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Title of Thesis — Titre de la thèse

Some aspects of Metamemory and Memory in Retarded and Nonretarded Children: A Developmental Study

University — Université

The University of Alberta

Degree for which thesis was presented — Grade pour lequel cette thèse fut présentée

Doctor of Philosophy

Year this degree conferred — Année d'obtention de ce grade	Name of Supervisor — Nom du directeur de thèse
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THE UNIVERSITY OF ALBERTA

"Some Aspects of Metamemory and Memory in Retarded and Nonretarded Children: A Developmental Study".

by

(C) Penumaka Dasaratha Ramayya

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Doctor of Philosophy

IN

Special Education

Department of Educational Psychology

EDMONTON, ALBERTA

SPRING, 1980

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Some Aspects of Metamemory and Memory in Retarded and Nonretarded Children: A Developmental Study", submitted by Penumaka Dasaratha Ramayya in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Educational Psychology, Special Education.

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Abstract

Metamemorial awareness (Flavell, 1970; 1977) and the relationship of impulsivity-reflectivity dimension (Kagan, 1964) to accuracy of estimation and recall were studied using retarded and nonretarded children matched on the Mental Ages (MA) of 6 and 8 levels. Additionally, the MA matched retarded and nonretarded recall performance was also examined in the present study.

The developmental course of metamemory was examined at two Mental Age (MA) levels of 6 and 8. At the lower mental age (MA 6) level there were three groups of 20 each of normal, Educable Mentally Retarded (EMR), and Trainable Mentally Retarded (TMR) subjects and the higher mental age (MA 8) level consisted of two groups 20 each of normal and EMR subjects. The results indicated that the normal and EMR subjects manifested a developmental awareness of memory phenomenon. The TMR group, however, showed a global awareness of the act of memory but failed to exhibit any clear and specific memory behaviors. Accuracy of estimation and recall performance were both observed to improve with repeated task experiences as well as with increase in mental age.

Accuracy of estimation and recall results were also examined relative to impulsivity-reflectivity dimension. The impulsive and reflective groups did not show any significant differences in overestimation at MA 6 level. However, the impulsive children at MA 8 level showed

improvement in their overestimation by reducing the discrepancy between their estimates and recall of items in a short-term memory task. From the developmental perspective, normal reflective group showed greater improvement in accuracy of estimation than the impulsive group at MA 8 level. With regard to recall performance, neither reflectivity nor impulsivity dimension emerged as a significant contributing factor for superior performance at these MA levels.

The present recall results were also examined relative to the controversy surrounding the developmental (Zigler, 1969) and the difference (Ellis, 1970) theoretical positions on MA matched retarded and nonretarded cognitive performance. The results supported a developmentalist position in that the normal and EMR groups at both MA levels performed similarly in recall tasks. The performance of these groups was discussed from the point of view of the developmental versus difference positions in mental retardation research (Weisz, 1976; 1977).

The present findings were discussed in terms of their implications for future research and also in terms of their practical application to obtain a better understanding of the retarded and nonretarded metamemory development.

Acknowledgements

The writer wishes to express his appreciation to all his teachers, particularly to his chairman, Dr. R. F. Mulcahy whose support, enthusiasm, and expectations have made a valued contribution both to the study and the author himself.

Sincere thanks are extended to other members of the committee, Dr. J. P. Das, Dr. L. L. Stewin, and Dr. T. E. Wall. Appreciation is also extended to Dr. N. Williams for consenting to serve as external examiner.

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I. INTRODUCTION

Piaget (1928) suggested that one aspect of the young child's cognitive immaturity is that he is generally less aware of his own thought processes, and consequently less able to introspect and evaluate such processes. If an individual does not view himself as an active memorizer or strategy using individual , then it is not likely that he will employ any strategies to assist him in coping with the demands of memory tasks.

Flavell (1970) coined the word "Metamemory" to explain an individual's knowledge and awareness of how his/her memory works in various memory situations. Since then, several investigators in the area of metamemory (Flavell1971; Kreutzer, Leonard & Flavell, 1975; Moynahan, 1976; Yussen & Levy, 1975) have provided valuable insights concerning children's knowledge of how their memory works in different situations.

The [illegible] of the research literature in the development of metamemory has dealt with normal populations at various age levels. There has, however, been little research carried out with retarded populations (Brown, 1977; Friedman, Krupski, Dawson & Rosenburg, 1976). The literature is almost void in comparative studies using normal and retarded populations with respect to the developmental aspects of metamemory abilities.

In the past decade, comparative cognitive research on retarded and nonretarded children, developmental versus "difference" or defect positions to mental retardation has been a subject of controversy. To date, this controversy has produced very inconclusive research literature. Therefore, an attempt to examine developmental versus difference positions to mental retardation, with particular reference to metamemory development in Educable Mentally Retarded (EMR) and Trainable Mentally Retarded (TMR) populations would appear to be valuable. Such an effort might provide evidence with regard to metamemorial awareness in retarded and nonretarded populations of comparable mental age.

Kagan & Kogan (1970) have suggested that performance differences on various cognitive tasks may depend on a child's cognitive tempo or style. An impulsive child is described as one who does not reflect on his performance and hence makes errors and overestimates this capacity in memory related tasks. Such a cognitive style has been found to account for performance differences in normal children (Drake, 1970; Massari & Schack, 1972). Since monitoring behavior requires one to reflect on his prior performance, it would be interesting to investigate if cognitive style has any effect on metamemory abilities, particularly with retarded and normal populations in comparative studies.

The major purposes of this study are:

1. Assessment of general metamemory knowledge in normal, EMR, and TMR groups;
2. Assessment of the metamemory process of estimation accuracy in comparable retarded and nonretarded MA groups,

and

3. the investigation of the developmental patterns in estimation accuracy of comparable retarded and nonretarded groups.

Additionally, this study is also concerned with the following minor investigations:

1. A comparision of recall performance of retarded and nonretarded children in a short-term memory task;
2. The role cognitive style may play in metamemory process of estimation accuracy and its developmental changes in reflective and impulsive children in retarded and nonretarded groups.

II. SELECTIVE REVIEW OF THE RELATED LITERATURE

One aspect of memory development that is beginning to receive attention since the early 1970s is the explicit knowledge individuals have about their own memory and the activity of remembering. This activity has been referred to as metamemory (Flavell, 1970) to distinguish it from the actual memory performance. As this study involves investigations into metamemory processes, the literature review to follow will deal with several aspects related to memory performance and metamemory.

Models of Memory

Models of memory within the information processing frame work approach date back to much earlier periods in the history of psychology. William James (1890) proposed that memory basically consisted of two components, namely, primary and secondary memory. According to his model of human memory, an item in primary memory is presently in consciousness or awareness while items in secondary memory will have left such awareness and may be retrieved from the past on demand by the organism. This model had been the basis for memory research for several decades until Broadbent (1958) proposed a model of selective attention which included a short-term memory store.

Broadbent's (1958) original model has been modified by several researchers, most notably, Waugh & Norman (1965), and Atkinson & Shiffrin (1968). Waugh & Norman (1965) viewed primary memory as a storage structure with limited capacity in which information can be either lost rapidly or displaced by new information. They claim that such information can be kept alive and delayed by means of rehearsal processes. Through rehearsal processes not only does an individual maintain information in primary memory, but he also transfers such information to secondary memory. This system is considered to be a much more stable and permanent store with much greater capacity than the primary memory. It is further argued that these two stores are not mutually exclusive.

Atkinson & Shiffrin (1968) have presented a multi-store memory model of memory. The significant contribution of this model is that it makes an explicit distinction between structural features and control processes. Structural features include both the physical system and the built-in processes that have a fixed ceiling and are invariant. Control processes are those processes under the control of the subject and these can be selected, modified, and utilized by the individual to meet the task demands . A similar view has been proposed by Brown (1974, 1975). According to Atkinson & Shiffrin (1968), control processes do not constitute a set of well defined procedures, but they are "... transient phenomenon under the control of the subject; their appearance depends on such factors as, instructional set, experimental tasks, and the past history of the subject" (p. 106).

Ellis (1970) extensively researched memory processes in the mentally rertarded and nonretarded and proposed a multi-process memory model. According to him, external stimulation is sensed through an attention process and fed directly into primary memory which is considered to be a limited capacity system capable of retaining a few items which are transient and constantly replaced by new items/information. The rehearsal strategy is viewed as a mechanism for transfering information from primary to secondary memory or long-term memory which is capable of retaining such information over days, weeks, months or longer.

Memory Functioning in The Mentally Retarded

It has often been reported that the retarded, generally, make little deliberate effort to organize or rehearse incoming stimuli (Kellas & Butterfield, 1971; McMillan, 1972; Rowher, 1970). Several investigators in the recent past have attributed these deficiencies to either control processes or structural features of the memory system.

According to Brown (1974), "Control processes are seen as those aspects of the system (memory) which can be programmed, i.e., altered through training" (p.6). Support for this view can be evidenced in the research literature. Belmont & Butterfield (1969; 1971), Brown, Campione, Bray & Wilcox (1973), and Ellis (1970) have found that retarded and young normal children do not spontaneously rehearse in a given memory task, but they can be trained to rehearse successfully. Studies have also pointed out that the use of cumulative rehearsal (Belmont & Butterrfield, 1971; Brown, Campione, Bray & Wilcox, 1973), organizational (Tenny, 1973), elaborative strategies (Brown, 1973b; Reese, 1972; Rowher, 1973), and intentional non-processing of irrelevant stimuli (Bray, 1973; Hagan, 1972) are all strategic behaviors under the control of an individual and respond to training.

In theories of memory functioning, structural features are identified as those aspects of the system that are not programmable , i.e , they can not be altered due to a structural ceiling or fixed upper limits of the organism (Atkinson & Shiffrin, 1968; Fisher & Zeaman, 1973). Some researchers have shown that this upper limit appears to be related to the developmental level in normal as well as retarded children (Kingsly & Hagan, 1969; McBane, 1972). Research into the developmental aspects of memory [illegible]ing has led to the discovery of several deficits [illegible] [illegible]ren may have in memory functioning . Related to c[illegible] [illegible]cesses and structural features , Flavell (1970) pro[illegible] major def[illegible]ts that children may have in memory functi[illegible] [illegible] are [illegible]ational and production defic[illegible]

T[illegible] [illegible]ona[illegible] [illegible]ficiency has been coined by Reese (19[illegible]) [illegible] [illegible]general characterization of a young child's apparent failure to show mediated performance in memory related tasks. In the developmental research, it has been shown that even with instructions there is an initial period wherein strategies are used insufficiently, and that such strategies are abandoned when instructions to use them are withdrawn(Hagan et al., 1975; Meacham, 1972). As Reese (1976) pointed out, developmentally there is an initial period of mediational deficiency in which instruction has no effect, follwed by a period of production deficiency in which some memory facilitation can be produced by appropriate training/instruction. Salatas & Flavell 1975) have gathered some evidence of mediational and production deficiency in young children through the use of categorically structured lists of items. They found that the transition from mediational to production deficiency occurs sometime while children go through kindergarten to grade three.

In discussions on mediational and production deficiencies, a major theoretical problem appears to be the occurance of production deficiency when mediational links are available to an individual. It has been suggested that one possibility could be that an individual is too immature to use one of the metamemorial processes, namely, the intention to remember(Reese, 1976). A similar possibility has been suggested by Wellman (1977) in his review of the development of intentional memory in young normal children. As Reese (1976) put it, a production deficiency could result "from the absence of an intention to remember, or failure of the intention to lead to selection of the appropriate strategy, or the failure of the implementation of the selected strategy" (p.192).

An alternative explanation is that production deficiency occurs whenever the mediating activity is not well established (Reese, 1976; Yendovitskaya, 1974), and when control processes are inadequately used (Brown, 1974; 1975). They suggested that such a deficiency could be remedied by adequate training and thereby performance in memory related tasks could be improved in retarded children.

In an effort to improve performance in memory related tasks, researchers have attempted to train the use of mediational strategies over a wide variety of situations and tasks. Kellas et al(1973) taught retarded individuals a simple cumulative rehearsal strategy in which previous items were repeated three times with each new item on a serial list. Mildly retarded showed greatly improved recall performance and successful utilization of the learned strategy. The researchers have also found significant retention of the learned cumulative strategy two weeks after the original training. Other studies have shown that the training in clustering strategy produced retention of the learned strategy two weeks later in the retarded populations (Bilsky & Evans, 1970; Bilsky, Evans & Gilbert, 1972; Turnure & Thurlow, 1973).

Furthermore, attempts to provide clustering and/cumulative rehearsal instructions to retarded adolescents with brain damage and cultural-familial etiologies have been successful (Reichhart, Cody & Borkowski, 1975). The findings of this study are significant because the subjects across several I.Q (means 38 to 55), MA (means 5.0 to 8.5), and CA ranges (means 12.2 to 15.6) showed significant positive transfer effects over a two week period on both the original and new test lists. This study also demonstrated that individuals with a mean I.Q. of as low as 48 and a mean MA around 7.0 can successfully learn and transfer a cumulative rehearsal strategy. Similar findings have been reported by other researchers (Kellas & Butterfield, 1971; Butterfield, Wambold & Belmont, 1973; Turnure & Thurlow, 1973; Wanchura & Borkowski, 1974).

In an effort to improve retention of information in the memory system of the retarded, some researchers have conducted progressive and mnemonic elaboration training studies (Bower & Reitman, 1972; Brown, 1975, 1976; Hyde & Jenkins, 1973; Jones, 1973). In general, it has been found that subjects who have received more than one experience in elaboration training have exhibited clear patterns of transfer, and that the subjects of average MA 8 showed spontaneous monitoring of the trained strategy.

The training research, as discussed in this section, provides some evidence for the success of mediational strategy training and transfer effects. Although the results are encouraging, the following three aspects seem to limit the generality of the trained strategy use and transfer (Brown, 1974):

1. mediational gains are transferable only after considerable training in strategy acquisition;
2. transfer is higher immediately following training, but one or two weeks later transfer effects are about 20% to 30% better than the control groups in many of the studies;
3. transfer of the trained strategy has generally been found most successful in mildly retarded populations.

In their review of strategy training studies, Butterfield et al (1973) suggested that concentrating training efforts on metamemorial awareness and control might be more productive in future research. Brown (1975) has also proposed a similar view and stated, "as the failure to use strategies effectively (by the retarded) is transsituational, attempts to train specific memorial skill without regard to metamemorial functioning might be of limited value" (p. 113).

Assessing metamemorial functioning,then, appears to be a logical step in the direction of understanding how individuals perform in memory tasks. Flavell (1970; 1977) defined metamemory as an individual's awareness and knowledge of how his/her memory works. In order for an individual to memorize , he/she must be able to evaluate his/her own memory capacity and limitations; evaluate the task demands; and evaluate the interaction of his/her abilities with the task on hand. These processes are presumed to originate at the person level and are related to the cognitive development of an individual (Flavell, 1977).

Cognitive Development and The Development of Metamemory

Cognition has been defined as a process by which sensory input is transformed, reduced, stored, elaborated, recovered and used (Neisser, 1967, p. 4). According to Flavell (1977) the concept of cognition can not be precisely defined, but includes several processes, such as consciousness, thinking, imagining, memory and generation of plans and hypotheses and strategies. Each process is believed to play an interdependent role in the operation and development of each other, affecting and being affected by each other. Flavell (1970; 1977) identified the act of remembering as one of the significant processes in hum memory and cognition. He suggested that in order to be an efficient memorizer, one should know his/her memory capacity and limitations.

Pioneering studies in metamemory, Flavell et al (1970) studied the accuracy of children's estimates of their own memory capacity in kindergarten, second, and fourth grades. The child was first asked how many items he thought he could remember from a list of ten (10) pictures, and after showing a list of pictures, the child was asked to recall the names of pictures he had just seen. The percentage of subjects who estimated that they could recall all the items from a ten item list had decreased from 57% at the nursery school to

21% at the fourth grade level. These results suggest that the children at the nursery school level were much less aware of the limitations of their own memory capacity than the fourth graders.

Yussen & Levy (1975) also investigated the developmental changes in accuracy of estimation. They used subjects from pre-school , third grade and college students. As anticipated, the results showed that prediction accuracy increased from pre-school to college years . In a second experiment in the same study, third graders and college students lowered their predictions in the face of "false" norms given to them, while college students were the only group to under predict actual recall in both experiments. In conclusion the authors pointed out that the adults, generally, were more accurate in their prediction than the elementary school children were, but their susceptibility to false norm information suggests that even adults have some doubts about their exact memory limitations or capacities.

In an effort to investigate prediction accuracy in recalling sets of categorized and non-categorized items, Moynahan (1973) conducted a study on normal first, third and fifth graders. The results of this study indicated that an awareness of the facilitative effects of categorization for recall improves with age. Although the first graders were able to detect the categories, they were less likely than the older children to predict that the categorized card would be easier to remember.

Masur, McIntyre & Flavell (1973) reported that children take a more active and strategic role in monitoring their memory performance with increasing age. In this study, for example, the first graders could tell with 97% accuracy whether or not they had been successful and correct in recall of a particular set of items.

Neimark, Slotnick & Ulrich (1971) reported that their first graders often said that they were ready to recall a set of items before their 3-minute study time period was over. After the recall, these children were surprised at how few items they could actually recall. The suggestion that the young children were less able to assess their memory performance than older children has been investigated by Birch & Evans (1973). Kindergarteners and third graders were asked to give confidence ratings for their recognition judgements in a memory task. A positive relationship was found between confidence ratings before and recognition judgements after a short-term memory task at both kindergarteners and third graders. The authors concluded that since the confidence ratings were much stronger for the older subjects than the younger children which seems to suggest that the younger children were much less able to assess their memory capacity limitations before the memory task performance.

To investigate more directly the development of the ability to assess recall performance in children, Moynahan (1976) conducted a study on first, and third graders. The results indicated that both groups were aware of their recall after the task was completed, but the third graders were more accurate in assessing the number of items they had just recalled. The author suggested that this improved awareness is an indication that the children become better assessers of their memory performance as they grow older in age.

Appel, Cooper, McCarrel, Sims-Knight, Yussen & Flavell (1972) attempted to test a differentiation hypothesis which suggests that young children would not study differently and subsequently do not recall any better when instructed to memorize items for future recall than when instructed to merely look at items presented to them. The authors tested the recall of 4, 7, and 11 year old children following instructions to either look or remember conditions. The results indicated that only at the 11 year old level children's recall in the remember condition was higher than in the look condition. In summarizing the results, the authors pointed out that the instructions to memorize or look were functionally undifferentiated for the young children, "with deliberate memorizing only gradually emerging as a separate and distinctive form of cognitive encounter with external stimuli" (p. 1365). Thus, the differentiation hypothesis was supported in that the very distinction between a set to memorize deliberately or look at items seems to be beyond the metamemorial abilities of very young children, in this case, 4 and 7 year olds.

