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NAME OF AUTHOR/*NOM DE L'AUTEUR* Judy Lee Luypaert

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NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* Dr. R. F. Mulcahy

DATED/*DATÉ* May 17 / 1978 SIGNED/*SIGNÉ* J. Luypaert

PERMANENT ADDRESS/*RÉSIDENCE FIXÉ* #1205 - Galbraith House
Michener Park
Edmonton, Alberta T6H 5A2

NL-91 (3-74)

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LEVELS OF PROCESSING IN EMR AND NORMAL CHILDREN

BY

© JUDY LEE LUPART

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Levels of Processing in EMR and Normal Children," submitted by Judy Lee Lupart in partial fulfilment of the requirements for the degree of Master of Education.

........R. Mulcahy........
Supervisor

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Date .Feb. 24, 1978...

ABSTRACT

The levels of processing approach to memory proposed by Craik and Lockhart (1972) was utilized in two experiments to examine memory processing differences in MA matched EMR and normal children.

In experiment one, the effects of differential learning conditions on memory performance were examined in the analysis of free recall and reaction time measures. Forty-two normal and 42 EMR children were randomly assigned to one of three learning conditions (14 normal and 14 EMR Ss in each condition). Subjects in the incidental condition were given unexpected recall, while subjects in the intentional conditions were given an expected recall test subsequent to the levels of processing task. Planned intentional subjects were additionally interviewed prior to the task to encourage the planning of memory strategies, or metamemory abilities. Both intentional, and planned intentional condition subjects were individually interviewed following the recall task, in an effort to determine the kinds of memory strategies and processes that were actually utilized during the task.

Experiment two was conducted in order to explore the possibility of an attentional deficit affecting the incidental learning condition, memory performance of the EMR children. In this study, free recall, reaction time and heart rate measures of 14 normal and 14 EMR children were examined during and subsequent to the levels of processing task.

The experimental task consisted of 30 orienting questions, which were designed to induce the subject to process the corresponding imperative word stimuli, at either the physical, phonemic or semantic level. There were ten orienting questions and related imperative word stimuli for each level of processing, with a total of 15 possible correct positive and 15 possible correct negative responses. Reaction times and heart rate were recorded while subjects performed the levels of processing task. Word recall was requested immediately following the task.

The recall performance, for both EMR and normal children was in accordance with the predictions of the levels of processing model. All subjects consistently demonstrated superior recall for semantically (deeper) processed words in both experiemtns, and under all learning conditions. Thus, the generalizability of the model for examination of children and EMR memory performance was affirmed in this study. However, the prediction of a hierarchical pattern of recall (i.e. physical $<$ phonemic $<$ semantic) was unsubstantiated in either experiment one or two.

Differential learning conditions improved overall memory performance for EMR and normal children. Although the improvement over incidental learning failed to reach significance for intentional learning, planned intentional learning conditions resulted in significant increases in memory performance. Interestingly, the improvement in terms of % increased recall was similar for both EMR and normal Ss. The interview protocols indicate that the subjects (EMR and normal), utilized similar memory strategies and processes. Since the planned intentional groups were able to significantly improve their recall performance through pre-task, memory strategy planning, it was suggested that the intentional groups performance might be attributed to a production deficiency.

The overall recall performance of the normal children was superior to that of EMR subjects in both experiments and over all learning conditions. Whereas there were essentially no group differences for physical processing, the deeper or more cognitively involved phonemic and semantic levels of processing resulted in superior performance for normal subjects. These results would suggest that the levels of processing model is sensitive to the memory processing differences of sample groups with disparate intelligence levels.

In general, all subjects demonstrated the expected increased reaction times for deeper levels of processing, although the pattern was not consistently upheld for EMR Ss. It might be suggested that this inconsistency was reflective of EMR inefficient information processing, although no significant group differences were obtained for reaction times. Moreover, the heart rate analyses, which resulted in no main effects for group differences, failed to support an attention deficit hypothesis.

It was concluded, that further investigation in the area of memory processes and memory strategies, and psychophysiological studies of the attention deficit hypothesis for retardates was required.

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CHAPTER I

INTRODUCTION

In comparison with normal populations, the inferiority of the mentally retarded with respect to memory performance is well documented in the literature. Theorists and researchers have traditionally aligned their investigations toward the search for specific or structural deficits; an orientation which purposedly serves to define mental retardation. In contrast to this, the interest of professionals in the field of education generally, and special education specifically, is more practically concerned with the problem of improving or facilitating the learning of the retardate. For the most part, researchers typically adopt one or the other orientation for their investigations. This research is addressed toward the resolution of these differing orientations. The problem is one of sorting out those factors which are structurally or developmentally delimiting; and those factors which can benefit the retardate's memory performance in terms of optimizing the memory strategies and processes that are available to him.

Researchers concerned with recall or information processing characteristics in memory, frequently adopt a "modal" model of memory. This experimental paradigm assumes a number of specific temporal - structural memory stores (sensory store, short term store, and long term store), and their related information transfer mechanisms. In the area of mental retardation research and theory, the modal memory model has been highly influential (Ellis, 1970; Fisher and Zeaman, 1973). Indeed, memory performance differences in the mentally retarded have been widely attributed to a defective STM store (Ellis, 1970; Scott and Scott, 1968). It is clearly evident that the utilization of the modal memory model is highly biased toward a structural orientation.

Very recently, an alternate memory model has been proposed by Craik and Lockhart, (1972). The levels of processing model centers around a continuum of perceptual analysis upon incoming stimuli. These analyses may be directed toward the domains of physical, phonemic or semantic processing. The semantic level constitutes the deepest or most elaborate analysis and results in the strongest memory trace.

An additional means of retaining stimuli is referred to as primary memory which proposedly functions in terms of the holding of items in consciousness or continued attention to prolong the item's accessibility. Brown, (1974) sagaciously points out that the crucial distinction between the levels-of-processing and the modal memory model is found in the status of short term memory. She indicated that within a modal memory model:

> "STS is a structural feature of the memory system. In a levels of analysis approach, processes subsumed under the heading STS in information processing models are seen as the result of deliberate strategic devices employed by the subject . . . Craik uses the term in the original James (1890) sense of continued attention to the item, ... as these short-term memory strategies are optional they are 'off to the side in the route taken from the environment to long-term memory and whether we maintain items at the STS level is very much an optional strategy than a structual feature' (Craik, 1973), (Brown, 1974, p. 58)."

The levels of processing model was determined to be a more viable alternative for the purposes of this study for the following reasons:

1. The emphasis on the qualitative distinction of analysis performed on stimuli.

2. A de-emphasis on specific structural features.

3. The concept of processing is emphasized, and the STS is replaced by the notion of optional strategies employed by the subject.

4. The model holds the promise of potential utility for investigation of developmental and non-standard population memory differences (Medin and Cole, 1975).

The levels of processing model has been formulated on the basis of several investigations conducted by Craik and his associates (Craik and Lockhart, 1972; Craik and Tulving, 1975; Lockhart, Craik and Jacoby, 1975; and Craik, 1973) and the distinction of three qualitatively differing levels of processing has largely been substantiated with adult subject populations. The question posed by this study is "Will the levels of processing be similarly distinct with subjects who are developmentally or cognitively immature and will the model discriminate between the memory performance of EMH and normal samples?"

In anticipating the factors which may be involved (in addition to recall performance) in the levels of processing task, the developmental and mental retardation literature was reviewed, and the development of intention and attention would appear to be crucial elements. The developmental literature suggests that intention to memorize becomes a critical "strategy" in the course of memory development, which enhances the memory of older children and adults. Craik and Lockhart (1972), on the other hand, assume a position which minimizes the incidental-intentional distinction and suggest that the level of processing is the primary predictor of memory. In an effort to explore this issue more fully, the experimental conditions of incidental, intentional, and planned intentional were incorporated into the experimental design of this study.

The importance of attention in memory performance has previously been alluded to in the brief summary of the levels of processing model. The review of the literature suggests immature attentional abilities in children, and an attentional deficit in the mentally retarded. Such differences appear to warrant closer examination. In this regard, psychophysiological measures would appear to be a viable dependant measure for examining attentional differences in EMR and normal samples. There is an extensive body of theoretical and empirical investigation to support the notion of a consistent relationship between autonomic response patterns and attention and information processing (Lacey, 1967; Coles, 1974; Coles and Duncan-Johnson, 1976; Bernstein, 1969; and Tursky, Schwartz, and Crider, 1970). The several investigations reported involving attention and effort (using autonomic indices) and information processing tasks, collectively suggest that sensory analysis requires minimal effort and attention; whereas the deeper levels of cognitive analysis progressively demand greater attention for successful processing. In the context of the levels of processing model, it would seem that Craik and Jacoby (1975) would concur with this notion.

> "The processes of attention are seen as regulating the analysis performed on the input-processing will be apparently "preattentive" or "automatic" when little processing is required.. . . The more complex and unfamiliar the processing, the more attention must be devoted to the processes of analysis" (p. 175).

With respect to this study, it would be expected that the presumed attentional deficit of the EMR subjects would be reflected in the comparison of the autonomic response patterns with normal subjects, as well as recall performance. For these reasons, autonomic measures (heart rate) were utilized in Experiment II of the study.

In summary, the specific purposes of this study were:

1) To test the generalizability of the levels of processing model with EMR and normal children.

2) To examine memory performance differences between EMR and normal children.

3) To determine the effect of incidental, intentional and planned intentional learning conditions on memory performance in both EMR and normal subjects (Ss).

4) To explore the interaction of attentional abilities on levels of processing in both EMR and normal Ss.

CHAPTER II

SELECTIVE REVIEW OF RELATED LITERATURE

Models of Memory

The Structural Model

Researchers interested in human memory performance, have traditionally utilized the recall or recognition paradigm in order to examine how information is processed (coded) and made available for retrieval. Information processing in memory has been extensively examined using the "box" model approach originally proposed by Broadbent (1958). The box model has subsequently been modified and altered by a number of authors including Waugh and Norman (1965); Atkinson and Shiffrin (1968), and Tulving (1968) but the essential features may be collectively described. The box model includes specific temporal-structural components of the memory system (sensory store, short term store, and long term store) and experimentation has centered on the flow of information from one store to the next and the mechanisms of transfer of information between the components.

