage efficiency. In addition, Anderson and Beh propose that the probable cognitive function of semantic markers "is that of supplying an efficient, combinatorial organization for verbal memory [Anderson & Beh, 1968, p. 1050]."

Semmel, Barritt, Bennett, and Perfetti (1968) used a W-A task to compare the syntagmatic and paradigmatic word-association responses of institutionalized and public school EMR children and nonretarded children matched for MA and CA. The results introduced intellectual level as a significant variable associated with the probability of emitting paradigmatic associates. EMR children gave fewer responses in the same form-class than normal children of equal CA. The institutionalized children gave the fewest paradigmatic responses, while the public school retarded and MA-matched normal children were similar in their paradigmatic responding. The findings were interpreted as revealing a deficit among EMR children characterized by a weakness in organizing linguistic units into classes. The data also provided further support for McNeill's semantic model.

Another study (Semmel, Barritt, & Bennett, 1970) compared the performance of EMR and normal children on a modified Cloze task. The same children who had participated in the previous W-A study were used as subjects (Ss) in this study. It was reasoned that EMR children, due to weak grammatical decoding strategies, would have particular difficulty in supplying words deleted from sentences (Cloze procedure) when compared to normal children, since such a task is highly dependent on the S's ability to retrieve words from grammatical form-classes which share the same privilege of occurrence as the deleted words. For instance, if presented with the sentence "The boy ________ home," retarded children should have particular difficulty in supplying an appropriate verb in the blank. It was also predicted that when asked to complete blanks at the ends of sentences, EMR children would show considerable improvement because the relatively long sequence of words preceding the blanks would cue their sequential-associative strategies and thereby permit appropriate sequential or associative responses. The last position in the sentence was thus relatively less dependent on grammatical cues and more constrained by sequential-associative dependencies than other positions in the sentence. These predictions were supported by the results. The EMR children performed as well as equal MA normal children in completing blanks at the final position of four-word sentences. However, the CA- and MA-matched normal groups were significantly more proficient in the total Cloze performance (i.e., across all positions) than both the public school and institutionalized retarded samples. A moderate correlation ($\underline{r}$ = .52) was found between performance on the Cloze task and the frequency of paradigmatic responses obtained by the same Ss in the previous W-A study. The results were interpreted as providing further support for the hypothesis that EMR children are relatively more dependent on simple associative relationships or transitional probabilities between linguistic units than on structural syntactic cues.

An exploratory pilot study reported by Semmel, Lifson, and Sitko (1967), indicated that EMR children may be trained to increase the frequency of high-associative paradigmatic responses on a multiple-choice

W-A task immediately after training. The training involved selective reinforcement of their correct paradigmatic choices. Reinforcing paradigmatic responses on the multiple-choice W-A task enabled the EMR Ss to transfer paradigmatic responding to a free W-A task in which words not occurring in the training list were used as free-associative stimuli. In addition, EMR Ss were able to maintain the new performance for a week after training. The authors concluded that confirmation of these results would imply that the relatively low incidence of paradigmatic W-As found among EMR children may not indicate an immutable lag in the development of linguistic competence, but may reflect a language performance, contingent upon environmental variables.

Although EMR children may have the tendency to emit sequential-associative (syntagmatic) responses on W-A tasks, previous results have shown significant individual differences in W-A responses within EMR samples (Semmel et al., 1967, 1968a & b). In fact, Baumeister (1968) has hypothesized that retarded Ss demonstrate greater "intra-individual variability" in performance than normal Ss. A recent study (Semmel, Sitko, and Semmel, in press) examined the paired-associate performance of EMR boys who showed themselves in a free W-A task as predominantly paradigmatic or syntagmatic responders. The paired-associate lists differed in the degree of associative strength and in the grammatical form-class of the items. The data indicated that syntagmatic EMR responders learned paired-associate stimuli which were linked in a strong associative relationship (as determined by W-A norms) with greater ease than when the relation between the stimulus pairs was based on grammatical form-class. Syntagmatic responders performed best when the associative strength between word pairs was high, regardless of the form-class relationship of word pairs. Their learning was inferior to that of paradigmatic responders when the associative strength between word pairs was low; especially when the stimulus items were low-associative paradigmatic nouns (e.g., chair-rug).

The results suggested that EMR children who are predominantly high-paradigmatic W-A responders are able to utilize both hierarchical and associative cues in learning paired-associates. On the other hand, low-paradigmatic responders are comparatively more dependent on simple associative cues between linguistic units than on hierarchically organized cues when decoding and recoding verbal stimuli. For this reason, their paired-associate learning may appear inferior to that of high-paradigmatic responders on lists where the association between stimulus pairs is low or based on paradigmatic criteria.

It should be noted that in a recent paired-associate experiment involving institutionalized EMR adolescents and normal Ss (matched in CA and MA), J.W. Gallagher (1969) also found that free-associative strength values between stimulus pairs had to be considerably high before influencing the performance of EMR Ss. Gallagher's Ss were orally presented with a syntagmatic or paradigmatic paired-associate list which consisted of three high-free-associative strength pairs, three low-free-associative strength pairs, and three nonassociative pairs. The normal Ss tended to learn the low and high pairs at a faster rate than the nonassociated pairs, while no differences were found for the retarded Ss between the low-free-associative strength and the nonassociated pairs. The EMR group tended to learn the high-free-associative strength pairs with fewer errors than the low-free-associative strength and nonassociated pairs. In general, the normal Ss tended to learn at a faster rate than the retarded groups, and the associated and nonassociated syntagmatic pairs were learned faster than paradigmatic pairs. However, more important to the present work and in agreement with the predictions of Semmel et al. (1968b) outlined above, it was reported that for high-free-associative strength pairs, the difference between the paradigmatic and syntagmatic pairs decreased as the ability level increased, with the EMR group showing the greatest difference. Gallagher noted that this finding was in agreement with the normative W-A data of Semmel et al. (1968a). Other investigators have also reported better paired-associate learning in EMR children and adolescents on stimulus materials of high-associative strength than on those of low-associative strength (cf., Drew, 1969; Drew, Prehm, & Logan, 1968).

Researchers have pointed out that "relatively little is known about how the structure of linguistic strings (i.e., the degree of syntactical and/or associative structure) affects the short-term memory span of EMR children [Semmel & Bennett, 1970, p. 674]." Investigations in psycholinguistics by Rosenberg (1967, 1968), Johnson (1965), and others have presented evidence which supports the hypothesis that the ability to understand a sentence is dependent upon the identification of its grammatical or base structure.

Rosenberg (1968) has suggested that in learning a sentence for recall, Ss recode the individual words into the largest memory units or "chunks" of information possible based upon both the "syntactic" and "associative-semantic" structure of the sentence. Such a strategy, according to Rosenberg, "would reduce the number of memory units to be stored while increasing the amount of information per unit [Rosenberg, 1968, p. 1081]."

In a recent short-term memory (STM) study, Semmel and Bennett (1970) provided evidence suggesting that EMR children take little advantage of structural cues within verbal strings. As a result, inefficient recoding behavior reduces input organization of the verbal material processed. Retarded children were asked to recall sequences of two- through eight-word strings which were constructed to differ in the degree of grammaticalness and associative strength between component words. The data indicated that "neither associative nor syntactic structure acted independently to cue recoding strategies of the EMR children. Only when interacting in a meaningful semantic context did these structural variables facilitate the recall of subjects [p.679]." The authors suggested that, when applied to language behavior, the STM deficit commonly observed in retarded children could possibly be due to faulty or inefficient organization of input as Spitz (1966) contends.

As indicated previously, Spitz hypothesized that the slower learning performance of MR children may be due to a particular deficit in the organization or grouping of the material to be learned possibly caused by Central Nervous System disturbance. He states that:

> Once we view human learning as largely dependent on both imposed and intrinsic organization of incoming stimuli, we must consider the possibility of qualitative differences, with retardates deficient in organizational capacity, not simply memory. (Spitz, 1966, p. 36)

It is to these qualitative differences between normal children and children categorized as EMR that the present authors' view of the language behavior of EMR children pertains. According to Spitz, a retarded S's deficit in input organization of stimulus material results in an overload of incoming information, which may exceed the "channel capacity" of his memory system. As a result, more "noise" may be introduced into his communication system during transmission, thus hindering learning and memory. Spitz sees the deficiency exhibited by MR Ss in category clustering on free recall verbal learning tasks as an example of this problem.

With respect to cognitive behavior, it can be predicted from Semmel's position on language processing that the inferior abstract thinking observed among retarded children on cognitive tasks may also be due to faulty or inefficient organization of stimulus input. If MR children tend to approach and process language on a sequential-associative basis and have relatively weak hierarchical rule-governed recoding strategies, it is plausible to contend that they would also reflect this sequential-associative predominance in their conceptual thinking. For instance, it can be predicted that EMR children, when asked to categorize or group objects according to a common attribute, would tend to use less efficient chunking strategies in making similarity transformations. On the other hand, normal children with relatively well-developed grammatical or hierarchical rule-governed strategies would tend to give hierarchical or superordinate responses when asked to make such similarity transformations.

Some support for these predictions was reported in a dissertation by Herzog (1968) who investigated the functioning of EMR and CA- and MA-matched normal Ss on various cognitive grouping tasks involving objects, pictures, and words. The tasks required that Ss group up to eight stimuli and respond to them in terms designating class membership. Herzog employed Bruner and Olver's (1965) model of strategies of associative grouping as a technique for examining the organizational structure imposed by the Ss on the stimuli. Of the three grouping strategies described in this model (i.e., superordinate, complexive, thematic), the superordinate strategy is said to be the most efficient when applying an information reduction criterion. Herzog found that when her EMR Ss were asked how items in an array of stimuli were alike, they used fewer efficient superordinate strategies than either equal CA or equal MA normal children. She concluded that EMR Ss use fewer efficient grouping strategies than normal children, and probably require more "cognitive effort" to process equal amounts of information. The results could also be interpreted as suggesting that the sequential-associative predominance in processing verbal stimulus input by EMR children may be responsible for their less cognitive behavior as well as their less adaptive language behavior.

The orientation to language and cognitive behavior outlined in this section shows some resemblance to Jensen's recent (1970) theory of primary and secondary familial mental retardation. Jensen cites evidence which indicates that approximately 70 to 80% of all persons labeled retarded fall within the designation of familial or cultural-familial retardation. These individuals generally demonstrate "no clinically identifiable cause" for their observed retardation. The IQs of the majority fall in the range of 50 to 70 or 75. In addition, these mildly retarded individuals are considered to be deficient in social competence and are mainly concentrated in the lower social classes. Jensen hypothesizes that within the retarded group there are actually two different types of retardation that can exist: that is, primary and secondary retardation, with different patterns of "maturational" mental abilities associated with each type. He contends that these patterns of maturational mental abilities stand in hierarchical relationship to one another as do mental abilities.

Jensen's (1970) theory applies mainly to mental abilities which are of a maturational or developmental nature, and which are more dependent upon innate than on experimental factors. He contends that mental abilities found in the lower levels of the hierarchy "involve relatively little processing or transformation of the information input" while "higher levels of the mental ability hierarchy depend upon elaborations and transformations of information input, and upon comparisons of the informational input with previously stored information [Jensen, 1970, p. 52]." In essence, he views the continuum of mental ability hierarchies as the result of two qualitatively different types of ability designated "Level I or associative ability" and "Level II or cognitive ability." Jensen postulates separate "genetic mechanisms" and developmental curves for Level I and Level II abilities, although Level II ability seems to have some degree of hierarchical dependence on Level I ability. Level I ability appears to be mainly independent of socioeconomic status, while Level II ability is considered to be different in upper and lower classes. Higher grades of Level II ability are found in the upper classes. Jensen suggests that most conventional intelligence tests are weighted to favor Level II ability, and that scholastic performance is also "heavily" dependent on this level.

In developing his theory, Jensen refers to a deficiency in Level I ability as "primary retardation," while a deficiency in Level II ability is labeled "secondary retardation." He contends that "comparatively little of the intellectual retardation found in low SES [socioeconomic status] groups is of the primary type [Jensen, 1970, p. 65]." This contention is shown to be especially indicative of so-called "slow-learners" with IQs from 70 to 85. He argues that Ellis' (1963) theory of STM deficit in MR Ss applies only to primary retardation:

> Secondary retardation does not involve a STM deficit but depends upon a specific deficiency in Level II, i.e., abstract and conceptual processes. We also believe that the majority of low SES children with IQs in the range from 50 to 85 are intellectually retarded only in the secondary sense and do not evince a STM deficit. (Jensen, 1970, p. 74)

On the other hand, he proposes that the vast majority of retarded individuals with IQs below 50, as well as institutionalized individuals with IQs in the range of 50 to 75, are "primary retardates." These individuals are seen as demonstrating a STM deficit.

A comparison of Semmel's view of the language behavior of EMR children with Jensen's theory reveals a correspondence between Jensen's Level I and Level II abilities and Semmel's sequential-associative and hierarchical strategies. Both formulations are concerned with hierarchical models, although Jensen ascribes genetic determinants to cognitive abilities or skills while Semmel refers to relatively more experientially acquired habits or organizational strategies for processing verbal stimulus input.

In summary, this section has reviewed the major theoretical position which served as a guide for the present study. According to our position, there is a qualitative difference in the organizational strategies used by EMR and nonretarded children in processing verbal stimuli. Retarded children primarily employ "sequential-associative" strategies while "hierarchical" and "sequential-associative" strategies seem to be synchronized in normal children. Of the two, sequential-associative strategies are relatively more primitive since they develop as the child experiences associations between linguistic units in a language environment. Hierarchical-grammatical and semantic strategies are more abstract, frequently taking the form of rules governing the permissible relationships between linguistic units. Because the generality of such strategies makes them more powerful tools for generating and processing language, they are probably related to more proficient language behavior than are sequential-associative strategies.

PURPOSE

The purpose of the present work was to analyze systematically organizational strategies used by EMR and normal children in processing verbal input. A free recall verbal learning paradigm was chosen as the means for empirically exploring our theoretical position. Three separate measures of input organization were used: category clustering, associative clustering, and subjective organization. The literature pertinent to organizational processes is reviewed in the following section.

REVIEW OF THE LITERATURE

The human organism is required to organize subjectively or to act on stimulus input in order to maximize the amount of relevant information that he is able to receive, process, and remember. The present chapter reviews: (a) the major psychological theories which attempt to explain the organizational processes involved in learning and memory; (b) category clustering in free recall; (c) associative clustering in free recall; (d) subjective organization in free recall; and (e) clustering studies of children. An attempt is made to summarize the literature pertaining to the above headings and to integrate them with the theoretical rationale developed in the preceding chapter.

Organizational Processes in Learning and Memory

In an important theoretical paper, Miller (1956) described a major organizational strategy used by the learner to overcome the limited capacity of the human information processing system. He provided evidence which indicates that the "channel capacity" of absolute judgment is limited to approximately 7 ± 2 units or "bits" of information, while the "channel capacity" of immediate memory is approximately 7 ± 2 "chunks" of meaningful information. In this scheme, a "bit" of information is the amount of information required to make a decision or an absolute judgment between two equally likely alternatives, while a "chunk" of information refers to the number of items of information in the span of immediate memory. However, through recoding or reorganizational strategies, the number of bits of information can be increased by building larger, but fewer, informationally rich chunks for subsequent storage--with more bits per chunk. One of the simplest recoding strategies, according to Miller, involves grouping the input events, applying a new name to the group, and then remembering the new name as a substitute for the original input events. In fact, Miller suggests that this linguistic translation of items into a symbolic verbal code is the most common type of recoding.

Mandler (1967a & b) extended Miller's earlier reasoning by contending that memory and organization are not simply correlated. Organization is a necessary condition for successful memory if memory is to exceed the limits of individual items. Mandler proposes that human memory for verbal material is hierarchical, with words organized into successively higher-order chunks or superordinate categories containing sets of words. For any single chunk or category, the organism can handle approximately 5 ± 2 items of information.

This figure differs from the "magical" number 7 ± 2 units or chunks which Miller estimated as the limiting value of immediate memory. Mandler (1967a) attributes this difference to a possible artifact in the immediate or short-term memory experiment (i.e., memory efforts within 30 - 60 seconds following input) that could spuriously inflate the limiting value. He states that data collected subsequent to Miller's work (e.g., Waugh and Norman, 1965) indicate that two separate memorization processes may be involved when a subject is required to recall relatively large sets of words: "short-term, or primary, memory which produces recall of the words immediately preceding the output; and organized memory, which typically includes earlier words from the list [Mandler, 1967a, p. 332]." As a result of the two separate memory processes, the number 7 ± 2, according to Mandler, may be made up of two components; e.g., 4 ± 1 plus 3 ± 1. In light of his own data, Mandler feels a value of 5 ± 2 seems more appropriate as the limiting value of items to be recalled per chunk from secondary or organized memory. In addition, there appears to be a similar limit of about 5 ± 2 categories at each higher level of categorization. It follows, therefore, that recall of verbal materials should be a direct function of the number of categories used by the learner to organize stimulus input.

Bruner and his colleagues (1956, 1966) contend that organizational processes in the form of categorization or classification are basic to perceptual and cognitive activity. Bruner states that experience itself must be organized into hierarchically organized categories in order to minimize the cognitive strain on memory and inference capacity, and to promote efficient learning. He also sees language as structure into linguistic categories which are organized in hierarchies. Through such properties as "remoteness," "arbitrariness," "compactibility," and "productiveness in combination," language as a symbolic system plays a most powerful role for the learner in "organizing acts of information processing into more integrated and long-range problem solving efforts [Bruner, 1964, p. 11]." For instance, Johnson (1968) has presented data from a variety of studies which indicate that Ss tend to capitalize on the organization of language by using it as a recoding device in learning and recall.

Tulving (1962, 1966) has demonstrated that organizational processes occur even in the recall of semantically "unrelated" stimulus words. In such a situation, people tend to impose their own "subjective organization" in order actively to retrieve stored information. Tulving regards subjective organization of verbal material as suggestive evidence for the development of higher-order memory, or "S" units, each consisting of two or more related items. These units allow the S to recall more items of information than can be handled by immediate memory.

The above theorists have presented considerable evidence which testifies to the importance of recoding or hierarchical-organizational strategies in verbal learning and recall.

Organizational Paradigms in Free Recall Verbal Learning

The present section provides a detailed description of various types of organizational paradigms employed in studies of free recall verbal learning. The free recall paradigm in verbal learning has recently become one of the most popular methods for investigating problems of recoding or input organization of verbal stimuli. In free recall experiments, word lists of varying lengths are presented at some constant rate to the S who is asked to recall, in any order, as many items as he can remember. In multitrial free recall, the above procedure then is repeated on successive trials with the items presented in a varying random order across trials. The paradigm provides one of the most efficient methods for studying the organizational strategies of children. Referring to the free recall paradigm, Mandler (1967a) stated:

> In such a situation much more can be learned about the activity of the subject in reorganizing, reordering, and

> recoding the input material than in a situation which shows, within limits, only the subject's successful or unsuccessful attempts to reproduce the order or organization of input, as in paired-associate and serial learning. (p. 40)

Similarly, Slamecka (1967) indicated that of all the methods utilized in verbal learning experiments, the free recall paradigm imposes the fewest external constraints upon the S's performance. It is, therefore, best suited for revealing whether, and to what extent, the learner takes an active role in organizing the verbal materials to be learned. In addition, through the use of the free recall serial paradigm, there has been at least some attempt to quantify the organizational processes in verbal learning and memory.

Category Clustering

Three types of free recall experiments have been employed in verbal learning research to investigate recoding abilities of Ss. The first type involves the presentation of lists of stimulus materials in which the items are organized into a number of conceptual categories or clusters (e.g., Bousfield, 1953; Bousfield & Cohen, 1953, 1955; Bousfield, Esterton, & Whitmarsh, 1958; Cohen, 1963, 1966). The lists are presented in a random order, with the members of subcategories randomly interspersed throughout the individual lists. In these experiments, attention is focussed upon how Ss utilize the conceptual organization systematically imposed on the input lists by the experimenter. Miller's (1956) chunking hypothesis is one position which is often suggested as an explanation of "category clustering," since Ss presumably recode or cluster items on the basis of category names.

Category clustering was first discussed by Bousfield (1953) who presented for free recall a randomized list of 60 items--15 items from each of four categories (names, animals, professions, and vegetables). Bousfield's data showed that Ss had clustered items recalled into groups of similar categories (i.e., two or more words belonging to the same category) at a level significantly above chance as determined by a parallel artificial experiment, and a ratio measure of repetition during recall. He defined clustering as the sequential occurrence in free recall of two items belonging to one of the categories represented in the word list. He concluded that the category clustering phenomenon implied the operation of an organizing tendency.

Bousfield and his associates subsequently found that the category clustering phenomenon was influenced by several variables. One of these was taxonomic frequency as determined by free word-association responses to category names (Bousfield, Cohen, & Whitmarsh, 1958). Lists of words containing high-probability associates of the category name were found to elicit a higher level of recall and category clustering than lists containing low-probability associates. List repetitions also affected the results (Bousfield & Cohen, 1953). Both category clustering and recall were found to be direct functions of the number of reinforcements or list repetitions. Another influencing factor was the Thorndike-Lorge word frequency count (Bousfield & Cohen, 1955). A word list containing 60 nouns of high-frequency usage as indicated by the Thorndike-Lorge word count elicited higher recall and clustering than a list containing 60 low-frequency nouns.

An excellent description of Bousfield's initial point of view is underlying clustering (including associative or category clustering and subjective organization) are "futile in the present state of the art." He states that "it seems more profitable at this time to start with the fact that certain words are more likely to be formed into clusters or S-units than others and to ask what 'intra-experimental' conditions determine the ease with which such S-units are formed [Tulving, 1968, p. 26]." However he decided that:

> The functional significance of organization lies in its facilitating effect on retrieval--organization makes individual list items more accessible to recall. Whether or not it also affects the amount of mnemonic information available in the storage, and whether or not it helps to conserve storage capacity, must for the time being remain open questions. (Tulving, 1968, p. 29)

From his recent review of clustering and organization in free recall, Shuell (1969) concluded that subjective organization does not offer a separate theoretical interpretation of clustering and suggested that the same behavioral processes are probably being studied in all three clustering paradigms. He noted that none of the present interpretations of clustering is completely satisfactory since none can explain all of the relevant data. This is basically the same conclusion Tulving (1968) reached after reviewing the clustering literature. According to Shuell, the most important contribution which the study of SO in free recall has provided is probably "the demonstration that there are discrepancies between the learning situation as defined by the experimenter and the learning situation as perceived by the subject [Shuell, 1969, p. 370]."

demonstrated by the following passage from Adams (1967):

> How do Bousfield and his associates account for clustering theoretically? They see it as a concept-formation situation. The separate words of a concept category have their habit strengths, or "subordinate perceptions" as Bousfield calls it; and these separate words are organized under a "superordinate perception" which is a conceptual state that has strength of its own derived from the strength of individual words. The strength for the superordinate accrues with practice on the subordinate. As a result of such learning, the occurrence of a subordinate perception will activate the superordinate structure, which in turn activates the responses of other subordinates. The result is words of the same conceptual class being recalled together, which is clustering. (pp. 157-158)

Other explanations have been formulated to account for categorical clustering in a free recall situation. Cohen (1963, 1966) presented evidence from a variety of experiments in support of a "some-or-none" rationale for free recall of categorized word lists. Subjects were presented with lists of words belonging to two different types of categories. In one case, the categories were exhaustive; that is, composed of item members which exhausted or nearly exhausted all the items typically subsumed under a given category label; e.g., north, south, east, west. In the other case, the categories were nonexhaustive; that is, composed of item members which only partially exhausted the number of items which were typically subsumed under a given category label; e.g., dog, horse, lion, bear. Cohen found that the exhaustive categories were recalled better and were clustered more than the nonexhaustive categories. However, <u>S</u>s tended either to recall a high proportion of the words of a given category or failed to recall any of the words of a category. In addition, when <u>S</u>s did recall the words of a given category, the mean word-recall per category appeared to be invariant over a wide variety

Primary and Secondary Organization

The previous review of clustering and subjective organization dealt with the recoding or organizational strategies utilized by Ss to overcome limitations on the amount of information they are able to receive, process, and remember. Tulving (1968) has referred to this type of organization in free recall as "secondary organization" since it deals with organization of items in recall, a process mainly governed by "semantic or phonetic relations among items or by pre-experimental and intraexperimental [intertrial] experiences the S has had with individual input items [Tulving, 1968, p. 30]." Presumably the two different measures of secondary organization (i.e., clustering and subjective organization) reflect the effects of common underlying processes (cf., Shuell, 1969; Tulving, 1968).

Tulving contrasts secondary organization in free recall with "primary organization" which refers to "constant discrepancies between input and output orders [i.e., presentation and recall] that are independent of the subjects' prior familiarity with a set of input items [1968, p. 15]." He also suggests that primary organization is relatively independent of the associative meaning of input items. For example, in his view, primary organization is probably the main determinant of the recency effect and may also play a role in the primacy effect in free recall. In fact, a strong serial ordering or position effect in free recall has been demonstrated by several investigators (Glanzer & Cunitz, 1966; Mandler & Dean, 1969; Mandler & Griffith, 1969; Murdock, 1962; Peterson, 1966; Waugh & Norman, 1965). Moreover, it should be noted that the serial position effect is common to other studies of of experimental conditions including list length, rate of presentation, serial position, sex differences, and category size. These results suggested that Ss are able to detect readily the categorized nature of the word lists, store some coded representation of each category in memory, and later attempt to retrieve the coded information during recall.

In contrast to Cohen's coding theory, Cofer (1966) provided evidence from several experiments which suggested that associations were the dominant factors responsible for the clustering and word recall observed in Bousfield's and Cohen's studies, while coding by the category name played a relatively minor role. However, clustering and recall data from additional studies by Cofer and his associates indicated that the operation of a coding factor in addition to association also seemed plausible. In these experiments the results indicated that, in general, clustering and word recall were augmented by block presentation (i.e., all items from one category presented together), by associative frequency of the list members, and by prolonged presentation interval. Cofer, Bruce, and Reicher (1966) concluded that associations between the category names and their related items or interassociations among items within a category may be suggested as supplemental or alternative mechanisms to a coding hypothesis. It should be noted that Bousfield later reinterpreted category clustering on purely associative grounds (Bousfield et al., 1958; Bousfield & Bousfield, 1966) rather than in terms of the superordinate process described earlier.

Recent support for the coding explanation of category clustering or chunking has come from a variety of sources (e.g., Johnson, 1969;

short-term memory involving serial learning and probed recall, and in studies of long-term memory.

In an extensive investigation of the serial position effect in free recall, Murdock (1962) showed that if probability of recall is plotted as a function of serial position, then the resulting serial position curve is generally characterized "by a steep, possible exponential primacy effect extending over the first three or four words in the list, and an S-shaped recency effect extending over the last eight words in the list, and a horizontal asymptote spanning the primacy and recency effect [Murdock, 1962, p. 488]." He found that the recency effect was independent of rate of presentation and list length.

Tulving (1968) reviewed the results from a number of studies of single-trial free recall and suggested that the serial position curve reflects operation of at least two storage systems. "Primary memory" was hypothesized as a short-term storage mechanism, while "secondary memory" was conceived as a long-term storage system. Primary memory was viewed essentially as an "echo-box" which had a very limited storage capacity and contained relatively unprocessed material. Other investigators have discussed a similar model for free recall based on the assumption of two distinct storage mechanisms (Ellis, 1969; Ellis & Hope, 1968; Glanzer, 1969; Glanzer & Cunitz, 1966; Peterson, 1966; Raymond, 1969).

Glanzer and Cunitz (1966) and Glanzer and Meinzer (1967) attributed the usual serial position effect in free recall to output from these two separate memory systems, with the primacy effect reflecting output

Pollio, Richards, & Lucas, 1969; Segal, 1969). Pollio et al. investigated the temporal properties of category recall and found a great deal of irregularity in individual recall records. Long inter-response times (IRTs) occurred between the words from different categories, and short IRTs occurred between words from the same category. These results were interpreted as supporting a conception of memory as a two-stage reconstructive process, the first stage involving a retrieval of the category label itself and the second a reconstruction of individual items or words on the basis of attribute similarity to the superordinate category.

Along similar lines, Johnson (1969) hypothesized that when Ss organize a sequence of items into chunks, they integrate the subunits separately and then learn the order of the subunits such that items within a chunk will tend to occur in an all-or-none manner or adjacently. Segal (1969) discovered that if Ss are given category names along with their category members, they tend not only to chunk or cluster their responses more than if the category label is withheld, but also tend to recall the category name before any of the category members. Segal concluded that the results were consistent with the theoretical formulation of Miller, Galanter, and Pribram (1960) and others (e.g., Mandler, 1967a & b) who propose that memory can be hierarchically organized. According to Shuell's (1969) excellent review of clustering in free recall, Segal's (1969) study presents the best evidence to support a coding interpretation.

It is impossible to determine from the studies presented above whether a coding process involving category membership or intracategory primarily from a long-term storage system and the recency effect reflecting output primarily from a short-term storage system. As support for their theory, they demonstrated that variables shown to affect short-term storage (i.e., delay or retention interval) affected recall of items from the end of the stimulus list, while variables found to affect long-term storage (i.e., rate of presentation) affected recall of items from the beginning of the list. Ellis and Hope (1968) reported similar findings using a probe-type or short-term memory (STM) task. According to Glanzer and Cunitz (1966) the short-term storage mechanism was "limited not with respect to capacity but with respect to the amount of time it can hold an item [p. 351]."