In another study, Tenny (1973) investigated the interaction of task demands and the child's memory ability. The experimentor gave the child a key word and asked him/her to generate a list of words which:

1. would be easy to remember with the key word;
2. consisted of words that were members of the same category as the key word, and
3. consisted of free associates to the key word.

The kindergarten children generated basica the same list words under the three conditions. Only the two older age children from grades 4 and 6 levels showed evidence of sufficient knowledge of the effects of categorization to produce a categorized list spontaneously.

In an effort to study knowledge about memory and memory related phenomenon (metamemory), Kreutzer, Leonard & Flavell (1975) conducted an extensive study. Structured interview format was employed to determine childrens' knowledge about a wide range of different aspects of memory phenomenon. The authors interviewed children from kindergarten, and grades 1, 3, and 5 on five significant aspects of one own knowledge of memory processes. They were:

1. the individual as an habitual user of menmonics;
2. properties of data that will facilitate future remembering of items or events;
3. acquisition of strategies that will facilitate subsequent recall;
4. ways to cope with the problem of retrieving the stored

information;

5. different mnemonic strategies and demands that are required in different retrieval situations.

The findings of this study are summarized below under two distinct developmental stages , namely, metamemory development at the beginning (kg to grade 1) and by the end of middle childhood (grades 3 to 5).

Even in the early grades of schooling (kg. and grade 1) children appeared to have some knowledge of all of the above five significant aspects of metamemory. Generally, they appeared to show some knowledge that information is lost rapidly from short-term memory , that previously learned but forgotten information can be re-learned easier the second time; that certain attributes of items make them easier to learn and retain, and that one can use other people as storage devices, such as mother or friend, to remember things.

By the age of 9 to 11 years (grades 3 to 5), children will have developed awareness that memory ability varies over occasions, types of data, and individuals; that accurate recall depends on the use of deliberate and systematic input and retrieval efforts; that relationships among items helps one to recall information more easily. These findings have also been supported by earlier researchers in memory and metamemory (Brown et al., 1974; Moynahan, 1973; Ritter et al., 1973; Tenny, 1973).

It is apparent from the available literature that the bulk of research in metamemory has been carried out on normal children ranging from elementary grades to college level. There are very few studies conducted using mentally retarded populations. The following section reviews the studies in metamemory on retarded populations.

<u>Metamemory Studies in the Mentally Retarded Populations</u>

Flavell (1977) suggested that both memory awareness and specific memory abilities are significant dimensions of interest for researchers in understanding an individual's performance on memory tasks. While Flavell's (1970) concern was chiefly directed at inefficiencies of normal children, Robinson & Robinson (1976) suggested that the characteristic nonstrategic approach of the retarded may similarly reflect their lack of awareness of their own memory processing (p. 300). Although research in this new area of investigation (Metamemory) has been primarily concerned with the developmental patterns of normals (e.g. Flavell,1970; Moynahan, 1973, 1976). Recently, there have been some attempts to investigate metamemorial abilities in the mentally retarded (e.g. Eyde & Altman, 1978; Friedman et al., 1976). Brown & Lawton (1977) reported that their educable retarded children at MA 8 and 10 levels could reliably predict their recognition accuracy, thereby suggesting sensitivity to their feeling of knowing experience. The younger children (MA 6) did not show evidence of this sensitivity, but were able to estimate success or failure of their responses after they had completed the task. In an attempt to assess metamemory processes in Trainable Mentally Retarded (TMR) populations, Friedman, Krupski, Dawson & Rosenberg (1976) conducted an interview study modelled after Kreutzer et al., (1975) study on normal children. Their subjects had a mean CA of 18 years and a mean IQ of 49. Based on the taxonomy of metamemorial knowledge suggested by Flavell & Wellman (1976), the authors structured their interviews around three classes of variables, namely, memory characteristics of the person, memory characteristics of the task, and strategies which might be used for particular situations or tasks. The investigators observed that the TMR individuals were able to generate functional strategies and exhibited higher levels of metamemory abilities than one would expect from their IQs.

By far the most comprehensive study to establish parameters in metamemory development in retarded populations has been undertaken by Eyde & Altman (1978). The subjects were 120 mildly and moderately retarded ranging in age from 5 to 16 years. Two groups of subjects were identified as mildly retarded (N=60) with a mean IQ of 67.03; and moderately retarded (N=60) with a mean IQ of 54.10. These subjects were equally distributed within chronological and ability (MA) ranges, with each range having 15 subjects. The research program was divided into four distinct phases, namely verification phase, measurement phase, comparision phase, and correlation phase. In verification phase, the chief concern was to verify the presence of age or ability related variables in the performance of a free recall memory task, while measurement phase was based upon the structured interviews and simulated memory problems described by Kreutzer et al (1975). Only seven of the Kreutzer et al interview schedules were selected for measurement which required minimal verbal processing demands by the retarded. As outlined by the authors the purpose in the comparision phase was to explore the growth of mnemonic strategies and metamemory awareness among the populations of retarded individuals. In this phase, the emphasis was placed on the analysis of the metamemory phenomenon along both chronological and mental age continuum. In the last phase of the research project, the correlation phase, attempts were made to find out the relationship between the subjects mnemonic awareness, as evidenced in the metamemory interviews, and their actual memory performance as measured by the memory tasks in the measurement phase. Briefly stated, the results of this extensive investigation established that the retarded, overall, showed similar developmental characteristics to that of normals in memory related behaviors. At each age group, higher ability retarded children performed better than the lower ability children. In the comparision phase, for example, the variables of chronological age and mental age were evident in response patterns, with the mental age (MA) variable being the best single predictor of performance. The authors suggest that knowing about the ways to plan and knowing how to use them spontaneously may be different aspects of memory processes which have been referred to as "executive control". For example in the verification phase, the higher ability children organized study behaviors in an efficient manner, whereas the lower ability retarded did not show evidence of this planfulness or control. This extensive research project has outlined the initial developmental parameters of metamemory and a tentative relationship between metamemory and memory ability among mildly and moderately retarded populations.

Conclusions

Since Flavell (1970) coined the word "Metamemory", several investigators attempted to establish provisional guidelines on the developmental patterns of metamemory in normal (e.g. Kreutzer et al., 1975) as well as retarded populations (Eyde & Altman, 1978). At this stage of research in metamemory, we know that normal as well as retarded follow roughly the same developmental pattern. Documented evidence suggests that a child becomes more realistic and accurate in assessing his own memory capacities with increase in age (CA) and mental ability (MA). Although a few studies have attempted to show evidence of metamemorial awareness and its relationship to efficient performance on memory related tasks. There are some gaps remaining in this new area of research. Initial investigations suggest the possibility that the metamemorial knowledge, as we understand now, can conceivably guide one to become strategic in memory performance. There are, however, several questions that are not fully answered with regard to strategy utilization, changing strategies in the face of failure on a task and the awareness that these behaviors are at the control of an individual. As Flavell (1977) noted, a question of interest is how a child acquires his knowledge of memory. Repeated informational feedback in various memory situations might be a source of this knowledge (Flavell, 1977, p. 214). There are also suggestions that future research should focus on life experiences of retarded persons in assessing metamemorial awareness (Friedman et al., 1976) and that the evaluation of metamemorial knowledge among retarded should be based on evidence gathered from several situations(Brown & Lawton, 1977).

In summarizing it can be stated that knowledge and awareness of one's own memory processes (metamemory) may play an important role in the memory performance. The survey of the literature, as presented in this section, indicates the need for more research into the development of metamemorial awareness in the mentally retarded, particularly, EMR and TMR populations. It appears, then, that a study aimed at assessing metamemorial abilities, their developmental changes in a short-term memory task in EMR and TMR populations would be a valid contribution to the growing research literature in metamemory.

It has been suggested that research to improve our knowledge and understanding of the behavior and the development of retarded persons rests on comparisions with the development of nonretarded persons (Kappauf, 1976, p. 240). The rationale implied in comparative studies is that the behavior of retarded individuals ca[illegible] better understood in relation to a normal baseline. An argument can be made by saying that a better understanding of retarded individual's behavior can be obtained when compared to normal individual's performance under comparable conditions.

Researchers in comparative studies of normal and retarded individuals have employed several matching methods (Ellis, 1963; 1970; Harter, 1967; 1969; Weisz, 1976; Zigler, 1969). It would seem pertinent to discuss some considerations regarding experimental designs and matching techniques employed in comparative studies of retarded and nonretarded populations.

Experimental Designs in Comparative Cognitive Research

In comparative cognitive research on retarded and nonretarded children, some researchers have advanced arguments in favour of Chronological Age (CA) matching whereas, others supported the use of Mental Age (MA) matching procedure. Discussed below are some considerations of CA and MA matching in comparative studies of retarded and nonretarded children on cognitive tasks such as learning, performance and problem-solving tasks.

CA Comparisions

According to Ellis (1969) the equal CA comparision is favoured because it is "directed at the primary characteristic of mental retardation ... the difference in adaptive behavior of persons of similar chronological age that define mental retardation" (p.563). The rationale implied in such matching is that the individuals may differ on account of CNS dysfunction, disease, genetic endowment, or any combination of these factors interacting with the environment ove a maturational period. Therefore, if one can be certain that the above factors did not interfere with an individual's maturation, then environmentally produced maturation or retardation may be studied in equal CA designs. The differences found under these conditions could then be attributed to the developmental interaction between the organism and the environment. However, some would argue that the behavioral differences in the extremes are so great that comparision based on the CA dimension can not be fully justified (Baumeister, 1967; Weisz, 1974, 1976; Zigler, 1969).

Other investigators (Harter, 1965, 1967; House & Zeaman, 1960; Zeaman & House, 1967) have not considered CA as a relevant dimension or variable, while at the same time reported MA and IQ as correlates of visual discriminating learning in comparative studies. Zeaman & House (1967) reported that with either MA or IQ held constant, "the other (MA or IQ) still correlates significantly with learning, thus establishing the independent relation of both MA and IQ to learning ability" (p. 57). In the discrimination learning set formation study on retarded and nonretarded, Harter (1965) concluded, "in view of the negligible relationship obtained between learning set and CA, one may conclude that CA is neither a contributing nor a contaminating factor, and that interpretations based solely on IQ and MA are justifiable" (p. 40).

In a discussion of problems in comparative cognitive research on retarded and nonretarded persons, Baumeister (1967) pointed out that the experimenter may be unable to meaningfully measure equal CA normals and retardates under the same conditions because the differences are more pronounced at both extremes. In a recent critique on the analysis of CA, MA, and IQ effects in comparative studies, Kappauf (1973, 1976) suggested that the MA X IQ design may be useful in interpreting comparative cognitive studies.

MA Comparisions

The rationale underlining an equal MA research design is that an MA-match equalizes the developmental level of retarded and nonretarded populations in comparative cognitive research (Weisz, 1974, 1977; Zigler, 1969). MA is based on achievemei which is believed to be the product of complex interactions of motivation and experience over a developmental period(Ellis, 1967; Zigler, 1969). Thus, MA may reflect past and present motivational as well as cognitive factors.

The research literature presents a broad mix of studies comparing retarded and nonretarded individuals. For example, Zeaman & House (1967) employed MA-matched groups in comparative studies and stated "IQ and verbal learning performance are positively correlated in both paired-associate tasks and serial position tasks for subjects of equal MA" (p. 202). Estes (1970) suggested that quantitative differences in rates of learning tend to disappear when MA is equated. In discussing the implications for the analysis of CA, MA, and IQ effects, Kappauf (1973) observed that an MA effect must be present in the data if performance improves with IQ.

The Necessity For Comparative Studies

The rationale implied in comparative studies is that the behavior of the retarded individuals can be better understood in relation to a normal baseline. Such an understanding of the retarded behavior can be obtained when compared to normal individual's performance under comparable conditions. Chronological age matching appears to pose several problems because CA, to date, is not found to account fully for the acquisition of cognitive abilities that are required in learning and performance of the retarded.

It must be noted, however, that there are similarly several problems associated with an MA match. As Baumeister (1967) pointed out, two individuals may arrive at a similar MA for entirely different abilities. In the case of normal and retarded, it is conceivable that there are qualitative as well as quantative differences in the structure of abilities. As a result of these factors, an experimentor may, unknowingly, constitute a group on the basis of MA highly related to the criterion measure. If such is the case, it may be possible to find differences in performance between groups even though they are matched on equal MA. Other factors, such as, school experience, reinforcement history, physical and motor impairments, institutionalization, socio-economic status, comprehension of instructions, to mention a few factors, may interfere with the performance of normal as well as retarded persons.

Researchers have attempted to minimize these factors through procedures such as, randomization, selection of subjects without any known physical impairments, obtaining retarded samples from schools for the retarded where success experiences are more compared to the retarded from regular classrooms. Absolute control seems impossible and researchers must be aware of these limitations.

The research review presented in this section on matching samples seem to suggest that the MA-match is favoured by several researchers (Weisz, 1974, 1977; Zigler, 1969) since MA is believed to equalize the developmental level of retarded and nonretarded. In conclusion, it seems useful to point out that many researchers may continue to use MA-match in comparative cognitive research "until a more refined index is constituted as a measure of general cognitive level" (Zigler, 1969, p. 542.) In view of the above discussion, it would seem appropriate to study retarded and nonretarded differences/similarities in cognitive behavior on a general intellectual level, in this case MA. In comparative research during the past decade, a controversy has emerged between proponents of "Developmental" and "Difference" theories to retardation. A selective review of research in this area is presented below.

Developmental versus "Difference" Theories To Mental Retardation

In proposing his hypothesis that mentally retarded children will perform equally well in various cognitive tasks when compared to normal children of equal MA, Zigler (1969) suggested that the theories of mental retardation could be classified into :

a cognitive developmentalist position (Zigler's own position), and

b "Difference" or defect position (Ellis, 1963, 1970).

Within the cognitive developmentalist position, a cognitive level or stage represents all of the formal cognitive processes such as, learning, problem-solving, memory etc. According to Zigler (1969), when compared to a child of equal MA, the retarded child will perform equally on various cognitive tasks to his younger CA peer. His chief concern is that the individuals differing in rate of development (operationally defined as I.Q.) but equated for the level of development (operationally defined as M.A.) will not differ in the formal cognitive processes they employ in reasoning and problem-solving.

Contrasting the developmentalist position is the difference or defect position which predicts that when MA is held constant, children of higher IQ will perform at a superior level to children of lower IQ. It can be stated that the two theoretical positions discussed by Zigler resulted in classifying all major research (e.g., Ellis, 1963, 1970; Spitz, 1963; Weir, 1967) as the difference group and Zigler's position (1969) as a cognitive developmentalist position.

There has been very little research reported surrounding the MA-match retarded and nonretarded performance differences. Das (1972) studied a group of mentally retarded boys matched on MA with normal children at grades two and three. The results in this study tended to support a difference point of view to mental retardation. In a recent investigation to clarify the roles of IQ and MA in a comparative study, Weisz (1977) used MA-matched subjects at three levels of IQ (70, 100, and 130) and three levels of MA (5.5, 7.5, and 9.5) to test hypothesis behavior. The term hypothesis was operationally defined as "a consistent selection of one stimulus property (e.g., color blue) across a series of nonfeedback trials" (Weisz, 1977, p. 109). In his findings, the author reported that none of the hypothesis measures showed a main effect of IQ. He also reported that the general findings and conclusions of this study are consistent with Zigler's developmental theory and inconsistent with the difference position.

Recent critical review (Weisz, 1976) of comparative research of MA matched retarded and nonretarded suggested that the performance differences between retarded and nonretarded individuals on cognitive tasks may have been related to some non-cognitive factors such as, personality differences, task familiarity etc. Following this line of argument, one may suspect that the impulsive/reflective cognitive style may be one of the contributing factors for the performance differences in MA matched retarded and nonretarded research. Therefore, a selective review of the related research on cognitive style is presented in the following section.

In the last decade, Jerome Kagan (1964) has studied cognitive processes in normal children from a problem-solving perspective. He observed that the child who pauses prior to responding (reflective) typically has fewer errors on a cognitive task than the fast responder (impulsive). An impulsive child is described as one who does not reflect on his performance and hence consistently makes errors and overestimates his capacity. If this is the case, such differences in cognitive style (reflectivity-impulsivity) may be reflected in a child's capacity for planning and foresight in memory related tasks.

Reflectivity-Impulsivity

Kagan & Kogan (1970) viewed problem-solving processes as consisting of several processes such as, encoding, memory, generation of hypotheses, and deduction. Memory is represented as having both a short-term and a long-term function. The role of evaluation during problem-solving process has been considered to influence the quality of the final product, i.e., evaluation defines how the child judges his final product (Kagan & Kogan, 1970). Therefore, it can be stated that the children will be constantly receiving feedback on their problem-solving activities. Based on this rationale, one crucial variable in the evaluation process has been isolated and labelled the reflectivity-impulsivity dimension (Kagan, 1964).

By using the Matching Familiar Figures (MFF) test, Kagan (1965) differentiated impulsive and reflective children. In the MFF the child is shown a familiar figure (standard) and six variants, only one of which is exactly like the standard. The refelective child is identified as one who is below the median in errors, but above the median in reaction time. The impulsive child is one who scores above the median in errors and below the median in reaction time.

The reflectivity-impulsivity dimension has been found to be stable over short and long periods of time in children. In a longitudinal study, Kagan (1971) observed habituation behavior to visual stimuli and distinguished between fast and slow tempo in 4 month old infants. Such estimates were found to be predictive of behavior when these infants were 27 months old. Similarly, for a group of first grade children re-tested a year later, correlations of between .48 to .50 for response time and between .25 to .51 for errors have been reported (Epstein, Hallahan & Kauffman, 1975). In a further test of the stability of the impulsivity-reflectivity dimension, Messer (1970) administered the MFF to 65 boys in their first grade of schooling. The author re-tested them 2.5 years later when these children were in grade 3 and found significant test re-test correlations ranging from .25 to .43. Test-retest reliability of the MFF test has been investigated by several researchers. For example, children between 6 to 10 years of age were retested on the same version of MFF test with a lapse of 1 to 8 weeks (Adams, 1972; Hall & Russell, 1974; Siegelman, 1969). Response time reliabilities were .58, .68, .73 and error reliabilities were .39, .34, .43 for normal populations. With respect to EMR populations, latency and error reliabilities of .96 and .80 were reported (Duckworth, Ragland, Sommerfeld, and Wayne, 1974). Internal consistency reliability of .89 and .62 for latency and errors was also reported in the research literature (Block, Block & Harrington, 1974).

Yando & Kagan (1970) constructed 10 different MFF tests each with a different number of variants, ranging from 2 to 12 pictures and administered these tests to 7 year old boys at the rate of one test per week for ten weeks. Median correlation over 10 weeks was .73 for latency and .68 for errors. The generality of reflection-impulsivity construct has also been explored using other tests. Kagan (1966) used the Design Recall Test (DRT) and reported moderate response time intercorrelations of .52. In another study, Russell and Hall (1974) correlated MFF latency with mean latency to choice of variant on Raven's Progressive Matrices and reported a .54 for latency. Together, the above research reports seem to indicate that the reflectivity-impulsivity construct is stable and that the construct also extends to tests containing different requirements and contents.