The processing begins when information from the external environment is entered into the infinite capacity sensory store through the senses. Unless the information is immediately processed (attention) decay results and information is lost. Further processing allows information to enter the limited capacity short-term store where the information is cycled (rehearsal) and if left here is also subject to decay. Information which enters the long term store may be recalled immediately or at some time later, and the capacity of this store is considered by some to be infinite.

Thus, retention is considered to directly relate to the amount of time items remained in the memory stores. Although processing of the items is included in the model, the central focus concerns the various structures and capacities of the memory stores.

Within the past decade, researchers have been increasingly more concerned with the processes generating the information flow, and how information reaches storage in long term memory. As new processes have become apparent, the "modal" theorists have attempted to incorporate these aspects within their existing models. For example Waugh and Norman (1965) incorporated a rehearsal process in the transfer of information from primary to secondary memory and Atkinson and Shiffrin (1968) changed rehearsal to a "control process" described as "transient phenomena under the control of the subject" (p.106). In spite of these changes, the structural-temporal stores have remained the favored focus of attention in experimental investigations, and correspondingly has delimited attention to the flow of information between and within the stores.

Craik and Lockhart (1972) have made three major criticisms of the multi-store memory models. The first is directed toward the fixed capacity notion of the stores. Empirical estimates of short-term memory capacity vary widely from 2-20 items. Craik (1973) suggests that such diverse findings are difficult to account for in a memory model which purportedly considers the limited capacity notion to be a defining characteristic of the STM. In contrast to the limited capacity notion, Craik and Lockhart (1972) exhort the claim that storage is a function of the type of processing that one utilizes.

The second criticism focuses on the supposed notion that different kinds of coding are specifically related to the different stores. Craik and Lockhart (1972) particularly oppose the formulations advanced by Conrad (1964) and Baddeley (1966) which suggest that information in the short term store is acoustically coded; whereas coding in the long-term store is characteristically semantic. More recent findings have led Craik (1973) to suggest that the type of coding employed is at the option of the subject and depends heavily on one's personal evaluation of the utility of various dimensions of the stimuli in carrying out task demands.

The final criticism is directed at the inflexibility of the modal model to account for inconsistencies (resulting from variations in experimental conditions and paradigms) in the retention characteristics of specific stores. For example Kellas and Butterfield (1971) have shown that retention varies according to known response requirements and Jacoby and Goolkasian (1973) have demonstrated that retention was affected more strongly through semantic coding than acoustic coding.

In a similar vein, the recent investigations of Chi (1976) point to the theoretical limitations of a structural model of memory. Through an extensive review and evaluation of the literature, he found no conclusive evidence to support the assertion that short-term memory (STM) capacity increases with age. There was however, substantial evidence found to suggest that the processing strategies used by adults are unavailable or deficient in children. Chi (1976) proposes that such deficits can be explained in terms of "the lack of proper control processes or processing strategies, as well as an impoverished LTM knowledge base rather than a limitation in STM capacity" (p. 599).

In an attempt to resolve some of the limitations inherent in the modal memory model, Craik and Lockhart (1972) have proposed an alternative orientation to memory research. They surmize that rather than formulating hypotheses on the basis of the notion of specific temporal stores, it ". . . is more useful to focus on the encoding operations themselves and to consider the proposal that the rates of forgetting are a function of the type and depth of encoding" (Craik and Lockhart, 1972, p. 673).

The Levels of Processing Model

As an alternative to the multi-store model, Craik and Lockhart (1972) proposed the levels of processing framework, which emphasizes the qualitative aspects of encoding operations on the stimulus. Similar to the views of Melton (1963) and Murdock (1972), Craik and Lockhart (1972) suggest that memory be considered as a continuum rather than a series of stores. The proposed model encompasses a hierarchy of analysis spanning many perceptual modalities. Incoming information is initially analyzed according to gross physical features such as amplitude in auditory input or brightness in visual input. Subsequent analysis follows through successive stages leading to deeper cognitive or semantic processing. Craik (1973) suggests that the memory trace is a product of these perceptual analyses and that "trace persistence is a positive function of the depth of analysis" (p. 48). Therefore information that is more deeply processed, analyzed or elaborated, will be better remembered.

The three classes of factors, comprising the criteria of depth of analysis are described by Craik (1973):

"1) stimulus salience or intensity;
2) the amount of processing devoted (or the amount of attention paid) to the stimulus; and
3) the item's meaningfulness or compatibility with the analyzing structures." (p. 50)

Within the concept of the basic levels of processing memory system, Craik and Lockhart (1972) distinguish between two types of rehearsal; maintenance rehearsal and elaborative rehearsal. Maintenance rehearsal is essentially viewed synonomously with the notion of primary member (PM). The PM allows for the maintenance of stimulus at any one level of analysis and serves to employ continued attention to the item or consciously hold the items in memory. That is, encoding operations that have already been accomplished are merely repeated or rehearsed. In contrast to elaborative rehearsal, the maintenance of information of any one level of processing "merely prolongs the items high accessibility without leading to the formation of a more permanent memory trace" (Craik, 1973, p. 51). On the other hand, elaborative rehearsal "involves further, deeper analysis of the stimulus and leads to a more durable trace" (Craik and Lockhart, 1972, p. 681).

To recapitulate, the major aspects of the 1972 levels of processing model include the notions of: a hierarchical or fixed sequence of analysis along a unidimensional continuum, with greater depth of processing related to better retention; maintenance rehearsal which serves to hold items in consciousness (attention) at any one level to effect immediate high accesibility from primary memory; and elaborative rehearsal which has a definite trace-strengthening function and serves to enhance memory performance.

The essential distinction between the levels of processing and multi-store memory model is described by Craik (1973):

"It should be noted that the present scheme maintains the distinction between a short term storage mechanism and long-term memory, but that the short term retention mechanism (PM) is seen, not as a store, but as the strategy of continued attention to some aspects of the stimulus" (p. 51).

The concept of a series or hierarchy of processing is not a new one. Craik and Lockhart (1972) point out that several theorists (Selfridge & Neisser, 1960; Treisman, 1964; Sutherland, 1968) have advanced the notion that incoming information is rapidly and hierarchically analyzed at perception. However, the formulations advanced by Craik and Lockhart (1972) represent the most comprehensive overview of pertinent empirical investigations as well as the meticulous integration of these findings into a model which can account for the levels of processing phenomenon.

For the most part, the central features of the 1972 formulation remain fundamentally similar; however more recent investigations have led to modification and extention of particular aspects of the model (Lockhart, Craik and Jacoby, 1975; Craik, 1973; Craik and Jacoby, 1975; and Craik and Tulving, 1975). Only those modifications which have direct relevance to this study will be outlined here.

Lockhart, Craik and Jacoby (1975) suggest that the original notion of a fixed sequential processing or continuum of perceptual analysis is unsatisfactory in that it is more fruitful to consider that not all stimuli must undergo full structural analysis before more deeper semantic processing.

Rather, the term "domains" is borrowed from Sutherland (1972) to suggest the orthographic, acoustic and semantic characteristics of words. The processing domains are considered to be qualitatively coherent and follow a hierarchical arrangement with shallow, structural analysis preceeding deeper, semantic analysis. Thus depth in this sense of the word infers that the memory trace progresses in a vertical direction. Lockhart, Craik and Jacoby (1975) further suggest an additional means of depth of processing which progresses horizontally within one specific domain. Greater depth (and resultant stronger memory trace) is concommitant with further analysis or elaboration of a stimulus through the employment of additional operations on a stimulus. The processing that takes place depends on the perceptual/cognitive ability of the processor to extract meaning from the presented stimuli, as well as, the interaction with factors such as the material, practice, context and set. Encoding that is well practised will require minimal processing or conscious awareness; that is, only those operations necessary or critical to effect deeper levels of processing are carried out. On the other hand, encoding of novel, difficult to process or more important stimuli requires more analysis and attention, and results in a richer memory trace.

Another important distinction incorporated into the levels of processing model is that of episodic versus semantic memory. This notion is similar to Tulving's (1972) formulation, although Lockhart, Craik and Jacoby (1975) and Craik and Tulving (1975) purport a closer interrelation of the two aspects of the perceptual/memory system. Episodic memory implies a structureless system which records the temporal sequence of encoded events or inputs. Semantic memory functions at encoding to interpret the stimulus in terms of "the system's structured record of past learning, that is, knowledge of the world"(Craik and Tylving, 1975, p. 291). The interpretation of the stimuli is achieved by means of complex analysing and encoding operations which constitute the memory trace. This memory trace forms the latest edition to episodic memory. The inherent interrelation of episodic and semantic memory may be understood in that, to the extent that stimuli have undergone deeper analysis or a greater number of elaborations by the perceptual system, so too will the event be more richly or uniquely specified in the episodic memory trace. The distinction of episodic and semantic aspects of the memory system, is of particular relevance when the notion of retrieval is considered. Whereas it has been suggested that there are a number of ways in which optimal encoding may be achieved, various factors likewise determine the maximal retrie[illegible] of information. Lockhart, Craik and Jacoby (1975) suggest that both scanning and reconstruction processes are operant in recognition and recall. The scanning process is simply a backward search in episodic memory, which becomes increasingly less efficient as more items are interpolated between initial processing and retrieval. On the other hand, interpretive or recall task requirements which are specified some time after processing occurs with minimal or limited cue value, would likely require reconstruction retrieval processes to relocate the desired encoding event. Reconstruction involves the cognitive structures of the processor which are "guided and constrained both by the structure of semantic memory and by feedback from the episodic trace itself" (Craik and Jacoby, 1975, p. 176). Whereas short term retrieval is adequately functional with "the scanning of episodic memory"; whenever a longer delay between presentation and test is apparent, then "the richer encoding, and more powerful retrieval processes, (reconstruction), associated with semantic information give rise to superior memory performance" (Craik and Jacoby, 1975, p. 177).