Glanzer and Meinzer (1967) explored the effects of intralist activity on free recall and found that word repetition had a significant differential effect with respect to list positions. When S̲s were required to overtly and successively repeat the list words aloud as they were presented, they recalled fewer words, especially from the beginning of the list. Repeating words six times as compared to once depressed the primacy effect but had little effect on recency. Similar results were reported by Hagen and Kingsley (1968) for ten-year-old children, and Ellis (1969) for a probe-type STM task. These findings were in support of the two-storage model of free recall. Glanzer and Meinzer (1967) identified repetition with "circulation" or "simple rehearsal," and hypothesized that repetition was an activity utilized by S̲s during the item interval to keep the preceding items in short-term storage. This activity was distinguished from learning or organizing (i.e., "effective rehearsal") the items in order to place them in long-term interitem associations are responsible for category clustering in free recall verbal learning. It seems plausible from the evidence reviewed that a coding process involving category membership and associative relationships between items have an interactive influence on category clustering. A review of associative clustering in free recall verbal learning may help to clarify this issue.

Associative Clustering

The second type of free recall experiment which has been employed in the study of verbal learning involves the presentation of lists of stimulus materials in which the items are organized by the experimenter into a number of associative clusters (e.g., Cofer, 1965; Deese, 1959; Jenkins, Mink, & Russell, 1958; Jenkins & Russell, 1952). In these experiments, attention is focussed upon how Ss utilize certain structural organizational aspects introduced into the lists, including items grouped in terms of varying degrees of interitem associations or grammatical relationships. In the case of interassociated items, it is believed that recollection of some of the items enables the S to reproduce other items with which those recalled are associated (Cofer, 1966). The associative clustering paradigm is similar to category clustering, since the items are selected beforehand by the experimenter in order to determine to what extent Ss actually make use of the organization or set of item relationships selected by the experimenter. However, associative clustering differs from category clustering in that item members are not selected specifically to be members of the same conceptual category. Associative clustering was illustrated in an experiment by Jenkins and Russell (1952), who presented Ss with a storage. Since repetition is identified with short-term storage, then, according to the model, it should interfere with "effective rehearsal" (i.e., secondary organization) that places the word in long-term storage. This means that repetition should lower recall of words from the beginning of the list, a result which was found. The authors also concluded, "effective rehearsal in free recall probably consists of linking list words in pairs or longer strings [p. 934]." This activity would correspond to Tulving's (1968) definition of "secondary organization." Presumably "simple rehearsal" is a process of "primary organization" as defined by Tulving.

Simple rehearsal was found to facilitate recency and depress primacy effects in a probe-type STM task (Ellis, 1969). Ellis hypothesized that "recency was facilitated as a result of added sensory cues or recirculation through a primary memory [p. 390]," while oral verbalization presumably preempted time for rehearsal (i.e., effective rehearsal) which is a main determinant of primacy. The results were viewed as providing further support for a two-process theory of STM with primacy and recency segments of the serial position curve arising from different determinants. Another study by Ellis and Anders (1969) which employed a similar probe-type STM task suggested that memory for recency items in free recall is less stable than memory for primacy items.

Raymond (1969) studied the influence of word frequency and type of stimulus material on the shape of the serial position curve, long-term storage, and short-term storage. The results indicated that stimulus materials (words versus trigrams), frequency (normative), and presentation rate all affected recall from long-term storage (i.e., primacy), list of 48 words constituting 24 randomly separated pairs. Each pair consisted of a stimulus word from the Kent-Rosanoff Free Word-Association Test and the word's primary response (e.g., man - woman). It was found that associated pairs tended to cluster or appear together contiguously during recall. At least half of the mean total number of words recalled were accounted for by either forward associations (i.e., a stimulus word followed by its primary response word) or reverse associations (i.e., the primary response word followed by its stimulus).

Jenkins, Mink, and Russell (1958) subsequently demonstrated that associative clustering in recall is an increasing monotonic function of the stimulus-response pairs (as measured by frequency of occurrence in the Kent-Rosanoff word-association norms). The data also showed that forward associations were more frequent and that forward and reverse associative clustering could be viewed as points on a continuous function. These results suggested that the habits which govern a S's responses in free word-association tests play an important role in the S's organization during verbal learning recall.

Deese (1959) considered the results from the previous two experiments and suggested that it would be more fruitful to examine associative relationships between all items, not just particular verbal pairs. He developed an index of interitem associative strength which he defined as "the average relative frequency with which all items in a list tend to elicit all other items in the same list as free associates [p. 305]." Deese found that free recall was positively correlated with the index of interitem strength (r = .88). He concluded that the results were consistent with an interpretation of free recall in terms of free assowhile delay affected recall from short-term storage (i.e., recency). The results were also considered favorable to a two-storage model of free recall. Raymond suggested that the drop in the end peak of the serial position curve when recall was delayed was due to a loss of stimulus items from short-term storage and not due to proactive interference from earlier items. This loss or forgetting is considered by Glanzer et al. (1969) to be primarily a function of displacement by new items rather than stimulus decay.

Primary organization in the form of a strong serial ordering effect employed by Ss to organize free recall has recently been demonstrated by Mandler and his associates. Mandler and Dean (1969) had Ss recall lists of words which were presented in an incremental order (i.e., by adding new items to a list on each trial). They found that Ss tended to adopt in their free recall output the serial order of the input list whenever possible. In addition, Ss tended to provide their own constant serial structure in their recalls in the absence of a constant serial input order. This "seriation" effect appeared to be the preferred method of organizing free recall lists, and was even maintained up to a list length of 50 words. The authors reported that maintenance of the same input order on successive trials improved performance when the serial order of the lists was experimentally constrained, while the structure of serial presentation facilitated recall when the input order of the lists was random. New items were found to appear earlier than dictated by their input positions. Mandler and Dean suggested that the input structure of random free recall lists does not provide an adequate retrieval mechanism for Ss. As a result, Ss employ subjective organization as a ciation.

The repeated presentation of stimulus-response word pairs has been shown to be accompanied by a significant increase in associative clustering (Rosenberg, 1966) as was the case with conceptual categories (Bousfield & Cohen, 1953). However, the relationship between associative clustering and repeated trials was shown by Rosenberg to vary significantly as a positive function of sex in favor of females, the direction of association in favor of forward associates, and the normative strength of associative pairs. These last two findings were in agreement with those of Jenkins et al. (1958) for single trials. It could be argued that many of the word pairs used by Rosenberg (1966) and Jenkins and his associates (1952, 1958) and the list of words which revealed a high index of interitem associative strength in Deese's work are members of the same hierarchical category. As a result, both associative and category clustering could each contribute to the clustering and recall effects demonstrated in these experiments.

In an important paper, Cofer (1965) reported the results of several studies in an attempt to develop a theoretical explanation for both category and associative clustering in free recall. Several of these experiments employed an index of Mutual Relatedness "which includes all of the associations which two words have in common expressed as a proportion of all of their associations [p. 267]." The evidence from all the experiments suggested the following explanation:

> When sufficiently prominent, experimenter-provided associational and categorical relations between members of a word pair provide a basis for clustering in free recall alternative to the bases--associational or

means of organizing constant output orders of their own. This subjective organization may be "an attempt by Ss to impose an idiosyncratic serial structure on items [p. 213]," (i.e., primary organization) as well as categorization or clustering of items (i.e., secondary organization).

Using a similar paradigm, Mandler and Griffith (1969) investigated acquisition and organization of new items in the free recall of random lists. Ss were required to recall lists of words presented in an incremental manner. The order of the old words was randomized on successive trials and new words were added either at the beginning, middle, or end of the input list. Regardless of input order, new items were found to occur early in output. Input order on any trial was unrelated to the organization of the output on that trial. However, the output order tended to reflect in part the order of addition of the new words to the random lists. According to Mandler, these findings argue against the notion of organization in free recall based exclusively on clustering on some categorical or subjective unit basis (i.e., secondary organization). Serial ordering (i.e., primary organization) as well is an important determinant of organizational behavior of the Ss in free recall.

Summary of Category Clustering Literature. Category clustering experiments have focussed upon how Ss utilize the conceptual organization systematically imposed on stimulus input. The occurrence of category clustering in free recall verbal learning implies the active operation of a recoding or reorganizational tendency by the learner in processing verbal stimuli. Category clustering in free recall has been shown

> otherwise--the subject will use to effect subjective organization or idiosyncratic pairing. (p. 271)

Cofer proposed, therefore, that most of the associative clustering demonstrated in the Jenkins et al. experiments consisted of relatively highly associated pairs, although category relations were probably also present. Both prominent category and associative relations provide the bases for category clustering. Similarly, if associative and category relationships are disrupted for some reason, then clustering will be attenuated, and "idiosyncratic pairings" or "subjective organization" will be prevalent (Cofer, 1965; Tulving, 1962). However, Cofer states that much more information is required before an explanation can be formulated as to how such factors actually function to affect recall in the way they do.

Marshall (1967) has presented data from three experiments which tend to support Cofer's (1965) conclusions. In these experiments, Ss were presented with lists of categorized and noncategorized word pairs in different mixed orders for three to four trials. In general, the results showed that measured association (as determined by the index of Mutual Relatedness), categorization, set, trials, and pattern of association were significantly related to clustering. As the index of Mutual Relatedness of word pairs increased, associative clustering increased. Categorization of word pairs (as determined by the cultural category norms of Cohen, Bousfield, and Whitmarsh (1957) tended to increase the associative clustering of weak and moderately associated pairs. On the other hand, set instructions to cluster increased the clustering of highly associated word pairs. As trials progressed, associative clustering increased, and an increase in the index of Mutual to be influenced by: (a) tasonomic or associative frequency (Bousfield et al., 1958; Cofer et al., 1967); (b) list repetitions (Bousfield & Cohen, 1953); (c) word frequency (Bousfield & Cohen, 1955); (d) blocked presentation (Cofer et al., 1966; Cohen, 1963, 1966); and (e) presentation interval (Cofer et al., 1966).

Two separate explanations have been proposed to account for the category clustering phenomenon. One position argues that Ss are able to detect the categorized nature of the stimulus lists, store some coded representation of each superordinate category in memory, and later retrieve the coded information during recall (cf., Cohen, 1963, 1966; Johnson, 1969; Pollio et al., 1969; Segal, 1969). The second position contends that associative relationships are the dominant factors responsible for category clustering. These associative factors include those between the category names and their related items, and the interassociations among items within a category (cf., Bousfield et al., 1958; Bousfield & Bousfield, 1966; Cofer, 1966; Cofer et al., 1966). However, based on the evidence presented, it is impossible to determine whether a coding process in terms of category membership or intracategory interitem associations are responsible for category clustering in free recall verbal learning. It seems plausible that a categorical coding process together with associative factors interacts in some manner to determine category clustering.

Summary of Associative Clustering Literature. Associative clustering experiments focus on how Ss utilize certain structural organizational aspects introduced into free recall stimulus lists, including items

Relatedness between word pairs augmented the effect of presentations in clustering. Direct associations (as indicated by the amount of overlap in Mutual Relatedness due to pair members eliciting each other in association) increased the clustering of both categorized and noncategorized pairs (as determined by the Cohen et al. 1957 cultural norms). Idiosyncratic association or clustering as analyzed from a recognition-association test which tapped S's awareness of word-pair relatedness significantly increased as the strength of association (Mutual Relatedness) of word pairs decreased. According to Marshall, these results indicate that category membership influences organization in free recall above and beyond the effects of association as measured by the index of Mutual Relatedness. Moreover, as the level of association decreases, the effects of conceptual relationships have a pronounced effect on clustering (both category and associative) in free recall.

According to Adams (1967), Marshall's experiment is important since it attempts to distinguish between the relative contributions of category and associative factors in clustering. However, both category and associative factors affect associative and category clustering. It would appear, therefore, that Cofer (1965) is correct in his assertion that the distinction between associative and category clustering is neither useful nor heuristic since, in free recall, Ss presumably will use either or both if the situation demands it.

Subjective Organization

The results of the two types of recall experiments presented above seem to indicate that adult Ss, at least, are sensitive to the grouped in terms of varying degrees of interitem associations and/or grammatical relationships. Associative clustering in free recall verbal learning is influenced by (a) normative strength of associative pairs (Jenkins et al., 1958; Rosenberg, 1966); (b) interitem associative strength (Deese, 1959); (c) list repetitions (Marshall, 1967; Rosenberg, 1966); (d) the index of Mutual Relatedness (Cofer, 1965); (e) categorization of word pairs (Marshall, 1967); and (f) "set" instructions (Marshall, 1967). The results from associative clustering experiments suggest that the habits which govern a S's responses in free word-association tests are related to the S's organization during verbal learning recall (cf., Jenkins et al., 1958). As was the case with category clustering, both associative and category relations present in the stimulus lists probably account for most of the clustering found in associative clustering experiments. However, there is some suggestion that in these experiments the S uses his own "subjective organization" or "idiosyncratic pairings" in addition to experimenter-provided associational and categorical relations between list items in organizing verbal stimuli for recall (Cofer, 1965; Marshall, 1967; Tulving, 1962).

Summary of Subjective Organization Literature. Subjective organization (SO) experiments focus on the sequential organization or clustering processes employed by Ss in a multitrial situation on verbal recall lists which are not restricted to semantic categories or associations. It is assumed that the lists are comprised of "unrelated" words since the items are experimentally unselected as to their meaning (Tulving, 1962; Bousfield et al., 1964). Subjective organization as measured by Tulving and Bousfield is found to increase with repetition and to be positively conceptual or associative relationships among the items of the stimulus input lists, and reorganize or recode the random input in terms of these relationships to facilitate item recall and clustering. There is a positive correlation between the amount of organization imposed by the S on the structured input and the number of items correctly recalled. However, Tulving (1962, 1964) provided evidence which indicated that there is also a positive correlation between the amount of "subjective organization" (SO) imposed by the S on unstructured stimulus input and the number of items correctly recalled.

The third type of free recall experiment which has been employed in the study of verbal learning thus involves the presentation of lists of stimulus materials in which there has been no attempt at preorganization. As discussed previously, Tulving (1962, 1964) found that organizational processes also occur in the recall of "unrelated" words (i.e., words which are experimentally unselected as to their meaning). He defines SO as "a subject's tendency to recall in an invariant order verbal items presented in varying orders from trial to trial [1962, p. 185]." The SO measure provides an excellent overall quantitative gauge for investigating the organizational process in verbal learning and recall since it measures organization which is not restricted to semantic categories or associations. According to Tulving (1968), the main disadvantage of associative and category clustering measures "is related to the fact that they tap organization of the kind that the experimenter is looking for, and hence tend to underestimate the extent to which organization has occurred in a given situation [Tulving, 1968, p. 17]."

correlated with recall performance (Bousfield et al., 1964; Tulving, 1962, 1964). In addition, there appears to be a good deal of commonality in the way Ss organize unrelated words (Tulving, 1962). It is suggested that SO is primarily responsible for intertrial as opposed to intratrial retention in free recall, and that increasing recall over trials is a consequence of the development of appropriate higher-order memory or "S-units" (Tulving, 1964). Order of presentation of stimulus materials has been shown to be an important determinant of learning unrelated words.

There is evidence that the presence of inappropriate higher-order memory units hinders free recall performance (Bower, et al., 1969; Wood, 1969). On the other hand, free recall performance appears to be facilitated if the experimenter reorganizes the S's memory units into larger and more appropriate groups or chunks of information over trials, or arranges for mediational linkages between S-units via common words (Bower, et al., 1969; Kintsch, 1968). There is some indication that free recall and recognition of lists of "unrelated" words is a linear function of the number of higher-order units or categories used by the S in organizing the lists (Mandler, 1967a, 1967b, 1968; Mandler et al., 1969a). It is even suggested that individual differences in SO may indicate differences of a general "learning ability" (Earhard, 1967, 1969).

Relatively little is known about the processes underlying SO. One contention is that rehearsal of items leads to the formation of stable S-units which facilitate organization (Allen, 1968). It is suggested that this rehearsal phenomenon is similar to the chunking or recoding

Studies of SO require a multitrial experiment in which randomized orders of list items are presented on successive trials. The paradigm was illustrated in Tulving's (1962) experiment. In this study, Ss were individually given 16 trials of a list of 16 "unrelated" disyllabic nouns. The order within each trial was randomized so that there was no second-order or higher-order redundancy in the lists. The Ss were instructed to write down in any order at the end of each trial as many words from the list as they could remember. It was found that Ss did impose a sequential structure or SO on their recall, that this SO increased with repetition, and that there was a positive correlation between SO and recall performance. In addition, there was a good deal of commonality in the way Ss organized their output.

Later studies by Tulving suggested that SO was primarily responsible for intertrial retention (i.e., the number of items recalled on trial N which were also recalled on trial N + 1) as opposed to intratrial retention (i.e., the number of items recalled on a particular trial which were not recalled on the previous trial) (Tulving, 1964), and that increasing recall over trials was a consequence of the development of appropriate higher-order memory units (Tulving, 1966). An S-unit is rigidly defined by Tulving as "a subset of verbal items consisting of two or more list items each of which is recalled more frequently in an output position immediately adjacent to other items constituting the S-unit than it is recalled in output positions immediately adjacent to items from other S-units [Tulving, 1968, p. 20]." Order of presentation was also found to be an important determinant of learning unrelated words (Tulving, 1965).

processes presumed to be operative in category and associative chunking. As was the case with associative and category clustering, both associative and coding effects are found in Ss' SOs (cf., Allen, 1968b). Tulving (1968) has reviewed the evidence relative to associative factors and coding processes in free recall and has concluded that attempts to distinguish between associative and mediational or coding mechanisms underlying clustering (including associative or category clustering and subjective organization) are "futile in the present state of the art [p. 26]." Similarly, in his extensive and most recent review of clustering and organization in free recall, Shuell (1969) concludes that subjective organization does not offer a separate theoretical interpretation of clustering, and he suggests that the same behavioral processes are probably being studied in all three clustering paradigms.

Summary of Primary and Secondary Organization Literature. The type of organization measured by clustering and SO may be referred to as "secondary organization" since it is a process which relies on the S's prior familiarity with verbal items before input (Tulving, 1968). This process may be contrasted with "primary organization" which refers to the organizational process which is independent of the S's prior familiarity with input items (Tulving, 1968). It is suggested that primary organization is probably the main determinant of the recency effect in free recall and may even play a role in the primacy effect (Tulving, 1968). In studies of STM including free recall, several investigators have demonstrated a strong serial ordering or position effect which is dependent on both primary and secondary organization (cf., Ellis, 1969;

There is evidence that the presence of inappropriate memory units results in impaired free recall performance (Bower, et al., 1969; Wood, 1969). In addition, it has been shown that Ss' recall is facilitated if the experimenter explicitly combines the Ss' functional recall units (i.e., S-units) into larger and more appropriate groups over trials, or arranges for structural linkages between S-units via common words (Bower, 1969; Kintsch, 1968).

Another measure similar to Tulving's SO measure was developed by Bousfield, Puff and Cowan (1964). In this free recall study, Ss were presented a list of ten words having zero interitem associative strength as determined by word-association norms. Bousfield et al. found that their measure of subjective organization (labeled intertrial repetitions) also increased over trials and was correlated highly with recall. A unit of intertrial repetitions was said to occur whenever any two items which appeared consecutively in recall on trial T also occurred in sequence on trial T + 1.

It may be concluded from the above studies of subjective organization that the learner brings a strong sequential ordering or clustering tendency to the learning situation. In fact, Earhard (1967, 1969) hypothesized that individual differences in subjective sequential ordering may indicate differences of a more general "learning ability" rather than simply the tendency to repeat pairs of words in the same order over trials. She states that the advantage the good subjective organizer enjoys in free recall performance is due to his ability to form associations between verbal stimulus items more rapidly and more permanently than the poor organizer.

Ellis & Hope, 1968; Glanzer & Cunitz, 1966; Glanzer & Meinzer, 1967; Murdock, 1962; Peterson, 1966; Raymond, 1969; Waugh & Norman, 1965).

Primary organization in the form of a strong serial order or "seriation" effect has also been shown to be an important determinant of organizational behavior of Ss in free recall (Mandler & Dean, 1969; Mandler & Griffith, 1969). It was suggested that serial ordering (i.e., primary organization) as well as organization based on clustering on some categorical or subjective unit basis (i.e., secondary organization) are both important determinants of organizational behavior in free recall verbal learning.

Clustering Studies of Normal and Educable Mentally Retarded Children

Although clustering of adult Ss in free recall verbal learning has been extensively studied, there has been very little research dealing with clustering behaviors of retarded and normal children. The few studies which have been completed will be reviewed in this section according to the three clustering paradigms discussed earlier in this chapter.

In an extensive review of verbal learning in children, Goulet (1968b) indicated that little research which incorporated age into the basic design had been completed in free recall learning. The few studies which had been undertaken suggested that the same variables affected free recall in adults and children. A similar conclusion was reached by Keppel (1964) in an earlier review of verbal learning in children.

Clustering of Normal Children

Bousfield, Esterton, and Whitmarsh (1958) compared the degree of

Mandler (1967a, 1967b, 1968) has provided evidence from several experiments which indicates that recall of lists of "unrelated" words is a linear function of the number of higher-order units or categories used by the S in organizing the lists. In a typical experiment, Mandler had Ss sort lists of 100 familiar but "unrelated" words into anywhere from two to seven categories. Ss were free to choose the number of categories into which they wished to organize the lists of "unrelated" words. The process was repeated until the Ss achieved stable categorizations (i.e., at least 95% sorting consistency on two consecutive trials). Immediately following this categorization, Ss were required to recall as many of the words on the original lists as possible. The experiments showed highly linear relations between the number of stable categories used during the sorting procedure and the number of items recalled.

Mandler hypothesized that during reorganization Ss store verbal items according to the category (i.e., S-unit) they have imposed on the material. In retrieval, they then use the category to gain access to these items and to retrieve about five items per category. Mandler et al. (1969) found that the number of stable organizations or categories imposed by the Ss also influenced recognition, just as it did free recall, both in immediate tests and in delayed tests two weeks later.

Although techniques for measuring SO have been devised, relatively little is known about the processes responsible for it in recall. Allen (1968a) attempted to determine some of these processes. His findings provide support for the contention that rehearsal of sequences of two or more items influences the amount of organization shown in free recall. It was found that the type of rehearsal the S was allowed to category clustering in free recall verbal learning among third grade, fourth grade, and college students. Ss were presented with 25 stimulus pictures which could be grouped on the basis of five colors or five categories such as fruits, vegetables, birds, flowers, and nature. The authors found that both the extent of recall of the stimulus items and the degree of total category clustering for the color and conceptual categories combined increased as a function of age.

Rossi and Rossi (1965) investigated category clustering in children between two and five years of age and found that even two-year-old Ss clustered at a level significantly above chance. In addition, children between two and five years of age organized the stimulus materials so that they recalled more by clustering than by serial ordering. The study was important since it implied that even very young children can use category clustering as an aid to recall. However, the results may have been confounded by the fact that Ss were forced to label or verbalize each of the stimulus items before recall. There is evidence which demonstrates that such rehearsal facilitates short-term memory performance in children for certain age levels (cf. Hagen & Kingsley, 1968; Hagen & Meacham, 1967). In addition, the authors did not control for associative strength, which may have biased the results toward either clustering or serial ordering.

A further study by Rossi and Wittrock (1967) compared category clustering and serial ordering in recall of four-year-old children. It was found that recall by category clustering was significantly higher than serial order recall. In this experiment, the authors controlled employ significantly affected both the amount and the pattern of organization. No evidence was found for a hypothesis of response cueing which would predict that those responses already made on the current test-trial cued recall of those items yet to be remembered. According to Allen, rehearsal of sequences of items leads to formation of stable higher-order units (i.e., S-units) which facilitate organization. It would appear that Allen uses rehearsal as a synonym for "chunking" or "recoding" processes presumed to be operative in category and associative clustering.

In another study, Allen (1968) investigated the effects of associative and coding processes on organization in multitrial free recall in which the effects of formal similarity (defined by letter overlap among response terms) and list length were studied. The results showed that high formal similarity of list items and shorter list lengths led to less SO as assessed by the intertrial repetitions measure developed by Bousfield et al. (1964). As was the case with associative and category clustering, both associative and coding effects were demonstrated. Allen concluded that the results suggest the possibility that either acquisition or recall or both in free recall learning entail two levels of processing. At one level, the <u>S</u> detects and stores information concerning the "codability" of the list items, while at the second level he attempts to form associative connections among the various items of each coded category.

On the other hand, Tulving (1968) has reviewed the major theoretical issues and research in free recall and has suggested that the attempts to distinguish between associative and mediational or coding mechanisms for associative strength between items, but a confounding due to rehearsal of list items before recall was still possible.

Associative clustering in normal children has been demonstrated by Wicklund, Palermo, and Jenkins (1965). Two experiments were carried out to assess the relation between associative strength and associative clustering in the recall of fourth grade children. Associative clustering was readily demonstrated for fourth grade _Ss_. The amount of associative clustering was a direct function of the verbal associative strengths of the word pairs based upon fourth grade word-association norms (i.e., Palermo-Jenkins word-association norms, 1964). The data also indicated that the greatest proportion of clustered pairs occurring were pairs whose associative bonds were bidirectional rather than unidirectional (i.e., distinctly Forward or Reverse pairs). The authors concluded that free-associative strength exerts a significant influence on the order in which children will recall associated words presented in a random order. The major differences between the child and adult clustering data (cf. Jenkins et al., 1958) were the lower total recall and lower frequencies of associative clustering found for children. Wicklund et al. (1965) suggested that associative connections between words are probably less highly developed for children than adults, and therefore exert less influence over children's performance on various learning tasks.

Laurence (1966) investigated age differences in performance and subjective organization (SO) in the free recall learning of pictorial material. The performance of five-, six-, eight-, and ten-year-old children was compared to that of college students and elderly _Ss_ on a free recall task involving 16 unrelated pictures of common objects. Laurence found that mean recall performance increased with age, with the college Ss achieving the highest mean performance on all trials. However, mean SO (as determined by Tulving's 1962 measure of subjective organization) did not vary significantly among the four child-groups, although the mean SO for children was markedly inferior to that of adult Ss. Subjective organization increased only minimally across trials for the child-groups, while adult Ss demonstrated a rapid increase in SO across trials. Laurence reported that the relationship between SO and recall performance was different for child- and adult-groups. Significant positive correlations between SO and recall were substantiated for the two adult-groups and the two oldest child-groups, while coefficients derived from the two youngest child-groups failed to obtain significance. Laurence cautioned that verbal learning patterns demonstrated by adults may not always be generalized to children.

Comparative Clustering Studies with Retarded Children

There have been a few clustering studies involving EMR children. However, due to methodological problems encountered in these studies, it has been difficult to interpret the findings. Differences among the various studies relative to sample selection, stimulus materials, and matching procedures demand that caution be used in generalizing from the results.

With respect to category clustering studies of retarded Ss, Spitz (1966) noted differences in the scoring procedures for calculating category clustering. He distinguished between a "corrected clustering" measure which only used the actual stimulus words in scoring clustering, and "noncorrected clustering" which included extralist words such as intrusions and repetitions (or perseverations) in the scoring. In addition, Spitz pointed out that the earlier measures of clustering did not take into account the number of words recalled. Recent studies employ the measure of clustering above chance developed by Bousfield and Puff (1964) which gives the amount of expected, or chance, clustering for the actual number of words recalled. In a comparison of the various category clustering measures which have been developed to measure organization in free recall, Shuell (1969) found the clustering above chance measure, or some form of it, to be the best measure currently available.

Category clustering in retarded Ss was reported by Weatherwax and Benoit (1957) who studied clustering in organic and familial retardates of equal MA. Ss were given six presentations of a list of 12 stimulus pictures from four categories. No statistically significant difference between the two groups was found in the amount of category clustering. This study was replicated by Osborn (1960) who also included a matched-MA normal sample. He found no significant differences in recall or category clustering among the three groups. No differences among the groups in the amount of categorical or irrelevant intrusions were found. The retarded samples did demonstrate qualitative differences from normal Ss in their overall pattern of clustering. According to Spitz (1966), the above studies employed a "noncorrected" measure of clustering.

Rossi (1963) showed six groups of normal and institutionalized retarded Ss matched on MA ($\bar{x}$= 4.5 to 10.0 years) five presentations of a randomized list of 20 stimulus words from four conceptual categories (animals, foods, articles of clothing, and parts of the body). His results revealed no significant differences between normal and retarded Ss on recall and on an "uncorrected" measure of category clustering. However, the retarded Ss elicited significantly more categorical intrusions (i.e., extralist words which were from the same categories as those used in the original list). When these intrusions were eliminated from the analysis by a "corrected" measure of category clustering, it was found that normal Ss clustered more than retarded Ss and that clustering improved over the five practice trials for both groups. The greatest difference in category clustering between the two groups occurred at the lowest level of MA (mean MA of 4-6 years). Clustering was positively related to MA within each group. A possible confounding due to rehearsal may have affected the results, since the Ss were required to label or repeat each word of the list as it was presented. As indicated previously, such "simple rehearsal" may affect "secondary organization" or "effective rehearsal" and prevent items from transferring to long-term storage as well as promoting recall of recent items (cf. Ellis, 1969; Glanzer and Meinzer, 1967). Hagen and Kingsley (1968) found that recall of early presented items (primacy) on a serial STM task was hindered by overt labeling, while recall of the most recent serial positions (recency) was facilitated for Ss from nursery school age to fifth grade.