The reflectivity-impulsivity dimension has been found to generalize to behaviors other than those evidenced in test situations. Significant positive correlations have been reported by several researchers between response latencies on MFF and three scorings on Inhibition of Movement Test (Harrison & Nedleman, 1972), as well as between reflectivity and motor inhibition (Constantini, Corsini & Davies, 1973). In another study, reflective children, in a free-play situation, were found to have been occupied in tasks for longer periods of time, while the impulsives spent more time in transition between the activities (Welch, 1973).

Massari & Schack (1972) manipulated the effects of the type of reinforcement (feedback) on discrimination performance of lower class children in the first grade. The authors found that positive reinforcement improved the performance of reflectives, while it had relatively little effect on the performance of impulsives. Negative feedback on errors, however, induced both reflective and impulsive children to make fewer errors. In another study, Hemry (1973) reported that (a) punishment, (b) reward plus punishment conditions to be superior to positive reinforcement alone. Thus, these studies appear to show that cognitive tempo does respond to reinforcement shedules and an improvement in tempo can be experimentally manipulated.

To study reflectivity-impulsivity dimension and school success, Messer (1970) conducted a longitudinal study on 65 boys in their first grade of school. When this group of Ss were in third grade, the author compared repeaters and nonrepeaters. The 7 Ss who failed in second grade were found to be more impulsive than the rest of the group of original 65 subjects. Although there was a suggestion that the impulsive style can be detrimental to one's academic success, there is not enough evidence to support this contention.

Some researchers have attempted to modify an impulsive cognitive style through training. By having impulsives instruct themselves, Meichenbaum & Goodman (1971) were able to increase latency and decrease errors on the MFF test. However, the authors cautioned that slowing down an impulsive child's response time through self instruction was not always sufficient to insure that the child will use that time efficiently for solving the problem. Self instruction was found to be helpful for some impulsives but not for all. Debus (1970) introduced four modelling conditions to test the effects of modelling on third grade children. The modelling conditions were:

1. an impulsive model;
2. a reflective model;
3. a change model from impulsive to reflective, and
4. a dual model of one reflective and one impulsive.

Increase in latency of responses were reported for all boys who viewed a reflective model, and for girls who viewed any model other than an impulsive model. In all conditions the number of errors remained the same for impulsives. Heider (1971) attempted to modify an impulsive tempo of 80 middle class and 80 lower class children of elementary grades . The Ss were assigned to one of the following three conditions, namely, forced delay, increased motivation, and strategy instructions. Only lower class impulsive children were influenced by strategy instructions and produced delay in responses and reduced errors. Direct instructions appeared to result in a change of strategies and subsequently led to improvement in performance of lower class children.

Some researchers have attempted to study the information processing characteristics of reflective and impulsive children. Nuessle (1972) found that older and more reflective children were better processors of information than impulsives in the elementary grades. The author concluded that the reflective cognitive style facilitated the analysis of more important and relevant features of stimuli. Support for this view can be found in the research literature (Odom, McIntyre & Neale, 1971; Siegel, Kirasic & Kilburg, 1973). Some other investigators, for example, Denny (1973) found that the reflectives tended to eliminate a greater number of alternatives in an array of problem-solving situations compared to impulsives; McKinney (1973) also reported that the reflectives tended to consider the relevance of conceptual categories rather than specific instances whereas the impulsives used information in a "random, trial and error fashion" (p. 145) in problem situations.

In summarizing the findings on reflective-impulsive cognitive styles on performance, one may describe an impulsive child as one who has difficulty in inhibiting motor movements (Harrison et al., 1972), is easily distractible (Welch, 1973), cannot sustain attention (Zelniker et al, 1972), uses less efficient strategies in problem-solving situations (Drake, 1970), processes information in a random trial and error fashion (McKinney, 1973).

The relationship between Kagan's

reflectivity-impulsivity dimension and cognitive or problem-solving strategies employed by children has been studied by several researchers. Impulsive children have been found to make more errors than reflectives, for example, in serial learning (Kagan, 1966), discrimination learning (Massari & Schack, 1972), and deductive reasoning (Kagan, Pearson & Welch, 1966). Impulsive elementary school age children have also been found to use less efficient strategies for scanning stimulus array in matching - to - sample tasks compared to reflectives (Drake, 1970; Seigelman, 1969; Zelniker, Jeffrey, Ault & Parson, 1972). Impulsive children were also found to be les[illegible]ly than reflectives to process information according [illegible]istinctive features on a perceptual learning task (Odom, McIntyre & Neal, 1971). In view of the research reviewed above, it is apparent that the impulsive style of an individual interferes with his performance in several situations. It seems valuable to examine the role cognitive style may play in cognitive tasks, such as, accuracy of estimation and the recall task proposed in this study. Attempts to investigate the role cognitive style may play in comparative studies of metamemory processes of normal, EMR, [illegible] children are non-existent. The task and the Ss seem suitable to examine the role impulsivity-reflectivity may play in the context of metamemory processes of estimation and recall performance.

Significance of This Study

Flavell (1970) identified memory as one of the significant aspects of human cognition and developed a rationale that in order to be an efficient memorizer, one should know how his/her memory works in various memory related situations. He coined the word "Metamemory" to explain an individual's knowledge and awareness of how his/her memory works. Several investigators have documented evidence about children's knowledge of how their memory works in various situations (Kreutzer et al., 1975; Moynahan, 1973, 1976; Yussen & Levy, 1976).

Flavell and Wellman (1977) emphasized that the developmental changes in metamemory may be the first step in assessing and understanding cognitive development in young children. Knowledge and awareness of one's own cognitive processes such as, plans, strategies, and reasoning may not only play an important role in memory performance, but may also affect cognitive development because each of these processes operate and develop affecting each other (Flavell, 1977). An argument can be made here that what a person knows about his/her memory processes greatly influences what he/she learns and remembers.

Assessment of metamemory development in children is a relatively new area of investigation. As discussed earlier, few studies have attempted to assess metamemory development in normal children and fewer studies with regard to retarded populations (Brown, 1977; Friedman et al., 1976). It appears, then, that a study aimed at assessing metamemorial abilities, their developmental changes in a short-term memory task, especially in EMR and TMR populations, would be a valid contribution to the growing research literature in metamemory.

In comparative cognitive research, the controversy surrounding developmental versus "Difference" positions to mental retardation has produced inconclusive research literature. The developmentalist position (Zigler, 1969) maintains that persons differing in rate of development (operationally defined as I.Q.) but equated for the level of development (operationally defined as M.A.) will not differ in formal cognitive processes they employ in reasoning and problem-solving. On the contrary, the "Difference" or defect position maintains that individuals matched on equal MA but differing IQs will show many cognitive and performance differences inherently related to their IQs. In the light of the significance of comparative studies discussed earlier, a better understanding of retarded individuals' metamemory processes can be obtained by comparing the performance of the normal individuals under similar conditions. By matching retarded and nonretarded on equal MA, the theoretical controversy surrounding developmental and difference positions to mental retardation can be examined. It has been documented by several researchers that the impulsive/reflective cognitive style can account for performance differences (Denny, 1973; Drake, 1970; McKinney, 1973; Odom et al., 1971). Attempts to investigate the role cognitive style may play in metamemory processes in normal, EMR, and TMR individuals are non-existent. The task and the Ss in this proposed study seem suitable to examine the role of impulsivity and reflectivity dimensions in the context of metamemory processes of estimation and recall performance of retarded and nonretarded groups.

III. Rationale and Hypotheses

Rationale

One aspect of memory development which has not received much attention in the field of experimental child psychology is the knowledge individuals have about the limitations of their own memory capacity.

Metamemory has made an entry into the experimental child psychology in the early 1970s. Attempts have been made to study several aspects of metamemory development in normal populations (Flavell, 1970; Moyanhan, 1973' 1976; Yussen & Levy, 1975). With regard to the mentally retarded, few studies, to date, have attempted to assess metamemory processes in Educable Mentally Retarded (EMR) and Trainable Mentally Retarded (TMR) populations (Brown, 1977; Friedman al., 1976). The majority of the studies reviewed here provided one or two experiences in prediction, recognition, and recall (e.g., Flavell et al., 1970; Levin et al., 1977; Moynahan, 1976) and their results were based upon limited experiences of the subjects. In order to gain a better measure of their prediction accuracy, several experiences seem necessary and it is believed that a repeated trials paradigm would provide such opportunities for the subjects. The survey of literature, as presented earlier, indicates the need for more research into the development of metamemorial awareness in the mentally retarded, especially in EMR and TMR populations. Two aspects of metamemory that need to be thoroughly researched are estimation accuracy and the developmental trends with increase in age. Hence this study proposes to investigate estimation accuracy and the developmental trends in the groups cf normal, EMR, and TMR populations.

The second important question that is pursued is the controversy surrounding developmental versus difference or defect theories cf mental retardation. Numerous investigators (e. g., Belmont & Butterfield, 1969, 1971; Ellis, 1970) in comparative cognitive research have documented evidence that suggest inferior recall abilities by retarded compared to nonretarded children. On the contrary, Zigler (1969) proposed that MA-matched retarded and nonretarded will perform similarly on cognitive tasks. In an effort to examine the perfromance of retarded and nonretarded relative to the above positions, the subjects are matched on MA dimension in this study.

Kagan (1964) studied cognitive processes from a problem-solving perspective and has identified reflective and impulsive cognitive styles in order to to account for performance differences in normal children. An impulsive child is described as one who does not reflect on his/her performance and, therefore, makes errors and overestimates his/her capacity (Kagan & Kogan, 1970). Attempts to investigate the role cognitive style may play in metamemory processes, as discussed, are non-existent in comparative research on normal, EMR, and TMR populations. The tasks and the Ss in this study seem suitable to examine the role cognitive style (reflectivity-impulsivity) may play in the context of metamemory processes of estimation accuracy in retarded and nonretarded groups.

This study, therefore, has the following purposes:

1. Assessment of metamemorial knowledge through structured interviews in retarded and nonretarded children matched on mental ages of 6 and 8 years;
2. Investigation into the developmental increases in accuracy of estimation from MA 6 to MA 8 and l w this pattern may change, especially for retarded children compared to children of average I.Q (normals);
3. Comparision of recall performance of retarded and nonretarded children in a short-term memory task at MA 6 and MA 8 levels;
4. Investigation of the role cognitive style (reflectivity-impulsivity) may play in metamemory processes of estimation accuracy and recall performance of retarded and nonretarded groups of children.

Definitions

Metamemory

The word metamemory refers to an individual's introspective knowledge concerning his/her own memory capacities and limitations.

Estimation

The ability of an individual to estimate, before hand, his/her memory capacity accurately in a short-term memory performance task. For example, the number of pictures a child thinks he/she could recall from a set of ten pictures in a short-term memory task is an estimation score.

Recall

An individual's actual recall of the number of items/pictures from a given list. For example, the number of pictures an individual actually recalls from a set of 10 pictures in a short-term memory task is his/her recall score.

Deviation Score A deviation score is computed by dividing the difference between estimation and recall by recall (E-R/R). This derived score reflects the degree to which a subject over/under estimated his actual recall performance (Moynahan, 1975; Levin et al., 1977).

Hypotheses

In this section brief summaries of the rationale are provided for each set of hypotheses.

Assessment of some General Aspects of Metamemory Knowledge

Several investigators in the area of metamemory (Flavell, 1970; Kreutzer et al., 1975) have studied metamemorial knowledge in normal children. With regard to retarded populations, very few studies have assessed metamemory processes in EMR (Brown, 1977) and TMR (Friedman et al., 1976) persons. One of the operational definitions of metamemory is an individual's ability to verbalize knowledge and awareness of how his/her memory works in various memory performance situations. Previous research supports the notion that this is an age-related phenomenon. Comparative studies using retarded and nonretarded populations to investigate this developmental awareness are almost void. In an attempt to examine metamemorial knowledge and its developmental changes in comparable mental age matched retarded and nonretarded populations, this study investigated the following specific questions:

1. What differences are manifested in metamemorial knowledge by normal, EMR, and TMR groups matched for Mental Age (MA) level?

2. What developmental differences are manifested in metamemorial knowledge by comparable normal and EMR children at MA 6 and 8 levels.

Assessment of Metamemory Processes

One of the interesting metamemory processes is the child's ability to monitor his/her memory functioning (Flavell & Wellman, 1977). Monitoring has also been described as one of the chief characteristics of "executive function" (Belmont & Butterfield, 1976). Estimation accuracy in a repeated trials paradigm appears to provide sufficient opportunities for a subject to monitor and modify his/her estimates in a short term memory task.

Therefore, in addition to the above questions, the specific metamemory process under investigation is accuracy of estimation in a short-term memory task. Hence, the following hypotheses are proposed relative to accuracy of estimation:

Hypothesis 1. Retarded children will display similar abilities in estimation in a short-term memory task to that of nonretarded of equal MA. Specifically,

1.1. There will be no significant differences in estimation accuracy between normal, EMR, and TMR groups at MA 6 level as measured by their mean deviation scores.

1.2. There will be no significant differences in estimation accuracy between normal, and EMR groups at MA 8 level as measured by their mean deviation scores.

Developmental Changes in Estimation Accuracy

In the developmental research in metamemory, some investigators have attempted to document age-related improvement in accuracy of estimation (Moynahan, 1973; Yussen & Levy, 1975). Provisional guidelines on the general memory awareness in retarded were also reported recently (Eyde & Altman, 1978). As discussed in the review section, the paucity of research, specifically, on the developmental changes in accuracy of estimation in comparable retarded and nonretarded groups appear to warrant thorough investigation. Therefore, it would seem valuable to investigate if accuracy of estimation increases from one MA level to another and if so how this pattern may change especially for the retarded when compared to children of average I.Q. Hence, the following hypothesis was proposed:

<u>Hypothesis 2.</u> There will be an increase in accuracy of estimation (a developmental trend) from MA 6 to MA 8 within each group of retarded and nonretarded subjects. Specifically,

2.1. The developmental increase in accuracy of estimation over five trials will not be significantly different for normal and EMR groups as measured by their mean deviation scores.

<u>Recall Performance</u>

Evidence documented by comparative research literature suggests that the retarded are inferior to that of normals in memory related behaviors (Belmont & Butterfield, 1969, 1971; Ellis, 1970). Zigler (1969) labelled the above research a difference position and proposed his own developmentalist position which predicts equal performance by retarded and nonretarded if they are matched on MA. Later research (Weisz, 1974, 1977) supported the developmentalist position. If this is the case, then one would expect the MA matched retarded and nonretarded to perform similarly in cognitive tasks. Recall performance in a short-term memory task appears to be a good candidate to test the developmentalist position and hence the following hypothesis is proposed:

<u>Hypothesis 3.</u> Normal, EMR, and TMR groups matched on equal MA will perform similarly in a short-term memory task. Specifically,

3.1. There will be no significant differences in recall performance between normal, EMR, and TMR groups at MA 6 level as measured by their recall scores.

3.2. There will be no significant differences in recall performance between normal and EMR groups at MA 8 level as measured by their recall scores.

Cognitive Style and Metamemory Processes

In comparative cognitive research most often performance differences between retarded and nonretarded groups have been attributed, in general, to the rate of cognitive development (I.Q.), and environmental and motivational factors. In the past decade, Kagan (1964) identified impulsive and reflective dimension or cognitive style to account for learning and performance differences in normal children. Epstein et al (1975) noted that these two perspectives "historically have received scant attention" (p. 11), especially, by special educators and researchers interested in learning and performance characteristics of exceptional children. An impulsive child is described as one who does not reflect on his/her performance and, therefore, makes errors and overestimates his/her capacity (Kagan & Kogan, 1970). Then, one may expect an impulsive child to overestimate his/her memory capacity in one of the metamemory processes, namely, estimation accuracy and also recall fewer items in a short-term memory task. Attempts to investigate the role cognitive style might play in metamemory and memory processes are non-existent with regard to retarded and nonretarded populations. The present study sought to examine the relationship of impulsivity-reflectivity dimension in estimation accuracy and its developmental changes and also recall performance in retarded and nonretarded groups. Hence the following hypotheses are proposed:

Hypothesis 4. Reflective and impulsive cognitive styles as identified by the Matching Familiar Figures (MFF) test will be expected to influence estimation accuracy and recall performance of retarded and nonretarded populations. Specifically,

4.1. Children with an impulsive cognitive style will be expected to overestimate compared to children with a reflective cognitive style in normal, EMR, and TMR groups at MA 6 level as measured by their deviation scores.

4.2. Children with an impulsive cognitive style will be expected to overestimate compared to reflectives in normal, and EMR groups at MA 8 level as measured by their deviation scores.

Hypothesis 5

There will be a developmental increase in accuracy of estimation from MA6 to MA8 level within each group of normal and retarded subjects. Specifically,

5.1. The developmental increase in accuracy of estimation will be significantly higher for the reflectives in normal groups compared to that of impulsives as measured by their deviation scores.

5.2. The developmental increase in accuracy of estimation for the reflectives will be significantly higher compared to that of impulsives in retarded subjects as measured by their group mean deviation scores .

<u>Hypothesis 6</u>

Impulsive children will be expected to recall fewer items in a short-term memory task compared to reflective children, specifically:

6.1. Impulsive children will be expected to recall significantly fewer items compared to that of reflectives in a short-term memory task in normal, EMR, and TMR groups at MA 6 level as measured by their group mean recall scores.

6.2. Impulsive children will be expected to recall significantly fewer items compared to that of reflectives in a short-term memory task in normal, and EMR groups at MA 8 level as measured by their group mean recall scores.

IV. Method

Subjects

A total of 100 subjects participated in this study. Normal and retarded subjects were chosen from regular and special classes within the city of Edmonton, Alberta. Pertinent CA,IQ,and MA information was obtained from the school records and the Psychologists offices at the schools. Initial screening by the investigator, in consultation with the school's psychologist resulted in the elimination of subjects suspected of having sensory and verbal fluency difficulties to perform the tasks in this study. Three subjects failed to meet pre-training requirements and two subjects failed to complete all stages of the experiment. Their data was excluded from the final analyses. Retarded and nonretarded were matched on similar mental ages. At the MA 6 level, there were 20 subjects in each of the normal, EMR, and TMR groups. Due to some problems in locating TMR subjects, the MA 8 level comprised of only normal and EMR groups of 20 subjects each. Complete descriptive statistics for all the subjects is provided in Table 1.