It is evident that the revised and extended levels of processing model is by far, more complex and elaborated than the original formulation. Due to the recency of the revised model, there has only been one major test of the levels of processing reported in the literature. The series of experiments reported by Craik and Tulving (1975) [illegible] primarily with levels of processing, recall and recognition, incidental and intentional learning conditions, elaboration, and depth of processing. In their concluding discussion, Craik and Tulving (1975) suggest that the evidence provided by their experiments "provided empirical flesh for the theoretical bones of the argument advanced by Craik and Lockhart (1972)" (p. 278), and that:

> "it is abundantly clear that what determines the level of recall or recognition of a word event is not intention to learn, the amount of effort involved, the difficulty of the orienting task, the amount of time spent making judgements about the items, or even the amount of rehearsal the items receive ... rather it is the qualitative nature of the task, the kind of operations carried out on the items that determines retention" (p. 291).

In concluding this section, it should be stressed and noted that the formulation of the 1972 levels of processing model as well as the revised model were based on evidence from experimental studies utilizing adult subjects. There are no studies reported in the literature of an examination of the levels of processing model using children and mentally retarded subjects (the sample populations for this study). This study is in part concerned with a test of the generality of the model with differing subject populations, whose memory processing abilities and cognitive structures are still developing. A further concern of this study is to closely examine memory processing differences between EMH and normal children, as well as an attempt to explore the learning conditions that promote optimal memory performance for both groups of subjects. With regard to the latter concern, the conditions of incidental, intentional and planned intentional are incorporated into experiment I. In experiment II, dependent measures of attention will be included, to provide further examination of possible memory processing differences in EMH and normal children. Following a brief review of the literature pertinent to these areas, the rationale for the two studies will be advanced.

The Development of Intention

Craik and Lockhart (1972) have argued that memory performance is differentially affected by the nature of the orienting task as opposed to incidental or intentional learning conditions. The intentional learning condition refers to an experimental paradigm in which subjects are informed of post-task recall or recognition requirements prior to task implementation. In the incidental learning condition, subjects are only instructed of task requirements. Craik and Lockhart suggested that emphasis should be shifted toward the systematic study of retention following different orienting tasks within an incidental learning condition as opposed to comparisons of incidental or intentional learning. Craik and Tulving (1975) have remained with their earlier position and present a stronger statement in support of the original:

> "It is abundantly clear that what determines the level of recall or recognition of a word event is not intention to learn, ... rather it is the qualitative nature of the task, the kinds of operations carried out on the items that determines retention" (p. 290).

A review of the developmental literature however, suggests that contrary to the admonishments of Craik and Lockhart (1972) the incidental versus intentional distinction should be no means be casually dismissed. The evidence brought to bear from developmental studies indicates that the utility of the incidental versus intentional learning condition appears to be closely interrelated with the development of more efficient attentional processes as well as improved utilization of memory processing strategies (control processes, metamemory, planning and executive functions). In advance of elaboration concerning how these combined processing functions facilitate memory performance under intentional learning conditions over incidental learning; a brief discussion of the separate areas of the development of attention and strategic memory development should clarify some of the processes which might be operant in an intentional learning situation.

The Development of Attention

Fishbein (1976) combines the views of Norman (1969), who emphasizes the selective aspects of attention and Gibson (1969) who emphasizes exploration aspects, to define attention as "any process that determines which of the actual or potential environmental information that gets selected for further processing" (p. 208). Thus attention, as conceptualized here, is concordant with the descriptions posed by Craik and Lockhart (1972). Within a developmental context, attentional processes are ever changing and improving with the growth of the child. Mature attention is seen as the optimization of attention which Gibson (1969) describes as:

> "... first, the tendency for attention to become more exploratory and less captive; second, the tendency for exploratory search to become more systematic and less random; third, the tendency for attention to become more selective; and fourth, the inverse tendency for attention to become more exclusive" (p. 456).

Evidence for a developmental trend in environment scanning and exploration efficiency was apparent in a study conducted by Zinchenko, Chzhi-tsin, and Taraknaov (1962). The tasks induced subjects of three to six years of age to visually attend to irregular shapes and then identify the shapes when they were again projected on a screen. From the results of this study Zinchenko et al. (1962) concluded: that increasing age reflected greater efficiency in familiarization tasks to attend to and isolate the relevant aspects of the shape; that familiarization and recognition tasks become increasingly differentiated; and that scanning behavior becomes more economical. Similar age/efficiency trends in tactile exploration were reported by Abravanel (1968).

Vurpillot (1968) recorded the oculo-motor activity of children between three and nine years of age in order to examine the development of scanning strategies and their relation to visual differentiation. The results of this study led Vurpillot to hypothesize a succession of four stages in scanning strategy development. Stage one children appeared to have no definite criterion of same or different, as scanning behavior was random and responses were unrelated to the information collected. In stage two, same and difference definitions were assumed by the existence or absence of a common element. No spatial frame of reference was apparent and visual scanning involved only portions of the stimulus. At the third stage, the same and difference definitions were similar to adult formulations and comparisons were employed within a limited spatial and temporal frame of reference which included only the elements that could be scanned and memorized in a few seconds. At stage four, a systematic strategy of scanning and a wide frame of reference was evident (Vurpillot, 1968, p. 649).

Selective auditory attention was examined (Maccoby and Konrad, 1966) in children ranging from kindergarten to grade four, on a task requiring the selection of one auditory message when two were simultaneously present. The results of this study indicated that increasing age enhanced performance. The authors suggested that "language familiarity allows older children to benefit by the redundancies in the material to be selected as well the ability to exlude irrelevant information (nonsense words)" (Maccoby and Konrad, 1966, p. 121).

Lehman (1972) examined selective strategies in children's attention to task-relevant information with a sample of children from grades Kindergarten - six. Developmental differences were found in terms of the property to be ignored and to the extent to which attention was directed to the relevant property. From this Lehman suggested that selective attention is a multi-faceted skill, with the development of its parts progressing at different rates. Similar findings have been reported by Hagen and his associates (Druker and Hagen, 1969; Hagen, 1967; and Maccoby and Hagen, 1965).

In summary, these collective findings would suggest that the random, exploratory attention of the young child is gradually improved with increasing age and interaction with the environment; whereas mature attention is characterized by optimal usage of selection and scanning strategies. On the basis of the evidence outlined here, mature attentional abilities begin to appear during the pre-adolescent years. Therefore within the context of the levels of processing memory model, memory performance that is in part dependent on the "optional strategy of continued attention" (Craik, 1973) would be differentially affected by the level of attentional development of the subject. Thus, for pre-adolescents whom we assume to be in the final transitional stage of attentional maturity, the intentional learning condition might be crucial in terms of eliciting the optimal attention of the subject.

The Development of Memory Strategies and Processes

The close interrelationship between the development of memory strategies and attention on the one hand and the ability of the processor to benefit from intentional learning conditions on the other, has previously been indicated.

There is an abundance of theoretical and empirical investigation, to support the notion of improved memory performance with increasing age. The more recent developmental literature, suggests that improved memory ability is characterized by the gradual accumulation of a repertoire of memory strategies and processes.

Flavell and associates have extensively explored this area (Moely, Olsen, Halwes and Flavell, 1969; Flavell, Friedrichs and Hoyt, 1970) and have distinguished two major deficits, that differentiate the memory performance of the young child (and the mentally retarded) and the adult. The first is a mediation deficiency; apparent when the subject is unable to employ a potential mediator (i.e. verbal) even when he is specifically instructed to do so, or when the subject is trained to produce the required strategy but this does not mediate his performance. The second is a production deficiency which refers to an inadequate use of control processes in memory performance. This form of memory deficiency can be remediated through training. Even more explicit is the distinction made by Brown (1974) who equates mediational deficiency with a developmentally related structural limitation and further suggests that:

> "If however, performance is mediated appropriately once the strategy is produced then the initial deficiency is termed a production deficiency. Therefore, if training works, the initial deficiency was one of production" (p.63).

This distinction would suggest important ramifications of interest to diagnostic and remedial specialists working with children. Whereas, the diagnostician would be concerned with identification of specific memory strategies that are acquired at each stage of development, the remedial specialist would be more interested in the kinds of training programs or procedures that promote the production of different memory strategies.

A further concept relevant to differences in child and adult memory performance, first introduced by Flavell (1971), is described as metamemory. The most recent statement containing the essence of the metamemory concept, (Flavell and Wellman, 1976) suggests that young children demonstrate inferior memory performance because they lack knowledge about: their own capabilities; the mnemonic requirements of different tasks; potential strategies for meeting task demands; and strategies for capitalizing on ones own capabilities. That being the case, the optimization of metamemory would not only imply careful self-assessment of strategies available for task execution, but would also require astute intuition on the part of the processor to select the strategy that is most appropriate and maximally efficient. For the adult, metamemory processes would likely be automatically employed in countless instances throughout the day; whereas the young child's options are both structurally and experientially limited in the course of development.

The more recent developmental literature has helped to elucidate the kinds of strategies and processes the young child brings to bear on different memory tasks.

The studies by Flavell, Beach and Chinsky (1966) and Keeney, Cannizzo and Flavell (1967) dealt with rehearsal as an organizational process. The results of the first study revealed that with increasing age (subjects were grades Kindergarten - six) there was greater recall, and evidence of a greater amount of rehearsal. The second study, utilized a similar experimental paradigm to examine the memory performance of three groups of first graders. One group consisted of children who rarely or never rehearsed, whereas children in the other two groups were usual rehearsers. For the first ten trials all children were instructed to rehearse, and subsequent recall was found to be similar for all groups. There were no instructions to rehearse given on the second battery of trials. The results indicated that the majority of the non-rehearsers had dropped their rehearsal activities and correspondingly, their subsequent recall performance was diminished. In contrast, all of the usual rehearsers maintained their previous level of high recall performance.

Another type of memory strategy, clustering criteria, was examined in a developmental study carried out by Denny and Ziobrowski (1972) with first graders and coll ge students. It was found that young children tended to cluster material according to complimentary relationships (e.g. pipe and tobacco); whereas adults tended to organize material according to similarity relationships (e.g. king and ruler). The authors concluded that "it cannot be assumed that because children categorize according to different criteria than adults they therefore lack the ability to use the criteria adults use" (Denny and Ziobrowski, 1972, p. 281).