Evans (1964) used Rossi's procedure with high IQ ($\bar{X}$ = 65) and low IQ ($\bar{X}$ = 47) institutionalized retarded adults. He found that the two groups did not differ significantly in the amount of "corrected" or "noncorrected" category clustering. Recall performance increased with practice for both groups and did not differ significantly between them. Half of the Ss were given a material incentive. Material incentive and low IQ groups tended to produce more inappropriate responses (i.e., redundancies and intrusions).

Stedman (1963) compared the clustering exhibited by normal and retarded Ss (matched according to CA) on a free recall list containing 30 word pairs made up of five representatives for each of six "semantic" categories. Subjects were required to rehearse the stimuli by reading each word pair aloud as it was presented to them. The normal Ss tended to exceed the retarded Ss both on recall performance and clustering (a "corrected" measure).

In a summary of the early research on clustering behavior with retarded Ss, Spitz (1966) reported that when "noncorrected" measures of category clustering are used:

> There are no differences between so-called organic and non-organic retardates. Retardates cluster and recall less than do equal CA normals, with recall positively related to MA within each group. Within the retarded population no significant relationship between clustering and either MA or IQ emerges unless extremely low MA Ss (4.5 years) are included.... Because retardates bring a greater number of category intrusions into their recall, their uncorrected clustering score reaches the level of equal MA normals. (Spitz, 1966, p. 39).

Spitz reported that retarded Ss recall as well as equal MA normal Ss but tend to cluster less on a "corrected" measure of clustering. He concluded that the equal recall of retarded Ss despite inferior clustering suggests "an extremely active storage and retrieval system, not a breakdown in these systems [p. 39]."

Gerjuoy and Spitz (1966) followed a procedure similar to Rossi's

(1963) to investigate the growth of clustering and free recall as a function of age, intelligence, and practice. The authors used a deviation measure of category clustering developed by Bousfield and Puff (1964) to compare clustering of middle- and high-grade institutionalized retarded and normal Ss matched on both MA ($\bar{x}$ = 9.8 years) and CA ($\bar{x}$ = 14.7 years). The results indicated that only equal CA and college Ss clustered above chance, and then only on the latter trials of a 5-trial 20-item free recall task. Clustering increased over trials for both types of Ss. Retarded Ss did not differ from equal MA normal Ss on recall, but both of these groups recalled significantly less than college and equal CA normal Ss. Gerjuoy and Spitz found a high positive relationship between clustering and recall once clustering was above chance. They also found that it was possible to increase recall and clustering in the retarded Ss by: (a) presenting the stimulus words in categories (block method), (b) requesting Ss to remember the words in categories, and (c) using a combination of the previous two methods. The last method produced the highest recall by retarded Ss. The authors concluded that "retardates seem to be deficient in spontaneous organization but they are able to utilize external organization [p. 926]."

Further support for this conclusion was furnished as a result of a recent study by Gerjuoy and Alvarez (1969) who demonstrated that the free recall and category clustering of both equal MA normal Ss and institutionalized educable retarded adolescents were significantly increased when the words were presented in a clustered (i.e., blocked) rather than randomized order. They concluded that it was thus possible to induce a "clustering set" for both retarded and young normal children who do not provide their own organization of stimulus materials. However, it was found that the clustering set induced by presenting the clustered list to Ss in one experimental session did not transfer to a second list of randomly presented familiar words approximately one week later. Gerjuoy and Alvarez speculated that the transfer of the clustering set could be facilitated by giving Ss several sessions with clustered materials.

Another study by Gerjuoy, Winters Jr., Pullen, and Spitz (1969) examined the effect of visual presentation on category clustering and free recall when the stimuli were presented randomly or clustered, and either singly or in pairs to adolescent educable retardates and normal Ss matched on MA. Ss were given five trials of a tachistoscopically presented free recall task composed of category items (five in each group) which included two-digit numbers, letters, colors, and geometric forms. No differences were found in recall when the items were presented one at a time, although normal Ss clustered more than retarded Ss. There was more clustering for both groups when the items were presented already clustered. When the items were presented in pairs, normal Ss clustered and recalled significantly more than did equal MA retarded Ss, and the presented-clustered condition facilitated recall and clustering for both groups. As was the case with most category clustering experiments, recall and clustering increased over trials although the clustering of the normal Ss increased more rapidly over trials than did that of the retarded Ss. In general, the clustering results were in agreement with the results of Gerjuoy and Spitz (1966). A comparison of the two experiments revealed that for randomized presented lists, visually presented stimuli were better recalled by retarded Ss than orally presented items. On the other hand, when the lists were presented already-clustered, the oral condition elicited superior recall.

The investigation into the effect of modality on the relationship between free recall and category clustering was pressed by Gerjuoy and Winters (1970). In this study, institutionalized EMR adolescents were given a free recall task with pictured stimuli presented bimodally (visual plus oral presentation) in one session, and unimodally (oral presentation) in a second session one week later. In addition, stimuli were presented either single random (one at a time), single clustered, group random (five at a time), or group clustered. It was found that recall did not differ among the four list conditions; however, clustering performance improved when the lists were presented clustered. These results were inconsistent with previous findings by Gerjuoy and Spitz (1966) and Gerjuoy and Alvarez (1969) who reported a high positive relationship between clustering and recall in retarded Ss once clustering was above chance. On the other hand, the findings are in agreement with Gerjuoy et al. (1969). Gerjuoy and Winters postulated that one possible reason for the inconsistent relationships between category clustering and free recall is the type of stimuli used in these several experiments. Clustering and recall appear to be related if stimuli are presented orally. However, when stimuli are presented visually, recall and clustering seem to be unrelated. Thus the mode of presentation of stimuli appears to be a significant variable determining the relationship between clustering and free recall in EMR Ss. In the Gerjuoy and Winters study, free recall of bimodally presented material was significantly better than free recall following unimodal presentation. The authors suggested that "bimodal presentation affects the overall recall whereas the separate modalities affect the association between clustering and recall [Gerjuoy and Winters, 1970, p. 516]."

In an extensive investigation of category clustering, Madsen and Connor (1968) found no difference in the amount of category clustering ("corrected") between institutionalized adult EMR Ss and college Ss when the Ss were pretrained to insure that the category concepts to be used in free recall of categorized lists were present in the conceptual repertoire of the individual. Madsen and Connor gave their Ss pretraining in the coding of 18 categories of four words each using a modified paired-associate method. Ss were then tested for free recall on 42 lists of 12 words each which differed both in the total number of categories represented in each list and in the temporal placements (i.e., contiguous or alternate) of items within the list. The results revealed that free recall by both groups improved with increased degrees of list categorization. College Ss recalled significantly more items than EMR adult Ss under each condition and clustered significantly more when an "uncorrected" measure of categorization not based on the number of words recalled was used. Both groups obtained higher recall and clustering scores with contiguous list constructions (i.e., "blocked" or "clustered" presentation) as opposed to alternate list constructions (words within a category were mixed with words from other categories). This finding is in agreement with that found in previously cited studies by Gerjuoy and her associates. Although presented-clustered lists are generally recalled and clustered better than random lists by EMR Ss, there is evidence that category clustering and recall are not facilitated by presented clustered lists when rhyme-related words are used as stimuli instead of conceptually related words (Reiss, 1968).

No published research was found which studied associative clustering in EMR Ss using associatively related materials based on word-association norms. Further, only one study was found which studied subjective organization and free recall in EMR Ss using "unrelated" words as verbal stimuli. J.R. Gallagher (1969) employed Tulving's (1962) SO measure to compare subjective organization of EMR and CA-matched normal adolescents (CA 13-14 years). Ss were presented with a list of 12 supposedly monosyllabic nouns. The results revealed that normal Ss recalled significantly more words than EMR Ss but there was no difference between the groups in their subjective organization scores. Gallagher concluded that the results provided further evidence for a STM deficit in mentally retarded individuals. However, the findings are subject to a possible confounding due to a failure to control the grammatical form-class of the list stimuli. An analysis of the stimuli indicates that half (close, full, good, little, try, weak) are more commonly classified as adjectives or verbs instead of monosyllabic nouns. It could be argued that the retarded Ss who appear to demonstrate a strong sequential approach in processing language (Semmel, 1967) may have utilized associative cues present in the list in the form of syntagmatic associates (e.g., full-mouth, good-try). In addition, Gallagher employed Tulving's (1962) measure to compare subjective organization of the two groups. This measure provides only a partial analysis of the amount of subjective organization imposed on the stimulus input by the learner since it accounts for forward pairwise clusters, but does not take into account two-word sequences in the reverse order (backward clusters). Tulving has recently extended his SO measure to include pairwise clusters in both directions; that is, word A followed by word B or word B followed by word A. Gallagher's findings are therefore biased toward what might be labeled "tight sequential organization." Goulet (1968) and Spitz (1968) both have pointed to the need for further research on subjective organization in MR Ss using the measure of clustering devised by Tulving.

Primary and Secondary Organization in Retarded and Normal Subjects

Primary and secondary organization in the form of serial ordering effects have been investigated recently by Ellis (1969). Ellis found that, as was the case with normal Ss, simple rehearsal or labeling facilitated recency and depressed primacy effects in a probe-type memory task where institutionalized EMR and adult Ss were required to remember the location of one of seven digits presented in a row by miniature projectors. Ellis indicated that recency performance is comparable in retarded and normal Ss, though the groups differ markedly in primacy. He cited previous evidence which suggests that the lower primacy performance by the retarded Ss is probably due to a less effective rehearsal strategy. If this hypothesis is supported, it would indicate that retarded Ss differ from normal Ss not in primary or short-term memory as Ellis' (1963) theory would predict, but rather in secondary or long-term memory which is determined by "secondary organization."

Belmont and Butterfield (1969) studied the relationship of STM to development and intelligence. They cited recent studies by Ellis (1970) which compared the recall of retarded and normal adults and adolescents using a probe-type memory task. Subjects were automatically presented lists of nine numerical digits shown successively on separate screens, and were required to indicate on which of the previous nine screens a tenth probe digit had originally appeared. The results indicated that normal and retarded Ss did not differ in recency performance, while retarded Ss were inferior in their primacy performance. In fact, the EMR Ss showed only recency effects. According to Belmont and Butterfield, Ellis again emphasized the distinction between primary and secondary memory in interpreting his results. Ellis concluded that the normal Ss showed evidence of using both primary and secondary memory while the retarded Ss employed only primary memory. These results, according to Belmont and Butterfield, suggest that the STM deficit of retarded Ss results "at least in part from an acquisition deficit, probably from a failure to rehearse material actively after it enters primary memory [p. 61]."

Belmont and Butterfield (1969) reported results from further probe-type STM studies of their own which suggest that the superiority of normal Ss in STM studies is probably due to a difference in acquisition processes rather than to defective retention or retrieval. The authors concluded that "the principal reason retardates differ from average adults in STM functioning is that the retardates employ less active acquisition strategies [p. 78]." In the present investigator's opinion, this statement could be reformulated to say that, compared with normal individuals, retarded Ss rely more on primary organizational factors and less on efficient secondary organizational factors in their STM functioning.

It seems that the effect of primary and secondary organizational factors on serial ordering in free recall has not been investigated with retarded children. However, evidence has been found which suggests that, similar to adult Ss, normal children seem to utilize two distinct storage mechanisms in serial order STM tasks, thus apparently reflecting the operation of primary and secondary organizational factors (Hagen & Kingsley, 1968; Kingsley & Hagen, 1969).

Using an eight-item serial STM task, Hagen and Kingsley (1968) found that overt labeling (i.e., simple rehearsal) of animal pictorial stimuli facilitated recency performance for children who ranged in age from nursery school to fifth grade. Recall of primacy items was hindered by overt labeling for fifth grade Ss. Primacy performance improved with age regardless of overt labeling over the CA levels studied, while recency performance tended to change little with age. Hagen and Kingsley found an optimal age range between first to third grade within which labeling facilitated STM. They suggested that primacy performance was probably hindered by labeling in older Ss, since it may interfere with covert labeling and spontaneous rehearsal that occurs with these Ss when no labeling is required. On the other hand, labeling facilitated recency for all Ss since it strengthened the memory trace before recall. Thus, recall on primacy items should improve with increasing CA because of a greater tendency to spontaneously rehearse (i.e., effective rehearsal) with older Ss.

Flavell, Beach, and Chinsky (1966) found a significant increase in the incidence of spontaneous verbal rehearsal with age for Ss between kindergarten and fifth grade. Flavell et al. argued that the results provided support for a verbal production deficiency hypothesis in young children (preschool and early school years). According to this hypothesis, young children do not spontaneously produce "would-be verbal mediators" in cognitive tasks which may require verbal mediation due to a lack of ability or "disposition" to produce or emit the relevant words on "appropriate occasions." It is assumed, however, that the child "knows the relevant words and that he can and does produce them in some situations [p. 284]." This hypothesis is opposed to a "mediational deficiency hypothesis [cf., Reese, 1962]," which holds that young children are deficient in "mediational power" since they are able to produce the relevant verbalizations in cognitive tasks but for some reason their verbalizations do not mediate effectively even though they are available.

Support for the "production deficiency" hypothesis was provided by Keeney, Cannizzo, and Flavell (1967) who demonstrated that the serial recall of first grade children was significantly facilitated when Ss were induced to rehearse the items to be recalled. In addition, it was shown that Ss who spontaneously rehearsed the items recalled significantly more items than Ss who did not spontaneously rehearse the stimuli.

More recently, Corsini, Pick, and Flavell (1968) demonstrated that the concepts of production and mediational deficiency which were initially proposed to describe young children's verbal mediation behavior are also applicable to their nonverbal mediation behavior. In this study, kindergarten and first grade Ss were required to reproduce patterns of six colored forms after they had been removed from sight. Paper replicas of the colored forms were provided in order to aid the Ss to reproduce the initial pattern by means of a nonverbal "ikonic" mediator. Experimental suggestions were also given for inducing nonverbal mediation. It was found that when mediators were produced and therefore available for use, they were generally utilized by the Ss in their reproductions. The results were interpreted as providing support for a production deficiency rather than a mediational deficiency in this type task.

More pertinent to the present investigation, Moely, Olson, Halwes, and Flavell (1969) studied production deficiency in young children's clustered free recall. Prior to a free recall test, groups of children from kindergarten and grades one, three, and five were given two-minute study periods during which they were free to manipulate pictures of categorized objects which they were later asked to recall. It was shown that the three younger child-groups tended not to cluster the stimulus items spontaneously into categories during the study periods except when they were helped to do so either by hints or instructions from the experimenter. On the other hand, fifth grade Ss tended to cluster the stimuli spontaneously by categories during the study periods. However, when the younger Ss were given hints or directions to use category clustering as a study technique, the resulting increase in study period category clustering led to a significant increase in free recall and recall category clustering for these Ss. The data provided further support for the generalization that category clustering in free recall verbal learning increases with age. Moely et al. compared the findings of this study to those of previous investigations of production deficiency

(Corsini, Pick, & Flavell, 1968; Flavell, Beach, & Chinsky, 1966; Keeney, Cannizzo, & Flavell, 1967). They concluded that, together, the studies suggest "that, at least where the mediational response is some verbal or nonverbal form of symbolic mnemonic activity, and the mediational response is recall, the young child is far more likely to show a production deficiency than a mediational deficiency [Moely et al., 1969, p. 32]."

A recent study by Kingsley and Hagen (1969) investigated the effect of induced versus spontaneous rehearsal in the STM of nursery school children. Four groups of Ss were given a serial STM task similar to that of Hagen and Kingsley (1968) except that difficult-to-label stimulus items were used. Three experimental groups were used and Ss in these groups were provided with verbal labels for the stimuli. Of these groups, one group was instructed to say the labels subvocally or covertly during the task, one group overtly pronounced the labels and also rehearsed them during the task, and one group was instructed only to say the labels overtly. A group of control Ss received no labels for the stimuli. It was found that induced rehearsal of the labels facilitated serial recall of primacy items, while overt labeling facilitated serial recall of the most recent serial item. However, covert labeling did not facilitate serial recall. Kingsley and Hagen concluded that the spontaneous use of a rehearsal strategy was not widespread among kindergarten and nursery school Ss and that qualitatively different processing strategies may determine primacy and recency effects found in children's serial recall. They also concluded that the results provide support for the "production deficiency hypothesis" of Flavell and his associates, since "production (overt verbalization, or rehearsal, or both) but not possession of labels was facilitative for these young subjects [Kingsley & Hagen, 1969, p. 45]."

An Interpretive Summary

In summary, studies of category clustering of normal children in free recall verbal learning have indicated that both the extent of recall and the degree of category clustering increase as a function of age (Bousfield et al., 1958); and that even preschool children show evidence of category clustering at levels significantly above chance (Rossi & Rossi, 1965; Rossi & Wittrock, 1967). Associative clustering in children was found to be a direct function of the free word-association strength of word pairs (Wicklund et al., 1965). Although there has been relatively little research dealing with clustering of children, there is some evidence that the same variables affect free recall in children and adults (cf., Keppel, 1964; Goulet, 1968b). With respect to associative clustering, the major differences between child and adult clustering data are lower total recall and lower frequencies of associative clustering found for children (Wicklund et al., 1965). However, there is some indication that the relationship between subjective organization and recall performance is different for child- and adult-groups (Laurence, 1966). The only data available reveals that subjective organization increases only minimally with practice for child-groups, while adults demonstrate a rapid increase in subjective organization with practice. In addition, significant positive correlations between subjective organization and recall are not as consistent in child-groups (Laurence, 1966).

The effects of primary and secondary organizational factors on serial learning also have been investigated with normal children. There is evidence that, similar to adults, normal children utilize in serial order STM tasks two distinct storage mechanisms which appear to reflect the operation of primary and secondary organizational factors (Hagen & Kingsley, 1968; Kingsley & Hagen, 1969). It has been suggested that children's recall on primacy items in serial learning improves with increasing CA due to a greater tendency to rehearse items spontaneously with older Ss (Hagen & Kingsley, 1968). It was also suggested that qualitatively different processing strategies may determine primacy and recency effects found in children's serial recall (Kingsley & Hagen, 1969).

There have been a few clustering studies conducted with EMR and normal children. These studies have dealt only with category clustering. The reviewer was unable to find any published studies of associative clustering and subjective organization of EMR children in free recall learning. The studies of category clustering in retarded and normal children display many methodological differences and weaknesses which reduce the external validity of the various findings.

A summary of the early clustering studies reveals that (a) organic and familial retardates of equal MA do not differ in their amount of category clustering and recall of pictorial stimuli (Osborn, 1960; Weatherwax & Benoit, 1957); (b) normals and institutionalized retardates do not differ on recall or on an "uncorrected" measure of category clustering when presented with pictorial or verbal stimuli (Osborn, 1960; Rossi, 1963); (c) with category clustering "corrected" for categorical intrusions, MA-matched normal Ss cluster more than institutionalized retarded Ss on a verbal free recall task, with clustering positively related to MA within each group (Rossi, 1963); (d) on a verbal recall task, high and low IQ institutionalized retarded adults do not differ significantly in either the amount of category clustering or free recall (Evans, 1964); and (e) equal CA normal Ss exceed retarded adolescents and adults on both recall performance and category clustering (Stedman, 1963).

Recent studies have used a more efficient measure of category clustering developed by Bousfield and Puff (1964) which gives the amount of expected or chance clustering for the actual number of items recalled. On the basis of this measure, it has been shown that middle- and high-grade institutionalized retarded Ss do not differ from equal MA normal Ss on recall, but both retarded groups recall and cluster significantly less than college and equal CA normal Ss (Gerjuoy & Spitz, 1966). With visually presented stimuli, it has been found that although adolescent and equal MA normal Ss do not differ in recall, the normal Ss tend to cluster more than the retarded Ss (Gerjuoy et al., 1969).

There is evidence which suggests that recall and clustering in adolescent and adult retardates may be increased by (a) presenting the stimulus items in clusters or categories (block method) (Gerjuoy & Alvarez, 1969; Gerjuoy & Spitz, 1966; Gerjuoy et al., 1969; Gerjuoy & Winters, 1970; Madsen & Connor, 1968); (b) requesting Ss to remember the words in categories (Gerjuoy & Spitz, 1966); (c) using a combination of the previous two methods (Gerjuoy & Spitz, 1966); and (d) pretraining Ss to insure that the category concepts to be used in the free recall of categorized lists are present in the "conceptual repertoire" of the individual (Madsen & Connor, 1968). From these findings it has been contended that a "clustering set" may be induced in retarded Ss who appear to be deficient in spontaneous organization and fail to provide their own organization of stimulus materials, although they are able to utilize external organization provided by others (Gerjuoy & Alvarez, 1969; Gerjuoy & Spitz, 1966). There is some indication, however, that category clustering and free recall in EMR Ss are not facilitated by block presentation when rhyme-related words are used as stimuli instead of conceptually related words (Reiss, 1968).

For randomized presented lists, there is some evidence that visually presented stimuli are better recalled by retarded adolescents than orally presented items. On the other hand, when the lists are presented already-clustered, the oral condition elicits superior recall (Gerjuoy et al., 1969). In addition,free recall of bimodally presented material (visual plus oral presentation) is significantly better in institutionalized EMR adolescents than free recall following unimodal presentation (oral presentation) (Gerjuoy & Winters, 1970). It also appears that the mode of presentation may be a significant variable determining the relationship between category clustering and free recall in EMR Ss (Gerjuoy & Winters, 1970). For orally presented stimuli, a high positive relationship between clustering and recall in adolescent retardates is reported once clustering is above chance (Gerjuoy & Alvarez, 1969; Gerjuoy & Spitz, 1966). On the other hand, when the stimuli are presented visually, recall and category clustering appear to be unrelated in EMR Ss (Gerjuoy et al., 1969; Gerjuoy & Winters, 1970).

No published research was found which studied associative clustering in EMR Ss using associatively related materials based on word-association norms. The only study which has investigated subjective organization and free recall in EMR Ss employed Tulving's (1962) measure of SO to compare subjective organization of EMR and CA-matched normal adolescents (Gallagher, 1969). It was shown that normal Ss exceeded retarded Ss in recall performance although the groups did not differ in their SO scores. The need for further research on subjective organization in EMR children appears substantiated by the foregoing review (Goulet, 1968; Spitz, 1968).

Primary and secondary organization in the form of serial ordering effects have recently been investigated with institutionalized adults. As is the case with normal adult Ss, simple rehearsal or labeling facilitates recency and depresses primacy effects in a probe-type memory task (Ellis, 1969). Recency performance is comparable in both retarded and normal Ss, but adult and adolescent retardates display a lower primacy performance than normal Ss (Ellis, 1969, 1970). From these findings it has been concluded that normal Ss show evidence of using both primary and secondary memory, while retarded Ss employ mainly primary memory and display a deficiency in secondary memory (Ellis, 1970). It was also suggested that the STM deficit of retardates results from an acquisition deficit which is probably due to a failure to rehearse actively stimulus input after it enters primary memory rather than due to defective retention or retrieval (Belmont & Butterfield, 1969). It seems plausible, therefore, to hypothesize a deficit in EMR children not in primary or STM, but rather in secondary memory which is determined by "secondary organization."

In conclusion, this section has reviewed the major psychological theories which attempt to explain the organizational processes involved in learning and memory, and the literature pertaining to clustering and subjective organization among children and adults. It seems plausible from the evidence reviewed that EMR children would demonstrate significantly less recall and clustering (both associative and category clustering) than normal children of similar age on verbal free recall tasks in which the items were organized into a number of conceptual categories or similar grammatical classes. Similarly, EMR children would display relatively inferior recall performance on verbal recall tasks composed of low-associative or semantically "unrelated" items since it would be relatively more difficult for them to organize unrelated items into appropriate higher-order memory units. On the other hand, EMR children would be expected to demonstrate a high degree of associative clustering and reveal best recall performance on recall of verbal stimuli composed of both high-associative and sequential relationships. The following section presents the experimental and statistical designs and the procedures employed to test these hypotheses.

METHOD

Subjects

Thirty normal and 30 EMR boys were selected as Ss from two elementary public schools in Taylor, Michigan. Taylor is a city of approximately 60,000 people situated in the southeast portion of Michigan approximately 33 miles east of the city of Ann Arbor, and 3 miles southwest of the city of Detroit. Subjects were randomly drawn from special and regular classes in session in these two elementary schools. Children were included in the EMR group if they had IQs between 55 and 80 on the Stanford-Binet Intelligence Test and were enrolled in Type A (i.e., EMR) special education classes. Children were included in the nonretarded group if they had IQs between 90 and 120 on the California Test of Mental Maturity and were enrolled in regular classes. Additional criteria for the selection of Ss for both groups were: (a) the absence of major visual, auditory, or motor disabilities, or emotional disturbance; and (b) a chronological age (CA) between seven and twelve years.

Both elementary schools were situated in a primarily urban, working class neighborhood. Subjects were all of Caucasian race and were considered to be homogeneous with respect to socioeconomic level. Table 1 summarizes the characteristics of the two groups of Ss used in this investigation.

Stimulus Lists

Word-association stimuli. Twenty high-frequency nouns were selected as stimuli for a word-association (W-A) task. The stimuli were selected

TABLE 1

CHARACTERISTICS OF THE TWO GROUPS

(n = 30 per group)

Variable		EMR Group	Normal Group
CA (Months)	Mean	115.27	117.00
	SD	15.36	15.37
	Range	88 - 145	87 - 145
IQ	Mean	69.90	105.10
	SD	6.50	9.10
	Range	58 - 78	90 - 118

from standard primer and pre-primer readers, and from the Mein and O'Connor (1960) list of words most commonly used by retarded children. Eleven of the nouns were of A or AA frequency of occurrence according to the Thorndike-Lorge general word count (1944). The remaining nine nouns ranged from 9 to 45 occurrences per million. Nouns were selected as stimuli since they were thought to have the highest probability of eliciting paradigmatic responses from EMR children (Semmel et al., 1968a). Table 2 (p. 73) lists the stimuli for the W-A task.

Categorized List (CL). A 12-word free recall list was constructed to measure category clustering in both child samples. The list was composed of 12 nouns, with three words from each of four mutually ex-

TABLE 2

FREE WORD-ASSOCIATION STIMULI

horse	money	thief	couch	cheese
snow	bug	gun	mouth	leaf
sun	radio	piano	moon	food
clock	fork	street	carrot	ball

clusive conceptual categories (animals, fruits, articles of clothing, and vehicles). The four categories were matched as closely as possible on the basis of the Thorndike-Lorge general word count (1944). Six of the stimuli were A or AA frequency of occurrence according to the Thorndike-Lorge general word count. The remaining six words ranged from 6 to 30 occurrences per million. All the stimuli in each category were among the first ten responses to category names present in the Battig and Montague (1969) category norms. The items of the categorized list are presented in Table 3.

TABLE 3

CATEGORIZED LIST

Categories			
Fruits	Animals	Articles of Clothing	Vehicles
apple	lion	coat	train
banana	tiger	sweater	car
orange	bear	pants	truck

Paradigmatic and Syntagmatic word lists. Four additional 12-word lists were constructed and are presented in Table 4 (p. 75). The items were selected from the following W-A norms: (a) Semmel, Sitko, and Semmel (1969) oral word-association norms for EMR children; (b) Gerjuoy and Gerjuoy (1965) preliminary word-association norms for institutionalized adolescent retardates; (c) Palermo and Jenkins (1966) oral word-association norms for children in grades one through four; and (d) Entwisle (1966b) oral word-association norms of young children in first, third, and fifth grades. An attempt was made to choose stimulus pairs which were common to both retarded and normal children's W-A norms. Each list contained at least three pairs of word-associations present on the W-A norms for retarded Ss and at least three pairs of word-associations present on the W-A norms for normal children.

The six word pairs in each list were composed of a stimulus noun element and a response noun, verb, or adjective. In the "H-P" list, the response items were high-associative paradigmatic nouns as indicated by the W-A norms. In the "H-S" list, the response items were high-associative verbs or adjectives (syntagmatic) which appeared on the norms. The criterion of high association was satisfied by choosing from the norms noun responses which could not be used sequentially with the stimulus nouns (i.e., could not appear in an immediately contiguous relationship to the stimulus). The criterion of syntagmatic responses was satisfied by choosing from the norms, verbs and adjectives which could be used sequentially with the stimulus nouns.

In the "L-P" list the response items were low-associative para-

TABLE 4

FREE RECALL WORD LISTS

High-Associative Paradigmatic (H-P)		Low-Associative Paradigmatic (L-P)	
table	chair	sheep	hill
girl	boy	flower	fruit
hand	fingers	milk	cake
mother	father	balloon	fun
bread	butter	door	wall
dogs	cats	city	river
High-Associative Syntagmatic (H-S)		**Low-Associative Syntagmatic (L-S)**	
bird	fly	fish	cook
boy	play	boat	go
water	drink	man	walk
bed	sleep	soft	sand
green	grass	black	hat
sugar	sweet	cold	floor

digmatic nouns as indicated by the W-A norms. In the "L-S" list the response items were low-associative verbs or adjectives (syntagmatic) which appeared on the norms. The criterion for inclusion as low-associative responses was four percent or less associative strength between the six pairs of primary stimuli as indicated by the W-A norms. As a result, the L-S and L-P lists contained 12 essentially semantically "unrelated" items.