Pre-Training Tasks

Metamemory research typically employed interview questions designed in such a way that they would elicit evaluative responses reflecting an individual's own general memory functioning. It was considered necessary and appropriate to conduct these interviews (e.g., Kretzer et

Table 1

Means and Standard Deviations of Chronological Age, Intelligence Quotient, and Mental Age for TMR, EMR, and Normals

Group	N	Mean CA (Range)	STD.	Mean IQ. (Range)	STD.	Mean MA (Range)	STD.
TMR	20	14.6 (12.3-17.9)	2.04	46.9 (38-54)	5.31	6.01 (5.10-6.10)	.40
EMR	20	8.8 (6.7-10.3)	1.28	73.9 (61-75)	5.87	6.72 (5.6-7.0)	.64
NOR	20	6.32 (5.10-6.8)	.23	104 (90-114)	6.04	6.58 (5.7-7.2)	.32
EMR	20	10.9 (9.6-14.5)	1.91	69.0 (57-75)	6.43	7.9 (7.2-8.6)	.43
NOR	20	8.15 (7.6-8.7)	.25	105.7 (91.115.5)	7.26	8.12 (7.6-8.7)	.53

al., 1975; Eyde & Altman, 1978) because the definition of metamemory primarily emphasized the ability of an individual to introspect and verbalize his knowledge of how his memory works as opposed to actual memory performance. Investigators repo[illegible]t the verb "remember" is used and produced as earl[illegible]years of age in children (Limber, 1973) that th[illegible]emember" and "forget" are understood and diffe[illegible]iated by 4 years of age (McNamara, Baker & Olson, 1976; Wellman & Johnson, 1979) and that the kindergarteners and first graders understand the meanings of learn, remember and forget fairly well (Kreutzer et al., 1975, p. 50). Therefore, it was assumed that the subjects would be able to perform the tasks in the present study. Through pre-training tasks, a measure of the subjects' knowledge of functional meanings of words "remembering", "memory", and "recall". was obtained. Comprehension of these words is considered important to perform the experimental tasks in this study. Hence the pre-training tasks are described here before stimulus materials and procedures are outlined in the following section.

<u>Pre-Training Tasks</u>

Identification of Missing Objects.

Each subject was shown 5 items, namely, a toy ladder, a doll, a car, a marble, and a key. After the subject identified and named all the items shown, one of them was removed and placed in the materials box. The examiner asked the subject, "Which thing is missing?". If the subject responded correctly, E said, "Very good that is called remembering." Accurate responses to the above questions were considered a sufficient indication that the subject understood the meaning and intent of this type of questioning.

Recall Task

The E showed five items to the subject. After all the items were named by the subject, they were removed from view and then E asked the subject the following questions: "Tell me how many things I showed you? ... what are they?". When the subject responded correctly, E said, "Very good. This is called recall or saying things from your memory". The above procedure was repeated when the subject failed to show a clear understanding. Thus through this pre-training basic knowledge of such words as remembering and memory/recall were established.

Stimuli and Procedure

Stimuli

Pre-task Metamemory Interview

The metamemory interview task consisted of 5 questions that were utilized to probe awareness and knowledge of memory processes (Kreutzer etal., 1975). The interview was conducted before the experimental tasks and the questions were as follows:

1. Do you forget things?
2. Are you good at remembering?
3. Are you better than your friends?
4. What things are easy to remember?
5. What things are hard to remember?

The responses to questions 1, 2, and 3 were scored under yes, no, sometimes, while the responses to questions 4 and 5 were scored under categorical, instances, none, or other. A response was considered categorical when any reference or mention was made to anything categorical or recurrent. An instance was when the subject made any reference to a particular or specific experience such as, "I forgot to remember X onetime." When the subject denied that anything was easier or harder to remember, it was then classified as none. If a response was not classifiable under any of the above, then it was scored as other.

Estimation and Recall Tasks

The stimulus pool consisted of 60 line drawings taken from the Peabody Picture Vocabulary Test (PPVT). In a pilot study, TMR subjects recognized and named all these pictures and therefore, it was assumed that the EMR and normal subjects in this study would be able to recognize and label the stimuli. All the pictures were photocopied, laminated and cut to 3" X 4" size cards. They were randomly grouped into six sets, each set containing 12 pictures. The sets were randomized across trials and subjects in the presentation (see Appendix 1.1 and 1.2 for samples).

Post-task Metamemory Questions

In order to assess the subjects' awareness of guessing as well as future predictions in memory-recall situations the examiner asked the following questions:

1. Did you guess any names during this test?
2. If you were given a similar test at some other time, how many out of 12 do you think you could recall?
3. If I had told you how many pictures you remembered after each test, do you think you would have done better?

Matching Familiar Figures (MFF) Test

Kagan (1964) constructed the Matching Familiar Figures (MFF) test to identify impulsive/reflective cognitive style in children which is believed to be responsible for differences in cognitive performance. Later research established reflectivity/impulsivity dimension to account for performance differences in normal as well as retarded populations (e.g., Kagan & Kogan, 1970; Harcum & Harcum, 1973). This test consists of two sample items and twelve test items. The subject is shown a picture of a familiar object (standard) and six variants, only one of which is identical to the standard. The subject is then required to select the identical alternative. Scoring is based upon the total number of errors and the mean latency to the first selection. Each subject is allowed a maximum of six errors on any trial after which the subject is shown the correct answer by the examiner (see Appendices 1.3 and 1.4 for MFF samples). As discussed in the review section, the MFF test has been found to be a valid and reliable instrument for use on both normal (Hall & Russell, 1974) and retarded populations (Duckworth et al, 1974).

Procedure

Each subject was seen individually in two sessions on two separate days. Total testing time for each subject was approximately 40 to 50 minutes for both sessions.

In the first session each subject was given pre-training in order to establish common referents for the memory tasks to follow. The subject was seated across from the examiner at a table. The material box was placed beside the examiner on the right hand side and hidden from the view of the subject. Five items were presented in the order as outlined earlier in this section. After removing one of them from view, the subject was asked a question on the missing item. A second question on recall was asked following removal of all the items from the subject's view. These training tasks were designed to establish meanings of words such as, remembering, memory and recall in a functional situation and hence responses were not recorded. Almost all the subjects responded correctly except for three who were excluded from this study.

Immediately following the pre-training tasks, each subject was asked 5 metamemory interview questions. Responses to each question was scored under the appropriate column as outlined in the earlier section. In the second phase of this session, each subject was asked an estimation question prior to the presentation of the stimuli. Subject's response was recorded as an estimation score. The subject was then presented with a set of 12 pictures and asked to name each one of them. A recall question was asked after removing all the items from sight. The actual number of items correctly recalled was entered as the the recall score. There was an interval of 10 to 15 seconds prior to the presentation of the second set of pictures. This procedure was followed for all the five test trials.

In the second session, approximately one to two weeks after the first session, each subject was administered the Matching Familiar Figures test. In each group, subjects' latencies were rank ordered from the fastest mean response time across all twelve items to the shortest and split at the median. The errors were also rank ordered from the highest number of errors to the lowest. Impulsives were those who scored above the median on speed and errors, while those who scored below the median on speed and errors were classified as reflectives. Subjects who did not fall into any of these two distinct categories were omitted from the analyses. This group consisted of 16 out of 100 subjects.

V. Results

The results of this study will be presented in four sections. The first section will deal with the results of the pre and post task metamemory interview questions. The developmental trends in the accuracy of estimation across groups and MA levels will be discussed in the second section, while the actual recall comparisions will be discussed in the third section. The fourth section will deal with the results of the impulsivity/reflectivity dimension and its related performance differences in retarded and non-retarded groups in this study. A significance level of .1 was chosen for all Scheffe's comparisions of means in this study (Ferguson, 1976).

Metamemorial Knowledge

Previous research results in metamemory (e.g., Kreutzer et al., 1975; Eyde & Altman, 1978) suggested that the increasing awareness of memory capacity limitations and the ability to differentiate, for example, things easier/harder to remember are mostly an age-related phenomenon. In an attempt to further clarify and, perhaps, provide new evidence , the following chi square analyses were performed on the subjects' responses to the five interview questions:

1. Subjects' responses X groups at MA 6 level (Nor./EMR/TMR);
2. subjects' responses X ability groups (normal and EMR at MA 8 level);

3. subjects' responses X normal groups (MA 6 and 8);
4. subjects' responses X EMR groups (MA 6 and 8).

A contingency table defined by Yes or Sometimes versus No/Other X normal, EMR, TMR groups at MA 6 level yielded a chi square value of 7.35, (df=2), $p<.025$ for question number 1 (Do you forget things?). The normal subjects at MA 6 level evidenced more awareness that they, in fact, "forget" things, whereas the EMR and TMR groups did not manifest this awareness (Appendix 2.1).

The chi square value obtained for the above question 1 with respect to the MA level was 7.033, (df=1), $p<.008$. Higher ability (MA 8) subjects apparently are more aware of forgetting things than the lower ability groups (Appendix 2.2). The responses of subjects to memory awareness questions 2, 3, 4, and 5 were not significantly related to either group membership (Nor/EMR/TMR) or MA levels (Appendix 2.3). However, a simple frequency count of the responses to question 2 indicated that almost every subject in all the groups across two MA levels said they were good rememberers. For question three, 40% of normals at MA 6 level either denied or said that they did not know their friends were better rememberers, and 85% of EMR and TMR subjects responded by saying that they were better rememberers than their friends. Overall large denials that they ever forgot were made by younger children at MA 6 level.

Post-task responses to questions 1 and 3 are presented in Appendix 3.1. There are no significant differences in their responses. Subjects responses to question 2 were tabulated in terms of actual number of items they think they could recall in a similar test at a later time (see Appendix 3.2).

Accuracy of Estimation

In order to compare accuracy of estimation, a deviation score was utilized by following the method suggested by earlier researchers (e.g., Levin et al., 1977). A deviation score was computed by dividing the difference between estimation and recall scores by the recall score. This derived score reflects the degree to which a subject over/under estimated his actual recall performance. The values closer to zero reflect a good match between estimation and recall by the subjects. Deviation scores for the three groups at the MA 6 level over five trials were compared by utilizing a 3 X 5 analysis of variance with repeated measures for the trials factor (Table 2).

There were no significant main effects. However, there was a significant group X trials interaction (F=2.942; df=8,228; p<.005) which is presented in Figure 1. Scheffe's tests of the significance of means (Winer, 1962) in this interaction shows that there is no significant differences on the trial means for the normal and EMR groups. However, the normal group was found to be better than the TMR group on the third trial (F=8.24; df=4,228; p<.01) and also on the fifth trial (F=16.82; df=4,228; p<.05)

Table 2

ANOVA for Accuracy of Estimation Data at MA 6 level
Involving 3(Groups) X 5(Trials)

Source	df	MS	F
Between			
A(Nor/EMR/TMR)	2	1.496	1.618
Error	57	0.924	
Within			
B(Trials)	4	0.210	0.985
A X B	8	0.628	2.942**
Error	228		

**$p < .005$

As presented in Figure 1, the curves for normal and EMR groups show a decreasing tendency. This tendency is indicative of improvement in accuracy of estimation by reducing the discrepancy between estimation and recall over five trials. The mean deviation scores for normal, EMR, and TMR groups are: .69, .45, .23, .30, .11; .62, .51, .44, .42, .47 and .39, .61, .65, .68, .72 respectively.

These results indicated that the normal as well as EMR subjects showed a developing awareness of accuracy of estimation over five trials and that these two groups performed similarly. Comparisions of all the three groups revealed that the TMR group overestimated significantly compared to that of the normal group.

Mean deviation scores for the two groups at the MA 8 level over five trials were compared utilizing a 2 X 5 analysis of variance with repeated measures for the trials factor (Table 3).

There were significant group ($F=6.13$; $df=1,38$; $P<.01$) and trials ($F=4.59$; $df=4,152$; $P<.001$) main effects. The performance of normal and EMR groups over five trials show a decrease which signifies improving awareness on the part of both the groups in accuracy of estimation. The mean deviation scores are: .26, .27, .20, .04, .05 for normals, and .49, .44, .41, .38, .17 for the EMR groups.

__Developmental Changes in Accuracy of Estimation__

The developmental increments of MA matched retarded

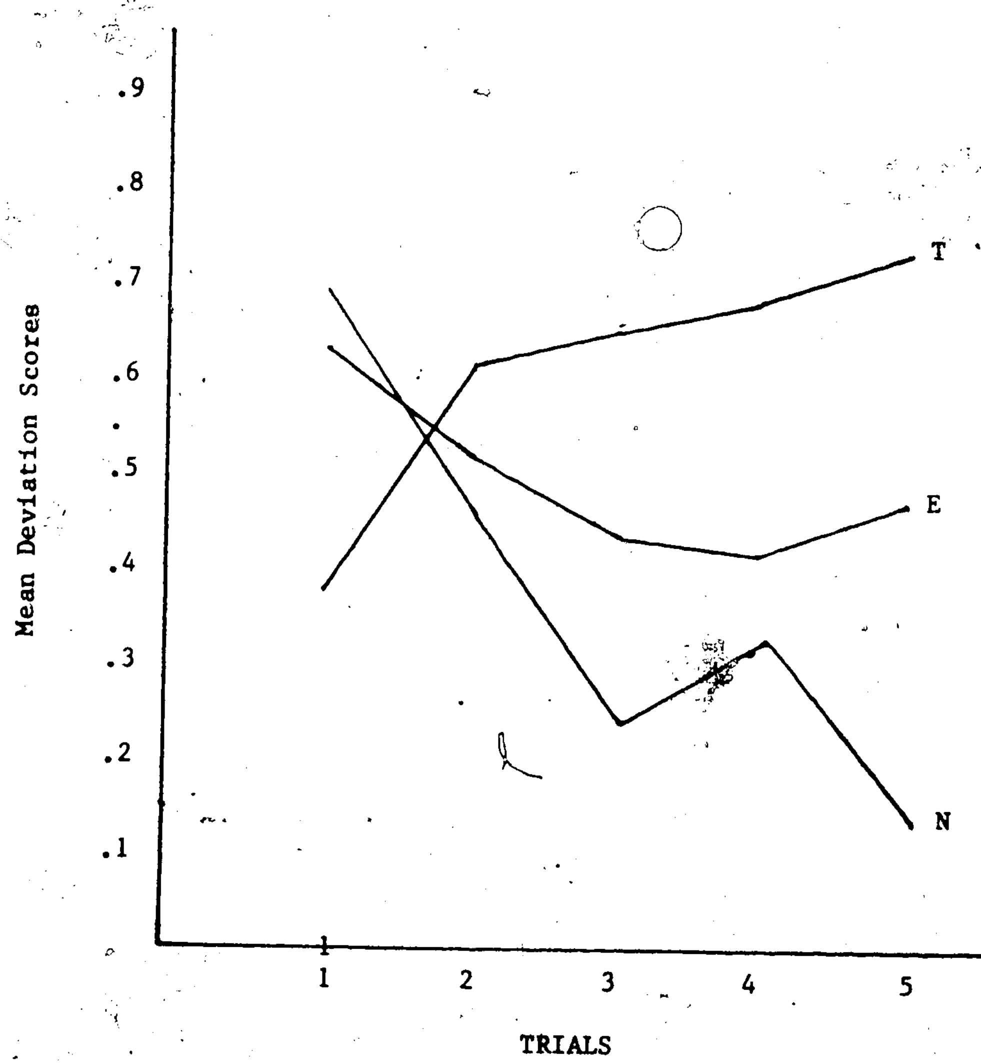


Figure 1. Mean Estimation Accuracy Scores of Normal, EMR, and TMR groups at MA 6 Level .
N=normal; E=EMR; T=TMR (N=60

Table 3

ANOVA for Accuracy of Estimation Data at MA 8 level
Involving 2(Groups) X 5(Trials)

Source	df	MS	F
Between			
A(Nor/EMR)	1	2.283	6.13**
Error	38	.373	
Within			
B(Trials)	4	.485	4.59***
A X B	4	.075	.712
Error	152	.106	

**$p < .01$

***$p < .001$

(EMR groups only) and nonretarded groups using a 2 groups (Nor./EMR) X 2 (MA levels) X 5 (trials) analysis of variance with repeated measures on the last factor. The results of these analyses are presented in the Table 4.

The results show evidence of significant main effects for both nor/ret (F=5.01;df=1,76; P<.05) and MA6/8 groups (F=3.96; df=1,76;P<.05). There is also a significant trials effect (F=7.79; df=4,304; P<.0005). The increases in accuracy of estimation over trials for normal and retarded groups as well as for the two MA levels are presented graphically in Figures 2 and 3. Considered together, the present results indicated that the developmental increases for the normal and EMR groups at both MA levels were not significantly different over the five trials.