The development of memorization strategies was examined by Niemark, Slotnick and Ulrich (1971) utilizing subjects from grades one, three, four, five, six and college age. All subjects were given 24 pictures to memorize for free recall during a three-minute study interval. During this study period an "organization rating" was determined. This rating assessed the extent to which the subjects rearranged the pictures into categories. The minimum possible rating was zero which reflected no systematic rearrangement of the pictures, and the maximum three point rating reflected a completely categorized rearrangement of the pictures. The ratings reflected organizational increases from .10 for grade one subjects; .30 for grade three Ss; .70 for grade four Ss; 1.0 for grade six; to 2.2 for college students. The older subjects made more frequent use of memory strategies than younger ones, and those who used more strategies remembered more than those who did not. Similar developmental related differences in the utilization of categorical cues were reported by Halperin (1974) who examined the recall and recognition abilities of samples of six, nine and twelve year old children.

In an examination of retrieval cues used by children in recall, Kobasigawa (1974) hypothesized that as children mature they are increasingly likely to make efficient use of accessible retrieval cues. The samples of children, from grades one, three and six were given a task in which recall items (e.g. bear) were presented with conceptually related cues (e.g. zoo). Kobasigawa (1974) found that the number of subjects who spontaneously used these picture cues to retrieve target items increased as a function of age, and that when older Ss used these picture cues, they tended to recall more items than younger spontaneous cue users. Whereas a highly directive cueing procedure was needed for cues to be facilitative at grades one and three; the mere availability of the cues during retrieval was sufficient to enhance the grade six Ss recall scores. Similar findings reported by Ritter, Kaprove, Fitch and Flavell (1973) led these authors to suggest that the development of retrieval skills in children may parallel the development of storage skills.

In summary, the literature supports the notion that efficient memory performance is the result of optimal usage of memory strategies and processes available to the processor. This applies to both encoding and retrieval operations. Whereas more mature subjects may spontaneously adopt these strategies during task performance; younger subjects may require cueing or instruction to elicit the employment of these strategies. Within the context of the levels of prossing memory model, memory strategies or control processes would appear to constitute the same processes which Craik and Tulving (1975) refer to as elaboration processes. If this premise is accepted, then closer examination of the age at which these strategies are employed and under what experimental conditions is warranted. The review of the literature, points to the possibility that conditions of intention to learn may lead the processor to bring to bear both optimal attentional and memory strategies on task performance.

Intention, Memory and Attentional Processes

Craik and Lockhart (1972) have suggested that examination of memory performance differences should be restricted to the incidental learning condition in which the experimenter has greater control over encoding operations employed by the subject. It is argued, on the basis of evidence from the developmental literature, that the condition of intentional learning may be crucial to the heuristic examination of memory performance and the development of memory and attentional processes and strategies.

Hagen (1972) utilized incidental and intentional learning procedures in the examination of selective attention in children of varying age levels. In a typical experimental task, the subject was shown pictures of two items belonging to two separate categories. In a given series of these pictures, the subject was instructed to remember only the items from one category. It was found that with increasing age, subjects intentionally attended only to the items required by the task. Younger subjects tended to attend to both items on a card regardless of instructions. These results would suggest that subject awareness and usage of intention instructions is more efficient in older subjects. Similar results were apparent in the investigations reported by Wheeler and Dusek (1973) and Hale and Piper (1973).

The developmental aspect of memory efficiency in terms of an intentional or incidental experimental conditions has been widely explored in Soviet psychology. Smirnov and Zinchenko (1969) summarized an experiment carried out by Zinchenko with subjects aged three and one half years, five and one half years, eight and one half years, eleven and one half years and one group of adults. Different subjects of each age level were tested under involuntary (incidental) and voluntary (intentional) conditions. The incidental condition required the subject to view 15 pictures of familiar objects and name them. In the second condition the subjects were asked to name the pictures and remember them for subsequent recall. All subjects were later requested to recall and name the objects that were represented to them. The results showed that under both the incidental and intentional conditions, the number of objects correctly recalled improved with increasing age, stabilizing at eleven and one half years. For the adults and eleven and one half year olds, recall was greater under the intentional condition; whereas the recall for the eight and one half year olds was similar in both conditions; and the incidental condition was superior for the three and one half and five and one half year olds.

A plausible explanation for these results has been advanced by Flavell, Friedrichs, and Hoyt (1970) who suggested that the young child does not differentiate "mere perception" from deliberate memory, even though he does exhibit the ability to remember. Flavell et al. (1970) hypothesized that:

> "... the deliberate intention to memorize perceptual inputs for later recall only gradually emerges and articulates itself from the less deliberate intention just to recognize and contemplate them" (p. 338).

This hypothesis was examined in a study by Appel, Cooper, McCarrell, Sims-Knight, Yussen and Flavell (1972). Subjects included children from preschool, grade one and grade five. Two experimental tasks were employed including the two conditions of "look" and "memory". The first task allowed subjects simultaneous access to all the object pictures, for one and a half minutes, during which time they were free to inspect and manipulate the pictures as they chose. Second task subjects viewed the same items through slide-projections, one at a time on a screen. Subjects in the "look" condition were told to look at the items carefully; while "memory" condition subjects were instructed to remember the names of the objects. The findings of both experiments indicated that under both conditions, the percentage remembered increased with increasing age. There were no performance differences between the look and memory conditions for the four and one half year olds. For the seven and one half year olds there was no difference in conditions in the first task, but the memory condition resulted in greater performance in the second task. Performance in both tasks was greater under the memory condition for the eleven and one half year olds. The authors concluded that:

> "Evidence from both experiments largely confirmed the predictions, derived from this "differentiation hypothesis", that young children would study no differently and subsequently recall no better when instructed to memorize items for future recall than when instructed merely to look at them" (Appel et al., 1972, p. 1365).

Although the results of the Appel et al. and the Zinchenko study differ somewhat, both would strongly suggest that the intention to remember, as a useful differentiated state of an individual's memory, doesn't start to emerge until about age seven; by the age of 11 this state is fairly well incorporated into the child's repertoire of memory plans and strategies; and they likely become more interrelated as the child matures.

Meacham (1972) adds further insight concerning the notion of intentionality in a review of recent American and Soviet research. He suggests that Flavell's production deficiency hypothesis, could be reformulated on the basis of certain Soviet discussions, in stating:

> "the effect of intention is that the subject chooses from among the mnemonic activities which are currently available that which he thinks is most

> appropriate for the material and then engages in that activity. It is important to note that this effect is not upon the mnemonic activity, per se, but rather upon the choice of a particular activity in which to engage" (Meacham, 1972, p. 214).

Meacham strongly suggests that memory performance comparisons should include consideration of task comprehension, ability to engage in the mnemonic activity, lack of integration of the various mnemonic activities, as well as the consideration of a production deficiency. In light of the Soviet research, Meacham suggests that:

> "after an activity (action) such as rehearsing, classifying, labeling, etc is "comparatively well formed", it can then be subordinated as a means (operation) towards achieving a new goal, such as that of voluntary memory (action). Periods of production deficiency, therefore, refer to the time during which an activity is well formed, but not yet subordinated to the goal of remembering" (Meacham, 1972, p. 216).

Thus, the importance of the structural/process distinction is once again apparent.

In concluding this section, it would seem apparent that conditions of intentional learning form an integral function with respect to the increased efficiency of the young processors memory performance. In utilization of the levels of processing memory model, it is suggested that the concommitant examination of incidental, intentional and particularly planned intentional learning conditions would most usefully serve to elucidate those aspects which promote and facilitate optimal memory performance and differentiate subject populations.

Memory and Attention in Mental Retardates

The study of memory in mental retardates (MR) has been widely influenced by the modal models of memory. Research in this area has primarily focused on the problem of identifying deficits in short-term memory (STM), long-term memory (LTM), and the role of input organization and related retrieval mechanisms. The more recent formulations appear to suggest that memory deficit in MR's is largely centered in the STM (Ellis, 1970; Fisher and Zeaman, 1973) and not necessarily in the LTM (Belmont, 1966). Although these investigations have provided valuable insight into the nature of retardate memory, the concept of STM deficit is of limited utility for the purposes outlined for this research. The levels of processing view maintains that the processes subsumed under the heading of STM in modal memory models, are essentially the result of the subject's strategy of deliberate attention to salient features of the stimulus, to prolong and maintain its analysis. Craik (1973) has further clarified this distinction in suggesting that short-term memory strategies are:

> "off to the side in route taken from the environment to long-term memory and whether we maintain items at the STS level is very much an optional strategy rather than a structural feature" (p. 63).

With respect to the memory performance of mental retardates, Brown (1974) has advanced a highly plausible reinterpretation of this distinction in suggesting:

"if STS mechanisms are seen as optional strategies, then the retardate short-term meory deficiency can be seen as one example of a general pattern of inadequate exploitation of strategic plans to organize, maintain, and attend to relevant materials. Thus the STS-LTS distinction is deemphasized and the distinction becomes not whether a task is one of a short or long term nature but whether it demands strategic transformations for its efficient execution" (p. 59).

The reasons for choosing the latter frame of emphasis for this research are similar to those outlined by Brown (1974). The levels of processing model not only makes it possible to incorporate and reinterpret a substantial amount of existing research concerning memory processes and strategies of retardates, but also allows the researcher to capitalize on the theoretical and empirical investigations of the developmental research outlined in the previous section. A comprehensive discussion of the assumptions underlying this position is given in Brown's (1974) overview and thus will only briefly be dealt with here. Of primary interest, is the observation that the threads which tie the recent developmental investigations of children's memory, are closely intertwined with those emerging out of mental retardation research. The common cord of interest essentially is that both subject populations repeatedly demonstrate inferior memory performance in comparison with normal adults, although memory performance for both groups tends to improve with increasing age, experience and training. It has been further suggested that those factors which characterize inefficient memory performance (e.g. production deficiency, mediation deficiency, metamemory abilities) seem applicable to both developmental and mental retardation fields of investigation. If indeed, the course of memory development is the same for young children and retardates, then it would be anticipated that those factors which are central to maximal efficient memory processing in normal development (e.g. attention, memory processes or strategies, intention), would be of similar import in retardate development. Investigations of strategic memory behavior and processing in the retarded have only recently begun to appear in the literature, and as such the assumptions posed above can only be speculative at this point in time. The following brief review of the literature, reveals that greater depth and breadth of investigation are required in this area.