Intralist association was controlled on all four stimulus lists. Only stimuli with low intralist associations on the norm lists were selected. The criterion for inclusion was four percent or less association between all possible pairs of secondary stimuli. Forty-six of the stimuli on the four stimulus lists were of A or AA frequency of occurrence according to the Thorndike-Lorge general word count (1944). The other two words (i.e., balloon and toy), were respectively 17 and 49 occurrences per million.

Experimental Design

Each S was given 12 successive free recall learning trials on the categorized word list. The position of words within the list was different on each of the 12 trials in order to minimize serial order effects. The list was constructed so that two words from the same category were never presented successively. In addition, the order of presentation of the items was such that each word appeared just once in each serial position in the course of 12 trials.

Each S was also given 12 successive free recall learning trials on each of the paradigmatic and syntagmatic word lists. On the H-P and H-S lists, the position of words within each list was different on each of the 12 trials in order to minimize serial order effects. The lists were constructed so that the two members of a pair were never adjacent. In addition, the order of presentation of the items was such that each word appeared only once in each serial position in the course of the 12 trials. On the L-P and L-S lists, the order of presentation of the items was such that each word appeared in each serial position only once and was preceded and followed by each other word in the list just once in the course of the 12 trials.

The order of presentation of the five free recall lists was randomized among the two groups so that the effects of order were equally counterbalanced across Ss. The order of presentation of the five lists was also randomized among the five trained testers who administered the lists. Specifically, the 60 Ss were randomly assigned to five groups. Each group was assigned a different order of presentation of the five lists. This order was determined by selecting a Latin square arrangement for squares of order five (Edwards, 1968). The investigator then randomized the rows and columns of the square and assigned the five lists at random to the letters. The testers were assigned at random to the groups by list combinations. Four female adults in addition to the investigator were trained to administer the tasks.

Procedure

All testing was done in a quiet school room. Ss were individually tested and were administered the five recall lists through magnetic tape recordings. Stimuli were presented at two-second intervals. A 75-second free recall period followed each trial. Total testing time for any word list did not exceed 25 minutes. Each word list was administered at separate testing sessions. A two-day interval was chosen as the minimum time lag between testing sessions for individual Ss. Each testing session was recorded by a portable tape recorder. In addition, the testers recorded the Ss' responses on response sheets.

Ss were introduced to the learning task with the following instructions:

> We are going to play a word game and I want you to do your best. In this game you will hear a man's voice on the tape recorder. He is going to say a list of words 12 times. There will be 12 different words on the list. Listen very carefully. When the man has finished each list, I want you to tell me, in any order, as many of the words as you can remember. Do you have any questions? [Any questions were answered at this time.] O.K., now listen and see how many words you can remember.

When a S paused for 30 seconds during the recall phase, the tester asked, "Do you remember any more?"

The free word-association task was administered to the 60 Ss as soon as testing on the five free recall lists was completed. Ss were individually tested on the 20 high-frequency noun W-A stimuli. The instructions to each S were as follows:

> Now we are going to play another word game. In this game, I will read you a word from one of these cards. The idea of the game is for you to say the first word you think of when I say the word to you. You should say just one word and not more than one.

Subjects were presented two sample stimuli in order to test their understanding of the task. The tester presented the first sample word by saying, "Now let's see if you understand the rules of the game. What's the first word you think of when I say 'cow'?" Any single-word response was reinforced by the tester with, "Very good!" This procedure was followed in presenting the second sample word (school). The test stimuli immediately followed the S's response to the second sample word. Words were randomized by hand-shuffling prior to presentation to the S.

Stimuli were printed in large manuscript letters on five- by eight-inch unlined index cards. Each A-A response was coded by the tester at the time of testing into paradigmatic and syntagmatic categories according to the procedure employed by Semmel et al. (1968a). When the response word could not be used sequentially with the stimulus word and was a noun (e.g., "fork" and "spoon"), the S was given credit for a paradigmatic response. Words which were not used sequentially and were of different parts of speech (e.g., "street" and "slow"),words which followed each other sequentially and were nouns (e.g., "piano" and "player"), and words which were used sequentially and were of different parts of speech (e.g., "mouth" and "chew") were all placed in the syntagmatic category. When the response word was a noun which could be used sequentially, the S was asked to make up a sentence using the response and the stimulus noun. The tester could then determine whether the response was paradigmatic or syntagmatic. The coding of W-A responses was later verified by two judges. Inter-judge agreement was 100% on the coding procedure.

In summary, two groups of 30 normal and 30 EMR boys were randomly selected as subjects for the study. Each S was presented with five separate stimulus lists, each composed of 12 verbal items. One list contained three words from each of four mutually exclusive conceptual categories. The remaining four lists were composed of six word pairs and differed in the degree of associative strength and in the grammatical form-class of their items. Each S was given 12 successive learning trials on the five lists. The position of words within each list was different on each of the 12 trials. Order of presentation of the five lists was randomized among the two groups and the five testers who administered the lists. Subjects were individually tested and were administered the five lists at separate testing sessions through tape recordings. A 20-item free word-association task was administered to all Ss as soon as testing on the five stimulus lists was completed. The results of the statistical analyses performed on the data obtained by the above procedures are described in the following section.

RESULTS

This section presents the statistical analyses of the data collected by the method described previously.

Free Word-Associations

Free W-A responses on the 20-word free W-A task were coded into either paradigmatic or syntagmatic responses. Table 5 presents the mean percentage of paradigmatic responses and standard deviations (SDs) on the W-A task for normal and EMR Ss. A t test for independent samples indicated a significant difference between the percentage of paradigmatic associations made by each group ($t = 4.856$ / $df = 58$ / $p < .001$).

TABLE 5

MEAN PERCENTAGE OF PARADIGMATIC RESPONSES ON THE FREE WORD-ASSOCIATION TASK

(n = 20 words)

Statistic	Total Subject Group (n = 60)	Normal Group (n = 30)	EMR Group (n = 30)
Mean %	52.33	67.33	37.33
SD	28.31	21.45	26.55
Range	0 - 100	30 - 100	0 - 100

Free Recall

The number of correct words recalled on each of the 12 trials was computed for each of the five word lists. The total number of words recalled correctly for each block of three trials was then computed and analyzed for each list.

Categorized List. The free recall data for the categorized word list was analyzed through a 2 x 4 fixed ANOVA design with repeated measures over the last factor (see Winer, 1962, Chapter 7). Total recall per trial block served as the dependent variable. The effects of a group classification (A) and trial blocks (B) were assessed. Table 6 presents the summary of this analysis.

TABLE 6

SUMMARY OF ANALYSIS OF VARIANCE OF RECALL ON THE CATEGORIZED LIST FOR GROUPS AND TRIAL BLOCKS

Source	df	MS	F
Between Ss	59		
Groups (A)	1	2933.00	35.09***
Subjects within groups	58	83.58	
Within Ss	180		
Trial Blocks (B)	3	896.08	126.31***
A x B	3	24.53	3.46*
B x Subjects within groups	174	7.09	

* $p < .05$

*** $p < .001$

The main effects of groups (normal versus retarded Ss) and trial blocks were highly significant ($p < .001$). The interaction of groups with trial blocks was also statistically significant ($p < .05$). Table 7 presents mean total recall and SDs across all trial blocks for the categorized list. Figure 1 (p. 85) indicates the nature of the significant AB interaction. Tukey and Scheffé methods were used to analyze multiple comparisons among group means, since the evidence shows that they produce the fewest Type I errors and are least susceptible to violations of underlying assumptions in the ANOVA model (Petrinovich & Hardyck, 1969).

TABLE 7

MEAN TOTAL RECALL SCORES FOR THE CATEGORIZED LIST

Group	Statistics	Trials 1 - 3	4 - 6	7 - 9	10 - 12	Total Trials
Normal	$\bar{X}$	21.00	28.20	29.97	30.93	110.10
(n = 30)	SD	4.87	4.44	4.71	4.61	16.77
EMR	$\bar{X}$	15.77	21.30	22.27	22.80	82.13
(n = 30)	SD	4.33	5.33	5.83	6.29	19.68

As is generally recommended (e.g., Guenther, 1964; Hays, 1963; Petrinovich & Hardyck, 1969) Tukey's method was used to investigate only paired comparisons while Scheffé's method was used to investigate more complex comparisons involving more than two treatment means. Tukey's method for multiple comparisons (Guenther, 1964) revealed that mean criterion scores between the two groups differed significantly across all four trial blocks in favor of normal Ss ($p < .01$). As shown in Figure 1, the recall of both groups tended to improve as trials progressed. However, normal Ss revealed a slightly steeper slope in their learning curve than EMRs. The difference in recall between the two groups gradually widened across successive blocks of trials.

Tukey analysis revealed that free recall of normal Ss increased significantly between the first and second block of trials ($p < .01$), and between the second and fourth block of trials ($p < .01$). However, the difference in recall between the second and third trial blocks and between the third and fourth trial blocks was not significant ($p < .05$). The analysis further revealed that recall of retarded Ss also increased significantly between the first and second trial blocks ($p < .01$), but there was no significant increase in recall between trial blocks two and four.

As indicated in Table 7, the magnitude of SDs for normal children was uniform across the four blocks of trials while the SDs of EMR children increased progressively across trial blocks. In addition, EMR children demonstrated a slightly greater variance in their total recall performance than normal children.

Paradigmatic and Syntagmatic Lists. The free recall data for the paradigmatic and syntagmatic word lists were analyzed through a 2 x 4 x 2 x 2 fixed ANOVA design with repeated measures over the last three factors. Total recall per trial block served as the dependent variable. The effects of group classification (A), trial blocks (B), associative strength of stimuli (C), and form-class of stimuli (D) were assessed. Table 8 (p. 86) presents the summary of this analysis.

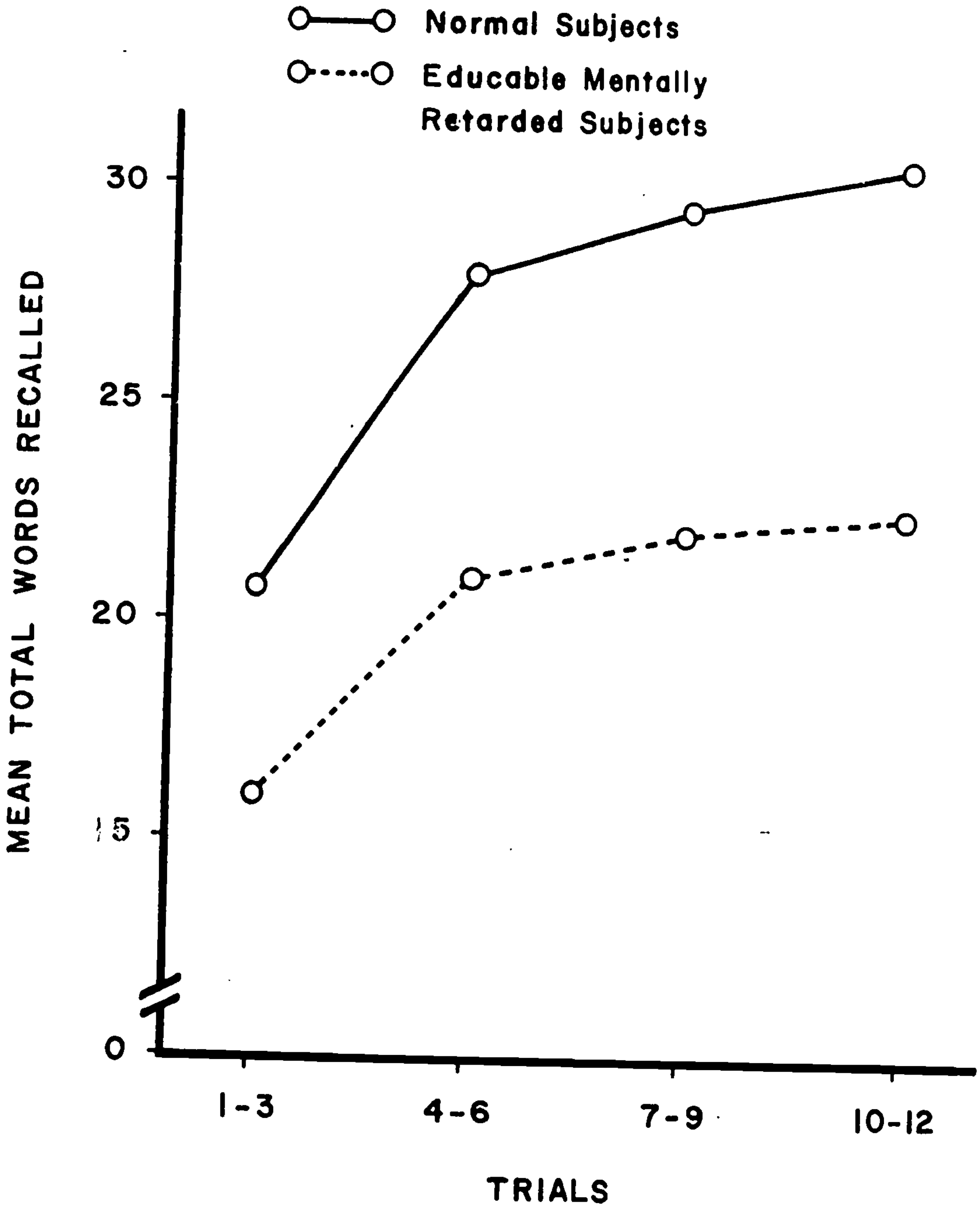

Fig. 1. Mean number of total words recalled as a function of trial blocks for retarded and normal subjects on the categorized list.

TABLE 8

SUMMARY OF ANALYSIS OF VARIANCE OF RECALL ON THE PARADIGMATIC AND SYNTAGMATIC LISTS FOR THE FOUR FACTORS STUDIED

Source	*df*	*MS*	*F*
Between *Ss*	59		
Groups (A)	1	14007.18	36.28***
Subjects within groups	58	386.07	
Within *Ss*	900		
Trial Blocks (B)	3	3364.91	258.82***
A x B	3	79.42	6.11***
B x Subjects within groups	174	13.00	
Associative Strength of Stimuli (C)	1	2880.80	129.19***
A x C	1	221.38	9.93**
C x Subjects within groups	58	22.30	
Form Class of Stimuli (D)	1	3.38	0.08
A x D	1	102.05	2.54
D x Subjects within groups	58	40.25	
B x C	3	11.07	1.75
A x B x C	3	15.01	2.38
BC x Subjects within groups	174	6.31	
B x D	3	14.05	1.97
A x B x D	3	1.93	0.27
BD x Subjects within groups	174	7.14	
C x D	1	221.38	6.63*
A x C x D	1	641.90	19.24***
CD x Subjects within groups	58	33.37	
B x C x D	3	2.44	0.43
A x B x C x D	3	0.65	0.12
BCD x Subjects within groups	174	5.63	

* $p < .05$
** $p < .01$
*** $p < .001$

The main effects of groups (normal vs. retarded Ss), trial blocks, (one through four), and degree of associative strength (high vs. low) of word pairs were highly significant ($p < .001$). These results indicated that across the four stimulus lists: (a) normal children recalled significantly more items than retarded children, (b) recall increased significantly across the four blocks of trials, and (c) stimulus lists with high-associative word pairs produced better recall than lists with low-associative word pairs. The two-way interactions of groups with blocks of trials and with degree of associative strength were also highly significant ($p < .001$; $p < .01$), as was the triple interaction of groups with degree of associative strength and form-class of stimuli ($p < .001$).

Table 9 (p. 89) presents mean total recall and SDs across each trial block for the four paradigmatic and syntagmatic word lists. Figure 2 (p.90) indicates the nature of the significant AB interaction (see Table 8). As shown in Figure 2, the free recall of both groups on each of the four stimulus lists tended to increase as trials progressed. However, normal Ss displayed a slightly steeper slope in their learning curve than EMR Ss between trial blocks one and three. On the other hand, the learning curves for the two groups are similar between blocks three and four. Scheffé's method for multiple comparisons (Guenther, 1964) revealed that the difference in mean criterion scores between the groups on trial block three was significantly greater than the difference in criterion scores on trial block one ($p < .05$). Figures 3 and 4 (pp. 91 & 92) represent the learning curves of normal and retarded Ss under the four list conditions. As shown in Figures 3 and 4, the similarity in the shapes of the learning curves for each group under all list conditions is consistent across trial blocks. The two curves partially illustrate the nature of the nonsignificant ABCD interaction by showing that the profiles of the ACD means are parallel within each level of factor B.

Tukey analysis of the significant AB interaction (Table 8) revealed that across the four lists mean criterion scores of normal Ss were superior to those of retarded Ss on each block of trials. The within-groups Tukey analyses revealed that free recall of normal Ss increased significantly between trial blocks one, two, and three ($p < .01$). No significant differences in recall were found between trial blocks three and four. On the other hand, free recall of retarded Ss increased significantly between trial blocks one and two ($p < .01$), and three and four ($p < .05$). No significant differences in recall were found between blocks two and three.

Figure 5 (p. 93) indicates the nature of the significant ACD interaction (see Table 8). The superiority in free recall of normal Ss was especially evident when stimulus pairs were either paradigmatic nouns, as in lists H-P and L-P or of low-associative strength, as in lists L-P and L-S. Tukey analysis showed that free recall was superior in normal Ss on all four paradigmatic and syntagmatic word lists ($p < .01$). Scheffé's method indicated that the difference in mean criterion scores between EMR and normal Ss on the high-associative syntagmatic list was significantly less than the difference in mean criterion scores between the two groups on the high-associative paradigmatic list ($p < .05$).

TABLE 9

MEAN TOTAL RECALL SCORES ON THE PARADIGMATIC AND SYNTAGMATIC LISTS

Groups (n = 30 per group)	Statistic	Trials 1 - 3	4 - 6	7 - 9	10 - 12	Total Trials
High-Associative Paradigmatic List						
Normal	$\bar{x}$	23.07	29.03	31.27	32.03	115.40
	SD	5.92	5.77	5.53	4.69	19.88
Educable Mentally Retarded	$\bar{x}$	15.23	20.13	21.27	22.90	79.53
	SD	4.58	5.82	5.97	7.01	21.14
Low-Associative Paradigmatic List						
Normal	$\bar{x}$	17.77	23.83	25.90	27.50	95.00
	SD	5.21	6.44	5.76	5.65	21.53
Educable Mentally Retarded	$\bar{x}$	12.80	15.80	17.43	18.50	64.53
	SD	3.72	4.81	6.60	6.92	20.19
High-Associative Syntagmatic List						
Normal	$\bar{x}$	19.07	25.73	28.10	29.03	101.93
	SD	4.60	6.30	5.68	5.82	20.22
Educable Mentally Retarded	$\bar{x}$	15.53	21.30	22.80	24.73	84.37
	SD	4.76	7.30	8.78	9.48	29.12
Low-Associative Syntagmatic List						
Normal	$\bar{x}$	19.30	26.00	27.70	29.30	102.30
	SD	5.05	5.33	5.39	5.34	19.68
Educable Mentally Retarded	$\bar{x}$	11.67	16.37	17.13	18.80	64.3[illegible]
	SD	4.37	6.22	6.46	7.27	22.24

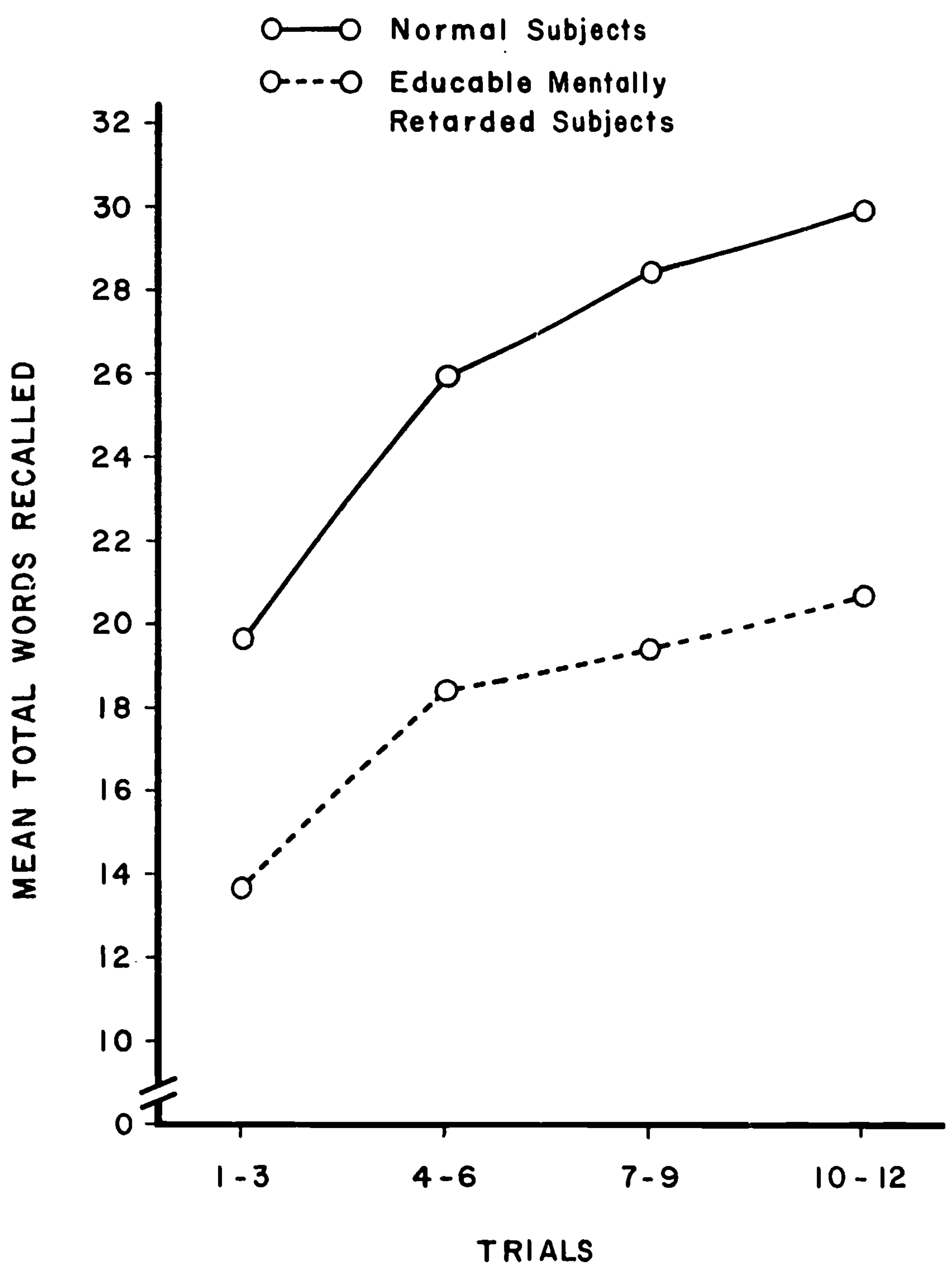

Fig. 2. Mean number of total words recalled as a function of trial blocks for retarded and normal subjects on the paradigmatic and syntagmatic lists combined.

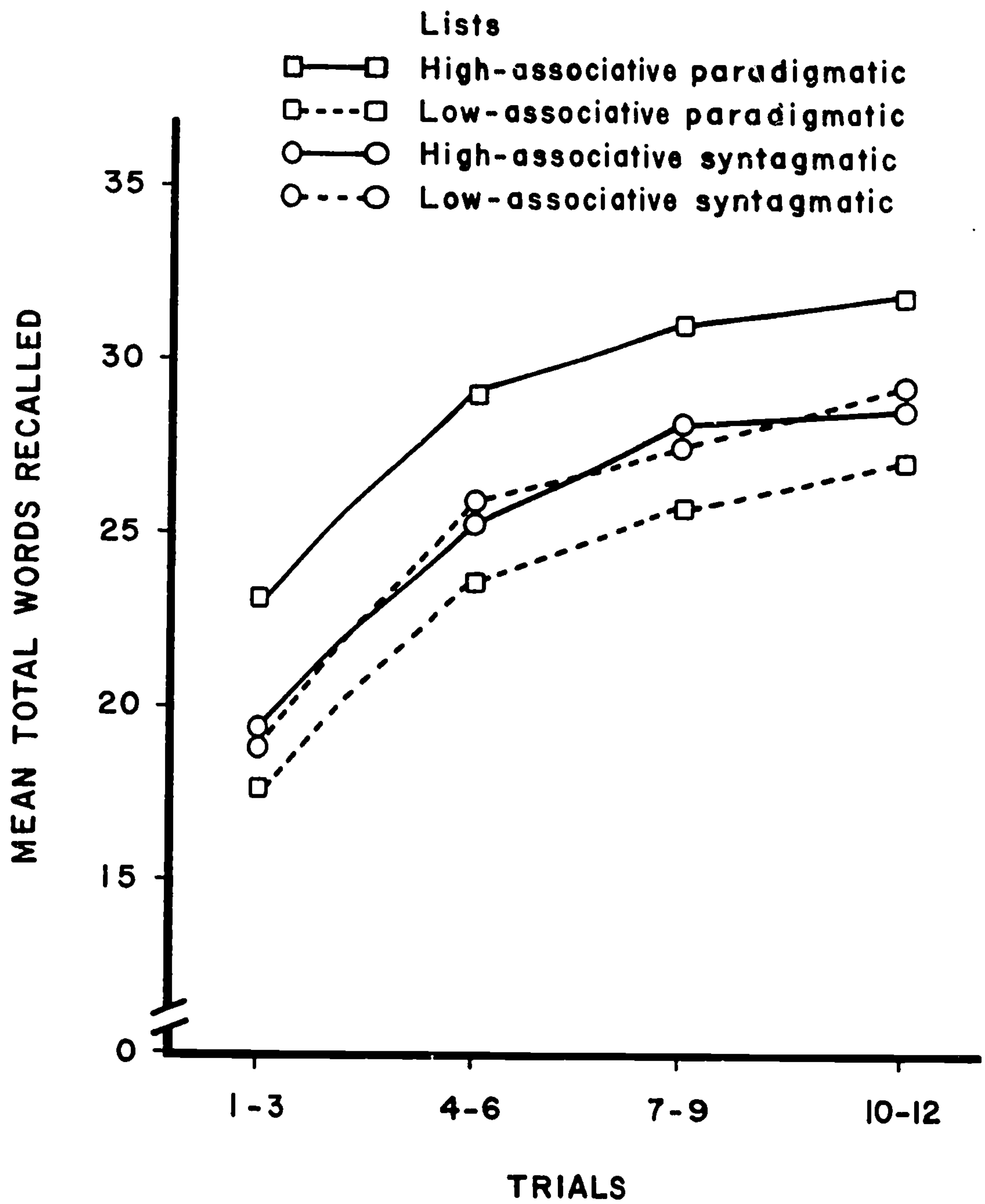

Fig. 3. Mean number of total words recalled as a function of trial blocks for normal subjects on the four paradigmatic and syntagmatic lists.

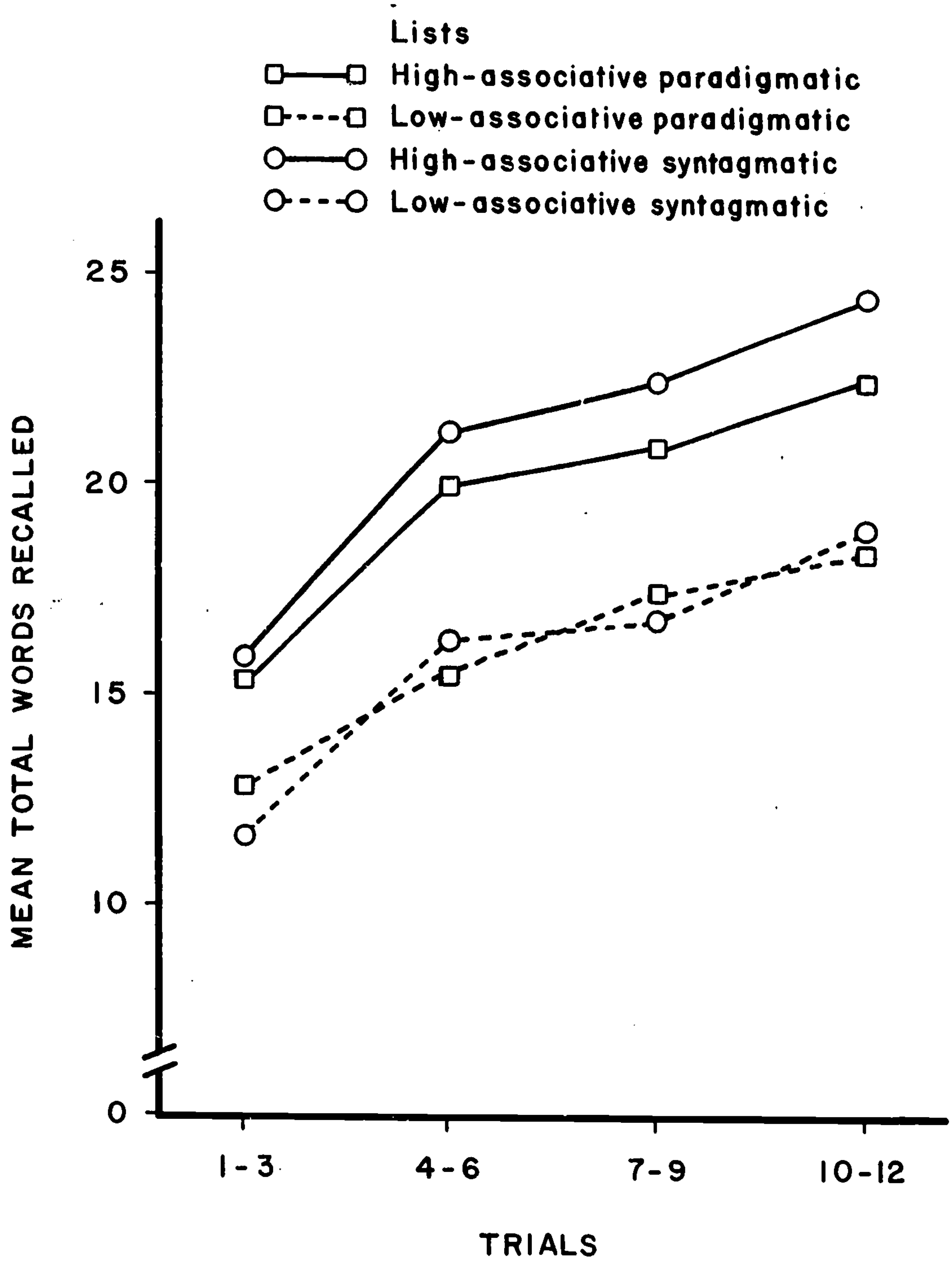

Fig. 4. Mean number of total words recalled as a function of trial blocks for educable mentally retarded subjects on the paradigmatic and syntagmatic lists.