Developmental Versus Difference positions

Recall Performance

The analysis in this section was based on the data from three groups of 20 subjects each of normal, EMR, TMR at MA6, and two groups of 20 each of normal and EMR groups at MA 8 level. Table 5 shows the results of the two-way analysis of variance with repeated measures for the trials factor at MA 6 level. These results indicated a group (F=13.65; DF=2,57; P<.00001), and also the trials main effect (F=10.11; DF=4,228; P<.00001). Scheffe's comparisions of mean recall scores collapsed over five trials revealed that the TMR group was superior in recall (P<.001) to both normal and EMR

Table 4

ANOVA for Accuracy of Estimation Data at MA 6 and 8 levels
Involving 2(Groups) X 2(MA Levels) X 5(Trials)

Source	df	MS	[illegible]
Between			
A(Nor/Ret)	1	2.972	5.01*
B(MA 6/8)	1	2.353	3.96*
A X B	1	0.170	0.29
Error	76	0.593	
Within			
C (Trials)	4	1.193	7.79***
A X C	4	0.105	0.70
B X C	4	0.172	1.15
A X B X C	4	0.231	1.55
Error	304	0.149	

*$p < .05$

***$p < .0005$

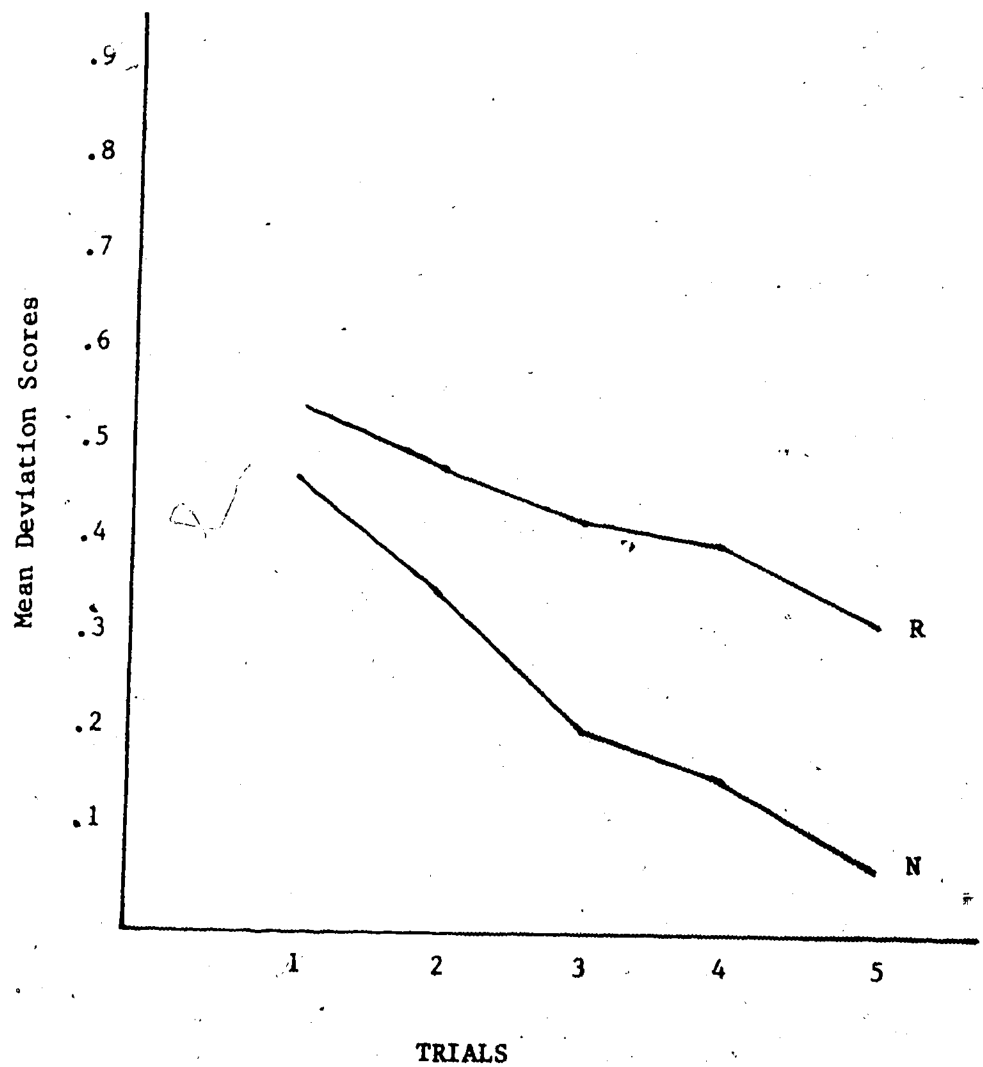


Figure 2. Increases in accuracy of estimation for normal and retarded groups over five trials. N=normal; R=retarded (N=80)

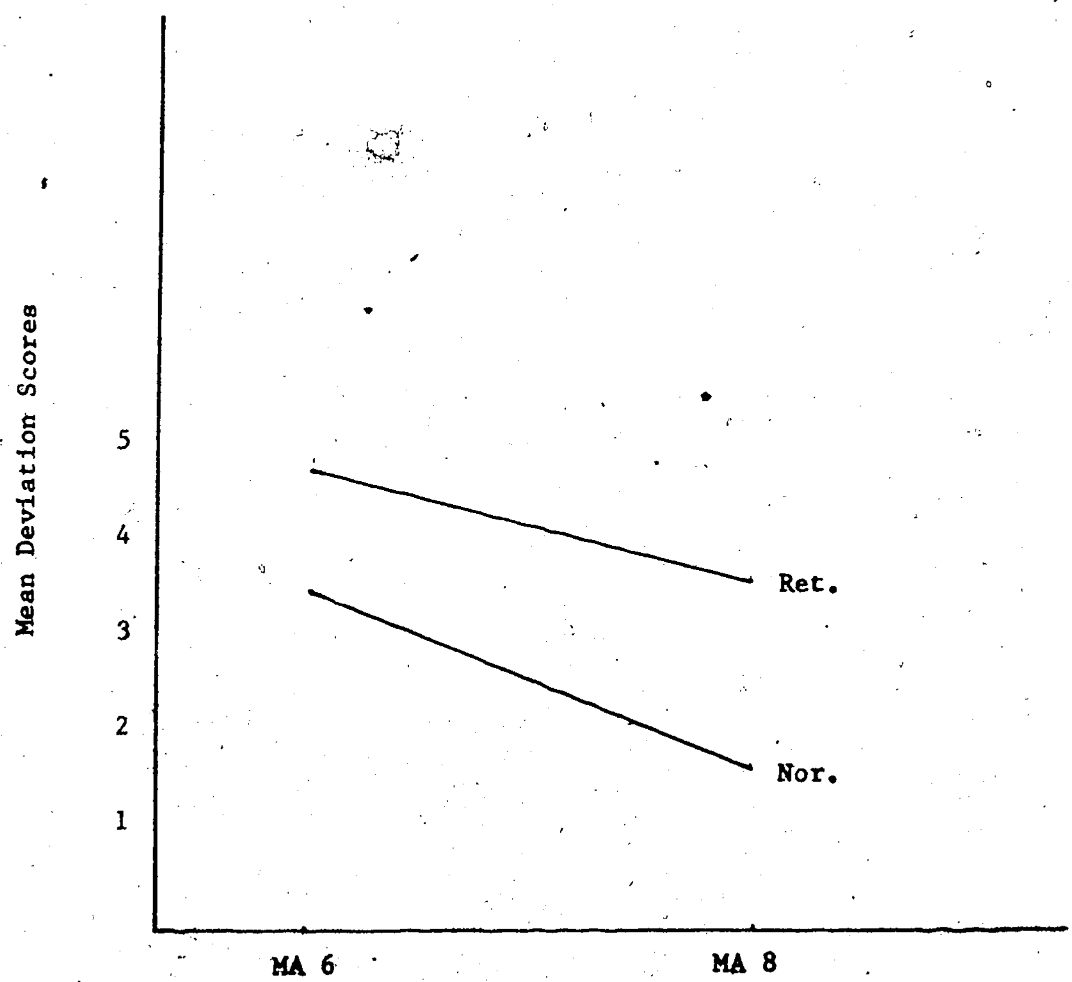


Figure 3. Increases in Accuracy of Estimation for Normal and Retarded Groups at two different MA levels. Ret.=Retarded; Nor.=Normal (N=80)

Table 5

ANOVA for Recall Data at MA 6 level

Involving 3(Groups) X 5(Trials)

Source	df	MS	F
Between			
A(Nor/EMR/TMR)	2	58.240	13.65***
Error	57	4.267	
Within			
B(trials)	4	6.824	10.11***
A X B	8	0.593	.879
Error	228	0.675	

***p .0001

groups while the normal and EMR groups are not significantly different at MA6 level. The mean scores for normal, EMR and TMR groups are: 4.26; 4.34; 5.62 (Figure 4).

Separate analysis was performed on the data from two groups of 20 subjects each of normal and EMR populations at MA 8 level. These results indicated that the normal and EMR groups at MA8 level performed similarly in a short-term recall in a repeated trials paradigm.

Cognitive Style and Metamemory Processes

In this section, the relationship between impulsive/reflective cognitive style and accuracy of estimation were analyzed. Six subjects each of impulsives and reflectives were selected from both MA levels for the purposes of analysis in this section. Descriptive statistics on all the subjects are provided in Appendix 5.1 and 5.2.

In order to determine estimation accuracy of impulsive and reflective subjects in normal, EMR, and TMR groups at MA6 level, a 3 (groups) X 2 (imp/ref) X 5 (trials) analysis of variance was performed with repeated measures on the last factor. The results of this analysis are presented in the Table 6.

There was no significant main effect for groups as well as for the impulsive and reflective dimension. However, there was a trials effect ($F=3.33$; $df=8,120$; $p<.0125$) and group X trials interaction ($F=2.85$; $df=4,120$; $p<.006$). When further comparisions were made utilizing Scheffe's method,

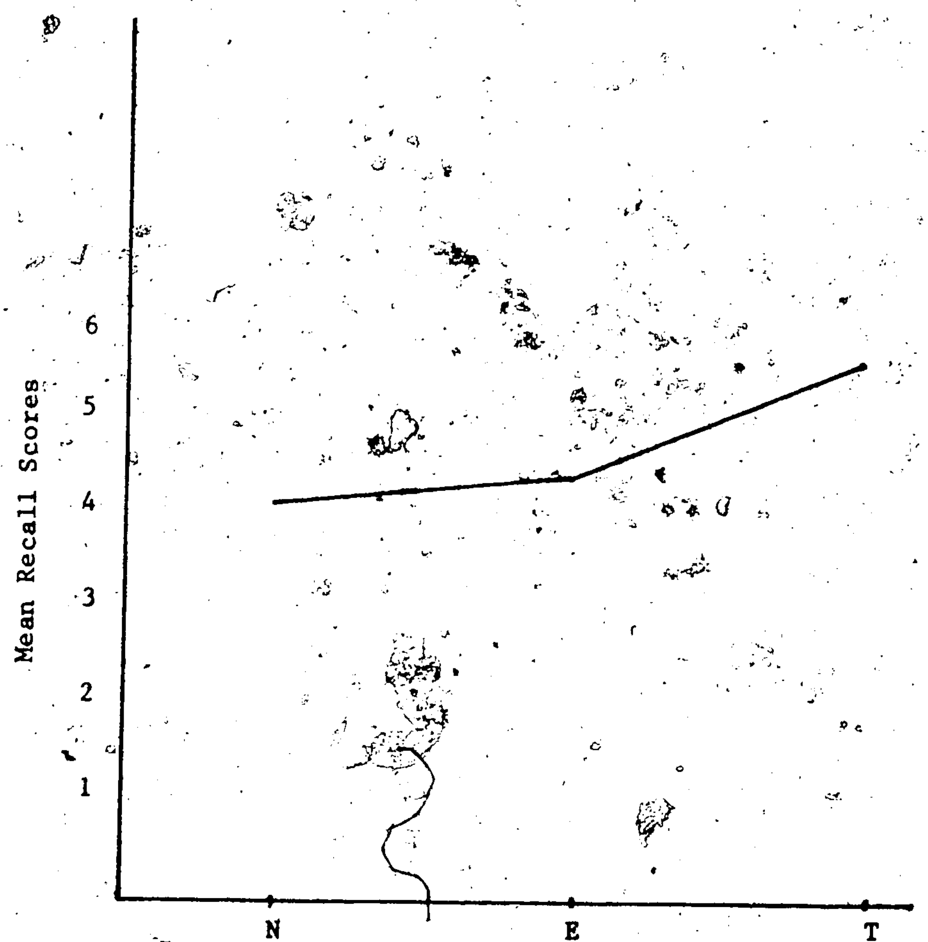


Figure 4. Mean Recall Scores for Normal, EMR, and TMR Groups at MA 6 Level (N=60).
N=Normal; E=EMR; T=TMR

Table 6

ANOVA for Accuracy of Estimation Data at MA 6 level Involving 3(Groups) X 2(Im/Re) X 5(Trials)

Source	[illegible]	MS	F
Between			
A(Nor/EMR/TMR)	2	0.125	0.15
B(Im/Re)	1	0.232	0.28
A X B	2	2.514	3.00
Error	30	0.838	
Within			
C(Trials)	4	0.683	3.33*
A X C	[illegible]	0.583	2.85**
B X C	4	0.119	0.58
A X B X C	8	0.168	0.82
Error	120	0.204	

*$p < .05$

**$p < .01$

on the means involved in this group X trials interaction, normal and TMR groups showed a significant difference only on the first trial (F=12.[illegible]; DF=8,120; p<.001). The mean scores are: .94, .54, .34, .30, .11 for the normal; .75, .51, .43, .42, .33 for the EMR and .29, .67, .72, .53, .47 for the TMR groups. These interactions are presented in Figure 5.

A similar three way analysis of variance was performed at the MA8 level using only two groups of normal and EMR subjects. The results of these analyses are presented in Table 7.

The results indicated a significant trials effect and impulsive/reflective X trials interaction. Both impulsives and reflectives in normal and EMR groups showed a significant improvement in accuracy of estimation over 5 trials (F=2.84; df=4,80; p<.03). The impulsive/reflective X trials interaction effect was also significant (F=2.50; df=4,80; P<.05). This effect was further analyzed by utilizing Scheffe's multiple comparisions of means. Impulsive subjects overestimated significantly higher than the reflectives in accuracy of estimation only on the first trial (F=5.03; df=1,80; p<.05). The performance of subjects on this task is presented in Figure 6.

Developmental Changes in Impulsive and Reflective Children

Normal Subjects

In this section, the developmental changes in normal

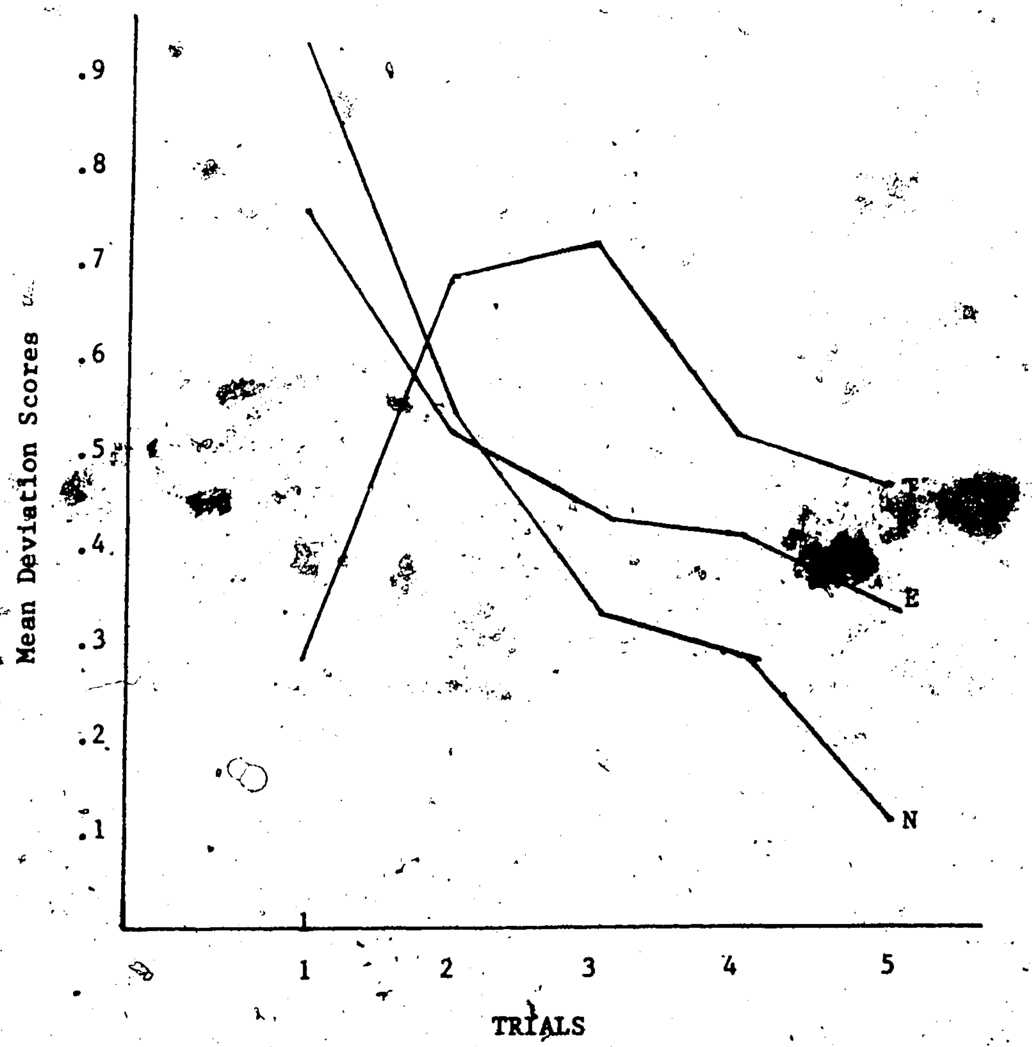


Figure 5. Cognitive Style and Accuracy of Estimation Data Involving Groups X Trials Interaction at MA 6 Level. T=TMR; E=EMR; N=Normal(N=60)

Table 7

ANOVA for Accuracy of Estimation Data at MA-8 level
Involving 2(Groups) X 2(Im/Re) X 5(Trials)

Source	df	MS	F
Between			
A(Nor[illegible])	1	1.092	3.13
B(Im/Re)	1	0.907	0.00
A X B	1	0.617	1.77
Error	20	0.348	
Within			
C(Trials)	4	0.364	2.84*
A X C	4	0.199	1.55
B X C	4	0.321	2.50*
A X B X C	4	0.162	1.26
Error	80	0.128	

*$p < .05$

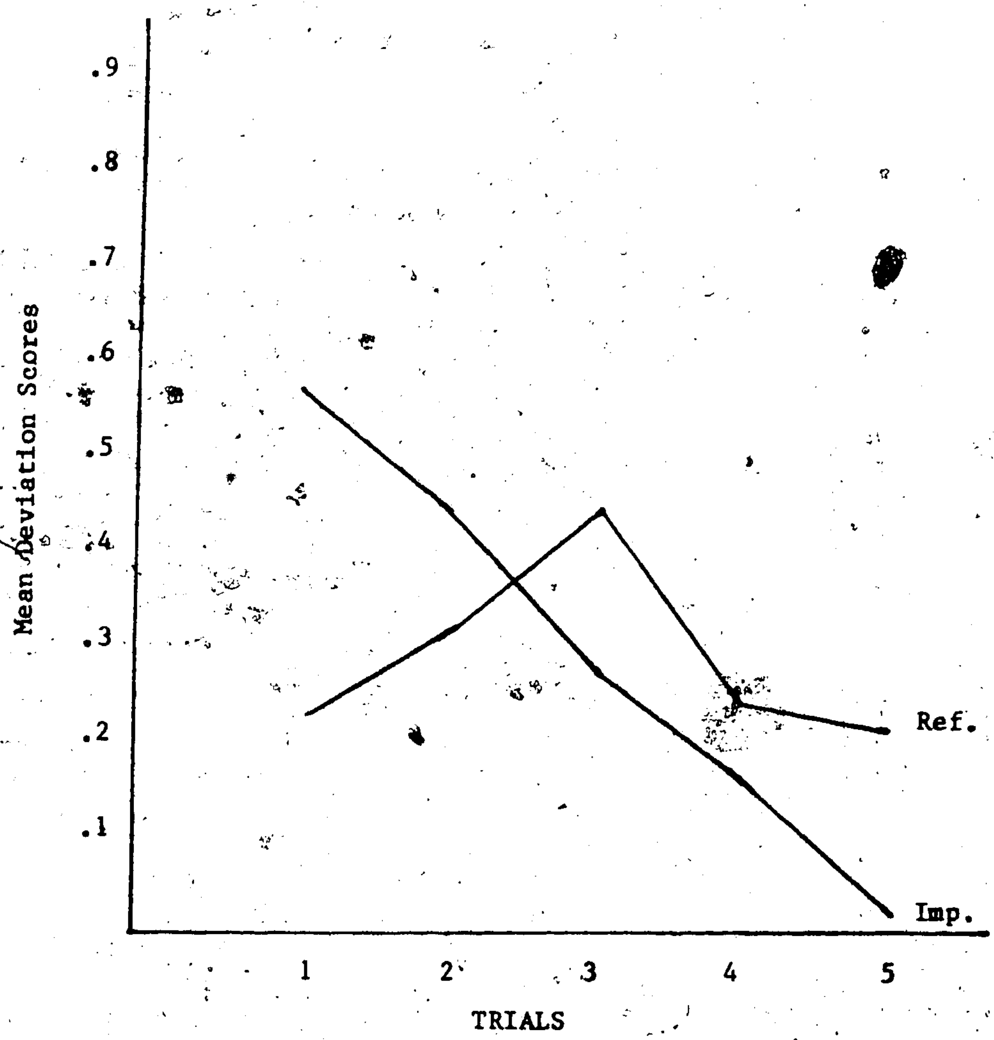


Figure 6. Cognitive Style and Accuracy of Estimation Data Involving Groups X Trials Interaction at MA 8 Level. Ref.=Reflective Group; Imp.=Impulsive Group (N=24)

impulsive and reflective children at MA6 and 8 levels are examined. Accuracy of estimation results across two groups (imp/ref), two levels (MA6/8), and five trials were compared using a 2 X 2 X 5 analysis of variance with repeated measures for the trials factor. The results are presented in Table 8.