One of the first systematic investigations of memory processes of the mentally retarded was initiated by Ellis (1970). Although his investigations were based on a structural memory model, Ellis (1970) emphasized that retardates typically fail to utilize rehearsal processes which he claims are crucial for transferral of information from short-term (primary-secondary memory) to long-term tertiary memory) stores. Evidence to support this claim was provided in an experiment in which messages were presented to CA matched normals and retardates under the conditions of rapid and delayed rates of presentation. It was found that the delay interval after stimulus presentation enhanced the memory performance of the normals, whereas retardate performance was similar in both conditions. The conclusion that retardate performance was inferior due to a rehearsal deficit, was further supported by the verbal reports of the subjects. When queried about the use of rehearsal during the task, the normals typically indicated that they had been rehearsing whereas the retardate's responses suggested minimal usage of rehearsal.

Dugas (1975) has recently provided evidence to support Ellis' (1970) hypothesis of a production deficiency in active encoding for CA matched retardates, and similar results have been reported in studies of mental age (MA) matched normal and retardate groups (Spitz, Winters, Johnson, and Carroll, 1975).

One approach to the rehearsal deficit problem in retardate memory that has numerous possibilities for remedial education, is that exemplified by the work of Belmont and Butterfield and their co-workers (Belmont and Butterfield, 1971; Butterfield, Wambold and Belmont, 1973). In the first series of experiments (Belmont and Butterfield, 1971) both normal and retarded subjects self-paced their own learning of serial lists of letters, and recall accuracy was examined. The greater recall accuracy of normal subjects was attributed to increasingly longer pauses in their study time reflecting more rehearsal as more list items were learned.

This assumption was tested in the second experiment in which case the normal Ss were deliberately refrained from rehearsal, and retardates were forced to rehearse. The resulting increase in recall accuracy for retardates and decrease for the normal subjects confirmed the research hypothesis. A later study (Butterfield, Wambold and Belmont, 1973) revealed that training in the use and sequencing of memory processes can substantially improve retardate memory.

These earlier studies of retardate memory performance have been supported and elaborated by the comprehensive investigations of Ann Brown and her associates (Brown, 1972; Brown, 1973; Brown, Campione, Bray and Wilcox, 1974; Brown, Campione and Murphy, 1974; Brown, 1974). Following Flavell's line of investigation, Brown has been instrumental in demonstrating that those factors which delimit the efficiency of memory performance of young children, similarly characterize retardate memory. Her initial investigations supported the notion of production deficiency in terms of the lack of rehearsal strategy usage in educable mentally handicapped (EMH) adolescents, as well as the successful training and long term retention of a rehearsal strategy over a six month period. As a result, Brown and her co-workers were able to conclude that the difference between retardates and normals in immediate-memory tasks was not in the structure of the memory system, but in the tendency to adopt the active rehearsal strategy. Brown's most noteworthy contribution was the effective demonstration that assuming a process emphasis in retardate memory investigations, can lead to new vistas of interest that would likely have remained unexplored within a traditional information processing model of memory. Within her own research, Brown (1974) conducted an elaborate series of studies which revealed that adolescent EMR memory performance was equally efficient as normal subjects in recognition type memory tasks but was demonstrably inferior in tasks requiring strategic memory processing. Thus, a qualitative distinction of processes operant in memory tasks, as opposed to an STM/LTM orientation, has led to findings which have far reaching ramifications for remediation concerns.

An alternate investigative area that offers substantial insight into the nature of retardate memory processing, is that of organization strategy utilization. For example, Ashcraft and Kellas (1974) have demonstrated that MA matched normals and retardates free recall performance was similarly improved through instructions to rehearse words according to category membership. Non-instructed Ss of either IQ group showed minimal spontaneous usage of conceptual groupings and performed poorly in comparison to instructed Ss. A recent experiment reported by Bilsky (1976) suggests not only the possibility of training of a categorical clustering strategy in EMH adolescents, but also the successful transfer of training to different tasks.

The effect of clustering according to semantic or acoustic relatedness of words in a free recall situation, with MA matched third grade children and retardates, was examined by Zupnick and Forrester (1972). Although the normals recalled significantly more words than retardates, the results indicated that semantically clustered words were better remembered by both groups. These findings support the predictions of the Lockhart, Craik and Jacoby (1975) levels of processing model and similar to Brown's (1974) investigations, the importance of examination of qualitative differences of memory processing is apparent.

Studies of elaboration learning in EMH children suggest that this type of strategic memory processing may be more recall facilitative than rehearsal or verbal labelling strategies. Taylor, Josberger and Knowlton (1972) found that subjects (Ss) given instructions to elaborate in the form of either images or verbal contexts, performed significantly better on a paired-associate word recall task than Ss instructed to rehearse. A different study of verbal elaboration of paired associate learning in retardates (Turnure, 1971) indicates that all three conditions of verbal elaboration (sentence, semantic paragraph, and syntactic paragraph elaboration) were markedly superior in comparison with a standard labelling condition, and that paragraph elaboration resulted in significantly greater recall than the sentence condition.

Another characteristic which distinguishes the memory performance of retardates and normals is the ability to capitalize on the information reduction potential of certain memory tasks. Spitz (1973) in a series of experiments of digit span and paired associate learning, demonstrated that retardates consistently failed to employ this strategy. He concluded that:

> "It appears that a major difference between educable retardates and equal CA normals occurs at the retrieval stage, and results largely from inefficient organization at input. If material is stored in an organized form, external and/or subjective cueing is more likely to result in successful retrieval. Examples of retardates' difficulty in recognizing and utilizing information-reducing aspects of a stimulus were presented as evidence of their general problem in selectively scanning and organizing material at input" (Spitz, 1973, p. 166).

With respect to the studies that have been reviewed thus far one might be superficially led to conclude that retardate memory deficiency can be simply resolved through the training of memory processes and strategies. Herriot, Green and McConkey (1973) justifiably caution that tools such as memory strategies or memory control processes cannot be used if:

> "a. Their use is not selected as appropriate.
> b. The operations required to use them are not sufficiently developed.
> c. The tools themselves do not exist" (p.99).

These factors warrant further examination at all levels of research in retardate memory performance and might be considered analogous to Flavell's concept of metamemory abilities, or Meacham's (1972) view of the association between intentional learning and efficient memory processing.

Unfortunately, this entire area of investigation with respect to retardation studies, remains essentially unexplored at present. The only research that could be located concerning retardate memory performance under intentional learning conditions was that of the Soviet psychologists, Zankov (1939) and Dul'nev (1940), which are described by Shif (1969). The results of these early experiments suggests that although retardates initially performed similarly in both incidental and intentional conditions the possibility of meaningful recall performance in older retarded subjects, through careful and thorough instructing of techniques is indicated. In summarizing the Soviet findings, Shif (1969) postulates that:

> "An intention is carried out only after a repeated perception of the material, and after sufficient comprehension of it. The oligophrenic's (mental retardate's) weak or poor fulfillment of an intention, in addition to showing a basic difficulty in understanding the material, also constitutes a manifestation of an inability to subordinate his activity to a definite "totality" of requirements imposed upon him" (p. 334).

Interestingly, the Soviet findings closely parallel the suppositions advanced by Meacham (1972) which suggest that poor memory performance during conditions of intentionality may be specifically or collectively due to an inability to engage in the mnemonic activity, lack of integration of the various mnemonic activities, as well as a production deficiency. As a result of the limited empirical investigation in this area, these considerations will constitute a major focus of exploration in experiment one of this study.

It has previously been indicated that optimal memory performance and learning depends not only on the development of strategic memory processes, but also is considerably affected by the development of attention. Attentional deficit has been widely implicated as a major factor in rationalizing observed performance differences in comparison of normal and mentally retarded subjects. More specifically, Zeaman and House (1963), on the basis of their research involving retardate visual discrimination learning, hypothesized that retardates lack the necessary ability to attend to relevant cues in learning. They postulated that the process of discrimination learning involves 1) attending to the relevant dimension, and 2) approaching the positive cue of that dimension. In their investigations, retardates consistently demonstrated an inability to exercise the initial step, although Zeaman and House (1963) point out that once the process starts, learning does not appear to be related to intelligence.

However, research subsequent to the attention-deficit hypothesis (Zeaman and House, 1963) suggests that a blanket description of retardates as distractible serves only to cloud the more important issues of in what situations this behavior is manifested and how it may be overcome. For example, Crosby (1972) concluded from his investigations involving four groups of mental retardates and one group of normal subjects, that attention deficit is more appropriately descriptive of the severely retarded or institutionalized retardates. In a similar vein, Sen and Clark (1968) found that retardate susceptibility to distraction was related to task difficulty and that variables important to the amount of distraction include such factors as the nature and duration of the task and its attentional value, as well as the intensity of the distracting stimuli and the relevance of the distractors to the task.

Therefore, although these and similar studies would support a general notion of attentional deficit in retardate learning and memory, it would seem apparent that the degree of retardation, the age of the subjects, and task parameters should be carefully assessed prior to formulation of performance predictions.