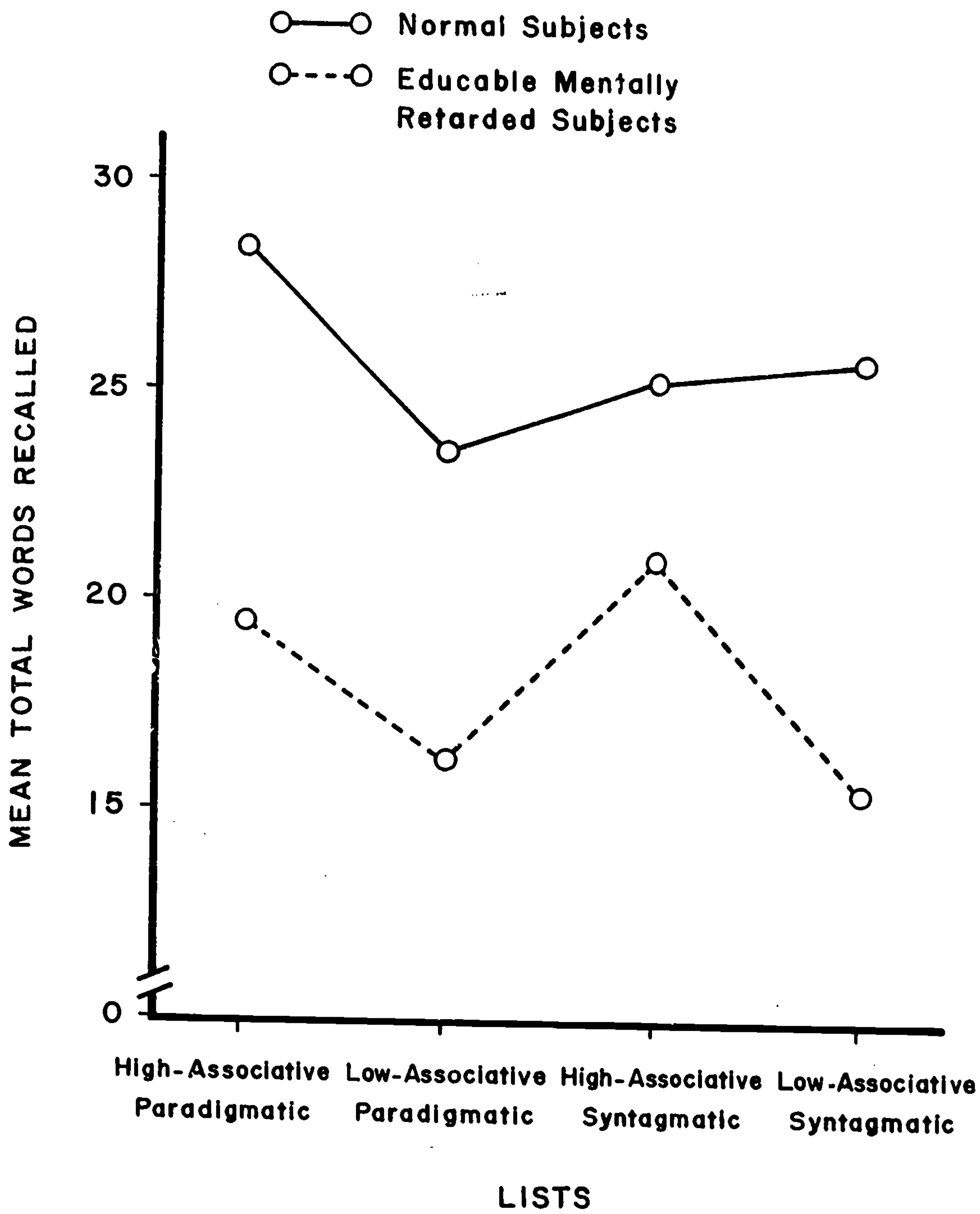

Fig. 5. Mean number of total words recalled across trial blocks for retarded and normal subjects on the four paradigmatic and syntagmatic lists.

Figure 6 (p. 95) illustrates more specifically the geometric nature of the ACD interaction. The profiles of the two-factor interaction means are plotted within each level of the third factor. Inspection of Figure 6 reveals that the forms of the graphs for each of the two-factor means within each level of the third factor are quite different. This finding is consistent with the significance of the ACD mean square. The profiles of the AC interactions for D_1 indicate that the differences in recall performance between the two groups on the H-P list were similar to group differences in recall on the L-P list. On the other hand, the AC profiles for D_2 indicate that group differences on the L-S list were significantly greater than group differences on the H-S list. Scheffé analysis of the difference in group means for high- and low-associative syntagmatic lists confirmed this finding ($p < .01$).

The profiles of the AD interactions for C_1 indicate that group differences in recall on the H-P list were greater than group differences on the H-S list. As indicated previously, Scheffé analysis showed these differences to be statistically significant ($p < .05$). On the other hand, the AD profiles for C_2 indicate that the differences in recall performance between the two groups on the L-P list were similar to group differences in recall on the L-S list.

The profiles of the CD interaction for A_1 and A_2 indicated that for both groups, the differences in recall performance on high-associative lists (H-S, H-P) were similar to the differences in recall on low-associative lists (L-S, L-P). Scheffé analysis confirmed this finding ($p < .05$).

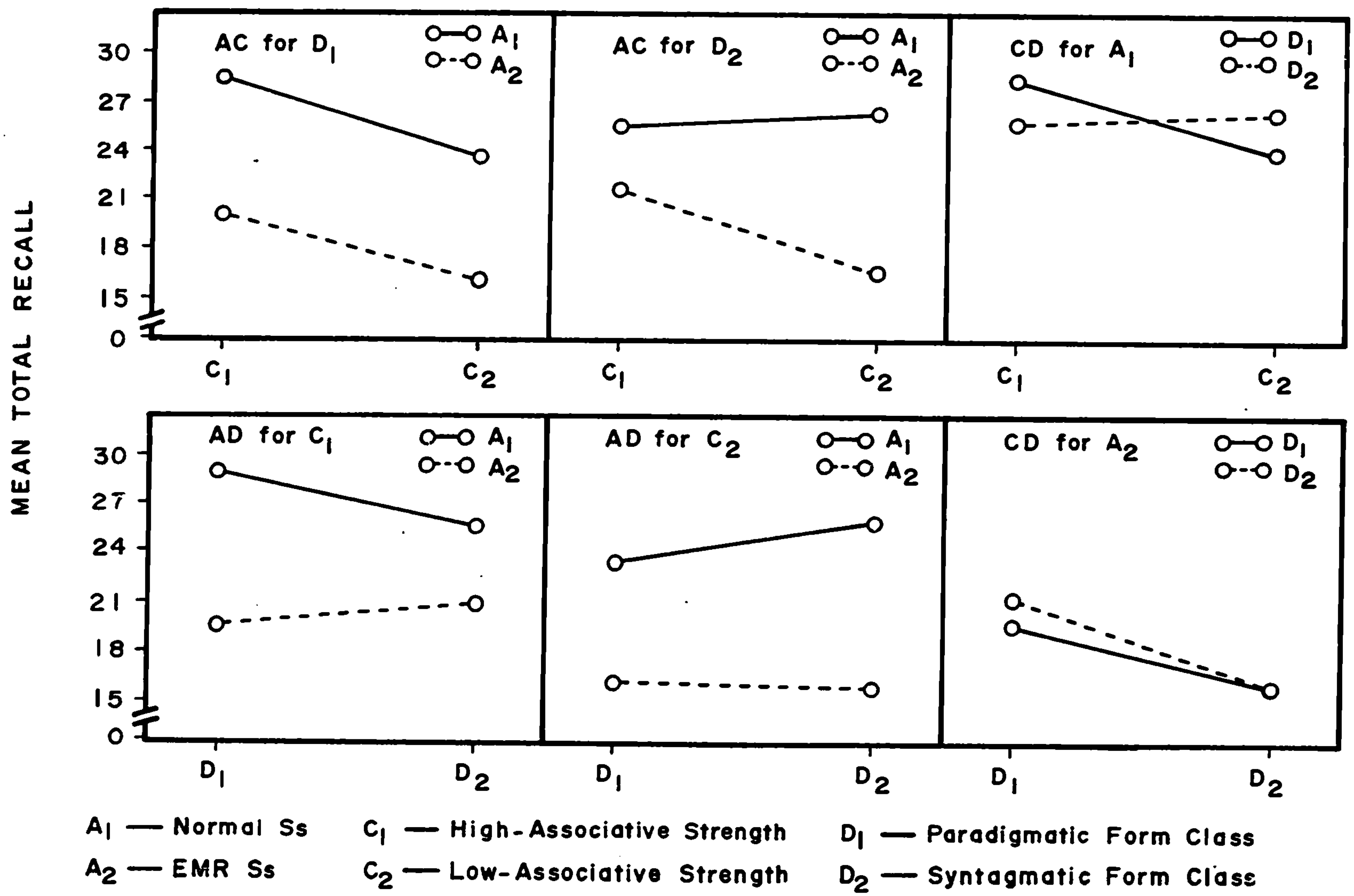

Fig. 6. Profiles for the ACD interaction shown in Table 8.

The Tukey analysis for within-groups revealed that mean recall scores for normal Ss were significantly higher ($p < .01$) for the H-P list than the mean scores obtained on each of the remaining three stimulus lists. Mean criterion scores of normal Ss on these other three lists were not significantly different ($p < .05$). For EMR Ss, Tukey tests showed that mean criterion scores on high-associative lists (H-S and H-P) were significantly higher ($p < .01$) than mean criterion scores obtained on low-associative lists (L-S and L-P). However, mean criterion scores of EMR Ss on the high-associative lists did not differ significantly ($p < .05$), nor did scores obtained on the low-associative lists ($p < .05$).

It should be noted that the SDs of EMR children for total words recalled on the H-S list exceeded the magnitudes of SDs for all other lists (Table 9). The SDs for normal children, however, were fairly uniform across all lists. In addition, the SDs of EMR Ss for the total 12 trials exceeded those of normal Ss on all stimulus lists except the low-associative paradigmatic list. As shown in Table 9, SDs of EMR Ss for criterion scores revealed a consistent trend. For each of the paradigmatic and syntagmatic word lists, the SDs increased in magnitude across the four blocks of trials. On the other hand, SDs of normal Ss were relatively consistent across the four trial blocks. These findings reflect a greater degree of individual differences in free recall among the retarded Ss both within and between treatment conditions, and a greater degree of consistency and homogeneity in the free recall of the normal group.

Category Clustering

Bousfield's method of scoring category clustering in free recall was used to analyze the clustering data for the categorized list (Bousfield & Bousfield, 1966; Bousfield & Puff, 1964). According to this method, the difference between the obtained and the expected number of category repetitions or clusters is used to measure the amount of above-chance clustering on a particular recall trial. Expected clustering is derived from the following formula:

$$E\ (SCR) = [(m_1^2 + \ldots + m_k^2)/n] - 1$$

where SCR = stimulus category repetition
E(SCR) = expected clustering
k = the number of non-overlapping categories
m = the number of items recalled from a particular k category
n = total number of recalled items $= m_1 + \ldots + m_k$

Obtained clustering is equal to the total number of sequential occurrences or repetitions of two words from the k categories. The total number of possible repetitions in a particular category is equal to one less than the number of stimulus items in that category. Therefore, three words from the same category which are recalled together are given a score of two according to the scoring procedure.

The amount of category clustering above chance for each S was calculated for each of the 12 recall trials. For each group single-mean t tests were performed in order to determine whether the amount of category clustering for each trial was significantly above chance. Categorical intrusions, i.e., extralist words belonging to an appropriate list category, were ignored in scoring the observed clusters. Perseverations or repetitions of stimulus words were not counted in scoring recall or clustering. Irrelevant intrusions; i.e., extralist words which did not belong to an appropriate list category were also not counted in scoring category clustering.

The category clustering data for the categorized list was analyzed through a 2 x 4 fixed ANOVA design with repeated measures over the last factor. The total amount of category clustering above chance per trial block served as the dependent variable. The effects of group classification (A) and trial blocks (B) were assessed. Table 10 presents the summary of this analysis.

TABLE 10

SUMMARY OF ANALYSIS OF VARIANCE OF CATEGORY CLUSTERING FOR GROUPS AND TRIAL BLOCKS

Source	df	MS	F
Between Ss	59		
Groups (A)	1	883.47	16.55***
Subjects within groups	58	53.37	
Within Ss	180		
Trial Blocks (B)	3	171.49	22.27***
A x B	3	26.85	3.49*
B x Subjects within groups	174	7.70	

* $p < .05$
*** $p < .001$

The main effects of groups (normal vs. retarded Ss) and trial blocks were highly significant ($p < .001$). The interaction of groups with trial blocks was also statistically significant ($p < .05$).

Table 11 (p. 101) presents mean total clustering above chance and SDs over all trial blocks for the categorized list.

Figure 7 (p. 100) indicates the nature of the significant AB interaction (see Table 10). Tukey analysis revealed that mean criterion scores between the two groups differed significantly on trial block one ($p < .05$) and trial blocks two through four ($p < .01$) in favor of normal Ss. As shown in Figure 9 (p.109), the clustering of both groups tended to improve as trials progressed although the rate of increase for normals was higher over the first nine trials. However, normal Ss appeared to reach an asymptote in their clustering between the third and fourth block of trials, while EMR Ss revealed a small but continued increase in category clustering between these same trial blocks. Tukey analysis showed that the category clustering of normal Ss increased significantly between trial blocks one and two, and two and three ($p < .05$). The difference in clustering between trial blocks three and four was not significant ($p < .05$). For retarded Ss, only the difference in clustering between the first and fourth trial blocks was significant ($p < .05$).

Above-chance clustering was further analyzed by a series of single-mean t tests for each trial. Table 12 (p.102) presents the summary of this analysis for normal and retarded Ss. The analysis indicated that category clustering of normal children was significantly above chance on all 12 trials ($p < .01$). On the other hand, category cluster-

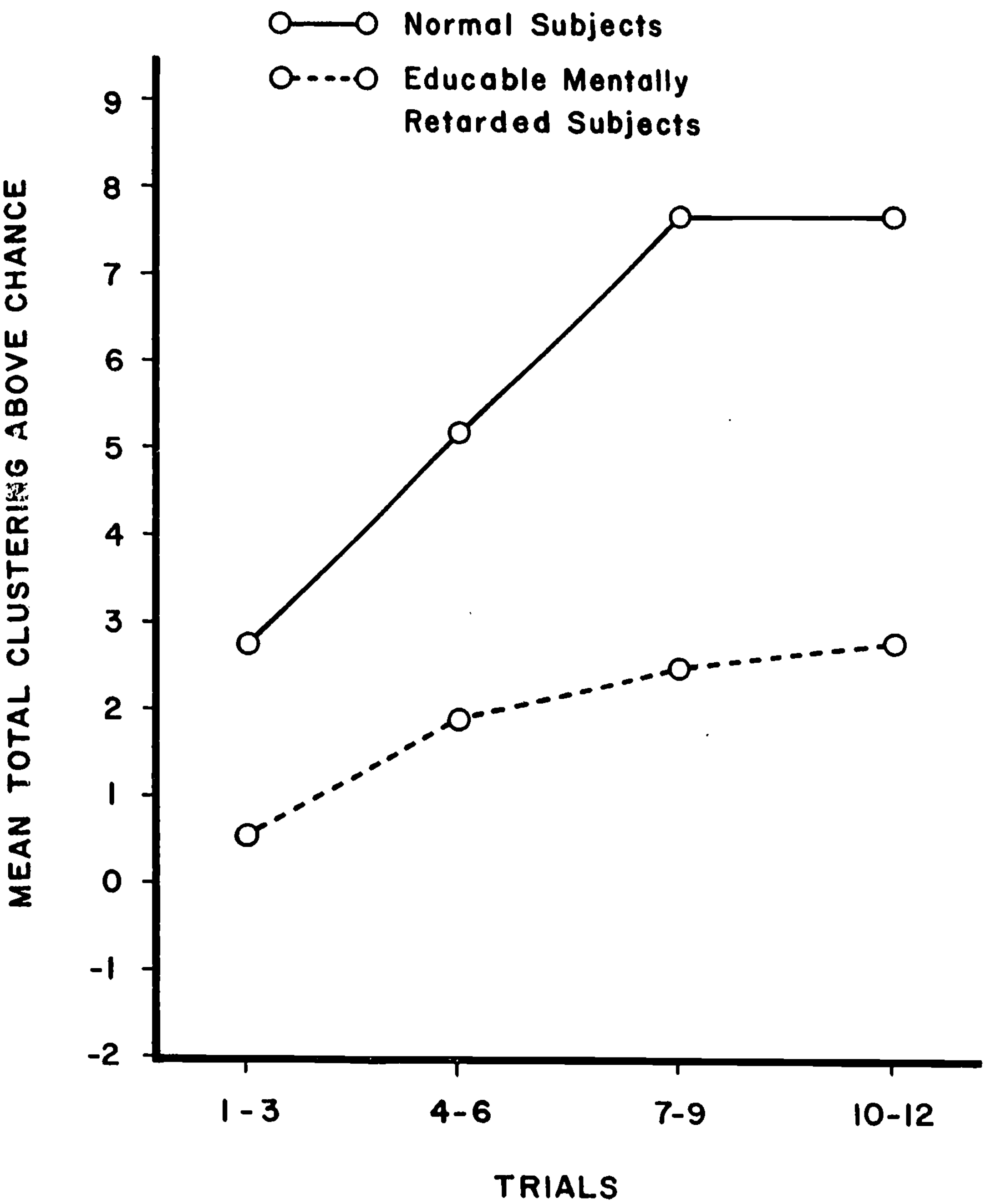

Fig. 7. Mean number of total category clusters per trial block for normal and retarded children on the categorized list.

TABLE 11

MEAN TOTAL CATEGORY CLUSTERING SCORES

FOR THE CATEGORIZED LIST

Group	Statistic	Trials				Total Trials
		1-3	4-6	7-9	10-12	
Normal	$\bar{x}$	2.80	5.15	7.66	7.72	23.32
(n = 30)	SD	3.00	5.29	6.06	7.12	19.37
EMR	$\bar{x}$	0.56	1.91	2.59	2.91	7.97
(n = 30)	SD	1.37	2.79	2.63	3.45	7.21

ing of retarded children was not reliably above chance until the third trial ($p < .01$). Retarded children clustered an average of less than one word above chance until the final trial, while normal children achieved that criterion by the third trial. Category clustering in normal Ss appeared to reach an asymptote by trial seven. Inspection of Tables 11 and 12 reveals that SDs of normal children tended to increase significantly over each block of trials and on each trial exceeded those of EMR children.

The product-moment correlations between the amount of category clustering above chance and recall performance over the total block of 12 trials for normal and retarded Ss on the categorized list were respectively: $r_N = .81$ ($p < .01$), $r_{EMR} = .78$ ($p < .01$). Both groups demonstrated a significant positive correlation between category clustering and total recall performance ($p < .01$). Approximately 66% of the variance of total recall for normal Ss and 61% of the variance for EMR

TABLE 12

SUMMARY OF SINGLE-MEAN t TESTS FOR ABOVE-CHANCE CLUSTERING ON THE CATEGORIZED LIST

(n = 30 for each group)

Trial	Statistic	Normal Group	t	EMR Group	t
1	$\bar{x}$	0.46	2.81**	-0.06	-0.56
	SD	0.90		0.61	
2	$\bar{x}$	0.94	4.61***	0.22	1.89*
	SD	1.11		0.64	
3	$\bar{x}$	1.40	4.61***	0.40	2.71**
	SD	1.67		0.80	
4	$\bar{x}$	1.40	3.77***	0.58	2.96**
	SD	2.04		1.07	
5	$\bar{x}$	1.86	4.70***	0.84	3.90***
	SD	2.17		1.19	
6	$\bar{x}$	1.89	5.26***	0.49	2.10*
	SD	1.97		1.27	
7	$\bar{x}$	2.68	7.48***	0.97	4.75***
	SD	1.97		1.11	
8	$\bar{x}$	2.62	6.06***	0.97	3.87***
	SD	2.36		1.37	
9	$\bar{x}$	2.36	5.43***	0.65	3.50**
	SD	2.38		1.03	
10	$\bar{x}$	2.58	5.62***	0.85	3.44**
	SD	2.52		1.36	
11	$\bar{x}$	2.57	6.00***	0.84	2.92**
	SD	2.35		1.58	
12	$\bar{x}$	2.57	5.43***	1.21	4.28***
	SD	2.59		1.56	

*$p < .05$, one-tailed test
**$p < .01$, one-tailed test
***$p < .0005$, one-tailed test

Ss was predictable from the variance of category clustering. A Z test of the difference between two correlation coefficients (Hays, 1963) indicated that the correlations for the two groups on the categorized list were not significantly different ($Z = 0.30$, $p > .05$). Thus category clustering was significantly related to free recall learning in each group to a similar degree.

Associative Clustering

Associative clustering for the high-associative paradigmatic and syntagmatic word lists (H-P and H-S) was analyzed through a 2 x 4 x 2 fixed ANOVA design with repeated measures over the last two factors. The effects of group classification (A), trial blocks (B), and form-class of stimuli (C) were assessed. An associative cluster was defined as the contiguous occurrence of stimulus pairs in the list. The total number of forward pairs (stimulus-response order) and reverse pairs (response-stimulus order) which occurred in recall were counted and combined for each S on each trial. The total number of associative pairs for each block of three trials served as the dependent variable. Repetitions of stimulus words and intrusions were not counted in scoring recall or associative clustering. Table 13 (p. 104) presents the summary of the analysis.

The main effects of groups (normal vs. retarded), form-class (paradigmatic vs. syntagmatic), and trial blocks (one through four) were highly significant ($p < .001$), while the triple interaction of groups with form-class of stimuli and trial blocks was significant at the .05 level.

TABLE 13

SUMMARY OF ANALYSIS OF VARIANCE OF ASSOCIATIVE CLUSTERING FOR GROUPS, TRIAL BLOCKS, AND FORM-CLASS OF STIMULI

Source	df	MS	F
Between Ss	59		
Groups (A)	1	1083.00	13.14***
Subjects within groups	58	82.39	
Within Ss	420		
Trial Blocks (B)	3	379.89	66.90***
A x B	3	12.45	2.19
B x Subjects within groups	174	5.68	
Form-Class of Stimuli (C)	1	299.25	12.05***
A x C	1	569.85	22.94***
C x Subjects within groups	58	24.84	
B x C	3	2.39	0.55
A x B x C	3	11.70	2.71*
BC x Subjects within groups	174	4.32	

* $p < .05$
*** $p < .001$

Table 14 (p. 106) presents mean total associative clustering and SDs per trial block for the high-associative paradigmatic and syntagmatic word lists. Figure 8 (p. 107) indicates the nature of the significant AC interaction (see Table 13). Inspection of Figure 8 indicates a greater relative degree of associative clustering by normal children on the high-associative paradigmatic list. On the high-associative syntagmatic list, however, there appears to be no significant difference in associative clustering between the two groups.

Tukey analysis verified these observations. The analysis revealed that the mean criterion score of normal Ss ($\bar{x}$ = 9.617, SD = 4.046) over the four trial blocks was superior ($p < .01$) to that of retarded Ss ($\bar{x}$ = 4.433, SD = 2.430) for the high-associative paradigmatic list. On the other hand, the mean criterion score of normal Ss ($\bar{x}$ = 5.858, SD = 3.776) did not differ significantly ($p < .05$) from that of EMR Ss ($\bar{x}$ = 5.033, SD = 4.133) for the high-associative syntagmatic word list.

The within-groups Tukey analysis showed that associative clustering of normal children was significantly greater ($p < .01$) on the high-associative paradigmatic list than on the high-associative syntagmatic list. However, retarded children showed no significant difference in their associative clustering on these same lists ($p < .05$).

Figure 9 (p. 109) indicates the nature of the significant ABC interaction (see Table 13). As is shown in Figure 9, associative clustering of both groups on each of the high-associative lists tended to improve as trials progressed. The rate of increase in associative clustering on the high-associative paradigmatic list was definitely higher for

TABLE 14

MEAN TOTAL ASSOCIATIVE CLUSTERING SCORES FOR THE HIGH-ASSOCIATIVE LISTS

Group (n = 30 per group)	Statistic	Trials 1 - 3	Trials 4 - 6	Trials 7 - 9	Trials 10 - 12	Total Trials
High-Associative Paradigmatic List						
Normal	$\bar{x}$	6.20	9.63	11.30	11.33	38.47
	SD	3.77	4.68	4.73	4.92	16.18
Educable Mentally Retarded	$\bar{x}$	2.77	3.80	4.97	6.20	17.73
	SD	2.00	2.71	3.22	3.70	9.72
High-Associative Syntagmatic List						
Normal	$\bar{x}$	3.73	5.40	6.80	7.50	23.43
	SD	2.70	4.18	4.46	5.24	15.11
Educable Mentally Retarded	$\bar{x}$	2.90	4.63	5.87	6.73	20.13
	SD	2.30	4.08	5.28	5.86	16.53

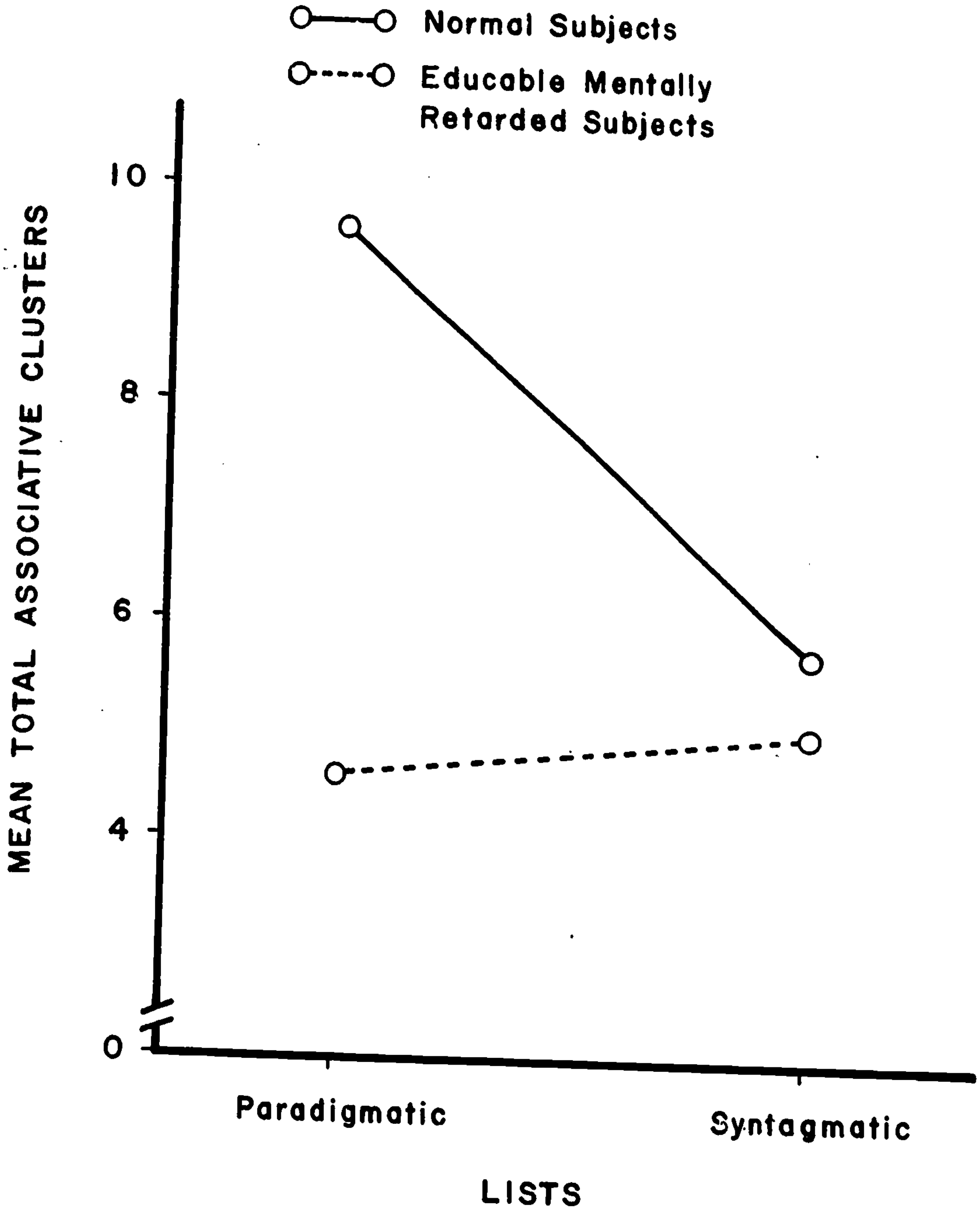

Fig. 8. Mean number of total associative clusters across trial blocks for normal and retarded children on the two high-associative stimulus lists.

normal than EMR _S_s over the first six trials. However, the clustering rates between the groups were quite similar between trial blocks two and three. As was the case with category clustering, normal _S_s appeared to reach an asymptote in their associative clustering between the third and fourth block of trials, while EMR _S_s revealed a small but continued increase in associative clustering between these same trial blocks. On the other hand, the growth in associative clustering by both groups on the high-associative syntagmatic list was similar.