Significant main effects for MA6/8 levels ($F=4.76$; $df=1,20$; $p<.04$), Imp/Ref. groups ($F=4.68$; $df=1,20$; $p<.04$), and trials ($F=5.06$; $df=4,80$; $p<.001$) were obtained. In addition, there was a significant interaction for MA level X trials ($F=2.68$; $df=4,80$; $p<.04$). Means involved in the latter interactions were compared utilizing Scheffe's method. The MA 8 group was found to be better than the MA 6 level group on the first ($F=17.34$;$DF=4,80$; $p<.01$) and fourth trials($F=9.89$; $DF=4,80$; $p<.1$). The mean scores involved in this interaction are: .94, .54, .34, .29, .11 for MA 6 group and .23, .32, .24, .01, .14 for the MA 8 group. These interactions are presented graphically in Figures 7. From the results of this analysis, it appears that the MA 8 normals have shown significant improvement and that the reflectives are better than the impulsives.

__EMR Subjects__

Accuracy of estimation results across two groups (imp/ref), two levels (MA6/8) and five trials were compared using a 2 X 2 X 5 analysis of variance with repeated measures for the trials factor. While the results of this

Table 8

ANOVA for Accuracy of Estimation Data of Normal Subjects Involving 2(MA6/8) X 2(Im/Re) X 5(Trials)

Source	df	MS	F
Between			
A(MA6/8)	1	1.978	4.76*
B(Im/Re)	1	1.948	4.68*
A X B	1	0.336	0.81
Error	20	0.415	
Within			
C(Trials)	4	0.891	5.06**
A X C	4	0.473	2.69*
B X C	4	0.322	1.83
A X B X C	4	0.602	0.34
Error	80	0.176	

*$p < .05$

**$p < .001$

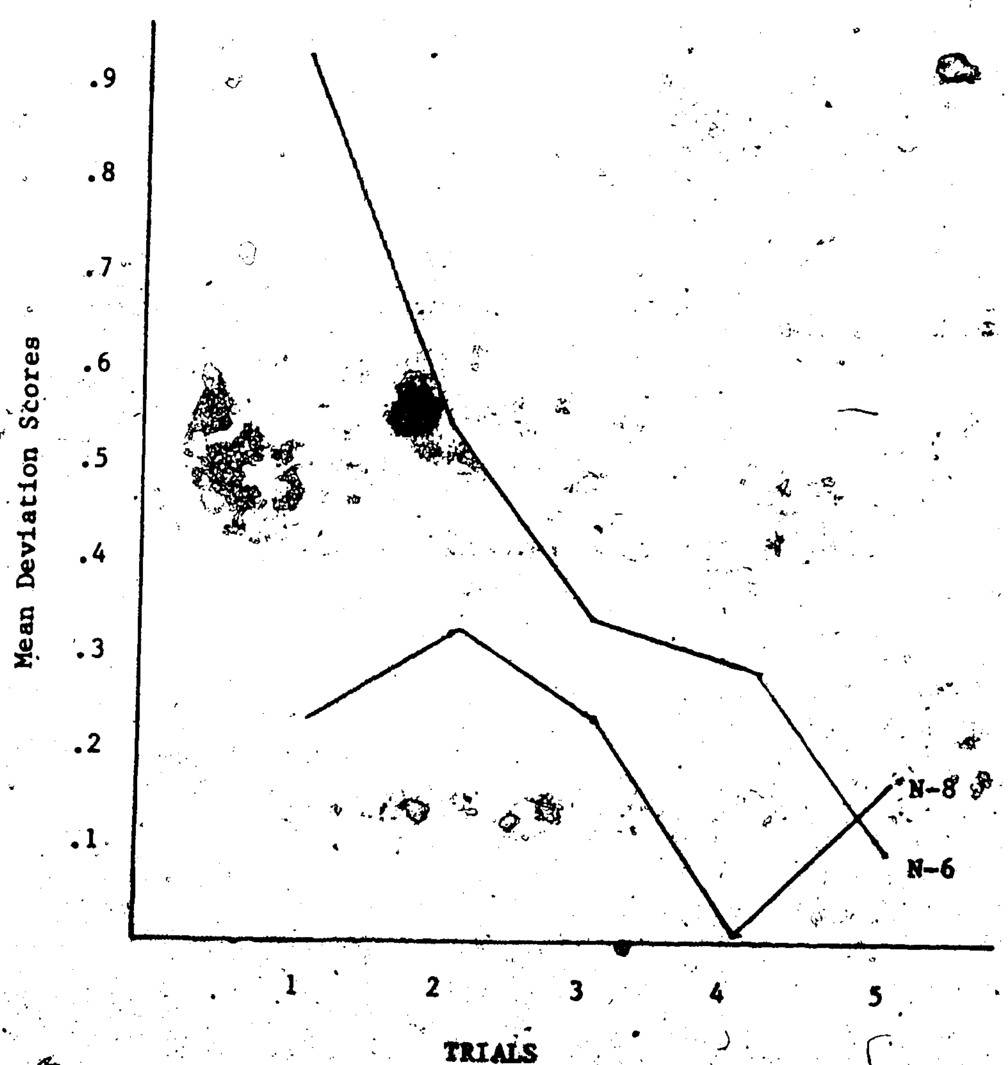


Figure 7. Data on the Developmental Changes in Accuracy of Estimation for Normals of MA 6 and 8 Levels. N-6=Normal MA 6; N-8=Normal MA 8 (N=24)

analysis did not yield any significant interactions, only the trials main effect emerged as significant ($F=3.40$; $df=4,80$; $p<.012$). The results of this analysis are presented in Table 9. Both impulsive and reflective groups at the two MA levels showed improvement over the five trials.

Recall Performance of Impulsive and Reflective Subjects

In this section, recall performance of impulsive and reflective subjects in all groups across the two ability levels were analyzed. These one-way analyses of variance included uneven number of impulsive and reflective subjects. As the results indicated, none of the reflective groups across two ability levels recalled significantly better than the impulsives (appendices 4.1 and 4.2).

Table 9

ANOVA for Accuracy of Estimation Data of Retarded Subjects Involving 2(MA6/8) X 2(Im/Re) X 5(Trials)

Source	df	MS	F
Between			
A(MA6/8)	1	0.361	0.57
B(Im/Re)	1	0.968	0.15
A X B	1	1.138	1.79
Error	20	0.634	
Within			
C(Trials)	4	0.600	3.40*
A X C	4	0.103	0.58
B X C	4	0.236	1.34
A X B X C	4	0.178	1.01
Error	80	0.176	

*$p < .05$

VI. Discussion

Metamemory

Documented evidence in metamemory suggests that the increasing differentiation in memory awareness is an age related phenomenon in normal children (Kreutzer et al; 1975). Subjects responses to the metamemory questions, paarticularly, the pre-task questions in this study generally concur with the above findings.

The results of the analysis for question 1 support earlier research in that most of the higher mental age (MA8) subjects in the educable mentally retarded and nonretarded groups admitted that they did "forget" things. Explicit denials of forgetting were largely made by the lower mental age (MA 6) subjects, specifically the TMR group. When the results across groups in higher and lower mental age levels are examined, the majority of normals at the two MA levels said that they forget to remember things. Within the Kreutzer et al (1975) study, normals of grades 1 and 3, comparable to MA6 and 8 level subjects in this study, manifested a similar developmental awareness to question 1. The proportions of subjects who admitted forgetting things at the MA 6 and 8 levels respectively are 17/20 (85%) and 19/20 (95%) in this study and 15/20 (75%) and 17/20 (80%) in the Kreutzer et al (1975) study. Higher mental age (MA8) EMR subjects proved to be significantly better in their knowlege and awareness of forgetting things (17/20 or 85%) as compared to lower mental age subjects who did not seem to conceptualize that they too forget to remember things. The proportion of subjects who denied that they ever forget was 11/20 (55%). These results appear to point out that the very young samples (MA 6) in this study are not well aware of their memorial efficiency in terms of remembering and forgetting things while the older (MA 8) children appear to assess their memory capacity much more realistically.

For question number 2, the proportion of subjects who said that they were good rememeberers was very high across groups and mental age levels (see appendices 2.1 and 2.2). Inspection of individual protocols suggested that higher mental age subjects are more aware of remembering and forgetting than the lower mental age subjects, and that memory ability may vary from person to person and across situations. A similar awareness is evident in subjects' responses to question 3. A small proportion of subjects in all groups across the two mental age levels denied that their friends were better rememberers (see appendices 2.1 and 2.2). A few higher mental age subjects, however, manifested the awareness that their friends are not always and necessarily better rememberers. Evidence of this awareness can be seen in the following examples from selected protocols: "my friend Johnny remembers almost anything ... depends on what to remember ... how much you are supposed to remember ... sometimes they (friends) are better and sometimes I am better."

Responses to questions 4 and 5 are not significantly related to either group membership (nor/EMR/TMR) or mental age levels (MA6/8). Of all the five pre-task metamemory questions, responses to questions 4 and 5 generated the most interesting qualitative data. Almost every one in the TMR group at the MA 6 level (19/20) stated that anything was easier to remember. In response to the fifth question on things harder to remember, 15 of the same 20 TMR subjects gave near repititions of the things they said were easier to remember for the previous question. In contrast, normal and EMR subjects of MA 6 level qualified their statements by citing specific examples related to school and school work. Although a smaller proportion of lower ability (MA6) subjects found it difficult to articulate and differentiate specific examples for easy and hard to remember, the majority of them cited school related tasks, for example, reading, writing and arithmetic, as either easy or hard to remember. The higher ability subjects similarly cited several examples related to school work and home work. Their responses were interesting particularly for things harder to remember, for example, some of them said that they hated math, and some of them said that spelling can be easy if your mother helps.

In general, many of the younger subjects (MA6) seemed to be responding to questions 4 and 5 in terms of things they liked, while the older subjects (MA8) reflected a broad range of knowledge relative to memory, demands of the task and the mnemonics they would use in remembering.

The results of this study support findings cited in earlier research. In addition, these results also provided evidence that the MA matched EMR and normal groups manifest a similar developmental awareness of their knowledge about how their memory works in various memory related tasks. It can be stated that this developmental awareness on the part of retarded and nonretarded may be related to general cognitive development, in this case MA. These findings, at best, should be viewed as tentative conclusions in comparative cognitive research on MA-matched retarded and nonretarded metamemorial knowledge.

Post-task Metamemory Responses

An examination of simple frequency count of yes/sometimes responses to question number one revealed that the majority of subjects at both MA levels admitted "guessing" in recall of items on the test trials. However, claims of "no guessing at all" were largely made by EMR subjects at both MA levels and also normal group at MA 6 level (see appendix 3.1). It is speculated that these children are either unaware of guessing during testing, or may never have been asked such a question in a testing situation and hence may have denied guessing. The majority of higher mental age normals admitted guessing unequivocally by saying "yes" or with a qualified "sometimes" citing examples. Responses to question two on estimated recall on a similar test situation produced an uneven pattern of answers. The number of items they said they could recall ranged from 3 to all 12. Specifically, younger TMR (MA 6) subjects, 8 out of 20, predicted that they would recall all the 12 items if they were given a similar test. This prediction appears to contradict the actual recall in the test situation (mean recall of 5.6 items) by the TMR group. The majority of normal and EMR children at both MA levels said that they would be able to recall any where between 4 to 7 items in a similar test. In general, these estimates correspond to the mean recall by normal and EMR groups (4.2 and 4.3). Although specific conclusions can not be drawn from these responses, the TMR subjects overpredicte their estimation accuracy over the five trials while the normal and EMR subjects manifested a drop in their overprediction (see Figure 1).

The third metamemory post-task question was designed to elicit responses from children if they thought feedback would have helped them to estimate better in their recall tasks. The majority of children responded with "yes/sometimes" answer (see appendix 3.1). It is difficult to ascertain if the subjects understood the importance of "feedback". It can, however, be speculated that some of the subjects may have thought about "feedback" as giving correct answers by the examiner. An interesting follow up would be to see if subjects awareness of their memory capacity becomes more realistic when feedback is provided after each test trial in a repeated trials paradigm.

In conclusion, a case can be made that the emergence of qualitatively superior cognitive abilities of introspection and prediction accuracy is an age-related phenomenon as well as related to cognitive developmental level (MA) when one considers retarded populations. The responses on all the pre and post task metamemory questions viewed together, indicated that the TMR subjects are not aware that the memory capacity varies between individuals and across situations, while some of the normal children of similar MA level showed this awareness. The higher mental age subjects in both normal and EMR populations showed improving awareness which is consistent with earlier findings in metramemory research.

Estimation Accuracy

Hypothesis 1.1 received partial support from the present results in that the performance of both normal and EMR groups was similar on the test trials. The performance of normal subjects was superior to that of the TMR subjects , while normal and EMR groups did not differ significantly. In terms of estimation accuracy, both normal and EMR groups consistently exhibited improvement over the trials , whereas the TMR group tended to overpredict without regard to thier memory capacity limitations.

The prediction that the normal and EMR subjects at MA 8 level would perform similarly did not find support from the results obtained in this study. Therefore, hypothesis 1.2

did not receive any support. Normal subjects performed better than than the EMR subjects at the MA 8 level.

Viewing the results in this section, it can be concluded that there were no significant differences evident for normal and EMR groups at the lower MA 6 level, whereas at the higher MA 8 level the normal group proved to be superior to that of their EMR counterparts. It can be speculated that the young EMR (MA 6) subjects may have had longer school related experiences in cognitive tasks like remembering and hence were able to match the performance of less experienced normal subjects who were presumed to posess average cognitive abilities to perform the tasks in this study. The evidence that the normal subjects were superior in their accuracy of estimation tasks to that of the EMR subjects at higher MA 8 level seemed to show a discrepancy in their cognitive functioning. Two reasons for this discrepancy can be advanced. First, from the methodological point of view pre-training tasks cued all subjects to performance requirements and provided functional referents to perform similar experimental tasks. It may be that the retarded were not able to utilize efficiently the training as well as task experiences. Secondly, the cognitive strategies that the normals may have attained by the MA 8 level is vastly superior that the retarded of equal MA could not match. The inferior performance of the retarded could be attributed to the deficient cognitive functioning. The retarded are known to be passive learners and do not deliberately rehearse or attempt to organize stimuli presented to them (Kellas & Butterfield, 1971; McMillan, 1972; Rowher, 1970). These cognitive behaviors may have contributed to their inferior performance.

Developmental Changes in Accuracy of Estimation

Contrary to the prediction in hypothesis 2.1, the overall performance of normal subjects is superior to that of retarded subjects. Across the two MA levels, higher mental age subjects performed significantly better than the lower mental age subjects. Although every group overestimated, the relative degree of overestimation is highest for the lower mental age groups. When the results are examined relative to the developmental changes, normals at MA 8 level showed better improvement than their EMR counterparts in accuracy of estimation.

Earlier research in accuracy of childrens' predictions (e.g., Flavell, et al., 1970; Yussen & Levy, 1975) primarily focussed on serial recall tasks. These studies reported a drop in overprediction by middle childhood (8 - 9 years) with younger normal children greatly overpredicting their actual memory span in short-term memory tasks. Yussen & Levy (1975) demonstrated that normal children become more accurate when they were given feedback and norms reflecting how their peer groups fared in the recall tasks. Recently, Levine et al (1977) reported that their subjects became more accurate in prediction following task experience and feedback. The majority of these studies provided, at the most, two opportunities at prediction and recall, while this study attempted to provide five opportunities in prediction and recall without any feedback. The findings on the developmental increments in accuracy of estimation in this study, in general, agree with research in metamemory in that the older (MA 8) groups exhibited improved metamemorial knowledge and this developmental increase was found to be better in the MA 8 normal group than the retarded of similar MA.

The results found with regard to the trials effect also provided evidence that the children's predictions become more accurate with repeated task experiences without any feedback. Together these findings appeared to answer speculations proposed by earlier researchers in metamemory that children may acquire knowledge of their memory capacity limitations through repeated task experiences (Flavell, 1977) and that they may become more realistic estimators simply with repeated task experiences but with no explicit feedback on their performance (Levine et al., 1977).

Recall Performance of The Retarded and Non-retarded Children

The results on the comparisions of recall performance of normal, EMR, and TMR groups at the MA 6 level partially supported hypothesis 3.1. While the normal and EMR groups did not differ significantly, the TMR group was found to be superior in recall to both normal and EMR subjects at MA 6 level. On the other hand, both normal and EMR groups performed similarly in recall tasks at MA 8 level. Therefore, hypothesis 3.2 was fully supported.

In a recent comparative study, Weisz (1977) conducted a study employing subjects at three IQ levels of 70, 100, 130 crossed with MA levels of 5.5, 7.5, and 9.5 years. In testing the hypotheisis behavior of the subjects, the author gave "right/wrong" feedback concerning selection of stimulus property in a prearranged sequence. The findings of this study taken as a whole supported the developmentalist position of Zigler (1969). There was no significant main effect of I.Q on any of the hypothesis measures tested in this study. Thus, the "difference" view that the individuals of equal MA, but of varying IQs are inherently inferior/different in cognitive behavior did not find full support in the above study. There is also evidence in the research literature that the children become increasingly organized and strategic in their approach to memory problems through experiencing the demands of the educational system (Liberty & Ornstein & Naus, 1976). The similar performance of the MA-matched normal and EMR groups at both MA 6 and 8 levels may have been a consequence of longer schooling on the part of the EMR group and also that they may have acquired equal cognitive abilities to recall similarly in a short-term recall task. Further, it can be argued that the repeated predict-recall tasks may have provided opportunities for both the groups to learn, reflect and perform similarly over the trials.