Soviet psychologists have traditionally adopted the view that mental retardation is the result of damage to the central nervous system and that all retardates suffer from some type of neurological impairment. Luria and his coworkers (Luria, 1963; Luria, 1971; Luria and Vinogradova, 1963) have hypothesized that a weakness in the strength, balance or lability of the nervous processes results in learning problems. The lability factor (ability of the cortical nervous processes to easily change from a state of excitation to inhibition) is considered a central aspect with respect to [illegible]date learning or cognitive processing. This factor is essential for the regulation of attention to both the external environment and the internal environment (memory and thought processes). In psychophysiological terms, the mechanisms controlling the above proceses are the orienting reaction and arousal. The orienting reaction (OR) was first described by Pavlov (1927) as a "What is it?" response to novel stimuli. This concept has been examined and elaborated into a theoretical formulation by the Soviet psychologist Sokolov (1963 A; 1963 B; and 1960). Essentially, the theory hypothesized that as a stimuli is repeatedly presented, the organism records a variety of the dimensions of the stimulus (e.g. quality, intensity, frequency, duration) in the form of a neuronal model within the cortex. The accumulation of stimuli information is made possible through the elicitation of the OR. Its function is preparatory in that it prepares the organism for optimal reception of information about the stimuli. The OR ensures increased receptor sensitivity by allowing the focusing of attention and preparing the organism for responding. Once a neuronal model is established all succeeding stimuli are compared to it. If a newly presented stimulus contains information discrepant to the existing neuronal model, the OR occurs to effect further analysis and its magnitude is proportional to the degree of stimulus discrepancy. As a result of the elicitation of the OR and further analysis, the new stimulus information is added to the neuronal model.

While the concept of arousal is not as central as the

OR, it plays an important facilitative role in the coordination of the balance between excitiation and inhibition in the CNS. Similar to the OR, the arousal vertex appears to stem from the reticular formation. The measures of GSR and HR have traditionally been used as dependent measures of arousal, and subsequently interact with the interpretation of the orienting components of an organism's reaction to stimuli. The discrimination of the two components may be facilitated by spearation of the tonic and phasic aspects of the OR. Sokolov (1963) suggests that the tonic reaction is delimited from the more general case of arousal in referring only to those cases of arousal increase which are functionally related to stimulus change. The arousal increase is said to be independent of the direction of stimulus change.

The relationship of behavioral measures of arousal, has been predicted to follow an inverted U-function (Hebb, 1955; Malmo, 1959). Thus we could expect improvement in performance up to some optimal level of arousal, followed by a decline. For example in regard to reaction time tasks, we could expect that faster responding should occur at moderate levels of arousal. This view is supported in the literature (McClean, 1969; Kleinsmith and Kaplan, 1964) in that galvanic skin response (GSR) related arousal observed in subjects at the time of learning, facilitated memory trace formation for subsequent recall.

Defective OR and arousal functioning in retardates has been widely purported in the literature. Luria's research led him to conclude that retardates cannot maintain an OR and that habituation of an OR is much faster in retardates than normals. Luria found that extinction of the OR begins in normal children after 10-12 repetitions of the stimulus, whereas for severely retarded children it would occur after one or two presentations. From this Luria (1963) concluded that:

> "The instability of active attention fundamental to the swift execution of the orientation reflexes in the MR leads to the complex connections formed by him quickly distinguishing" (p. 104).

In experimental situations where both normal and MR children were involved in a task requiring concentration, extraneous events (e.g. a knock on the door) elicited only the attention of the MR. Luria claims that the distractibility of the MR is due to a weak OR which impairs retardate attention span, and a defective filtering mechanism. On the other hand, normal children elicited strong OR's to the appropriate stimulus which effectively prevented other stimulus events from impinging on the attention of the organism. In addition to this, Luria observed in a number of experimental situations, that stimuli of low or medium intensity which always evoked an OR in normal children, did so only infrequently in MR children of the same CA. With strong stimuli, however, retardates tended to give large OR responses which were difficult to habituate.

On certain tasks, verbal instructions were given to make a relevant stimulus a signal stimulus, which normally elicits a strong OR, resistant to distinction. Luria found this procedure resulted in an OR strong enough to hold the normal child's attention, to the extent that they were unsusceptible to distraction to irrelevant stimuli, whereas the procedure was found to be ineffective with MR children.

In summary, Luria suggests that mental retardation is directly related to different types of neurological impairment. This further implies that the examination of OR differences in normal and MR children will discriminate the specific areas causing learning and attentional deficits in the mentally retarded. A similar hypothesis has been proposed by Meldman (1970). He contends that the MR shows lower general arousal and low selectivity of attention; and thus Meldman (1970) describes mental retardation as "mental hypoattentionism".

However, in reviewing the literature, it becomes apparent that the results of Western research have failed to support Luria's theory in its entirety.

In terms of OR research, the main point of contention appears to centre on the habituation aspect of the OR. The studies which provide support for Luria's hypothesis come from experiments using similar simple stimuli such as tones or light flashes. Berkson (1961) examined GSR responses of normal and MR subjects and concluded that MR children respond less intensely and for a shorter period of time to short duraation auditory or visual stimuli than do normals. Further evidence supporting Luria's research is reported by Vogel (1961) who found that retarded subjects consistently recovered the baseline GSR more quickly than normals. The results of these studies support the hypothesis of a weak OR in MR subjects and faster habituation effects.

Support for Luria's hypothesis concerning the differential responding of MR's to weak and strong stimuli is evident in the findings reported by Fenz and McCabe (1971). They found that the normal subjects showed a greater OR to weaker and average tones, whereas retardates responded more strongly than normals to strong tones.

On the other hand, several studies have reported no habituation differences in comparing MR and normal subjects (Clausen & Karrer, 1969; Das, 1973; Johnson, 1976) and others have reported (in direct contradiction to Luria's hypothesis) slower habituation in MR subjects in comparison with normal subjects (Baumeister, Spain and Ellis, 1963; Tizard, 1968).

In interpreting the results of no difference or slower habituation of the OR in MR subjects, Lewis, Goldberg and Campbell (1968) have presented a viable alternate hypothesis. They suggest that if one accepts the neuronal model assumptions proposed by Sokolov, then it would be predicted that the MR's would be less efficient in processing stimulus information. With each stimulus presentation normal subjects acquire information more efficiently and therefore would habituate faster than the MR's who would require more stimulus presentations to form an adequate neuronal model. This possibility has been expressed by other Western researchers (Heal and Johnson, 1970; Johnson, 1976).

Luria's hypothesis of a generally weak OR in MR subjects, has been questioned as a result of a series of investigations by Johnson and his associates (Johnson, 1976; Elliot and Johnson, 1971; Heal and Johnson, 1970). For example, Elliot and Johnson (1971) compared CA matched samples of 15 EMH and 15 normal subjects on measures of the digital blood volume component of the OR to two kinds of stimuli. In phase one a relevant tone stimulus was presented 10 times, which resulted in a significant OR for both groups. In phase two, irrelevant light stimuli were presented 10 times during performance of a task and neither groups significantly oriented to the stimulus. The results would support Sokolovs theory concerning the filtering aspects of OR, although the findings of no difference in the magnitude of the OR, fails to support the notion of a weaker OR in retardates.

Similar discrepant results have been found in studies concerning arousal deficits in retardates. In their studies of the delayed response performance of retardates and comprehensive overview of studies of reaction time task performance Baumeister and Kellas, (1968) suggest that the MR is unable to maintain a level of attention that is required for fast RT performance. In support of Luria's hypothesis Baumeister and Kellas (1968) conclude that:

> "Enough evidence has been presented to lead to the tentative conclusion that retardates suffer a pre-stimulus arousal deficiency or attentional lag" (p. 88).

Hermelin and O'Connor (1970) specifically reviewed several psychophysiological studies in the area of mental retardation and their findings indicated that there is "the possibility of unusual levels of arousal in subnormals and severely subnormal subjects" (p. 146). On the basis of their review Hermelin and O'Conner concluded that:

1) Such unusual levels of arousal certainly contribute to psychological deficit.

2) There is substantial experimental evidence in relation to both CNS and ANS to ratify the theoretical proposition of differences in arousal levels of MR's and normal subjects.

3) If arousal and expectations are to be related to cognitive impairment in mental retardation then measures such as anticipatory response will become apparent.

4) Some attempt at sub-classification on the basis of different brain pathology should be made.

Berkson (1961) compared normal and MR subjects on GSR measures and findings favored the suggestion of impairment of arousal in MR's. He concluded that MR children respond less intensely and for a lesser period of time to short duration auditory or visual stimuli than do normal children. Despite these strong claims purporting an arousal deficit in MR's, the literature once again reveals gross discrepancies in results.

At the conclusion of his analysis of ability structure, Clausen (1966) indicated that retardates do not control their own level of arousal to the same extent as do normals and that they display an impairment of mobilization of arousal which interferes with their readiness to respond to outside stimuli. However, in a later paper concerning arousal theory in mental retardation, Clausen (1973) suggests that the evidence favoring an arousal deficit in MR's is not conclusive, and that we cannot assume that all MR's show less psychological activity than normals. In a review of the experimental studies of ANS functions and behavior of MR's, Karrer (1966) found MR's (except Down Syndrome subjects) to have lower skin resistance than normals and were less reactive to stimuli of weak or moderate intensity. However, confounding results were reported in responses to strong stimuli. The Stern and Jane (1973) review of more recent research, also indicates that there is no clear cut evidence for one position over the other. They point out that there is evidence for MR's showing higher arousal levels, lower arousal levels, no differences and mixed results. They conclude that the theory of arousal deficit in the mentally retarded is still open to question.