Tukey analysis revealed that mean criterion scores between the two groups on the high-associative paradigmatic list differed significantly over all four trial blocks in favor of normal _S_s ($p < .01$). Tukey analysis also indicated that associative clustering of normal _S_s on the high-associative paradigmatic list increased significantly between the first and second blocks of trials ($p < .01$). However, the differences in associative clustering between trial blocks two and three, three and four, and two and four were not significant ($p > .05$). The analysis further revealed that associative clustering of EMR _S_s on the same list increased significantly between trial blocks one and three ($p < .01$) and between blocks two and four ($p > .05$). However, the differences in associative clustering between adjacent trial blocks were not significant ($p > .05$).

Tukey analysis of mean criterion scores on the high-associative syntagmatic word list disclosed an important finding. The analysis indicated that none of the mean associative clustering scores between the two groups on each of the trial blocks differed significantly ($p > .05$).

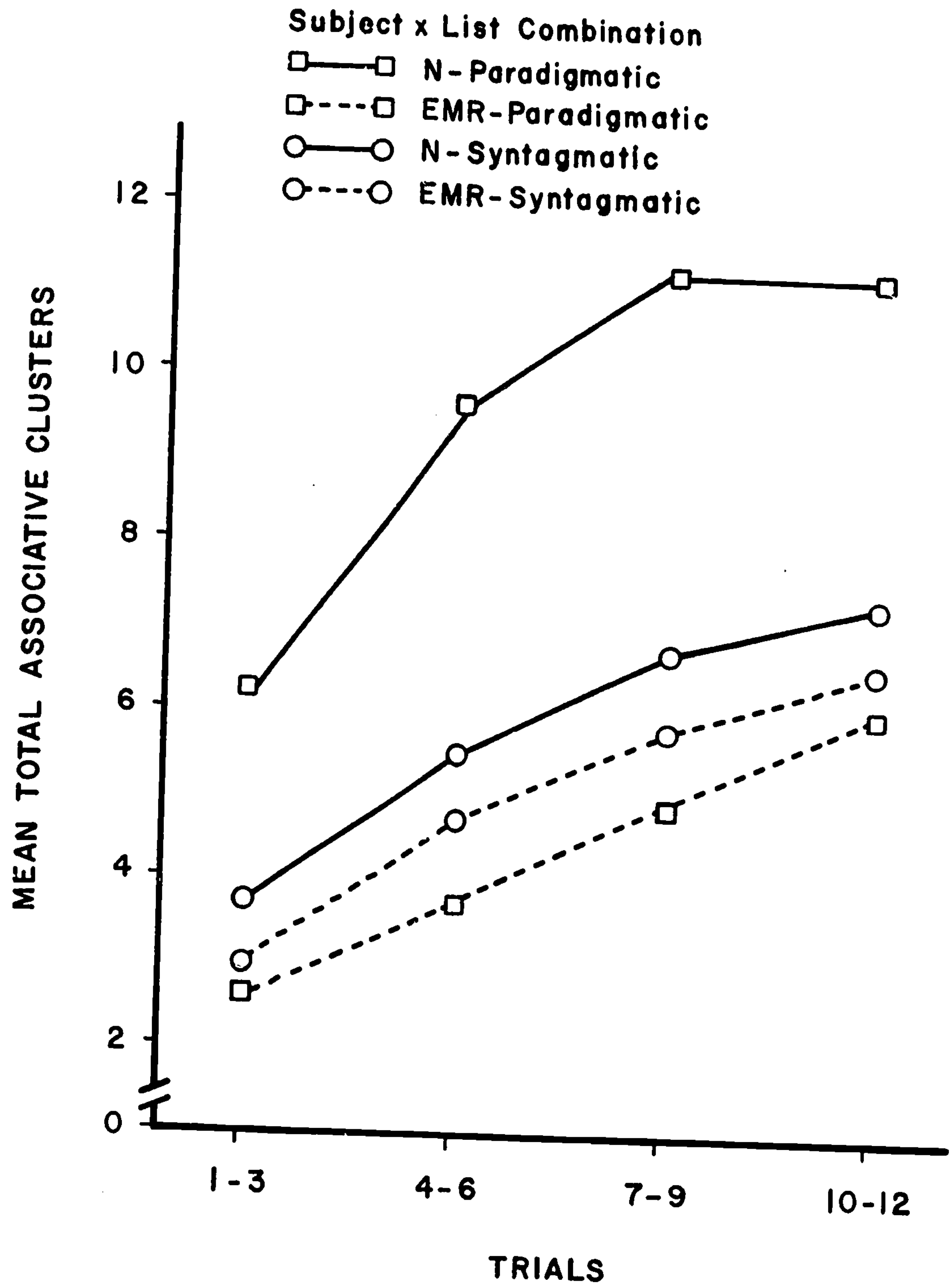

Fig. 9. Mean number of total associative clusters per trial block for normal (N) and educable mentally retarded (EMR) children on the two high-associative stimulus lists.

However, associative clustering of normal children did increase significantly between trial blocks one and three, and two and four ($p < .01$). The within-groups analysis for retarded children on the high-associative syntagmatic list paralleled that of normal children. Associative clustering of retarded children did not differ significantly between adjacent trial blocks ($p > .05$). However, associative clustering of retarded children did increase significantly between trial blocks one and three, and two and four ($p < .01$).

Tukey tests further revealed that for each block of trials, associative clustering of normal children on the high-associative paradigmatic list was superior to that demonstrated on the high-associative syntagmatic list ($p < .01$). Retarded children demonstrated no significant differences in their associative clustering on each block of trials for these same stimulus lists ($p > .05$).

Inspection of Table 14 shows that the SDs of both groups for both high-associative lists increased progressively over successive blocks of trials. On the high-associative paradigmatic list, normal Ss displayed relatively more variance in associative clustering over each block of trials than retarded Ss. However, the variability in associative clustering between the two groups on the high-associative syntagmatic list was comparable.

The product-moment correlations between the amount of associative clustering and recall performance over the total block of 12 trials for normal and retarded Ss on the high-associative paradigmatic list were respectively: $r_N = .85$ ($p < .01$), $r_{EMR} = .77$ ($p < .01$). Both groups demonstrated a significant positive correlation between associative clustering and total recall performance. Approximately 72% of the variance in total recall for normal Ss, and 59% of the variance for EMR Ss on the high-associative paradigmatic list was predictable from the variance in associative clustering. A Z test of the difference between the two correlation coefficients was not significant ($Z = 0.87$, $p > .05$).

Correlations between associative clustering scores and total recall performance for the two groups on the high-associative syntagmatic list were respectively: $r_N = .78$, ($p < .01$), $r_{EMR} = .92$, ($p < .01$). Both groups demonstrated a significant positive correlation between associative clustering and total recall performance. Approximately 61% of the variance in total recall for normal Ss, and 85% of the variance for EMR Ss on the high-associative syntagmatic list was predictable from the variance in associative clustering. A Z test of the difference between the two correlation coefficients was significant ($Z = 2.00$, $p < .05$). Thus the relationship between free recall and associative clustering for the high-associative syntagmatic list was relatively stronger for EMR Ss. In general, associative clustering for both groups on the high-associative lists was significantly related to free recall learning.

Subjective Organization

An extended version of Tulving's (1962) method of scoring subjective organization in free recall learning was employed to measure subjective organization on the low-associative paradigmatic and syntagmatic lists.

According to Tulving, subjective organization (SO) in a multitrial free recall learning experiment is measured by the following formula:

$$SO = \frac{\sum_{ij} nij \text{ log. } n_{ij}}{\sum_{i} n_i \text{ log. } n_i}$$

The formula is based on pairs of successive responses contained in a recall matrix which is constructed for each Ss. The matrix consists of L+1 rows and L+1 columns where L = the number of stimulus words in the stimulus list. Recall responses are pool-d for all L trials. The rows in the matrix represent the words in the n^{th} position in the S's recall list. The columns in the matrix represent the same words in the $(n = 1)^{th}$ position in the S's recall list. The entries in the cells of the matrix are symbolized as n_{ij} and indicate the frequency with which word "i" is followed by word "j" in the S's recall on all L trials. The marginal totals of the rows are symbolized as n_j and indicate the number of times each word "i" appeared in the S's recall on all L trials. Tulving regards $\sum_i n_i$ log n_i as a measure of the maximum organization possible in the list; $\sum_{ij} n_{ij}$ log n_{ij} as the actual organization imposed by the S on the list; and SO as a measure of the actual organization imposed on the list relative to the maximum possible organization. Subjective organizatic. as measured by Tulving's formula can assume all values between 0 and 1.

The form.la described above measured pairwise sequences occurring in only one direction (i.e., A - B). According to Shuell (1969), the formula can easily be modified to consider sequences occurring in either direction (i.e., A-B, and B-A) by summing the corresponding cells in the recall matrix across the diagonal. The investigator employed the modified formula in measuring SO for the low-associative paradigmatic and syntagmatic word lists. Recall matrices and SO scores for both lists were calculated for each S. Each score was based on the data from the total block of 12 trials. Extralist intrusions were ignored in calculating SO scores. However, repetitions of list words within a given trial were included in compiling the recall matrices. A computer program from the Human Performance Center at the University of Michigan was employed to compile and calculate recall matrices and SO scores for each S. The program also calculated mean SO scores for each group of Ss and the product-moment correlation between SO and recall scores for each low-associative stimulus list. Table 15 presents mean SO scores and SDs of normal and retarded Ss for each low-associative list.

TABLE 15

MEAN SUBJECTIVE ORGANIZATION SCORES FOR THE LOW-ASSOCIATIVE LISTS

Group n = 30 per group	Statistic	Lists	
		Low-Associative Paradigmatic	Low-Associative Syntagmatic
Normal	$\bar{x}$	0.425	0.426
	SD	0.065	0.056
Educable Mentally Retarded	$\bar{x}$	0.452	0.473
	SD	0.056	0.054

Subjective organization for the low-associative paradigmatic and syntagmatic lists (L-P and L-S) was analyzed through a 2 x 2 fixed ANOVA design with repeated measures over the last factor. The effects of group classification (A) and form-class of stimuli (B) was assessed. SO scores over the total block of 12 trials served as the dependent measure. Table 16 presents the summary of this analysis.

TABLE 16

SUMMARY OF ANALYSIS OF VARIANCE OF SUBJECTIVE ORGANIZATION FOR GROUPS AND FORM-CLASS OF STIMULI

Source	df	MS	F
Between Ss	59		
Groups (A)	1	0.04030	7.79**
Subjects within groups	58	0.00517	
Within Ss	60	0.00382	2.57
Form-Class of Stimuli (B)	1	0.00283	1.91
A x B	1	0.00149	
B x Subjects within groups	58		

** $p < .01$

Only the main effects of group classification (normal vs. retarded Ss) were significant ($p < .01$). Retarded Ss displayed a higher average level of SO than normal Ss on each of the two low-associative lists. Inspection of Table 15 shows that mean SO scores within each group did not differ significantly between the two lists. In fact, the mean SO scores for normal Ss on these lists were virtually identical. A comparison of the SDs for each group also indicates a high degree of uniformity in SO scores both between and within the two groups on the two lists.

The product-moment correlations between SO scores and recall performance over the total block of 12 trials for normal and retarded Ss on the low-associative paradigmatic list were respectively: $r_N = .33$ ($p > .05$), $r_{EMR} = -.24$ ($p > .05$). Neither of the correlations was significant ($p > .05$). Correlations between SO scores and total recall performance for the two groups on the low-associative syntagmatic list were respectively: $r_N = .29$ ($p > .05$), $r_{EMR} = -0.44$ ($p > .05$). For this list neither group demonstrated a significant positive correlation between SO and total recall performance. EMR Ss did display a significant negative correlation between SO and total recall ($p < .05$). However, only 19% of the variance in total recall for EMR Ss on the low-associative syntagmatic list was predictable from the variance in subjective organization. In general, SO for the low-associative lists was not highly related to free recall learning in either group.

As indicated above, a computer program was used to measure subjective organization for each S on the low-associative lists. The SO scores obtained from this program measure pairwise sequences occurring in either direction in a S's recall matrix. The program also provides a measure of subjective organization (SO_1) which is based on Tulving's original (1962) formula. This formula analyzes pairwise sequences occurring in only one direction in the S's recall matrix. In order to contrast subjective organization obtained by the two formulas, SO_1 scores are given below.

The mean SO_1 scores for normal Ss for the low-associative paradigmatic and syntagmatic lists were respectively: 0.266 (SD = 0.070); 0.264 (SD = 0.066). The mean SO_1 scores for EMR Ss for these same lists were respectively: 0.259 (SD = 0.061); 0.280 (SD = 0.048). A t test for independent samples indicated that mean SO_1 scores between the two groups for the L-P list did not differ significantly ($t = -1.060/df = 58/p > .05$). Similarly, SO_1 scores between the two groups for the L-S list did not differ significantly ($t = 0.386/df = 58/p > .05$). As was found with the modified SO measure, mean SO_1 scores within each group did not differ significantly between the two lists. Furthermore, the mean SO_1 scores for normal Ss on these lists were virtually identical. A comparison of the SDs for each group also indicates a high degree of uniformity in SO_1 scores both between and within the two groups on the two lists.

The product-moment correlations between SO_1 scores and recall performance over the total block of 12 trials for normal and retarded Ss on the low-associative paradigmatic list were respectively: $r_N = .46$ ($p < .01$); $r_{EMR} = -.08$ ($p > .05$). Normal Ss demonstrated a significant positive correlation between SO_1 scores and total recall performance ($p < .01$). Approximately 21% of the variance in total recall for normal Ss on the low-associative paradigmatic list was predictable from the variance in subjective organization as measured by SO_1. Correlations between SO_1 scores and total performance for the two groups on the low-associative syntagmatic list were respectively: $r_N = .43$; $r_{EMR} = .00$. Normal Ss again demonstrated a significant positive correlation between

SO_1 scores and total recall performance ($p < .05$). Approximately 19% of the variance in total recall for normal Ss on the low-associative syntagmatic list was predictable from the variance in subjective organization as measured by SO_1. In general, SO_1 for the low-associative lists was not related to free recall learning in EMR Ss but moderately related in normal Ss.

Intrusions

Extralist intrusions were measured for normal and retarded Ss on all five stimulus lists. For the categorized list, attention was given to both category and irrelevant intrusions. The number of category intrusions especially by normal children on the categorized list were few. Over the 12 trials, normal children gave only a total of 35 intrusions. The mean number of categorical intrusions made by normal Ss was 1.17 ($SD = 2.52$). Retarded Ss gave a total of 119 categorical intrusions on the categorized list. The mean total number of categorical intrusions made by retarded Ss over the 12 trials was 3.97 ($SD = 5.58$).

The number of irrelevant intrusions made by normal children on the categorized list was also few. Over the 12 trials, normal children gave only a total of 21 irrelevant intrusions ($\bar{x} = 0.70$; $SD = 1.21$). Retarded children, however, gave a total of 130 irrelevant intrusions on this list ($\bar{x} = 4.33$, $SD = 8.62$). Between-groups analyses were not performed because of the extremely small number of extralist intrusions shown by both groups, especially normal children.

The number of irrelevant intrusions by normal and retarded children on the four paradigmatic and syntagmatic lists was analyzed through a

2 x 2 x 2 fixed ANOVA design with repeated measures over the last two factors. Total number of intrusions over the total block of 12 trials served as the dependent variable. The effects of group classification (A), associative strength of stimuli (B), and form-class of stimuli (C) were assessed. Table 17 (p. 119) presents the summary of this analysis.

The main effects of groups (normal vs. retarded) and degree of associative strength (high vs. low) of word pairs were significant ($p < .01$). None of the two-way or three-way interactions was statistically significant ($p > .05$). These results indicated that over all four lists, retarded children introduced a greater number of irrelevant intrusions in their recall than normal children. In addition, stimulus lists with low-associative word pairs elicited more intrusions from both groups than stimulus lists with high-associative word pairs.

Table 18 (p. 120) presents mean total intrusions and SDs by each group for each of the four syntagmatic and paradigmatic word lists. Inspection of Table 18 indicates that within each group mean intrusion scores did not differ significantly for either the high-associative lists or the low-associative lists.

In addition, SDs of EMR Ss exceeded the magnitudes of SDs of normal Ss for all four lists although both groups exhibited considerable variability in their intrusion scores. However, the SDs of both groups on the low-associative lists exceeded the magnitudes of SDs for the high-associative lists. It should be noted that the mean intrusion scores and SDs of normal Ss were quite similar on the two syntagmatic word lists. The higher magnitudes of SDs of retarded Ss relative to those of normal

TABLE 17

SUMMARY OF ANALYSIS OF VARIANCE OF INTRUSIONS FOR GROUPS, ASSOCIATIVE STRENGTH OF STIMULI AND FORM-CLASS OF STIMULI

Source	*df*	*MS*	*F*
Between *S*s	59		
Groups (A)	1	8283.75	15.22***
Subjects within groups	58	544.38	
Within *S*s	180		
Associative Strength of Stimuli (B)	1	1540.27	10.02**
A x B	1	390.15	2.54
B x Subjects within groups	58	153.76	
Form-Class of Stimuli (C)	1	32.27	0.31
A x C	1	163.35	1.55
C x Subjects within groups	58	105.62	
B x C	1	101.40	1.21
A x B x C	1	84.02	1.00
BC x Subjects within groups	58	84.07	

** $p < .01$

*** $p < .001$

TABLE 18

MEAN TOTAL EXTRALIST INTRUSIONS ON THE PARADIGMATIC AND SYNTAGMATIC LISTS

Group (n = 30 per group)	Statistic	Lists			
		H - P	L - P	H - S	L - S
Normal	$\bar{x}$	2.53	7.53	4.10	4.13
	SD	5.04	10.12	7.81	5.98
Educable Mentally Retarded	$\bar{x}$	11.27	19.00	13.77	21.17
	SD	12.56	20.58	18.42	25.11

List Abbreviations

H - P -- High-Associative Paradigmatic List
L - P -- Low-Associative Paradigmatic List
H - S -- High-Associative Syntagmatic List
L - S -- Low-Associative Syntagmatic List

Ss demonstrates the greater individual differences found among EMR children in the degree to which they produced irrelevant intrusions in their free recall.

Product-moment correlations between irrelevant intrusions and recall performance over the total block of 12 trials were calculated. The results for normal and retarded Ss on each of the five stimulus lists are presented in Table 19 (p. 121). Inspection of Table 19 indicates that for normal Ss, intrusion scores were moderately related to total recall performance on three of the stimulus lists (H-S, L-S, L-P), but only slightly related to total recall on the categorized and high-associative lists.

TABLE 19

CORRELATIONS BETWEEN FREE RECALL AND INTRUSION SCORES

(n = 30)

List	Groups	
	Normal	Educable Mentally Retarded
CL	-.31	-.46**
H-P	-.20	-.53**
H-S	-.41*	-.40*
L-P	-.46**	-.36*
L-S	-.50**	-.52**

List Abbreviations

CL -- Categorized
H-P -- High-Associative Paradigmatic
H-S -- High-Associative Syntagmatic
L-P -- Low-Associative Paradigmatic
L-S -- Low-Associative Syntagmatic
* significant at .05 level
** significant at .01 level or above

The former correlations were statistically significant ($p < .05$). For EMR Ss, intrusion scores were moderately related to total recall performance on all five stimulus lists. All five correlations were statistically significant ($p < .05$). In general, total recall was negatively related to extralist intrusion scores in both groups. However, none of the correlations between the two groups for the five lists were significantly different ($p > .05$).

Repetitions

Repetitions of correctly recalled words over the total block of 12 trials were measured for normal and retarded Ss on all five stimulus lists. For both groups repetitions of correctly recalled words were more numerous than the number of extralist words introduced during recall. For the categorized list, the mean number of repetitions made by normal Ss over the total block of 12 trials was 14.60 (SD = 10.53). The mean number of repetitions made by retarded Ss on the categorized list was 26.37 (SD = 21.69). A t test for independent samples indicated a significant difference between the number of repetitions made by both groups ($t = 2.674$/$df = 58$/$p < .05$).

The number of correct word repetitions by normal and retarded Ss on the four paradigmatic and syntagmatic lists was analyzed through a 2 x 2 x 2 fixed ANOVA design with repeated measures on the last two factors. Total number of correct word repetitions over the total block of 12 trials served as the dependent variable. The effects of group classification (A), associative strength of stimuli (B), and form-class of stimuli (C) were assessed. Table 20 (p. 123) presents the summary of this analysis. The two-way interaction of degree of associative strength with form-class of stimuli was statistically significant ($p < .01$). However, none of the main or interaction effects involving groups was significant.

Table 21 (p. 124) presents mean total repetitions and SDs by each group for each of the four syntagmatic and paradigmatic lists. Tukey analysis of the significant CD interaction (Table 20) revealed that for

TABLE 20

SUMMARY OF ANALYSIS OF VARIANCE OF REPETITIONS FOR GROUPS, ASSOCIATIVE STRENGTH OF STIMULI, AND FORM-CLASS OF STIMULI

Source	df	MS	F
Between Ss	59		
Groups (A)	1	1316.02	2.42
Subjects within groups	59	543.09	
Within Ss	180		
Associative Strength of Stimuli (B)	1	45.06	0.40
A x B	1	260.42	2.33
B x Subjects within groups	58	111.57	
Form-Class of Stimuli (C)	1	41.67	0.38
A x C	1	28.02	0.26
C x Subjects within groups	58	109.83	
B x C	1	540.00	8.69*
A x B x C	1	8.82	0.14
BC x Subjects within groups	58	62.15	

* $p < .01$

TABLE 21

MEAN TOTAL REPETITIONS OF CORRECTLY RECALLED WORDS ON THE PARADIGMATIC AND SYNTAGMATIC LISTS

Group (n = 30 per group)	Statistic	Lists			
		H - P	L - P	H - S	L - S
Normal	$\bar{x}$	13.30	12.97	17.43	1i.87
	SD	16.07	10.64	18.57	8.96
Educable Mentally Retarded	$\bar{x}$	16.20	20.80	19.73	17.57
	SD	15.81	17.49	11.96	12.57

List Abbreviations

H - P -- High-Associative Paradigmatic
L - P -- Low-Associative Paradigmatic
H - S -- High-Associative Syntagmatic
L - S -- Low-Associative Syntagmatic

high-associative lists, both groups made a significantly greater number of repetitions when the stimuli were syntagmatic word pairs rather than paradigmatic nouns. However, there were no significant differences in the number of repetitions made by both groups on the high-associative paradigmatic and syntagmatic lists ($p > .05$).

Inspection of Table 21 indicates that SDs of EMR Ss exceeded the magnitude of SDs of normal Ss for low-associative lists. On the other hand, SDs of normal Ss exceeded the magnitudes of SDs of EMR Ss for high-associative lists. Both groups displayed a high degree of variance in their repetition scores. It can also be seen that the SDs of EMR Ss for paradigmatic lists exceeded the magnitudes of SDs for syntagmatic lists. In contrast, the SDs of normal Ss on high-associative lists exceeded the magnitudes of SDs for low-associative lists. Thus, form-class of stimuli was the major variable determining the degree to which EMR children repeated correctly recalled words, while associative strength of stimuli was the major determinant for normal children.

Product-moment correlations between repetitions and recall performance over the total block of 12 trials were calculated. The results for normal and retarded Ss on each of the five stimulus lists are presented in Table 22 (p. 126).

Inspection of Table 22 reveals an interesting finding. Repetition scores for all lists were negatively related to total recall performance for normal Ss, and positively related to total recall for retarded Ss. For normal Ss, repetitions were moderately related to total recall on the categorized list ($p < .05$), but only slightly related to total recall on the other four lists ($p > .05$). For EMR Ss, repetitions were moderately related to total recall on the low-associative paradigmatic list ($p < .05$), but only slightly related to total recall on the other four lists ($p > .05$). The correlations between the two groups for the categorized and low-associative lists were significantly different ($Z_{CL} = 2.03$; $p < .05$; $Z_{LP} = 3.02$, $p < .01$; $Z_{LS} = 2.12$, $p < .05$). However, the correlations between the groups for the high-associative lists were not significantly different ($p > .05$).

Correlations Involving Subject Variables

The product-moment correlations between frequency of paradigmatic

TABLE 22

CORRELATIONS BETWEEN FREE RECALL AND REPETITION SCORES

(n = 30)

List	Groups	
	Normal	Educable Mentally Retarded
CL	-.39*	.14
H - P	-.22	.16
H - S	-.04	.26
L - P	-.31	.46**
L - S	-.23	.33

List of Abbreviations

CL -- Categorized
H-P -- High-Associative Paradigmatic
H-S -- High-Associative Syntagmatic
L-P -- Low-Associative Paradigmatic
L-S -- Low-Associative Syntagmatic
* -- significant at .05 level
** -- significant at .01 level

W-A responses and the two subject variables (CA, IQ) for the total subject population were respectively: $r_{CA} = -.01$ ($p > .05$), $r_{IQ} = .46$ ($p < .01$). Approximately 21% of the variance in IQ was predictable from the variance of paradigmatic W-A responses. The correlations between the same three variables within the normal group were respectively: $r_{CA} = .35$ ($p > .05$), $r_{IQ} = -.23$ ($p > .05$). Neither correlation was statistically significant. The correlations between the same three variables within the EMR group were respectively: $r_{CA} = .38$ ($p < .05$), $r_{IQ} = .06$ ($p > .05$). Frequency of paradigmatic responses was moderately related to CA but unrelated to IQ.

The correlations between each of the major dependent measures (i.e, total recall, category and associative clustering, and subjective organization) and the two subject variables (CA, IQ), and between each of the major dependent variables and paradigmatic W-S responses for the total and within-subject populations are shown in Table 23 (p. 128).

Inspection of Table 23 indicates that, for normal Ss, CA was significantly related to total recall performance on the categorized list, and more strongly related to total recall on the four paradigmatic and syntagmatic lists ($p < .01$). In addition, CA was significantly related to category and associative clustering on the CL and H-S lists, and more strongly related to associative clustering on the H-P list ($p < .01$). However, CA was not significantly related to subjective organization on the low-associative lists ($p > .05$).

Normal Ss demonstrated little or no relationship between IQ and total recall performance for the five lists ($p > .05$). Furthermore, none

TABLE 23

PRODUCT-MOMENT CORRELATIONS BETWEEN DEPENDENT MEASURES AND SUBJECT VARIABLES

Variable	Group	CL List		H - P List		H - S List		L - P List		L - S List	
		Total Recall	Cat. Clust.	Total Recall	Assoc. Clust.	Total Recall	Assoc. Clust.	Total Recall	SO	Total Recall	SO
CA (Months)	Normal (n=30)	.56**	.47**	.66**	.69**	.63**	.56**	.67**	.16	.65**	.18
	EMR (n=30)	.66**	.69**	.47**	.27	.72**	.76**	.44*	-.49**	.64**	-.54**
	Total (n = 60)	.52**	.45**	.46**	.44**	.65**	.66**	.48**	-.15	.51**	-.18
IQ	Normal (n=30)	.06	.12	.08	.16	.04	.11	.12	.03	.04	.08
	EMR (n=30)	.13	.16	.32	.40*	.31	.26	.30	-.20	.26	-.02
	Total (n=60)	.59**	.47**	.66**	.64**	.37**	.17	.61**	-.23	.66**	-.35
Frequency of paradigmatic W-A Responses	Normal (n=30)	.19	.10	.05	.18	-.01	.13	.04	.04	.04	.01
	EMR (n=30)	-.30	-.27	-.19	-.01	-.43*	-.43*	-.23	-.10	-.39*	.24
	Total (n=60)	.26*	.24	.30*	.40**	-.04	-.11	.25	-.15	.23	-.11

* significant at .05 level

** significant at .01 level or above

List Abbreviations

H - P List -- High-Associative Paradigmatic List
H - S List -- High-Associative Syntagmatic List
L - P List -- Low-Associative Paradigmatic List
L - S List -- Low-Associative Syntagmatic List
SO -- Subjective Organization

of the correlations between IQ and category clustering, associative clustering and subjective organization were statistically significant ($p > .05$). There was similarly little relationship between the frequency of paradigmatic W-A responses and total recall, clustering, and subjective organization ($p > .05$).