A recent review (Weisz & Zigler, 1979) offers rather consistent support for the similar sequence hypothesis which proposes that the retarded and nonretarded pass through the same cognitive development in the same order differing only in the rate of progress. This evidence is drawn from 3 longitudinal and 28 cross-sectional studies of Piagetian developmental theory utilizing both retarded and nonretarded populations. When the retarded and nonretarded were matched on MA level, as in the present study, the differences in the rate of progress seemed to vanish. The present results favoured the developmentalist's arguments that the MA matched retarded and nonretarded perform similarly in cognitive tasks such as, learning and performance (Weisz, 1974; 1977; Zigler, 1969). It must be, however, noted that the present findings, while harmonious with and supportive of developmentalist theory, may not be regarded as conclusive. In the continuing controversy on the developmental versus difference orientations to perfromance differences in retarded and nonretarded populations, the present results indeed appear to provide support for the developmentalist position.

Previous research has shown that the retarded do not rehearse efficiently (Belmont & Butterfield, 1969)69), and that they can be trained to rehearse and improve their memory functioning (Brown, 1974; Ellis, 1970). Recent research (Friedman et al, 1976) has documented evidence suggesting that the TMR groups are more capable of generating functional strategies than one would give credit for their lower IQs (mean IQ=49). The above study focussed on the verbalized knowledge of the TMR samples. The superior recall performance of the TMR subjects in the present study supports the notion that they are not only capable of verbalized abilities but also are capable of superior performance in a recall situation. Two reasons can be advanced for their superior recall. First of all, the TMR group in this study are about two times older than the normal subjects in their chronological age which may mean that they have had much longer school experiences dealing with rehearsal and production aspects in memory tasks. Secondly, the particular tasks employed in this study may have been familiar to the subject population. It can be speculated that a combined effects of longer schooling (Liberty et al, 1976) and task familiarity may have produced superior recall compared to younger normal children (mean CA=6.32) who have just started schooling. Recently, there is also a suggestion that the older individuals are superior in the speed of initial information processing, such as name retrieval and encoding and hence may have a larger capacity for memory span (Chi, 1977). All of the above factors may have collectively contributed to the superior recall of higher chronological aged TMR group at MA 6 level in this study.

Contrary to the prediction in hypothesis 4.1, impulsive and reflective children did not show any significant differences in overestimation at MA 6 level. Impulsive groups exhibited a significant rate of improvement than the reflectives at MA 8 level and hence hypothesis 4.2 did not receive any support.

As anticipated, the development of knowledge about accuracy of estimation is found to be significantly better for the normal reflectives. Thus, there was support for hypothesis 5.1. A similar comparision with the retarded populations did not yield any significant improvement for the MA8 reflectives compared to their impulsive counterparts. Therefore, hypothesis 5.2 was not supported. Viewed together, these results indicated that higher ability normal reflectives showed greater improvement in metamemorial development (accuracy of estimation) compared to their equal MA EMR counterparts.

Recall Performance of Impulsive and Reflective Children

Evidence found with regard to recall performance of impulsive and reflective subjects did not support hypotheses 6.1 and 6.2. Therefore, the prediction that the reflectives recall better than the impulsives within each group of retarded and nonretarded subjects is not supported. Research related to comparisions of recall performance of impulsive and reflective children is almost void. Therefore, it can be speculated at this time that the present findings may have been a result of several factors. First of all, the MA match may have equalized the simple recall ability of retarded and nonretarded without regard for their differences in cognitive style. Secondly, the repeated task experiences may have eliminated whatever differences both groups may have had initially. If one considers monitoring (Brown & Lawton, 1976) and improvement in memory performance through repeated task experiences (Flavell, 1977) are purely cognitive abilities, then the assumption that the impulsive style may account for performance differences does not appear to be valid. Based on the present results, it appears that the impulsive cognitive style has no bearing on the recall ability of individuals.

VII. Conclusions and Implications for Future Research

The utilization of metamemory interviews coupled with actual memory performance in this study revealed that the retarded and nonretarded populations exhibit similar developmental characteristics relative to explicit verbalizations of knowledge about memory. Although retarded subjects are slow and appeared to be immature compared to normal subjects of similar mental age, the developmental pattern is found to follow a similar progression. Past research (Flavell, 1971; Reese, 1975) indicated that the level of cognitive maturity mediates to improve memory efficiency in children. This notion found support from the present findings in that the developmental level, in this case MA, appeared to mediate between the child's capacity for memory and the demands of the task. The higher ability children exhibited a more realistic and accurate picture of their memory abilities than the lower ability children particularly at the MA 6 level.

Investigations into the development of metamemorial awareness in children appear to provide a good basis from which to examine other subject and task variables leading to a better understanding of how an individual acquires and improves his knowledge of memory behaviors. By investigating factors other than verbalized knowledge of memory awareness originally proposed by Flavell and his colleagues (Kreutzer et al., 1975) as determinants of metamemory, studies such as this one do not detract from the concepts in metamemory but attempt to refine it further. It has been proposed that an individual may acquire knowledge and capacity limitations of his memory system through repeated task experiences and their outcomes in memory situations (Flavell, 1977). There is also a suggestion that nonfeedback memory experiences may make one become more accurate in judging his capacity limitations (Levin et al., 1977). The present results provided supportive evidence for these notions. For example, the present findings revealed, in addition to a developing metamemorial awareness with increase in cognitive development, that the repeated task experiences facilitate improvement in prediction accuracy and that this improvement is better at higher cognitive levels.

With respect to future research implications, the quality of data obtained from these metamemory interviews could be improved by more structuring of responses. For example, the responses may be efficiently scored if forced choice lists are used, such as things at school, things at pl , hings related to home and homework/school work. The metamemory questions employed in this study, for the most pa required the subject to make evaluative generalizations about his memory efficiency which may have penalized younger and less verbal subjects in this sample. For instance, judgemental responses as to being a good memorizer and/or better than friends and also questions that probed awareness of "forgetting" aspect of memory may have been difficult for the younger subjects to respond. In future research these questions may be designed in such a way that the responses will clarify more precisely "forgetting", "remembering", and "friends better" with regard to specific aspects of memory in several memory related situations. Post-task metamemory questions provided some interesting qualitative data. Younger subjects' predictions that they would be able to recall all the twelve items at a later time appeared to pointout that these children obviously did not learn from their task experiences. It is unclear whether the results reflect a failure on the part of the subjects to monitor their earlier predictions or "posturing" behavior children are known to exhibit in similar situations (e.g., Friedman et al, 1976). In all probability, the younger subjects are not fully aware of their memory capacity limitations. It would be beneficial if one were to investigate how accurate their estimates would be in a similar test later, for example, six weeks after the original testing. Future research may also attempt to investigate the relationship or the impact meaningful and non-meaningful lists of items would have in accuracy of estimation tasks.

There is some indication that the lower ability children were able to more readily attach meaning to the colored items (Eyde & Altman, 1978). Such an initial attachment is crucial in memory performance and therefore facilitate information processing at deeper levels of analysis (Craik & Lockhart, 1972). Thus, it might prove fruitful to utilize colored and uncolored stimuli in future investigati s tc verify if this dimension improves memory performance and facilitate improved awareness (metamemory), particularly, with retarded populations.

Recall measures obtained in the present study are also analyzed from the developmental versus difference positions on MA-matched retarded and nonretarded cognitve performance. Previous research suggests that the retarded are nonstrategic (Brcwn, 1974), inferior in attention-retention (Zeaman, 1973) processes, and have poor short-term memory and consequently their performance is inferior to that of MA-matched nonretarded. The present results, on the contrary, supported the developmentalist position (Zigler, 1969, Weisz, 1974, 1977) atleast partially in that the MA-match equalizes cognitive abilities in basic learning, reasoning and problem-solving areas at the lower ability (MA6) level. It must be noted that the experimental control in the present study provided sufficient opportunities, through repeated trials paradigm, for the retarded and nonretarded to learn, reflect and perform. Therefore, the conclusion that the equal performance of these subjects is not an artifact of task simplicity, but a result of cognitive efficiency to produce similar recall. This result is not consistent at the higher ability (MA8) level. Therefore, it appears worthwhile to investigate further on the effects of IQ and MA at several levels to pin point the specific differences that these children manifest.

In addition to specific concepts in metamemory development, present results have also provided insights into the role of reflection-impulsivity dimension in prediction accuracy. The finding that higher ability normal reflectives are better predictors of their memory capacity limitations and thus are more accurate in estimation appeared to support the notion that metamemorial knowledge of estimation accuracy is not only relateed to cognitive development but also to cognitive style. Additionally, it appears that the acquisition of knbowledge about one's own memory capacity limitations is related to repeated task experiences as well as to the cognitive style one engages to monitor, introspect and evaluate his memory behaviors. Earlier research in metamemory documented evidence on developoing awareness as an age-related phenomenon (Kreutzer et al., 1975; Yussen & Levy, 1975) without regard to subject variables such as cognitive style. On the basis of the present results, one would conclude that subject factors such as cognitive style and developmental level interact to determine prediction accuracy. For this reason, although both impulsive and reflective subjects showed improvement in accuracy of estimation with repeated tasks, higher mental age reflectives performed better than the lower mental age subjects. The present data must be further refined in terms of determining more specific relationships between reflective and impulsive subjects' development of metamemorial knowledge at various age levels , between cognitive style and task demands per se longer lists of items in a similar repeated trials paradigm. It would also seem profitable to investigate the relationship of impulsive/reflective dimension to span estimation and actual recall performance by replicating earlier studies utilizing similar samples (Flavell et al., 1970; Levin et al., 1977; Yussen & Levy, 1975).

Bibiliography

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

Atkinson, R. C., & Shiffrin, R. M. Human memory: A proposed system and its control processes. In K. W. Spence(Eds.), The Psychology of Learning and Motivation: Advances in Research and Theory. Vol. 2. New York: Academic Press , 1968, 89-195.

Ault, R.L., Crawford, D.E., & Jeffrey, W.E. Visual scanning strategies of reflective , impulsive, fast accurate and slow accurate children on the matching familiar figures test. Child Development, 1972, 43, 1412-1417.

Balla, D. Comment on Das "Patterns of cognitive ability in nonretarded and retarded children". American Journal of Mental Deficiency, 1973, 77, 748-749.

Baumeister, A.A. Problems in comparative studies of mental retardates and normals. American Journal of Mental Deficiency, 1967, 71, 869-875.

Belmont, J.M., & Butterfield, E.C. The relation of short-term memory to development and intelligence. In L.P.Lipsitt & H.W. Reese (Eds.) Advances in Child Development and Behavior, Vol. 4, New York:Academic Press, 1969, 30-83.

Belmont, J.M., & Butterfield, E.C. Learning strategies as determinants of memory deficiencies. Cognitive Psychology, 1971, 2, 411-420.

Birch, D.B., & Evans, R.C. Decision processes in children's recognition memory. Journal of Experimental Child Psychology, 1973, 16, 148-164.

Bilsky, L., & Evans, R.A. Use of associative clustering techniques in the study of reading disability: Effects of list organization. American Journal of Mental Deficiency, 1970, 74, 771-776.

Bilsky, L., & Evans, R.A., & Gilbert, L. Generalization of associative clustering tendencies in mentally retarded adolescents: Effects of novel stimuli. American Journal of Mental Deficiency, 1972, 77, 77-78.

Bower, G.H., & Reitman, J.S. Mnemonic elaboration in multilist learning. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 478-485.

Bray, N.W., & Ferguson, R.P. Memory strategies used by normal and retarded children in a directed forgetting paradigm. Journal of Experimental Child Psychology, 1976, 22, 200-215.

Broadbent, D.E. Perception and Communication. London: Pergamon Press, 1958.

Brown, A.L. Mnemonic elaboration and recency judgements in children. Cognitive Psychology, 1973, 5, 233-248.

Brown, A.L. The role of strategic behavior in retardate memory. In N.R.Ellis(Ed.), International Review of Research in Mental Retardation, vol. 7. New york: Academic Press, 1974.

Brown, A.L. The development of memory: knowing, knowing about knowing, and knowing how to know. In H.W.Reese(Ed.),Advances in Child Development and Behavior, Vol. 10. New York: Academic Press, 1975.

Brown, A.L., & Barcley, L.C. The effects of training mnemonics on the metamnemonic efficiency of retarded children. Child Development, 1976, 47, 71-80.

Brown, A.L., Campione, J.C., Bray, N.W., & Wilcox, B.L. Keeping track of changing variables: Effects of rehearsal training and rehearsal prevention in normal and retarded adolescents. Journal of Experimental Child Psychology, 1973, 101, 123-131.

Brown, A.L., & Lawton, S.C. The feeling of knowing experience in educable retarded children. Developmental Psychology, 1977, 13, 364-370.

Butterfield, E.C., Wambold, C., & Belmont, J.M. On the theory and practice of improving short-term memory. American Journal of Mental Deficiency, 1973, 77, 654-669.

, M.T.H. Age differences in memory span. Journal of rimental Child Psychology, 1977, 23, 266-281.

M., Frankel, F., & Sharp, D. Development of free learning in children. Developmental Psychology, 1971, 123.

A.F., Corsini, D.F., & Davies, J.E. Conceptual ation of movement and acceleration of movement 9 year old children. Perceptual and Motor 7, -784.

Crai & Lockhart, R.S. Levels of processing: A frame memory research. Journal of Verbal Learning and Verb ehav , 972, 11, 671-684.

Das, J.P. Patterns of cognitive ability in nonretarded and retarded children. American Journal of Mental Deficiency, 1972, 77, 6-12.

Das, J.P. Reply of an eclectic to a developmentalist. American Journal of Mental Deficiency, 1973, 77, 749-750.

Debus, R.L. Effects of brief observation of model behavior on conceptual tempo of impulsive children. Developmental Psychology, 1970, 2, 22-32.

Denny, D.R. Reflection and impulsivity as determinants of conceptual strategy. Child Development, 1973, 44, 614-623.

Drake, D.M. Perceptual correlates of impulsive and reflective behavior. Developmental Psychology, 1970, 2, 20[illegible]-214.

Duckworth, S., Ragland, G.G., Sommerfeld, R.E., & Wayne, M.D. Modification of conceptual impulsivity in retarded children. American Journal of Mental Deficienc 1974, 79, 59-63.

Ellis, N.R. The stimulus trace and behavioral inadequacy. In N.R. Ellis (Ed.), Hand book of mental deficiency. New York: McGraw-Hill, 1963.

Ellis, N.R. A behavioral strategy in mental retardation: Defence and critique. American Journal of Mental Deficiency, 1969, 73, 557-566.

Ellis, N.R. Memory processes in retardates and normals. In N.R. Ellis (Ed.), International Review of Research in Mental Retardation, Vol. 4. New York: Academic Press, 1970, 1-31.

Epstein, P., Hallahan, D.P., & Kauffman, J.M. Implications of the reflectivity-impulsivity dimension in special education. Journal of Special Education, 1975, 9, 11-25.

Estes, W.K. Learning theory and mental development. New York: Academic Press, 1970.

Eyde, D.R., & Altman, R. An exploration of metamemory processe in mildly and moderately retarded children. Final report. Department of special education, University of Missouri-Columbia, January, 1978.

Ferguson, G.A. Statistical analysis in Psychology and education. New York: McGraw-Hill, 1976.

Fisher, M.A., & Zeaman, D. An attention-retention theory of retartdate discrimination learning. In N.R. Ellis (Ed.), International Review of Research in Mental Retardation, Vol. 6. New York: Academic Press, 1973, 171-251.

Flavell, J.H. Developmental studies of mediated memory. In H.W. Reese & L.P. Lippisit (Eds.), Advances in Child Development and Behavior, Vol. 5. New York: Academic Press, 1970, 181-211.

Flavell, J.H. Cognitive development. New Jersey: Prentice-Hall, 1977.

Flavell, J.H., Fredericks, A.G., & Hoyt, J.D. Developmental changes in memorization processes. Cognitive Psychology, 1970, 1, 324-240.

Flavell, J.H., & Wellman, H.M. Metamemory. In R. Kail & J. Hagan (Eds.), Perspectives on the development of memory and cognition. New York: Erlbaum, 1977.

Friedman, M., Krupski, A., Dawson, E.T., & Rosenberg, P. Metamemory and mental retardation: Implications for research and practice. A paper presented at the Fourth International Congress of the Association for the Scientific Study of Mental Deficiency (IASSMD) Washington, D.C., August, 1976.

Hagan, J.W., Joneward, P.H., & Kail, R.V. Cognitive perspectives on the development of memory. In H.W. Reese (Ed.), Advances in Child Development and Behavior, Vol. 10. New York: Academic Press, 1975.

Hallahan, D.P., & Cruickshank, W.M. Psychoeducational foundations of learning disabilities. Englewood Cliffs: Prentice-Hall, 1973.

Hallahan, D.P., Kauffman, J.M., & Ball, D.W. Selective attention and cognitive tempo of low achieving and high achieving sixth grade males. Perceptual and Motor Skills, 1973, 36, 579-583.

Harcum, P.M., & Harcum, E.R. Tempo modification in visual perception of EMR children. Perceptual and Motor Skills, 1973, 37, 179-188.

Harter, S. Discriminating learning set in children as a function of I.Q. and MA. Journal of Experimental Child Psychology, 1965, 2, 31-43.

Harter, S. Mental age, I.Q. and motivational factors in the discrimination learning set performance of normal and retarded children. Journal of Experimental Child Psychology, 1967, 5, 123-141.

Harrison, A., & Nedleman, L. Conceptual tempo and inhibition of movement in black preschool children. Child Development, 1972, 43, 657-668.

Heider, E.R. Information processing and the modification of an impulsive conceptual tempo. Child Development, 1971, 42, 1276-1281.

Hemry, E.P. Effects of reinforcement condition on a discrimination learning task for impulsive versus reflective children. Child Development, 1973, 44, 657-660.

Jones, H.R. The use of visual and verbal memory processes in three year olds. Journal of Experimental Child Psychology, 1973, 15, 340-351.

Kagan, J. Impulsive and reflective children. In J. Krumboltz (Ed.), Learning and Educational Process. Chicago: Rand McNally, 1965. (a)

Kagan, J. Reflection-impulsivity and reading ability in primary grade children. Child Development, 1965, 36, 609-628. (b)

Kagan, J., & Kogan, N. Individual variation in cognitive processes. In P. Mussen (Ed.), Carmichael's manual of child psychology, New York: Wiley, 1970.

Kagan, J., Pearson, L., & Welch, L. Conceptual impulsivity and inductive reasoning. Child Development, 1966, 57, 583-594.

Kagan, J., Pearson, L., & Welch, L. Modifiability f an impulsive tempo. Journal of Educational Psychology 1966, 57, 359-365. (b)

Kellas, G., Ashcraft, M.H., & Johnson, N.S. Rehearsal processes in th short-term memory performance of mildly retarded adolescents, American Journal of Mental Deficiency, 1973, 77, 670-679.

Kellas, G., & Butterfield, E.C. The effect of response requirement and the type of material on acquisition and retention performance in short-term memory. Journal of Experimental Child Psychology, 1971, 88, 50-56.

Kings P.R., & Hagan, J. Induced versus spontaneous rehea in short-term memory in nursery school children. Developmental Psychology, 1969, 1, 40-46.

Kobasigawa, A. Utilization of retrieval cues by children in recall. Child Development, 1974, 45, 127-134.