The resolution of discrepant Soviet and Western research has more recently become aligned with a general OR theory, in that findings such as those reported by Clausen, Lidsky and Sersen (1976) strongly indicate that autonomic responding patterns widely vary across different subgroups of retardates, and can likewise be altered as a result of varying task parameters and degrees of stimulus complexity. Failure to consider the above in comparative research, might well result in situations of discrepant interpretation. With respect to the apparent lack of agreement in regards to Soviet and Western research, Das (1973, 1976) and Das and Bower (1971) have pointed out, that the subjects utilized in Luria's and other Soviet experiments, were of significantly lower mental a[illegible]telligence in comparison to retardate subjects ty[illegible] employed by Western researchers. In addition, to th[illegible] the majority of the Soviet and Western studies have utilized simple stimuli such as light flashes and tones, and little has been done in terms of control for the information processing and attentional demands intrinsic in task parameters and stimuli complexity. Recent studies have shown that performance differences may accrue as a result of varying the preparatory interval in a reaction time task (Krupski, 1975) by varying the quality of the stimulus (Das, 1976, Freeman, 1972) as well as altering sustained attention requirements in vigilance tasks (Semmel, 1965; Swets and Kristofferson, 1970). Of particular interest to this research, is a study by Freeman (1972) as outlined by Johnson (1976). The separate influences of brain damage and MR on the OR were examined to clarify whether the Soviet hypothesized OR weakness in MR's is a function of either or both. The subjects included 2 groups of EMR and normal CA matched subjects diagnosed as brain damaged, and 2 groups of EMR and normal CA matched subjects with no evident brain damage. The design was similar to that of Luria and Vinogradova (1959) and the words stimuli (cap, hat, map and tree) were presented auditorily as heart rate measure was recorded. Following a series of habituation trials for each word, the stimulus word "cap" was invested with signal value by instructing the subject to press a button each time he heard it. The analysis indicated that no significant variance was associated with brain damage or the interaction of brain damage with IQ. Important differences were found however between MR and normal subjects in terms of responses to qualitative differences in words. Responses to phonetically similar and neutral words produced slight acceleration for both groups and similar strong decelerative responding was apparent for the signal word "cap". The significant differences occurred in response to semantically similar words. The MR subjects showed significant deceleration, to the word "hat" with no difference in magnitude from the response to the signal word. In contrast, the normal group responded to the semantically similar word with significant acceleration. Freeman (1972) concluded that:

1) The presence or absence of brain damage seems unlikely to be responsible for inconsistencies in the literature;

2) The differences being detected by measures of the OR may be cognitive.

In summary, of the theoretical and empirical literature concerning retardate attention deficit, and OR and arousal, the following conclusions may be drawn:

1) While attention deficit may be considered a discriminating factor peculiar to MR's, there is no conclusive evidence to support a neurological impairment or weak OR and arousal hypothesis.

2) The several studies reporting slower habituation of MR's may plausibly be considered in view of Sokolov's theory. MR's would be considered inefficient information processors, and lacking in ability to efficiently select and filter out relevant and irrelevant stimulus information. Thus the MR is unable to maximize the amount of information processed per stimulus presentation and would require more presentations to form an adequate neuronal model.

3) Consideration must be given to the degree of mental retardation as well as physiological responding characteristics of the subgroup of MR subjects being examined.

4) Research results have been confounded by the utilization of simple and complex stimuli. The evidence from more recent studies indicates that it would be more profitable to simultaneously examine the attention and information processing demands required by the experimental setting in comparing MR and normal subject differences. Both reaction time and vigilance task parameters appear to be useful experimental paradigms for such examination as well as variation of the quality of

information to be processed.

In concluding this section, it would appear that the general notion of attentional deficit in MR's due to arousal and OR malfunction, is still open to question. The more recent investigations in the psychophysiological literature would suggest that if attentional differences do exist in EMH children when compared to MA matched normal children, such differences should become apparent in examination of autonomic responding during an information processing task. These considerations are to be specifically examined in experiment two of this study. While the literature is essentially void with respect to comparisons such as the above, Clausen, Lidsky and Sersen (1976) have indicated that:

> "Of the autonomic measures in the various conditions of this and other studies, Skin Resistance (SR) and Heart Period (HP) appear to be the most productive in discriminating groups. Both have merits of high intersession reliability and ease of recording"(p. 79).

Since HR measures are considered to be reliable measures of OR and arousal, it is anticipated that the inclusion of HR (along with reaction time) measures in the levels of processing task would similarly provide reliable dependent measures of attentional differences in EMH and normal children. The validity of HR and RT as measures of attention will be discussed in the rationale for Experiment two.

In summary, the selective review of the literature indicates a wide variety of approaches in terms of examination of memory performance differences in EMR and normal children. Although the levels of processing model was formulated on the basis of adult experimental investigations, the model possesses several advantages over the traditional "modal" memory. Particularly in view of retardate investigations, the "modal" model has biased research in this area toward the search of the "defective" memory store, and consequently the emphasis has been directed toward structural limitations. The levels of processing model abandons the notion of memory stores, in favor of emphasis upon the qualitative nature of processing operations. Since the phenomenon of deeper levels of processing at encoding, resulting in greater recall appears to be a robust concept in adult investigations, it is possible that the effects will be similarly demonstrable in EMR and normal children samples. Moreover, an emphasis on qualitative differences in memory processing, could lead to greater insight, in terms of which levels of processing most readily differentiate normal and retardate samples.

The more recent investigations in the developmental and mental retardation research have generated a substantial understanding of the factors which delimit the memory performance of young children and retardates (i.e. mediation deficiency, production deficiency, metamemory abilities). Effects have similarly been directed toward a delineation of the factors that facilitate the memory performance of older children and adults. Both the development of attention abilities and memory processes (i.e. rehearsal, imagining) as well as memory strategies (i.e. categorization, elaboration learning), would appear to be crucial factors in this regard. More important, studies have shown that young children and retardates can be successfully trained to utilize such facilitative factors, and thus increase their levels of performance. Experiments concerning differential learning conditions, point to the positive effects of employment of intentional learning conditions, particularly for older children. It would seem that children at this age level may possess the ability to enhance memory performance, although elicitation of these abilities requires an intentional learning condition. Therefore, performance that is inferior due to a production deficiency, may be improved through knowledge of a recall requirement and/or the strategic planning prior to task implementation.

The design of this study is such that memory processing differences in EMR and normal children, can be simultaneously assessed with respect to levels of processing, as well as a result of differential learning conditions, through examination of recall performance.

Since the notion of attention deficit has often been advanced in interpreting memory differences in retardate and normals, this possibility will be explored in experiment two, through utilization of heart rate and reaction time measures.

CHAPTER III

EXPERIMENT ONE

Rationale

The levels of processing memory model (Craik and Lockhart, 1972) has been formulated on the basis of research involving adult samples. The research literature is essentially void with respect to any experimental investigations utilizing the levels of processing model with children or retardate samples. However, the feasibility and efficacy of such investigation has been widely exhorted in the literature (Medin and Cole, 1975; Jablonski, 1974, and Brown, 1974). Medin and Cole (1975) have suggested that future research with children or retardates using the levels of processing approach lends promise of enhancing the cognitive theorists position as an "additional source of theoretically relevant variation" (p. 130). In addition, they have posited that such experiments may serve to clarify the relation between "depth" caused by different rehearsal activities from "depth" resulting from differential comprehension. This distinction is implicit with that posed in the introduction of this study. Are differences in retardate and normal memory processing the result of the retardate's failure to adopt strategic memory devices such as control processes and memory strategies (i.e.

subject to remediation) or is it a matter of limited or fixed structural capacity (i.e. maturational level)?

The direction of present developmental research points to the necessity for a flexible framework in which to examine changing normal and retarded children's memory processes and performance. The levels of processing model presents a qualitative orientation, as opposed to a structurally confined memory model, and as such can accommodate a wide range of experimental questions. Whereas the experimenter utilizing a modal memory model posits questions relating to capacity/temporal aspects of various memory stores and subsequent retention, the levels of processing model generates questions that focus on how the subject processes the information presented him, and which processing strategies promote optimal retrieval. The distinction is astutely explicated by Craik (1973):

> "Memory is a by-product of an essentially perceptual system, STS is off to the side in the route an item takes from the environment to LTS and whether we maintain the item at the STS level is very much an optional strategy rather than a structural feature" (p. 62).

The levels of processing model allows simultaneous examination of sample differences in "strategic" processing, as well as how individuals use their available "options" for maximal memory efficiency. The corollary extends through all stages of memory maturity. Therefore it is possible to examine memory performance differences of various population samples (e.g. adult-child; normal-retarded) and systematically determine how the qualitative interaction in memory performance differs as a result of experimental conditions, age, and intellectual level. Since memory depends heavily on optional strategies employed by the individual, the possibility of training optimal encoding and retrieval strategies and processes is apparent.

The notion of individual variation in memory performance is suggested in Underwood's (1969) attribute theory. The concept implies that individual differences in memory performance may be the result of differential attention to the ensemble of attributes at the time of encoding. This notion has been examined at varying age levels and the results suggests that there are differences in the relative importance of various attributes at different ages. Bach and Underwood (1970) examined developmental changes in attribute dominance of acoustically and semantically varied words. The results revealed that for younger subjects, the acoustic attribute dominated, whereas for older subjects, the semantic attribute was stronger. Moreover, subjects who encoded items according to acoustic dominant attributes, forgot the words more quickly than subjects who encoded items according to semantic dominant attributes. Similar findings have been reported by Felzen and Anisfeld (1970) and Freund and Johnson (1972). The importance of individual differences, such as the above, in experimental research is seen to be centrally relevant to cognitive studies (Hunt and Lansman, 1975, Butterfield, 1976). Further investigation in this area, can be suitably accommodated within the levels of processing framework.

Butterfield (1976) has discussed at length, the problems and controversies associated with investigative attempts to determine whether retardate memory performance differences are solely a function of developmental structural capacity, or a function of causative factors peculiar to retardation. On the one hand we have seen that training or instructional experiments with retardate subjects can result in more proficient performance (Brown, 1974; Brown, Campione and Murphy 1974; Flavell, 1970; Butterfield, Wambold and Belmont, 1973). On the other hand, Zeamon (1973) and others have argued that retardate growth rate remains stable, and therefore structural limits must differentiate the retardate from the normal. The difficulty that this issue presents is well formulated by Brown (1974):

> "There appears to be a problem with establishing a valid distinction between fixed capacity restrictions and trainable control processes in that this would require that the effectiveness of a training procedure be independantly evaluated. The problem is not acute if a particular training procedure is successful since it would then be possible to conclude that a trainable control process was involved and had responded to training. However, difficulty arises when training does not alter performance. Is this due to the presence of a structural capacity limitation or due to the inadequacy of the training procedure itself? It would be necessary to exhaust all possible training techniques before concluding that an intrainable structural feature had been discovered, surely a logical impossibility" (p. 61).