Inspection of Table 23 further indicates that for EMR Ss, CA was moderately related to total recall performance on the paradigmatic lists, and more strongly related to recall on the categorized and syntagmatic lists ($p < .01$). In addition, CA was strongly related to category clustering and associative clustering on the CL and H-S lists ($p < .01$), but only slightly related to associative clustering on the H-P list ($p > .05$). EMR Ss demonstrated significant negative correlations between CA and subjective organization ($p < .01$). As was the case with normal Ss, EMR Ss demonstrated no significant relationship between IQ and total recall performance for the five lists ($p > .05$). Furthermore, EMR Ss demonstrated little or no relationship between IQ and category clustering, between IQ and associative clustering on the H-S list, and between IQ and subjective organization ($p > .05$). However, IQ was moderately related to associative clustering on the H-P list ($p < .05$).

Frequency of paradigmatic W-A responses for EMR Ss is shown in Table 23 to be moderately related to total recall performance on the syntagmatic lists ($p < .05$). Both correlations were negative. However, the correlations between paradigmatic W-A responses and total recall on the categorized and paradigmatic lists were not significant ($p > .05$). Frequency of paradigmatic W-A responses showed a moderate but negative relationship to associative clustering on the H-S list ($p < .05$). However, none of the correlations between paradigmatic W-A responses and category clustering on the CL list, between paradigmatic W-A responses and associative clustering on the H-P list, or between paradigmatic W-A responses and subjective organization were statistically significant ($p > .05$).

Table 23 indicates that for the total subject population, CA was moderately related to total recall performance on four of the stimulus lists (CL, H-P, L-P, L-S) and more strongly related to total recall on the H-S list ($p < .01$). Between 21 and 27% of the variance in total recall on the former lists and 42% of the variance in total recall on the H-S list were predictable from the variance in CA. In addition, CA was moderately related to category and associative clustering on the CL and H-P lists, but more strongly related to associative clustering on the H-S list ($p < .01$). Between 19 and 20% of the variance in category and associative clustering on the former lists, and 44% of the variance in associative clustering on the H-S list were predictable from the variance in CA. However, the correlations of CA with subjective organization were not significant ($p > .05$).

Intelligence quotient for the total subject population is shown in Table 23 to be significantly related to total recall performance on four of the stimulus lists (CL, H-P, L-P, L-S) but only moderately related to total recall on the H-S list ($p < .01$). The variance in IQ accounted for between 35 and 44% of the variance in total recall on the former lists, and 14% of the variance in total recall on the H-S list.

In addition, IQ was moderately related to category clustering on the CL list, and more highly related to associative clustering on the H-P list ($p < .01$). The variance in IQ accounted for 22% of the variance in category clustering and 41% of the variance in associative clustering on the H-P list ($p < .01$). On the other hand, the correlations of IQ with associative clustering on the H-S list, and of IQ with subjective organization on the L-P list were not significant ($p > .05$). A moderate but significant negative correlation was revealed between IQ and subjective organization on the L-S list ($p < .01$). For this list, the variance in IQ accounted for only 12% of the variance in subjective organization.

Table 23 further indicates that frequency of paradigmatic W-A responses for the total subject population was only slightly related to total recall performance for the CL and paradigmatic lists. Between six to nine percent of the variance in total recall on these lists was predictable from the variance in paradigmatic W-A responses. However, there were no significant correlations between the frequency of paradigmatic W-A responses and total recall for the syntagmatic lists. Although the correlation between the frequency of paradigmatic W-A responses and associative clustering on the H-P list was significant ($p < .01$), frequency of paradigmatic W-A responses was not significantly related to associative clustering on the H-S list, or to subjective organization and category clustering ($p > .05$). The variance in paradigmatic W-A responses accounted for 16% of the variance in associative clustering on the H-P list.

A number of first-order partial correlation coefficients were calculated in order to investigate the relationship of clustering and free recall with the effects of CA or IQ held constant. The partial correlations between category clustering and total recall, with the effects of CA removed for normal and retarded Ss, were respectively: $r_{12.3_N} = .75$; $r_{12.3_{EMR}} = .60$. With the effects of CA held constant, both EMR and normal Ss demonstrated significant relationships between category clustering and recall, although the relationship was stronger in normal Ss.

The partial correlations between associative clustering and total recall (with the effects of CA removed), for normal and retarded Ss on the H-P list were respectively: $r_{12.3_N} = .73$; $r_{12.3_{EMR}} = .75$. The same partial correlations for the groups on the H-S list were respectively: $r_{12.3_N} = .66$; $r_{12.3_{EMR}} = .83$. In addition, the partial correlation between associative clustering and total recall with the effects of IQ removed for EMR Ss on the H-P list was $r_{12.3_{EMR}} = .74$. Even with the effects of CA held constant, normal subjects demonstrated significant relationships between associative clustering and total recall performance. Removing the effects of CA and IQ had little effect on the significant relationships between associative clustering and total recall performance for EMR Ss on the H-P list. With the effects of CA held constant both groups demonstrated significant relationships between associative clustering and recall performance on the H-S list. Moreover, the relationship for EMR Ss was particularly reliable.

Summary

In summary, the results of the investigation revealed the following general findings. EMR boys elicited significantly fewer paradigmatic responses than normal boys of equal CA on a 20-word free W-A task. EMR boys demonstrated significantly less category clustering and free recall than normal boys of equal CA on a 12-word list composed of three words from each of four conceptual categories. In addition, category clustering was significantly related to total recall in each group to a similar degree.

EMR boys demonstrated significantly less associative clustering and recall than normal boys of equal CA on a 12-word list composed of high-associative paradigmatic nouns. Paralleling the results for category clustering, both groups demonstrated a significant positive correlation between associative clustering and total recall. The difference in free recall between EMR and normal boys of equal CA on a 12-word list composed of high-associative syntagmatic word pairs was significantly less than the difference in recall between the groups on a list composed of high-associative paradigmatic nouns. Furthermore, EMR boys demonstrated the same degree of associative clustering as normal boys on the high-associative syntagmatic list, and revealed their best recall performance relative to normal boys on this list.

EMR boys demonstrated significantly less recall than normal boys of equal CA on both a 12-word list composed of low-associative paradigmatic nouns, and a 12-word list composed of low-associative syntagmatic word pairs. When a modified measure of subjective organization was used, EMR boys demonstrated significantly more subjective organization than normal boys on the low-associative word lists. Neither group exhibited a significant positive correlation between subjective organization and total recall performance, although EMR boys did display a moderately high and significant negative correlation between subjective organization and total recall. On the other hand, subjective organization scores between the two groups did not differ significantly when a traditional measure of subjective organization was used. In addition, normal boys exhibited a significant positive correlation between subjective organization and total recall on each of the low-associative lists. However, subjective organization was not significantly related to total recall in EMR boys on either list.

Both groups gave relatively few categorical and irrelevant extralist intrusions on the categorized list. However, over the four paradigmatic and syntagmatic lists, EMR boys introduced a significantly greater number of irrelevant intrusions in their total recall than normal boys. Both groups gave more intrusions on stimulus lists with low-associative rather than high-associative word pairs. Total recall for the five stimulus lists was negatively related to extralist intrusion scores in each group.

EMR boys made significantly more repetitions of correctly recalled words on the categorized list than normal boys. However, there were no statistically significant differences in the number of repetitions made between the two groups over the four paradigmatic and syntagmatic lists. Repetition scores for each list were negatively related to total recall performance for normal boys and positively related to total recall for retarded boys. For both groups, repetitions of correctly recalled words were generally more numerous than the number of extralist words introduced during recall.

Product-moment correlations between frequency of paradigmatic W-A responses and the two subject variables (CA, IQ) were calculated and discussed for the total and within-subject populations. The correlations between these same three variables and the major dependent measures for the total and within-subject populations were also calculated and analyzed. The following section provides a discussion of the results.

DISCUSSION

The present section provides a discussion of the results presented in the previous section. The results are discussed in relation to Semmel's (1967, 1969) model of language behavior of EMR children. Implications of these results for theory and practice will be presented in the following section.

The purpose of this study was to analyze systematically organizational strategies of EMR and normal children in processing verbal input. A free recall verbal learning paradigm was selected and three separate measures of input organization were employed: category clustering, associative clustering, and subjective organization. The comprehensive analysis was expected to reveal that normal children employ predominantly grammatical or hierarchical organizational strategies while retaining the ability to use associative cues when necessary. However, EMR children, as a group, were expected to be dependent on sequential-associative recoding strategies, and thus to reveal weak or inefficient chunking habits. As a result, EMR Ss were expected to demonstrate inferior recall of verbal materials when compared to normal children of equal CA.

Free Word-Association Responses

The results of the free W-A task indicated that EMR boys emitted fewer paradigmatic free word-associations than normal boys of equal CA. These results were consistent with the findings of Semmel et al.(1968a) who also found that EMR children gave fewer paradigmatic responses than normal children of the same CA. It is possible that the Semmel et al. (1968a) findings were due to the specific nature of the stimulus list. However, the present study found similar results with different W-A stimuli. It may be that the dependency of EMR children on sequential-associative strategies prevents them from acquiring a sufficient number of semantic features or "markers" to ensure that their word associations are of the same form-class as the stimulus words. "Semantic markers" are identifying characteristics which help the child form a definition of a word; e.g., "bird" helps identify "sparrow." These hypothetical semantic markers are thought to provide an "efficient combinatorial organization for verbal memory [Anderson & Beh, 1968, p. 1050]." As a result, the possible failure of EMR children to acquire a sufficient number of contrasted semantic features of words may limit their ability to organize or recode linguistic units into hierarchical classes. It would be relatively more difficult for retarded children to chunk verbal stimuli since they would tend to have much broader semantic classes than normal children.

Category Clustering and Recall

It seems plausible from the evidence reviewed previously that the coding processes used in the free recall of categorized lists involve a combination of coding or chunking of items by the category or superordinate name, and the arrangement of items into associative networks. According to the language model, if EMR children demonstrate a strong bias for sequential-associative strategies in processing linguistic stimuli, they should, therefore, be hampered in structuring a word list in which the items are organized into a number of conceptual categories. It should be more difficult for EMR children to recode and abstract the common categories from such a list. On the other hand, it should be easier for children of average intelligence who display relatively well-developed grammatical competencies to employ hierarchical chunking strategies in categorizing related items. It follows therefore that EMR boys should demonstrate significantly lower category clustering and free recall than nonretarded boys. The results of this investigation supported these predictions. These findings are in line with the results of Stedman (1963) and Gerjuoy and Spitz (1966) which also revealed better recall and category clustering for normal adolescents and adults matched in CA with EMR Ss. The present study extends these findings to include EMR children.

The results also suggest that the superiority of normal Ss is maintained over an extended period of practice. Recall learning curves for the categorized list indicated that the difference in recall between the two groups increased significantly across trials (see Figure 1). However, differences between the groups were smallest for the first block of trials. A possible explanation for this differential learning is that normal Ss required an initial adaptation period in order to retrieve from storage the organizational strategy most appropriate to the recall task. Thus, an initial stage in their learning consisted of a hypothesis testing phase during which various hierarchical-grammatical and semantic strategies stored in secondary memory were searched and tested for their applicability to the problem at hand. However, the dependence of EMR children on sequential-associative strategies prevented them from employing an efficient hierarchical strategy to organize the related stimulus items. As a result, the performance of EMR children lagged progressively farther behind that of normal children.

Some evidence for this position is shown in the differential category clustering rates for the two groups (see Figure 7). Before reaching an asymptote in their clustering performance, normal Ss revealed a significantly more rapid and linear acquisition rate than EMR Ss. Paralleling the results for recall, the differences in total clustering between the two groups were at a minimum for the first block of trials. Furthermore, the retarded children displayed very little above-chance clustering over the 12 trials. Gerjuoy and Spitz (1966) reported a similar finding for their EMR sample. Nevertheless, unlike normal children, the EMRs did not appear to reach an asymptote in their clustering performance. The asymptote shown in the clustering performance of normal Ss was paralleled by a nonsignificant increase in recall over the final block of trials. It could be argued that the asymptotic level for clustering of normal Ss represented the point at which they reached their upper limit in recoding capacity. Little improvement was expected in recall for normal Ss once this capacity was reached, even with additional practice. On the other hand, EMR children would be expected to show some improvement with additional practice, both in recall and clustering.

The substantial positive correlations between the amount of category clustering imposed by both groups on the categorized list and the number of items correctly recalled is in agreement with the results of other verbal free recall experiments which used categorized lists. Gerjuoy and Spitz (1966) and Gerjuoy and Alvarez (1969) reported a high positive relationship between clustering and recall in retarded Ss once clustering was above chance. In general, category clustering and recall appear to be significantly related in retarded Ss if stimuli are presented orally rather than visually (Gerjuoy and Winters, 1970). More important to the present work is the finding that the small degree of categorical clustering which EMR Ss do reveal is significantly related to free recall learning. Thus, EMR boys demonstrated some ability to organize hierarchically conceptually related verbal items, although exhibiting subaverage clustering and recall performance. Within each group, the significant correlation between CA and clustering and recall, and the absence of significant relationships between IQ and clustering and recall suggest that CA is a more important variable in determining the relationship between category clustering and free recall. Nevertheless, even with the effects of chronological age held constant, both EMR and normal Ss demonstrated significant relationships between category clustering and recall.

Recall on Paradigmatic and Syntagmatic Lists

As indicated previously, the results of this investigation revealed that EMR boys demonstrated significantly less recall than normal boys of equal CA on a free recall task composed of (a) high-associative paradigmatic nouns, (b) low-associative paradigmatic nouns, (c) low-associative syntagmatic word pairs. Furthermore, the difference in recall between the two groups on a free recall task composed of high-associative syntagmatic word pairs was significantly less than the difference in recall on a free recall task composed of high-associative paradigmatic nouns. Although normal children demonstrated superior recall on the paradigmatic and syntagmatic lists, recall increased significantly over trials for both groups. In addition, stimulus lists with high-associative word pairs elicited higher recall from retarded and nonretarded Ss than lists with low-associative word pairs as determined by free W-A norms. As with the categorized list, the results suggested that the superiority of normal Ss was maintained over an extended period of practice. In addition, the acquisition curves for both groups over the combined lists (see Figure 2) indicated that the difference in recall between the two groups increased significantly over the first nine trials. Differences between the groups were again at a minimum for the initial block of trials.

These findings lend additional credence to the two-stage learning position hypothesized in the previous section. When applying this notion to syntagmatic and paradigmatic lists, the investigators would argue as follows: Normal children appear to require an initial adaptation period in order to retrieve from storage the organizational strategy most appropriate to the recall task. During this period, various organizational strategies are retrieved from storage in secondary memory and tested for their applicability to the free recall learning task at hand. Inappropriate strategies are rejected and only the most efficient strategies are applied. For paradigmatic lists, a grammatical and/or semantic hierarchical strategy will be most appropriate in organizing the verbal items. EMR children are relatively hampered by their weak grammatical and semantic decoding habits. They are forced to rely primarily on associative cues present among the items when attempting to structure the paradigmatic lists. On the other hand, normal children will be able to utilize both the associative and categorical cues in clustering these lists. For syntagmatic lists, a combination of hierarchical and sequential-associative strategies will be most appropriate in organizing the verbal items. Since hierarchical and sequential-associative strategies seem to be synchronized in normal children, they will be expected to demonstrate superior free recall compared to EMR children who must rely primarily on sequential-associative cues when organizing syntagmatic lists. Once the appropriate strategy is selected by normal Ss, the differences between the groups will increase until asymptotic levels in organizational capacity are reached.

The results further revealed that form-class of stimuli as an independent variable had little effect on free recall learning. Only when interacting with associative strength of stimuli did form-class influence the recall of subjects. The inferior recall performance of EMR Ss was especially evident when stimulus pairs were either paradigmatic nouns or low-associative strength (see Figure 5). Thus, when strong associative cues are not available to EMR children, they take longer to learn a free recall task than nonretarded children who reveal a relatively lower degree of dependence on simple sequential-associative strategies. Differential performance on the high-associative paradigmatic list by both groups suggests that nonretarded children probably utilize both associative and category relations present in the list to cue their recoding strategies. On the other hand, EMR Ss rely mainly on the associative cues and show little evidence of an ability to shift to more efficient hierarchical strategies in the absence of strong sequential-associative relationships between pairs of words.

Within-group comparisons showed that EMR boys performed well when the associative strength between word pairs was high (as determined by free W-A norms), regardless of the form-class relationship (i.e., paradigmatic or syntagmatic) of word pairs. Normal boys performed best when the associative strength between word pairs was high and when the association between stimulus pairs was based on paradigmatic criteria. In comparison with normal boys, EMR boys performed best when the associative strength between word pairs was high and when the association between stimulus pairs was based on syntagmatic criteria. A list composed of high-associative syntagmatic word pairs provided stronger sequential-associative cues than a list composed of high-associative paradigmatic or low-associative syntagmatic word pairs. It seems, therefore, that EMR children are comparatively more dependent on simple associative relationships and/or transitional probabilities between linguistic units than on structural syntactic or semantic cues. As a result, their free recall learning is inferior to that of normal children on lists constructed so that the association between stimulus pairs is low or based on paradigmatic criteria.

Associative Clustering

As indicated previously, the results revealed that EMR boys demonstrate significantly less associative clustering than normal boys of equal CA on a free recall task composed of high-associative paradigmatic nouns. Paralleling the results for category clustering, the superiority of normal Ss was maintained over the total 12 trials, although associative clustering for both groups increased significantly across trials. Differences between the groups were at a minimum for the first block of three trials and gradually increased with additional practice up to a maximum on the third block of trials. This finding provides further evidence for the two-stage learning position developed previously. Normal Ss displayed an asymptote, after nine trials, in their associative clustering performance. Their performance was similar to their category clustering scores. This asymptotic level was accompanied by a nonsignificant increase in recall over the final block of trials. The retarded children did not appear to reach an asymptote during acquisition. It could again be argued that the asymptotic level for associative clustering of normal Ss represented the point at which they reached their maximum limit in recoding capacity. Therefore, little improvement would be expected in their recall on the high-associative paradigmatic list once this capacity was reached, even with additional practice. These findings appear to indicate once again that normal children are able to use both associative and grammatical relations in organizing verbal lists for recall. On the other hand, EMR children are comparatively more dependent on simple associative relationships and are at a disadvantage when structuring lists based on paradigmatic criteria. Furthermore, the moderately significant relationship revealed between the frequency of paradigmatic W-A's elicited on the W-A task and associative clustering on the H - P list suggests that W-A responses may be indicative of storage and/or retrieval strategies of individual children. Since normal children tend to produce significantly more paradigmatic W-A's, they can be expected to display superior recoding performance on verbal learning tasks containing both associative and grammatical cues.

The results on the high-associative syntagmatic list showed no significant differences in associative clustering between normal and retarded boys over each block of three trials. In addition, the acquisition curves revealed similar clustering rates for the two groups (see Figure 9). EMR boys demonstrated no significant differences in either recall or associative clustering on high-associative lists. On the other hand, associative clustering and recall performance of normal boys was reliably greater on the H - P list than on the H - S list. These findings imply that both groups employed similar organizational strategies on the H - S list and different strategies on the H - P list. The hierarchical strategies employed by normal children on the H - P list resulted in more efficient performance than the sequential-associative strategies they presumably employed on the H - S list.

Paralleling the findings for category clustering, a high degree of correlation was found between the amount of associative clustering imposed by each group on the high-associative list and the number of items correctly recalled. The relationship between free recall and associative clustering for the high-associative syntagmatic list was more reliable for EMR than normal Ss. On the other hand, the correlations for the two groups on the high-associative paradigmatic list were similar. It could be argued that for the H - S list, normal Ss employed a combination of associative and hierarchical (i.e., semantic and grammatical) cues in clustering the items whereas EMR Ss were restricted mainly to employing the associative cues. As a result, normal Ss may have organized the verbal items in units larger than pairs.

Significant positive relationships were indicated between CA and associative clustering and recall for normal Ss on the high-associative lists. On the other hand, for these same lists IQ was not significantly related to associative clustering or recall in normal Ss. These findings would suggest that for normal boys, CA was a more important variable in determining the relationship between associative clustering and total recall on high-associative lists. Thus, older nonretarded children are more likely to organize hierarchically highly associated items grouped in varying degrees of grammatical and/or semantic relationships. Nevertheless, even with the effects of CA held constant, normal Ss demonstrate substantial relationships between associative clustering and free recall verbal learning.

In contrast, for EMR Ss, CA was not significantly related to associative clustering on the H - P list, and only moderately related to total recall. Intelligence Quotient showed little relationship with total recall and only a moderately high relationship with associative clustering. However, removing the effects of CA and IQ had little effect on the significant relationship between associative clustering and total recall performance for EMR Ss on the H - P list. Hence, CA and IQ cannot account for the significant relationship among EMR boys between associative clustering and free recall performance. The results suggest that EMR children do not develop the capacity to organize hierarchically or recode highly associated words grouped on the basis of grammatical and/or semantic criteria as they grow older. In fact, the associative clustering results for EMR Ss on the H - S list suggest a different trend.

Substantial positive relationships were indicated between CA and associative clustering and recall for EMR Ss on the H - S list. Moreover, IQ was not significantly related to total recall and associative clustering, whereas a moderate negative correlation was revealed between frequency of paradigmatic W-A responses and both total recall and associative clustering. It is plausible to conclude that for retarded children, CA is a more important variable in determining the relationship between associative clustering and total recall on a H - S list than is IQ. Thus, EMR children are more likely to approach and process free recall learning tasks on a sequential-associative basis as they grow older. Nevertheless, even with the effects of CA held constant, EMR Ss demonstrated a significant relationship between associative clustering and free recall verbal learning.

Subjective Organization Comparisons

As indicated previously, EMR boys displayed relatively inferior recall performance on free recall tasks composed of low-associative paradigmatic and syntagmatic word pairs. In addition a modified measure of subjective organization based on Tulving's original (1962) formula indicated that retarded boys displayed a higher average level of subjective organization (SO) than normal boys on each of the two low-associative lists. This formula analyzed pairwise sequences or clusters of responses occurring in either direction in a Ss recall matrix. On the other hand, when Tulving's (1962) original formula was used to analyze the data, no significant difference was found between the groups in their subjective organization (SO_1) scores on each of the two low-associative lists. The original formula analyzed pairwise sequences occurring in only the forward direction (A-B) in the S's recall matrix and provided a "tighter" measure of subjective organization. The finding using the original formula was in agreement with Gallagher (1969) who employed Tulving's SO_1 measure to compare subjective organization of EMR and CA-matched normal adolescents. Gallagher's findings also revealed that normal Ss recalled significantly more words than EMR Ss but there was no difference between the groups in their subjective organization scores. However, as indicated previously, Gallagher's findings are subject to a possible confounding due to a failure to control the form-class (i.e., paradigmatic vs. syntagmatic) of the list stimuli.

It is reasonable to conclude that the original measure of subjective organization (SO_1) provided a more accurate analysis of the amount of subjective organization imposed on the low-associative stimulus items by nonretarded boys. Mandler (1967a, 1967b, 1968) has argued that free recall of "unrelated" words is a linear function of the number of higher-order units or categories used by Ss in organizing such lists. Similarly, Marshall (1967) has indicated that as the level of association decreases, conceptual relationships have a pronounced effect on clustering in free recall. Since normal Ss show less dependence on simple associative relationships between words, they may have recoded the individual items on the low-associative lists into stable higher-order memory units or conceptual categories larger than pairs. As a result, a "tighter" measure of subjective organization would be more likely to reveal this hierarchical-organizational activity.

Some evidence for the above conclusion is indicated in the relationship between subjective organization scores and recall performance of normal Ss on the low-associative paradigmatic and syntagmatic lists. When subjective organization was measured by the modified SO measure, neither of the correlations between SO scores and total recall performance for the L - P and L - S lists was significant. However, when Tulving's original SO_1 measure was used, normal Ss revealed moderately significant positive correlations between SO_1 scores and total recall performance for both low-associative lists.

It may be argued that the modified measure of subjective organization (SO) provided a more accurate analysis of the amount of subjective organization imposed on the low-associative stimulus items by EMR boys. Since the associative strengths between these items were low, EMR Ss would experience difficulty in attempting to impose a sequential-associative rather than a rule-governed hierarchically organized strategy on the stimulus input. It would be especially difficult for them to form permanent contiguous relationships among the items. As a result, EMR Ss would have to employ a lower-order sequential strategy based mainly on idiosyncratic associations among the items. Hence, their organizations would be of a lower order than those of normal children. There is evidence that the presence of inappropriate memory units results in impaired free recall performance (Bower et al., 1969). It follows that a measure of subjective organization that accounts for both forward and reverse pairwise sequences is sensitive to idiosyncratic organizational activity and the presence of "inappropriate" memory units in the free recall of EMR children. Some support for this contention is indicated in the relationships between subjective organization scores and recall performance of EMR Ss on the low-associative paradigmatic and syntagmatic lists. When subjective organization was measured by the traditional SO_1 measure, neither of the correlations between SO_1 scores and total recall performances for the L - P and L - S lists were significant. In fact, EMR Ss revealed an absence of relationship between the two variables. However, when the modified SO measure was used, EMR Ss revealed negative relationships between SO and total recall for both low-associative lists. Moreover, the correlation between SO and total recall for the H - S list was significant and moderately high. The latter finding suggests that EMR Ss formed more "inappropriate" memory units on the L - S list.

Both measures of subjective organization were equally reliable. A comparison of the variability in mean SO scores for each measure indicated a high degree of uniformity in SO scores both between and within the two groups on the two lists. In general, subjective organization for the low-associative lists was not reliably related to free recall learning in either group. The significant correlations obtained between SO_1 and total recall for normal Ss were below those obtained by Laurence (1966) for children of similar CAs (r = .62). However, Laurence used pictures rather than words, and her normal Ss were generally above average intelligence. In addition, her Ss were presented with a longer free recall task and were given more recall trials. It is possible that differences between the results of the two studies can be explained by the differences in subject populations and experimental procedures. Laurence (1966) found no significant differences in SO scores according to age among her four groups, but did find a significant age-group difference in recall performance, with greater recall accompanying increasing age. These findings are consistent with the findings of the present study. Normal boys demonstrated only slight relationships between CA and SO for low-associative lists, and moderately high relationships between CA and free recall performance. In contrast, negative but moderately significant relationships were obtained by EMR Ss between CA and SO for low-associative lists, and positive but moderately high relationships between CA and free recall performance. It would appear that younger EMR children are more likely than older children to organize subjectively, low-associative or "unrelated" words on the basis of idiosyncratic pairings and to form inappropriate memory units.

Tulving's SO_1 measure has been criticized by Mandler (1967a) since it only evaluates pairwise sequential dependencies and cannot evaluate possible categorical sequences larger than two. The same criticisms were directed by Mandler at the measure developed by Bousfield and his associates for measuring subjective organization (Bousfield & Bousfield, 1966; Bousfield, Puff, & Cowan, 1964). Shuell (1969) has noted that in some instances these pairwise contingencies on which these measures are based "may provide only a crude index of the organization actually present [Shuell, 1969, p. 361]." It is reasonable to propose that a measure of subjective organization which evaluates both pairwise and higher-order sequential dependencies in the subject's recall matrix may reveal more significant correlations between subjective organization and free recall learning. Perhaps a SO measure based on Markovian matrix algebra would more sharply discriminate among the patterns of recall sequences characteristic of both groups of children. Furthermore such a measure may provide more qualitative information concerning the types of primary and secondary organization typical of good as well as poor organizers. It may be that the higher-order memory units of good organizers are based on a greater variety of relationships including conceptual, associative, phonetic, grammatical, serial, and idiosyncratic.

Intrusion and Repetition Comparisons

The analysis of extralist intrusions revealed relatively few categorical and irrelevant intrusions for both groups on the categorized list. However, EMR boys introduced a significantly greater number of irrelevant intrusions in their recall than normal children over all four paradigmatic and syntagmatic lists. In addition, low-associative lists elicited more intrusions from both groups than did high-associative lists. Recoding habits are not as strong in EMR children as in normal children. As a result, when associative relations among verbal items were low, EMR Ss were unable to form as many permanent associational bonds between the items as normal Ss, and they had to rely on more idiosyncratic bases of organization. The unstable connections thus formed were subject to more interference from extralist words linked associatively to the stimulus words. A stronger associative network existed for high-associative lists and the associatively related stimuli were already integrated units. Retention of some of the associated items facilitated retrieval from secondary memory of other items with which those recalled were associated. However, the presence of lower-order memory units in EMR Ss may have reduced the accessibility of information in storage and permitted more interference from associatively related extralist words.