Kreutzer, M.S., Leonard, C., & Flavell, J.H. An interview study of children's knowledge about memory. Monographs of the Society for Research in Child Development, 1975, 40 (1, Serial No. 159).

Levin, J.R., Yussen, S.R., De Rose, T.M., & Pressley, M.

Developmental changes in assessing recall and recognition memory capacity. Developmental Psychology, 1977, 13, 608-615.

Liberty, C., Ornstein, P.A., & Naus, M.S. Rehearsal and organizational processes in children's memory. Child Development, 1976, 46, 818-830.

Limber, J. The genesis of complex sentences. In T.E. Moore (Ed.), Cognitive development and the acquisition of language, New York: Academic Press, 1973.

McNamara, J., Baker, E., & Olson, C.L. Four year olds understanding of pretend, forget, and know: evidence for propositional operations. Child Development, 1976, 47, 62-70.

MacMillan, D.L. Paired-associate learning as a function of explicitness of mediational set by [illegible] and nonretarded children. American Journal of Mental Deficiency, 1972, 76, 686-691.

Massari, D.J., & Schack, M.L. Discrimination learning in impulsive and reflective children as a function of reinforcement schedulle. Developmental Psychology, 1972, 6, 183-189.

Masur, E.F., McIntyre, C.W., & Flavell, J.H. Developmental changes in apportionment of study time among items in a multitrial free recall task. Journal of Experimental Child Psychology, 1973, 15, 237-246.

McKinney, J.D. Problem-solving strategies in impulsive and reflective second graders. Developmental Psychology, 1973, 8, 145-149.

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

Meichenbaum, D.H., & Goodman, J. Training impulsive children to talk to themselves. Journal of Abnormal Psychology, 1971, , 115-128.

Messer, S. Reflection-impulsivity: Stability and school failure. Journal of Educational Psychology, 1970, 61, 487-490.

Messer, S. Reflection-impulsivity: A review. Psychological Bulletin, 1976, 83, 1026-1052.

Milgram, N.A. Retention of mediation set in paired-associate learning in trainable retardates. Journal of Experimental Child Psychology, 1967, , 341-349.

Moely, B.E., & Shapiro, S.I. Free recall and clustering at four age levels: Effects of learning to learn and presentation method.. Developmental Psychology, 1971, 4, 490-494.

Moynahan, E.D. The development of knowledge concerning the effects of categorization upon free recall. Child Development, 1973, 44, 238-246.

Moynahan, E.D. The development of the ability to assess recall performance. Journal of Experimental Child Psychology, 1976, 21, 94-97.

Naus, M.J., Ornstein, P.A., & Kreshtool, K. Developmental differences in recall and recognition: The relationship between rehearsal and memory as test expectation changes. Journal of Experimental Child Psychology, 1977, 23, 252-265.

Neimark, E., Slotnick, N.S., & Ulrich. Development of memorization strategies. Developmental Psychology, 1971, 5, 427-432.

Neisser, U. Cognitive Psychology. New York: Appelton-Century-Crofts, 1967.

Nuessle, W. Reflectivity as an influence on focussing behavior. Journal of Experimental Child Psychology, 1972, 14, 265-276.

Odom, R., McIntyre, C.W., & Neale, G.S. The influence of cognitive style on perceptual learning. Child Development, 1971, 42, 883-891.

Ollendick, T.H., & Finch, A.J. Reflection-impulsivity in brain damaged and normal children. Perceptual and Motor Skills, 1973, 36, 654-659.

Piaget, J. Judgement and Reasoning in the Child. New York Harcourt Brace, 1928.

Reese, H.W. Verbal mediation as a function of age levels. Psychological Bulletin, 1962, 59, 502-509.

Reese, H.W. Models of memory and models of development. Human Development, 1973, 16, 398-416.

Reese, H.W. The development of memory: Life-span perspectives. In H.W. Reese (Ed.), Advances in Child Development and Behavior, New York: Academic Press, 1976, Vol. 1, 11, 190-209.

Reichhart, G.J., Cody, W.J., & Borkowski, J.G. Training and transfer of clustering and cumulative rehearsal strategies in retarded individuals. American Journal of Mental

Deficiency, 1975, 79, 648-658.

Ritter, K., Kaprove, B.G., Fitch, J.P., & Flavell, J.H. The development of retrieval strategies in young children. Cognitve Psychology, 1973, 5, 310-321.

Ridberg, E.H., Parke, R.D., & Heatherington, E.M. Modification of impulsive and reflective cognitive styles through observation of film mediated models. Developmental Psychology, 1972, 369-377.

Robinson, N., & Robinson, H. The Mentally Retarded Child: A psychological approach. New York: McGraw-Hill, 1976.

Rowher, D.W. Elaboration and learning in children and adolescents. In H.W. Reese (Ed.), Advances in Child Development and Behavior, New York: Academic Press, 1973.

Ross, D. Retention and transfer of mediation set in paired-associate learning of educable retarded children. Journal of Educational Psychology, 1971, 62, 322-327.

Salatas, H., & Flavell, J.H. Behavioral and metamnemonic indicators of strategic behaviors under remember instructions in first grade. Child Development, 1976, 47, 81-89.

Seigel, A.W., Kirasic, K.C., & Kilburg, R.R. Recognition memory in reflective and impulsive preschool children. Child Development, 1973, 4, 651-656.

Seigelman, E. Reflective and impulsive observing behavior. Child Development, 1969, 40, 1213-1222.

Spitz, H.H. The role of input organization in the learning and memory of mental retardates. In N.R. Ellis (Ed.), International Review of Research in Mental Retardation, Vol. 6. New York: Academic Press, 1973.

Tenny, Y.H. The child's conception of organization and recall: The development of cognitive strategies. Unpublished Doctoral Dissertation, Cornell University, 1973.

Turnure, J.E., & Thurlow, M.L. Verbal elaboration and the promotion of transfer of training in educable mentally retarded children. Journal of Experimental Child Psychology, 1973, 15, 134-148.

Vaughan, M.E. Clustering, age, and incidental learning. Journal of Experimental Child Psychology, 1968, 6, 323-334.

Wanchura, P.B., & Borkowski, J.G. Long-term transfer of a mediational strategy by moderately retarded children. American Journal of Mental Deficiency, 1975, 80, 323-333.

Waugh, N.C., & Norman, D.A. Primary memory. *Psychological Review,* 1965, 72, 89-104.

Welch, L.A. A naturalistic study of the free play behavior of impulsive and reflective four year olds. Paper presented at The Society for Research in Child Development Annual Meeting, Philadelphia, March, 1973.

Wellman, H.M. The early development of intentional memory behavior. *Human Development,* 1977, 20, 86-101.

Wellman, H.M. Tip of the tongue and feeling of knowing experiences: A developmental study of memory monitoring. *Child Development*, 1977, 48, 13-21.

Wellman, H.M., & Johnson, C.N. Understanding of mental processes: A developmental study of remember and forget. *Child Development*, 1979, 50, 79-88.

Weir, M. Mental retardation. *Science*, 1967, 157, 576-577.

Weisz, J.R. Studying cognitive development in retarded and nonretarded groups: The role of theory. *American Journal of Mental Deficiency*, 1976, 81, 235-239.

Weisz, J.R. Follow-up developmental study of hypothesis behavior among mentally retarded and nonretarded children. *Journal of Experimental Child Psychology*, 1977, 24, 108-122.

Weisz, J.R., & Zigler, E. Cognitive development in retarded and nonretarded persons: Piagetian tests of the similar sequence hypothesis. *Psychological Bulletin,* 1979, 86, 831-851.

Yendovitskaya, T.V. Development of memory. In A.V. Zaporozhets & D.B. Elkonin (Eds.), *The Psychology of Preschool children.* Cambridge: M.I.T. Press, 1971.

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

Yussen, S.R., & Levy, V.M. Developmental changes in knowledge about different retrieval problems. *Developmental Psychology*, 1977, 13, 114-120.

Zeaman, D., & House, B.J. The role of attention in retardate discrimination learning. In N.R. Ellis (Ed.), *Hand Book of Mental Deficiency*, New York: McGraw-Hill, 1963.

Zelniker, T., Jeffrey, J.R., Ault, R., & Parsons, J. Analysis and modification of search strategies of impulsive and reflective children on the matching familiar figures test. *Child Development*, 1972, 43, 321-335.

Zelniker, T., & Oppenheimer, L. Modification of information processing of impulsive children. Child Development, 1973, 44, 445-450.

Zigler, E. Mental Retardation: Current issues and approaches. In L.W. Hoffman and M.L. Hoffman (Eds.), Review of child development research. Vol. 2. New York: Russell Sage Foundation, 1966.

Zigler, E. Developmental versus difference theories to mental retardation and the problem of motivation. American Journal of Mental Deficiency, 1969, 73, 536-556.

Zigler, E. National crisis in mental retardation research. American Journal of Mental Deficiency, 1978, 83, 1-8.

APPENDIX 1

Stimulus pool and Matching Familiar Figures

Test

APPENDIX 1.1

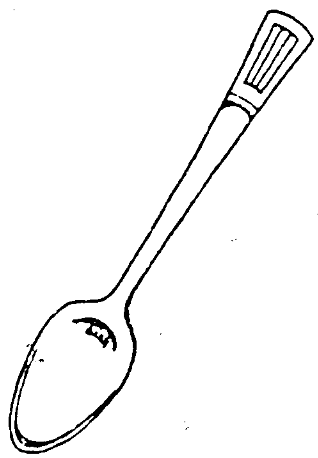
Estimation - Recall Tasks

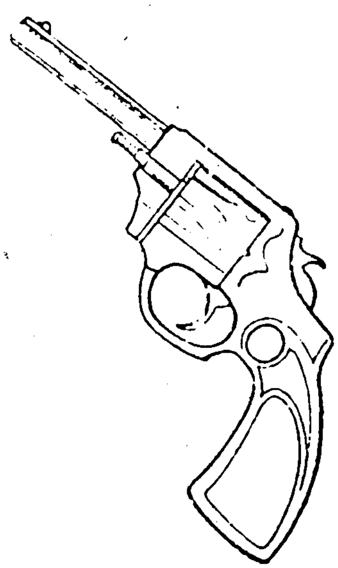
Stimulus Pool

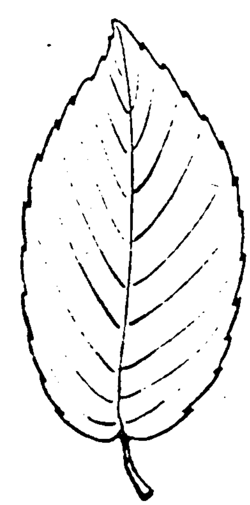
1. Ear
2. Wagon
3. Stove (Oven)
4. Belt
5. Tie
6. Boot (Shoe)
7. Can
8. Brush
9. Truck
10. Dog
11. Pear
12. Banana
13. Spool (Thread)
14. Apple
15. Rooster
16. House
17. Drum
18. Blocks
19. Icecream Cone
20. Duck (Bird)
21. Mug (Cup)
22. Boat (Sailboat)
23. Boy
24. Nail
25. Spoon
26. Cat
27. Bear
28. Jacket
29. Girl
30. Guitar
31. Rain (Umbrella)
32. Purse
33. Hand
34. Knife
35. Finger
36. Birthday Cake (Cake)
37. Soap
38. Bus
39. Head
40. Baby
41. Table
42. Pie
43. Girl
44. Cow
45. Horse
46. Broom
47. Clown
48. Tree
49. Chair
50. Wheel (Tire)
51. Keys
52. Fish
53. Bell
54. Pencil
55. Ball
56. Pin
57. Baby
58. Elephants
59. Suitcases
60. Hot dog

APPENDIX 1.2

Estimation - Recall Tasks
(Sample Stimuli)







APPENDIX 1.3

Matching Familiar Figures

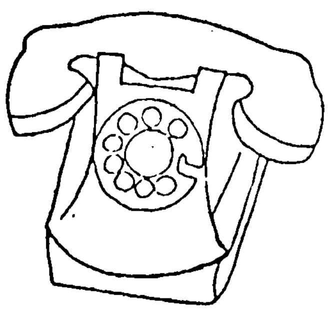
Test Items

1. House
2. Scissors
3. Phone
4. Bear
5. Tree
6. Leaf
7. Cat
8. Dress
9. Giraffe
10. Lamp
11. Boat
12. Cowboy

APPENDIX 1.4

Matching Familiar Figures Test

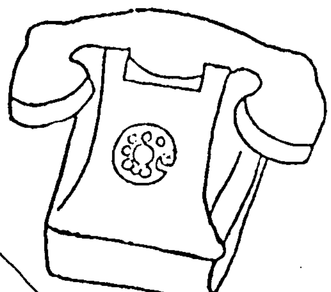
Sample items



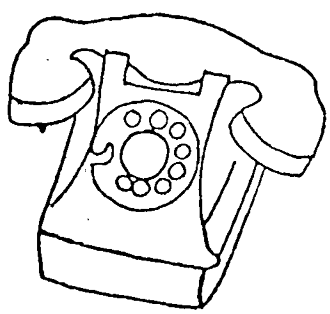
1

2

3



4



5

6

Guidelines for Administering and Scoring The Matching Familiar Figures Test

"I am going to show you a picture of something you know and then some pictures that look like it. You will have to point to the picture on this bottom page (pint) that is just like the one on this top page (point). Let's do some for practice." E shows practice items and helps the child to find the correct answer. "Now we are going to do some that are a little bit harder. You will see a picture on top and six pictures on the bottom. Find the one that is just like the one on top and point to it."

E will record latency to first response to half-second, total number of errors for each item and the order in which errors are made. If S is correct, E will praise. If wrong E will say, "No, that is not the right one. Find the one that is just like this one (point)." Continue to sode responses (not times) until child makes a maximum of six errors or gets the item correct. If incorrect, E will show the righr answer.

It is necessary to have a stand to place the test booklet on so that both the stimulus and the laternatives are clearly visible to the S at the same time. The two pages should be practically at right angles to one another.

Note: It is desirable to enclose each page in clear plastic in order to keep the pages clean.

Instructions for the Scoring of the MFF

Rank order latencies from the fastest mean response time across all twleve items to the slowest and split at the median. Then take the total number of errors and rank order them from the highest number of errors to the lowest. Children who were above the median on speed and above the median on errors are called impulsives. The children who are below the median on speed (that is, they have very long average response times) and below the median on errors are called reflective children. The other children are omitted from the analysis. Thus one combine both response time and errors.

APPENDIX 2

Pre-test metamemory responses of all subjects

APPENDIX 2.1

Pre-test Metamemory Responses of All Groups
(N Ss Giving Types of Answers to Questions 1, 2, and 3)

Subjects (N=20)	MA	1. Forget?		2. Good Rememberer?		3. Friends Better?	
		Yes/Sometimes	No	Yes/Sometimes	No	Yes/Sometimes	No
Normal	6	17	3	20	0	12	8
EMR	6	9	11*	19	1	17	3
TMR	6	14	6	19	1	17	3
Normal	8	19	1	20	0	17	3
EMR	8	17	3	19	1	16	4

* Chi Square Value = 7.35; df=2; $p<.025$

APPENDIX 2.2

Pre-test Metamemory Responses of Normal and EMR Groups
(N Ss Giving Types of Answers to Questions 1, 2, and 3)

Subjects (N=20)	MA	1. Forget?		2. Good Rememberer?		3. Friends Better?	
		Yes/Sometimes	No	Yes/Sometimes	No	Yes/Sometimes	No
Normal	6	17	3	20	0	18	2
Normal	8	19	1	20	0	19	1
EMR	6	9	11*	19	1	17	3
EMR	8	17	3	19	1	16	4

* Chi Square Value = 7.033; df= 1; $P < .008$

APPENDIX 2.3

Pre-test Metamemory Responses

(N Ss Giving Types of Responses to Questions 4 and 5)

Subjects (N=20)	MA	4. Things Easier to Remember?			5. Things Harder to Remember?		
		Categories	Instances	No/Other	Categories	Instances	Np/Other
Normal	6	4	16	0/0	2	17	1/0
EMR	6	1	19	0/0	0	20	0/0
TMR	6	1	19	0/0	1	15	2/2
Normal	8	1	18	1/0	1	18	1/0
EMR	8	0	1[illegible]	1/1	0	19	1/0

APPENDIX 3

Post-test metamemory responses of all subjects

APPENDIX 3.1

Post-test Metamemory Responses.
(N Ss Giving Types of Answers to Questions 1 and 3)

Subjects (N=20)	MA	1. Any Guessing?		3. Feedback Helps?	
		Yes/Sometimes	No	Yes/May be	Not Sure
Normal	6	9	11	17	3
EMR	6	9	11	20	0
TMR	6	15	5	19	1
Normal	8	12	8	18	2
EMR	8	8	12	18	2

APPENDIX 3.2

Recall How Many(out of 12 items)?

# of items	Normal(N=40)	EMR(N=40)	TMR(N=20)	MA 6	MA 8
1	0	0	0	0	0
2	0	0	0	0	0
3	1	0	0	0	1
4	10	7	0	11	6
5	11	11	2	12	12
6	15	12	1	14	14
7	1	3	0	3	1
8	1	7	4	7	5
9	1	0	0	0	1
10	0	0	5	5	0
11	0	0	0	0	0
12	0	0	8	8	0

APPENDIX 4

ANOVA Tables for recall data of all reflective and impulsive subjects

APPENDIX 4.1

Summary of one-way Analysis of Variance on Recall Data for All Impulsive and Reflective Groups at MA6 Level

Source	N	df	MS	F
Between				
TMR(Im/Re)	8/7	1	0.01	0.01
Error		13		
Between				
EMR(Im/Re)	8/8	1	0.56	1.55
Error		14	0.36	
Between				
Nor(Im/Re)	6/11	1	0.71	1.19
Error		15	0.60	

APPENDIX 4.2

Summary of one-way Analysis of Variance on Recall Data for All Impulsive and Reflective Groups at MA8 Level

Source	N	df	MS	F
Between				
EMR(Im/Re)	9/10	1	1.65	1.95
Error		17	0.85	
Between				
Nor(Im/Re)	7/10	1	0.11	0.15
Error		15	0.68	

APPENDIX 5

Descriptive data on all impulsive and reflective subjects

APPENDIX 5.1

Median Scores for MFF Time and Errors
for MA [illegible] Subjects

Subjects	N	Time(Sec.)	Errors
Normal	20	13.45	20
EMR	20	7.45	20
TMR	20	9.16	30

Median Scores for MFF Time and Errors
for MA 8 Subjects

Subjects	N	Time(Sec.)	Errors
Normal	20	15.62	14
EMR	20	11.12	17

APPENDIX 5.2

Impulsive and Reflective Subjects at MA 6 Level

Group (N=20)	Impulsive	Reflective
Normal	6	8
EMR		11
TMR	8	7

Impulsive and Reflective Subjects at MA 8 Level

Group (N=20)	Impulsive	Reflective
Normal	7	10
EMR	9	10