Tulving (1968) has presented evidence that supports the above interpretation. His findings indicate that the primary role of organization in free recall learning is to make desired list items more accessible for retrieval. Thus, organization facilitates the retrieval of desired information stored in secondary memory in the form of memory units. He states that "the retrieval system can have access to only a limited number of functional S-units [i.e., memory units] in a given output phase, and, any increase in the recall of nominal E-units [i.e., single items defined as such by the experimenter] reflects the increase in the size of the accessible S-units as a consequence of secondary organization [Tulving, 1968, p. 31]." When applied to EMR children, this view would suggest that weaker recoding habits would provide less powerful retrieval cues than normal Ss possess and would permit interference from accessible associative responses made to the list items during storage.

Total recall was negatively related to extralist intrusion scores in both groups. Retarded Ss demonstrated moderate but significant correlations for all five lists, while normal Ss demonstrated similar correlations for only the low-associative lists and high-associative syntagmatic list. The significant correlations for normal Ss on the L - S, L - P, and H - S lists paralleled their relatively lower recall performance on these same lists. These findings would indicate that irrelevant intrusions introduced into the free recall of both retarded and nonretarded children have an interfering effect on free recall performance. Moreover, children who display a high incidence of irrelevant intrusions in their recall performance are more likely to demonstrate inefficient organizational processes in processing verbal stimuli.

The results for repetitions indicated some differences from the intrusion data. EMR boys gave significantly more repetitions of correctly recalled words than normal boys on the categorized list. However, there were no significant differences between the group repetition scores on the paradigmatic and syntagmatic lists. In contrast to the intrusion data, repetitions by both groups on high- as opposed to low-associative lists did not differ significantly. Repetition scores tended to be negatively related to total recall performance for normal boys but positively related to total recall for retarded boys. Nevertheless, only the correlations between repetitions and recall for normal boys on the CL list and for retarded boys on the L - P list attained significance. It is difficult to interpret these findings. It may be that repetitions by normal boys interfered with the establishment of hierarchical relationships among list items and thereby affected their recall performances. This interference was most effective in preventing category clustering of conceptually related items on the categorized list. Repeating words transferred them from storage in secondary memory to primary memory, and thus preempted time that could have been spent in secondary organization.

It could also be speculated that repetitions for EMR boys provided a means of rehearsing the items by recirculating them through primary memory. Such rehearsal would be most effective on the L - P list where the possible sequential-associative relations among the items are relatively low.

In summary, this section has discussed the results of this experiment in relation to Semmel's (1967, 1969) model of language behavior of EMR children. It appears reasonable to conclude that this investigation lends additional support to Semmel's view of the language of EMR and nonretarded children. It may be concluded that there is a qualitative difference in the organizational strategies used by EMR and nonretarded children in processing verbal stimuli. Retarded Ss primarily employ "sequential-associative" strategies, while "hierarchical" (i.e., semantic and grammatical) strategies seem to be synchronized in non-retarded children. The generality of hierarchical strategies appears to make them associated more with proficient language behavior--free recall verbal learning in this case--than are sequential associative strategies. The results of this investigation have also been examined in relationship to the literature concerning both free recall verbal learning and mental retardation. The authors offered their own logical interpretations to account for findings that were not explainable in terms of the language model or the literature in the two areas. The implications of this work in relationship to theory and practice are presented in the next section.

IMPLICATIONS

The findings of the present work have significant implications for theory and practice. The theoretical views of input organization which were incorporated into the design of this study also have implications for understanding and modifying the school performance of mentally retarded children. This section discusses these implications within the framework of theory and practice although it is recognized that the two areas of professional activity are closely interrelated.

Implications for Theory

Short-term Memory Theory. Ellis (1970) has recently revised his earlier short-term memory (STM) theory of mental retardation (Ellis, 1963, Ch. 4). His earlier work had contended that, compared to normal *Ss* of similar CA, retardates suffer from a "diminished" (in terms of duration and intensity) or "impoverished stimulus trace" which results in a STM deficit. Ellis had provided evidence from a variety of sources which offered support for his view. However, subsequent studies have both confirmed and refuted some of his predictions (Butterfield, 1968; Ellis & Anders, 1968; Fagan, 1968; Scott & Scott, 1968). These studies have been extensively reviewed by Scott and Scott (1968). The revised theory provides evidence for two STM processes in both retarded and normal *Ss*, as well as evidence that retarded *Ss* demonstrate a deficit in "rehearsal strategies." The revised theory is based primarily on comparisons of normal and institutionalized retarded adults and adolescents of equal CA on a probe-type STM task. Ellis (1970) postulates a multi-process memory model which is a modified version of the two-factor theories of memory previously described (e.g., Glanzer & Cunitz, 1966; Waugh & Norman, 1965).

According to Ellis' model, rehearsal strategies are the mechanisms transferring information from primary memory to secondary memory and then to tertiary memory. Primary and secondary memory make up STM, while tertiary memory is conceived of as being synonymous with long-term memory or retention over a time period of a day or longer. Primary memory is a limited capacity system and is viewed "as a sensory, echoic memory dependent upon attention to stimuli only [Ellis, 1970, p. 19]." Secondary memory is a longer storage system which serves to store the "overload" of information from primary memory. Ellis indicates that rehearsal strategies are able to feed stored information back to primary memory. This process may involve "chunking strategies, other grouping and organization devices, and encoding [p. 71]." Based on previous research (Belmont, 1966), Ellis assumes that the long-term memory process is "normal" among retarded children.

The results of the studies using the probe-type memory task indicated that normal and retarded Ss did not differ in recency performance, while retarded Ss were inferior in their primacy performance. From these findings, Ellis hypothesized that the primary memory process appears approximately equal in normal and institutionalized retarded Ss, while the secondary memory process differs markedly due to inadequate rehearsal strategies among retarded Ss. Furthermore, storage in the retardate is determined mainly by primary memory since his rehearsal strategies fail to store the overload of information from primary memory into secondary memory. As a result, secondary memory fails to function adequately in retardates, and information in the "message" (i.e., primacy items) other than terminal items is lost. Ellis also suggested that "possibly the retardate fails to store information in SM [secondary memory] as a result of inadequate language skills which attenuate his capacity to rehearse [p. 29]." In our opinion, Ellis' findings could be interpreted in terms of Tulving's (1969) definitions of primary and secondary organization. Thus, when compared with normal individuals, retarded Ss rely more on primary organizational factors and less on efficient secondary organizational factors in their STM functioning.

The results of the present study provide some support for Ellis' (1970) position. However, the findings suggest that the hypothesized deficit in "rehearsal strategies" characteristic of retarded Ss is not the result of a failure to store information into secondary memory, or an inefficient secondary memory process per se. Rather, the results imply that EMR children, at least, employ secondary organizational strategies to store and retrieve verbal information from secondary memory, but do so on a more primitive and less efficient basis. The present study did not investigate primary organization of EMR and normal children. Ellis' (1970) results indicated that normal and retarded Ss did not differ in their recency performance. According to Tulving (1968), the recency effect is one of the "manifestations" of primary organization, although primary organization may be related to the primacy effect as well. It would appear from Ellis' findings that normal and retarded Ss employ similar processes in primary organization.

Theory of Primary and Secondary Familial Mental Retardation. As indicated earlier in this work, Jensen (1970) has developed a theory of primary and secondary familial mental retardation which shows some resemblance to Semmel's (1967, 1969) language position. Jensen hypothesized two different types of retardation (primary and secondary) with qualitatively different patterns of maturational mental abilities related hierarchically. Separate genetic mechanisms and developmental curves are postulated for Level I and Level II abilities. Mental abilities found in lower levels of the hierarchy are labeled "Level I or associative ability." These abilities require relatively little processing or recoding of input information, and are considered to be essentially independent of socio-economic status (SES). A deficiency in Level I ability is referred to as "primary retardation." However, a relatively small degree of the intellectual retardation found in low SES groups and among "slow learners" is thought by Jensen to be of the primary type. He proposes that the vast majority of retarded individuals with IQs below 50 are "primary retardates." These individuals are generally clinically abnormal and are seen as demonstrating a STM deficit.

Level II abilities, according to Jensen, require relatively more recoding of input information, and comparisons of new input with previously stored information. Higher grades of Level II ability are said to be found in upper SES groups. In addition, academic performance is thought to be heavily dependent on this abstract and conceptual level.

A deficiency in Level II ability is referred to as "secondary retardation." Jensen proposes that the majority of low SES children with IQs in the range from 50 to 85 are of the secondary type. These individuals are generally clinically normal and are not seen as demonstrating a STM deficit. Jensen's theory deals mainly with this latter cultural-familial retarded group.

With respect to clustering performance, Jensen (1970) posited that free recall of uncategorized lists, that is, lists "composed of items which are relatively unrelated to one another by any supraordinate concept or category labels [p. 91]," reflected mainly Level I ability. On the other hand, free recall of categorized lists reflected a certain degree of Level II ability as well as Level I ability. Jensen predicted that "subjects differing in Level II ability (but not in Level I) should show less difference in FR_u [free recall of uncategorized lists] than in FR_{cl} [free recall of categorized lists] [p. 96]." He argued that free recall of uncategorized lists "requires nothing more than Level I ability, involving simply the reproduction of the input [p. 91]." Free recall of categorized lists, however, would evoke more Level II processes.

Jensen cited evidence which supported the above view. Low SES groups of second and fourth grade Negro Ss were compared in their free recall of categorized and uncategorized lists with high SES groups of second and fourth grade Caucasian Ss. Subjects were presented sets of 20 objects over five trials. The categorized lists were presented in either a blocked or random fashion. The results indicated that for categorized lists, recall performance of fourth grade children was superior to that of second grade children under all conditions, and that SES differences in recall were greater at fourth than at second grade. Recall of the uncategorized lists revealed a relatively small difference in favor of the high SES groups at both grade levels, with the SES difference nearly the same for the second and fourth grade levels. This finding was in contrast to the categorized lists, which revealed a relatively large interaction between SES and grades. Blocked presentation of the categorized list was shown to reduce the SES difference by facilitating the recall performance of low SES subjects. Jensen concluded that these findings were consistent with the view that social class differences in ability involve mainly Level II rather than Level I processes.

It is unlikely that subject differences in Level I and Level II processes could account for the findings of the present experiment. Jensen contends that a greater degree of heterogeneity in Level I learning abilities should be present among a group of EMR children in special classes for the educable mentally retarded than among average children, despite similar variance in IQ or Level II ability. Presumably groups of Ss drawn from EMR special classes will contain a large mixture of primary and secondary types of retardation. The prediction from Jensen's theory would be that EMR children demonstrate relatively more variance than normal children of equal CA in their recall performance on uncategorized or unrelated lists as opposed to categorized lists. The findings of the present experiment showed no significant differences in total recall variance between the groups for all five stimulus lists. In addition, the recall findings cannot be explained in terms of social class differences in ability level since SES and race were controlled in the present work.

Jensen's theory further implies that normal children who are relatively high in Level II ability should display greater performance differences when compared to retarded children with relatively low Level II ability on categorized lists as opposed to uncategorized or unrelated lists. Clustering of conceptually related items is presumed to occur on the basis of hierarchically arranged verbal mediators and to require more than Level I ability. In the present experiment the items on the CL and the H - P lists would each require a conceptual process of the type which characterized Level II. Free recall of uncategorized or unrelated lists is hypothesized as requiring nothing more than Level I ability. Thus, recall performance for the low-associative lists (L - P and L - S) would depend mainly on Level I ability. The reader may recall that, in contrast to these predictions, the differences in recall performance between normal and EMR Ss on the H - P list were similar to group differences in recall on the L - P list. Although the differences were not tested, an inspection of total group means for the CL list indicated a similar finding for group differences on the CL and L - P lists. Moreover, there is a trend for group differences on the L - S list to be greater than group differences on either the CL or H - P lists. These findings may be interpreted as indicating that recall of unrelated as well as categorized word lists requires more than Level I ability to organize adequately the items into appropriate higher-order memory units. In fact, there is evidence that free recall of unrelated words is a linear function of the number of higher-order units or categories used by Ss in organizing such lists (Mandler, 1967a, 1967b, 1968). Marshall (1967) has contended that as the level of association decreases, conceptual relationships have a pronounced effect on clustering in free recall. It seems logical to speculate that the "abilities" of Jensen's theory and the "strategies" of Semmel's view of language are the manifestations of qualitatively different but overlapping cognitive structures or processes.

Theory of Input Organization of Mental Retardates. As indicated earlier in this work, Spitz (1966) contended that the slower learning performance of mentally retarded individuals may be due to a particular deficit in the organization or grouping of the material to be learned. This deficit may be caused by Central Nervous System disturbance. Spitz formulated the following descriptive model in order to compare the information processing abilities of retarded and normal individuals. According to this view, the learning process can be broken up into the following seven steps:

(a) arouse (person is alerted)

(b) attend (attention is given to a specific stimulus)

(c) input (file into appropriate "hold" area)

(d) hold (hold for permanent storage)

(e) recall (retrieve material from temporal file if necessary)

(f) storage (put into appropriate permanent file)

(g) recall (retrieve material from permanent file if necessary)

[Spitz, 1966, p. 53]

The reader may note the similarity of this model with the multi-process memory models described previously (Ellis, 1970; Glanzer & Cunitz, 1966;

Waugh & Norman, 1965).

Spitz argued that the slower learning performance of retardates is probably due to a deficit at step three; that is, "input, and specifically the organization of the material as it enters for filing." This deficit results in an overload of incoming information which may exceed the "channel capacity" of the individual's memory system. As a result, more "noise" may be introduced into his communication system during transmission, thus hindering learning and memory. Noise is described by Spitz as "produced by the subject and is manifested by the subtraction, rearrangement, or addition of information [p. 53]." Noise for retarded Ss is suggested as occurring as "subjective disorganization" which hinders their learning and memory. In contrast, noise for normal Ss is in the form of "subjective organization" which aids their learning and memory. Spitz sees the deficiency exhibited by MR Ss in category clustering on free recall learning tasks as an example of this problem. However, he emphasizes that short-term memory research with retardates should be directed towards delineating the conditions and manner in which retardates organize materials, as well as indicating how efficiently they display their organizational capacity.

In keeping with Spitz's suggestion, the present experiment both revealed the organizational processes used by EMR Ss and explored the nature of these strategies. In support of Spitz's view, the results revealed an input organizational deficit in EMR boys in processing a wide range of verbal stimuli. The findings indicated that EMR children tend to organize verbal materials on a sequential-associative basis (i.e., in terms of meaningful contiguous or associative relationships), and when compared to normal children of the same CA, EMR children demonstrate inefficient recoding of linguistic input (in terms of abstract hierarchical-grammatical and semantic relationships). Furthermore, there was some suggestion that the sequential-associative habits of EMR children become stronger with age. However, developmental study in this area remains to be researched. Spitz and his colleagues have primarily employed samples of institutionalized retarded adolescents and adults as subjects in category clustering experiments. The present study extends the category clustering deficits found with older EMR Ss to include younger children in public school special education classes for the educable mentally retarded.

Implications for Practice

Grouping. The analysis of the data in this study indicated that EMR Ss generally demonstrated greater variability in their performance than nonretarded boys. Exceptions to this trend were shown in the category and associative clustering data for the CL and H - P lists and for repetitions on the H - S list. For these measures, normal Ss revealed a higher degree of variability in their performance than EMR Ss. Retarded Ss displayed the highest degree of variance relative to normal Ss in their intrusion scores and in their repetition scores for low-associative lists. It appears plausible to suggest that structural and associative relationships between verbal stimuli interact with storage and/or retrieval strategies used by retarded children to produce differential learning rates within the population. Some support for this contention was previously reported by Semmel, Sitko, and Semmel (1968). Differential rates of paired-associate learning were revealed between

EMR boys, who varied in the degree to which they gave paradigmatic responses on a free W-A task. Paired-associate performance of Ss classified as low-paradigmatic responders was inferior to that of high-paradigmatic responders when associative strength between paired-associates was low. The performance of the two groups did not differ when associative strength between stimulus items was high, regardless of the form-class relationship of word pairs. The authors concluded that there appears an obvious need to further study individual differences in the verbal learning performance of children relegated to the generic category of the educable mentally retarded population.

Prehm (1968) reviewed the research for rote verbal learning and memory in the retarded and concluded that the rote verbal learning performance of retarded subjects was considerably more variable than that of nonretarded subjects. Baumeister (1968) has argued for greater attention to the analysis of "critical aspects of variability" within the retarded population. He contended that retardates demonstrate greater intra-individual variability than normals. In some situations this variability contributes more to the performance of retarded than nonretarded subjects. In other words, retarded Ss may be less able to maintain consistently an optimal performance level than nonretarded Ss. An implication of this variability "is that any single observation of performance is more likely to be an underestimate of the retardate's optimal level than of the normal's [Baumeister, 1968, p. 478]." Baumeister suggested that variables related to motivational, attentional, or arousal processes may be implicated in "normal-retardate efficiency differences."

The results of the present investigation indicated a moderate amount of overlap in variability between the groups on most of the dependent measures. The writers propose computerized multivariate analyses based on comparisons between good and poor learners on various verbal learning tasks. Such analyses should provide more meaningful results than comparisons between heterogeneous intelligence groups in terms of the usefulness of these data for educational application. Teaching strategies could be more effectively revised to focus on providing more individualized help for the child with poor learning skills. Emphasis would be changed from teaching him specific information to teaching him how to learn. For instance, with the aid of the computer, large masses of child data based on various verbal learning tasks could be screened and analyzed by multiple discriminant analysis for patterns of responses that discriminate between good and poor learners. Children might be effectively regrouped for instructional purposes on the basis of these qualitative patterns.

Hopefully such groupings will prove more effective in designing prescriptive programs leading to the amelioration of poor school achievement among children than those presently used: namely, labeling children as mentally retarded on the basis of psychometric tests which usually yield only global scores. For research purposes alone, multivariate discriminant or cluster analysis would improve the chances of obtaining treatment groups with more homogeneous intra-individual variability in their performance scores, and provide a greater measure of confidence in the results.

Training Strategies. Bateman and Wetherell (1965) investigated the language performance of retarded children on the Illinois Test of Psycholinguistic Abilities (ITPA), a test developed by Kirk and McCarthy (1961) to assess the differential language abilities of children. The authors reported that retarded children reveal a characteristic pattern of psycholinguistic deficits in the "entire automatic-sequential level" as compared to the "representational level." The automatic-sequential level of the ITPA refers to "the relative automatized encoding or decoding of sequences of symbols [Mehrabian, 1970, p. 439]" and is composed of three subscales of the ITPA: (a) a test of visual memory for a series of geometric forms (Visual-Motor Sequential Scale), (b) a digit repetition task (Auditory-Vocal Sequential Scale), and (c) a test of the ability to supply the correct grammatical form of words within sentences (Auditory-Vocal Automatic Scale). Bateman and Wetherell stressed the need for memory training in retarded children, but noted that memory skills were among the most difficult to remediate. Consequently, the authors suggested that memory skills may be more closely related to genetic factors than are the representational level abilities. Bateman (1968) later reported that the performances of retardates in these three areas were all in the general range of two-thirds to three-fourths of their mental age. She also related the retardates' grammar deficiency to incidental verbal learning and predicted that the deficiency would attenuate "with prolonged exposure to language patterns [Bateman, 1968, p.717]."

Weener, Barritt, and Semmel (1967) critically evaluated the ITPA and found that the theoretical model proposed by Kirk and McCarthy (1961) does "not adequately integrate the nine subscales nor does it adequately explain the relationship among subscales or between subscale performance and other relevant behavior [p. 379]." Furthermore, Semmel (1967) and Semmel and Bennett (1970) argued that what Bateman and Wetherell interpreted as a short-term sequential language deficit is actually an artifact of the stimulus materials contained in the automatic-sequential scales of the ITPA. For instance, it is difficult to regard stimuli such as a sequence of digits or geometric forms as linguistic in nature or revealing any associative or grammatical structure. Mehrabian (1970) agreed with these views and indicated that some of the subtests of the ITPA could "be more appropriately subsumed under the general category of cognitive abilities, particularly sensory-motor and perceptual abilities [p. 439]." He provided additional data which failed to support the model of psycholinguistic abilities by Kirk and McCarthy (1961).

Contrary to Bateman and Wetherell's position, the findings of the present experiment provide strong evidence that retarded children use primarily "sequential-associative" strategies in processing language. They indicate that the language position developed by Semmel and his colleagues would have more direct relevance to the practical application of educational treatment for educable mentally retarded children than implications drawn from the performance of these children on the sequential scales of the ITPA. Considering the importance of organization in learning and memory, it seems logical to contend that modifying relatively inefficient sequential-associative organizational strategies in the direction of more hierarchical rule-governed strategies will result in greater academic success for EMR children. If EMR children store information in a very inefficient way, then the relationships between words in storage are primitive relationships, and it is, therefore, harder to retrieve information. By teaching retardates to chunk or impose organization on language input, we may eliminate their dependence on sheer rote memory and associative cues, thereby extending their memory capacity. An improved memory capacity will allow EMR Ss efficiently to store and retrieve more information, and thus to show a higher level of language functioning and problem solving.

There is recent evidence by Bilsky and Evans (1970) which suggests that the difficulty experienced by retarded Ss in reading comprehension and perhaps in other classroom activities may be due to a basic inability to organize verbal materials. The authors presented two groups of older retarded children and adolescents with four trials of a 20-word free recall task composed of five words from each of four conceptual categories. One group was presented the stimuli in categories for the first two trials (i.e., blocked), but randomly on the last two trials. Both groups were further divided into above- and below-median subgroups on the basis of the Metropolitan Achievement Test reading comprehension scores. The results indicated that organized or blocked word presentation on the first two trials increased clustering on subsequent random or nonorganized trials. Moreover, the above-median reading comprehension subgroup revealed significantly more category clustering than the below-median subgroup.

A similar study (Evans, 1970) investigated the effects of reading level and stimulus presentation mode on category clustering and recall performance of mentally retarded adolescents. The results indicated that bimodal presentation (combined auditory-visual modes) had a significant effect on recall but not clustering performance. However, reading grade level was not significantly related to either recall or category clustering. In order to help explain this discrepant finding, Bilsky and Evans reported one major difference between the two studies. Both the reading scores and category clustering scores in the Evans study were higher than those obtained in the Bilsky and Evans study. This finding suggested that "a certain level of organizational ability may be required for the development of reading comprehension ability. However, once this level has been attained, it is possible that other processes begin to play a more important role in determining reading comprehension [p. 775]." The authors reported that in their study the correlation between reading comprehension and category clustering was significantly higher when clustering was "spontaneous" than when clustering was increased by the presentation of clustered lists. They suggested that in order to improve reading comprehension performance significantly, it would probably be necessary to establish "somewhat stable tendencies for individuals to organize incoming verbal materials [p. 775]." The fact that blocked presentation increased clustering on subsequent random trials suggested to Bilsky and Evans that it may be possible to increase the "effectiveness" of organizational skills in mentally retarded individuals. From the total findings, they concluded that one may be able to facilitate the educational performance of mentally retarded individuals on such tasks as reading comprehension by remediating specific deficiencies in input organization.

The present writers have recently studied the effect of phrasal cueing on the free recall of EMR and nonretarded children. Free recall and coding of sentences is most representative of information processing in the classroom (e.g., reading comprehension, mathematical problem solving, concept formation). We are working from the premise that retarded children probably have the ability when prompted to recode linguistic units into hierarchical components. Unlike nonretarded children who tend to avail themselves of this competence naturally, EMR children fail to reveal these tendencies. They apparently rely on simple associative cues between linguistic units rather than constructing hierarchical organizers when processing verbal stimuli. Assuming the validity of the above line of thinking it appears reasonable to contend that distinctive cueing of organizational or chunking strategies will result in the utilization of such strategies by EMR children and will improve their memory of verbal stimuli.

In order to test this hypothesis the writers presented EMR and nonretarded _S_s with four types of nine-word strings which differed in the degree of syntactic and associative structure. Each _S_ was presented with one of three cueing conditions. The main findings indicated that recall of EMR children did not differ significantly from that of nonretarded children when pausal cues were provided at phrasal boundaries within sentences containing standard syntax. Recall of EMR children was relatively inferior when _S_s were not provided with these cues but were required to impose a structure in recoding verbal strings which conformed to standard syntactic rules. Nonretarded children also exceeded retarded children in recall when given sentences with distorted syntactic structure and phrasal cueing. The results of the cueing study emphasize the importance of phrasal cueing within the context of standard syntax on the free recall of sentences among retarded children. We infer from these findings that it may be possible to improve the storage and/or retrieval abilities of retarded children through the development of specific pedagogical cueing procedures.

The studies reviewed in this work indicated that it is possible to increase the free recall and category clustering of stimulus materials by retarded children by: (a) presenting the items in clusters or categories (block method) (Gerjuoy & Alvarez, 1969; Gerjuoy & Spitz, 1966; Gerjuoy et al., 1969; Gerjuoy & Winters, 1970; Madsen & Connor, 1968), (b) requesting Ss to remember the words in categories (Gerjuoy & Spitz, 1966), (c) using a combination of the previous two methods (Gerjuoy & Spitz, 1966), and (d) pretraining Ss to insure that the category concepts to be used in the free recall of categorized lists are present in the "conceptual repertoire" of the individual (Madsen & Connor, 1968). From these findings, it has been contended that it is possible to induce a "clustering set" in retarded Ss who appear to be deficient in spontaneous organization, and who fail to provide their own organization of stimulus materials although they are able to utilize external organization provided by others (Gerjuoy & Alvarez, 1969; Gerjuoy & Spitz, 1966). Future research is required to determine whether such "clustering sets" for both cognitive and verbal materials will transfer to classroom activities. Gerjuoy & Alvarez (1969) were unable to obtain transfer of the clustering set induced by presenting blocked lists to a list of randomly presented words one week later. They speculated that the transfer of the clustering set could be facilitated by giving Ss several sessions with clustered materials. Nevertheless, the findings from the present investigation and other studies suggest that teachers may be able to improve storage and/or retrieval of information in retarded children, and make information more "accessible" in secondary memory by presenting stimulus materials in a highly organized manner. In this way, they may cue the utilization of organizational strategies that prove more efficient than these which currently characterize this population of school-age children.

Teaching Sight Vocabulary. Other important applications of the present research are in teaching reading and constructing reading materials for retarded children. Ryan and Semmel (1969) have emphasized the importance of language-processing strategies in beginning and mature reading. They contend that reading can be viewed as a "constructive active process in which the reader uses his cognitive and linguistic knowledge to reproduce a probable utterance from a careful sampling of cues and then matches that prediction for appropriateness [p. 81]." The authors suggest that the beginning reader should be encouraged to develop appropriate higher-order language strategies. Emphasis should be focussed on "conceptual" aspects of reading more than "perceptual" aspects, and relations, more than units or single words, should be stressed. If reading is viewed as a constructive process, then it follows that a knowledge of the organizational strategies used by EMR children in verbal learning situations may provide useful criteria in selecting initial sight vocabulary words, and in determining how such words should be taught. If children naturally organize words using a characteristic strategy, then it might be more efficient to structure words in accordance with the "natural" strategies. Hence it is hypothesized that teaching words in structured pairs is as efficient as reading single words in isolation. Also, presenting pairs which have a high-associative relationship should be most efficient for children who reveal sequential-associative strategies when compared to children who reveal a tendency to organize input hierarchically. When the association between word pairs is relatively low, it is suggested that sequential organizers will be most efficient in learning syntagmatic pairs (e.g., orange grass), and hierarchical organizers will be relatively efficient in learning paradigmatic pairs (e.g., mother chair).

In any event, the present results suggest that, for EMR children, the critical variable in the selection of sight vocabulary may be associative value. Hence, one paradigm for teaching EMR children to read words might follow these steps: (a) select a high-frequency word, (b) ask the child to free associate to the word stimulus, (c) record all associations, (d) pair the stimulus word with the highest associates, and (e) teach each pair using the paired-associate method of anticipation and confirmation. By giving a list of high-frequency words to a total class, W-A norms for the class can be derived, then pairs selected based on the norms. A study by the present writers is presently in progress which is directed toward investigating these hypotheses.

These principles can further be incorporated in developing reading materials for retarded children in which new words are chosen to appear in contexts which EMR children should find easiest to decode. Ryan and Semmel (1969) have indicated that "easy reading materials often contain the shortest, most frequently used words with little attention given to controlling syntax and semantic associations within a sentence or passage [p. 81]." They suggest that beginning reading materials should be written which include "controlled syntactic patterns, highly associated words, and strong continuity among sentences [p. 81]." Rosenberg (1967, 1968) has also demonstrated that associative dependencies between words play an important role in the recall and comprehension of sentences and paragraphs. It has further been shown that paired-associate learning and retention in retarded children can be significantly facilitated by providing them with sentences as aids (Jensen, 1967; Martin, 1967; Rohwer, 1967). It is reasonable to conclude that reading materials constructed in accordance with the organizational strategies of EMR children will be most effective in improving their reading behavior. Presumably these principles could also be incorporated into instructional materials designed for subjects other than reading (e.g., mathematics).

Scientific research should provide new understanding of the behavior deficits of mentally retarded individuals, as well as providing methods for furthering their psychoeducational functioning. It is hoped that the present work has successfully accomplished these goals. In the opinion of the writers, a focus on the language behavior of poorly achieving children will eventually lead to specific educational interventions which will eliminate the need to label these children "educable mentally retarded" and segregate them from the mainstream of education.

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