The problem, therefore, becomes one of sorting out cognitive structural variables that can be anticipated from a developmental context; those structures that specifically delimit the mentally retarded; and those processes which may promote cognitive growth. Butterfield (1976) has suggested that in identifying process differences between samples "the goal is to account for all between subject and all within subject variance in task performance" (p. 42). He further suggests that this goal may be achieved by certain manipulations of the laboratory situation. One method would be to record direct measures of what people do to produce the performance outcome (e.g. response time). As an alternative method, Butterfield (1976) suggests "that simple age and IQ affects implicate no process; but interactions with manipulated variables do allow inferences about processes that distinguish age and IQ groups" (p.16).

This approach is closely aligned with the position outlined by Medin and Cole (1975) who urge researchers to utilize a process orientation in a comparative psychological approach in studying human cognition. They suggest that using non-standard populations in experimental research can serve to "maximize both the generality and parsimony of a theory.. . The process orientation applied in a theoretical framework can serve to sort out what observed differences in" (p. 115). This approach has already been successfully applied in the area of mental retardation (Brown, 1974) and child development studies (Flavell, Beach, and Chinsky, 1966;

Keeney, Cannizzo and Flavell, 1967; Meacham, 1972; and White, 1965). With respect to experimental investigation, the approach calls for a holistic frame of reference in identifying logical referents for study and then working through plausible variations on a basic experimental paradigm. This procedure is clearly evident in Brown's (1974) investigations which have previously been described. Brown's approach served not only in identifying distinctions in memory performance of retarded and normal subjects (of relevance to the psychometric tradition); but she further extended the utility of such investigation by attempting to determine whether the distinction was structural or functional (of relevance to remedial specialists).

Thus far, experimental investigations of the levels of processing model, and the recent developmental research concerning memory control processes and strategies, have remained separate and independent. In light of the above discussion, it is suggested that the two approaches might be fruitfully melded to allow simultaneous examination of memory performance differences that accrue from levels of processing, as well as from utilization of strategic memory and control processes. The major purpose of this experiment is to examine memory processing differences in normal and retarded children utilizing a levels of processing model. In addition, differential learning conditions (i.e. incidental, intentional, and planned intentional) have been incorporated into the experimental design, in order to examine and compare memory strategy and process differences in normal and EMR children. The incidental learning condition involves only the levels of processing task, whereas the intentional conditions also involve knowledge of the recall requirement. Intentional condition subjects will be individually interviewed in an attempt to determine the memory strategies and processes that were utilized during the levels of processing task to facilitate their recall. The approach to be utilized will follow the structured interview technique described by Kreutzer, Leonard and Flavell (1975). The technique focuses on the subject's own awareness of his mnemonic ability and limitations; his assessment of task demands involved in retrieval situations; and how the child might use a repertoire of de erate and conscious memory strategies particularly in confrontation of an expected recall requirement. While the use of this technique remains relatively unexplored in the literature, Butterfield (1976), in reviewing the more recent trends in cognitive development research, suggests that interviewing may be a "valuable tool" in examining children's memory processing differences. In summary, this experiment has three specific purposes:

1) To investigate memory performance differences in normal and retarded children on the basis of recall, utilizing the induced levels of processing paradigm.

2) To examine differences in memory performance in normal and retarded children's recall that

might result from differential learning conditions.

3) To explore the further differentiations in recall performance that may occur as a result of informing the subject of subsequent recall requirements, as well as the inducement of the subject toward the planning of memory strategies prior to task presentation. It is anticipated that the inclusion of the pre and post task interviews will provide some indication of such metamemory skills of individual subjects.

A peripheral area of exploration to be included in this study, is the measuring of reaction time. Since depth of analysis is considered to relate to "the amount of attention paid to the stimulus" (Craik and Lockhart, 1972), we should be able to predict differing processing times for the qualitatively distinct levels of processing. Thus shallow levels of processing (physical) would require the least analysis and should reflect shortest response latencies; whereas deeper semantic levels analysis should result in longer response latencies.

Definitions

Incidental Condition - Subjects are only instructed in a description of the experimental task.

Intentional Condition - Subjects are instructed in the description of the experimental task as well as the recall requirement at task completion. Subjects in this condition are interviewed after the recall requirement task.

Planned Intentional - Subjects are provided the same instruction as the intentional group and given further information regarding the categorical nature of the words included in the task. A pre-task interview is given to induce the subject to devise strategies to improve their recall performance. A post-recall task interview is conducted to determine the strategies employed by the subject.

Hypotheses

The hypotheses presented here are in part, a test of the basic formulations of the levels of processing model (Craik and Lockhart, 1972, Craik and Tulving, 1975) and generalizability to differing subject populations. This would imply that above all encoding strategies employed by a subject, it is the level of processing that will best predict subsequent recall performance. Whereas the prediction of greater recall following deeper levels of processing in children has been supported (Lawson, 1976), earlier studies of memory attribute dominance (Bach and Underwood, 1970; Felzen and Anisfeld, 1970; Freund and Johnson, 1972) have indicated that the orthographic/acoustic attributes are dominant in children's memory and that the semantic attribute dominates in the memory of older subjects. The results of this study should help clarify the matter at least for the pre-adolescent stage of development.

On the basis of evidence from developmental research, (Brown, 1974, 1975; Flavell 1971; Meacham, 1972) there is a strong indication that conditions of intentional learning, greatly enhance memory performance, particularly at the pre-adolescent stage of development. General recall has been improved, both as a result of simply instructing the subject of subsequent recall requirements, as well as by soliciting the subject to employ his metamemory abilities in planning memory strategies optimally efficient for task execution. The present study has the additional advantage of simultaneous examination of both the levels of processing effect and differential learning conditions (e.g. incidental, intentional and planned intentional). In light of the above considerations the following hypotheses are posited.

Hypothesis I: Over all experimental conditions, recall performance for both groups (normal and EMR) will be positively related to deeper levels of processing (i.e. physical < phonemic < semantic).

Hypothesis 1-1: Over all experimental conditions, recall performance of normal subjects will be greater than that of EMR subjects.

Hypothesis 2: Over all experimental conditions, reaction time latencies will be positively related to deeper levels of processing (i.e. physical < phonemic < semantic), for both suject groups (normal and retarded).

Hypothesis 2-1: Over all experimental conditions, reaction time latencies will be shorter for normal subjects in comparison with EMR subjects.

Hypothesis 3: Overall recall performance will be positively affected by differential learning conditions (i.e. incidental < intentional < planned intentional) for both experimental groups (normals and EMR).

Hypothesis 3-1: The positive effect in recall performance due to differential learning conditions will be greater for normals as compared to EMR subjects.

Method

Subjects

Normal and educable mentally retarded (EMR) children were the two populations utilized in this study. The normal children were selected from an elementary Separate school and the EMR children were from a special school in the City. Preliminary screening involved the perusal of school records and consultation with the teachers and counsellors in order to exclude subjects with any sensory, emotional or organic anomalies. Letters were then sent to the parents or legal guardians to obtain written consent for their child to participate in the experiment.

The sample characteristics of the groups were as follows:

Sample	Chronological Age (CA)	Mental Age (MA)	Intelligence Quotient (IQ)
42 Normal	$\bar{x}$ = 10.2 years (range 9.0 to 12.0 years)	$\bar{x}$ = 10.4 yrs (range 9.0 to 11.10 years)	$\bar{x}$ = 102.6 (range 90 to 114 Lorge-Thorndike)
42 EMR	$\bar{x}$ = 14.3 years (range 13.2 to 16.7 years)	$\bar{x}$ = 10.3 yrs (range 9.0 to 11.11 years)	$\bar{x}$ = 72.5 (range 63-80 WISC)

Subjects were randomly assigned to one of three experimental conditions (incidental, intentional, and planned intentional), and each experimental group included 14 normal children and 14 EMR children. Male and female subjects were equally represented in each experimental condition.

It should be noted that the sample groups in this study

(EMR and normal children) were matched on the basis of mental age. This basis of comparison was favored over a chronological age match to provide a more stringent test of sample differences. It is acknowledged that the advanced CA [illegible] e EMR sample would bias the results in terms of general ex[illegible]iential background. However, the bias is favored toward the EMR sample in the expectation that performance would be more closely related to that of their normal counterparts. Differences that may result therefore, are even more stringently examined.

Stimuli and Apparatus

The experimental task involved the presentation of 30 slide mounted orienting questions and corresponding imperative word stimuli. There were ten of each of the three orienting question types (i.e. physical, phonemic; semantic). A question such as "Does this word start with a "t?" was chosen in order to necessitate the subject to process the corresponding imperative word stimuli at a relatively shallow level. In order to correctly respond to su[illegible] a question it was anticipated that one would engage in an analysis of the physical structure of the word. A deeper level of analysis was activated by asking the subject to make a decision about a word's rhyming characteristics. To induce the subject toward this level of processing the corresponding imperative word stimuli, a question such as "Does this word rhyme with cat?" was presented. The deepest level of analysis (semantic) was obtained by inducing subjects to process the categorical characteristics of a word. A question typifying the activation of this type of processing would be "Does this word mean a type of animal?"

In view of the above description of the levels of processing orienting questions, it might be argued that the questions direct the subject's attention to specific aspects of the word. For example, in asking the subject to make a decision about the starting letter of a word, it might be said that the whole word is not being processed, and therefore would result in limited recall of physically processed words. This possibility was examined by Craik and Tulving (1975, Experiment 5) and the results indicated that even with complex physical processing of the entire word, it [illegible] he depth of analysis that determined recall.

The word stimuli were selected from the Rosch (1975) goodness-of-example ratings of semantic categories. From each of the chosen six categories (clothing, furniture, fruit, vehicle, vegetable, and weapon), five high ranking words were selected. Table XXXIII of Fisher and Yates (1953) random numbers was utilized to randomize the words. The words were then paired with a "yes" or "no" value and physical, phonemic or semantic orienting question, and then randomly recorded. A complete listing of the orienting questions and related imperative word stimuli may be found in Appendix A.

An experimental trial began with the exposure of the orienting question slide for a period of six seconds. During this time, the question was read aloud by the examiner. An interstimulus interval of 4 seconds followed and the imperative word stimulus was then exposed on the screen for one second. The time interval from imperative word stimulus onset to onset of the next orienting question was 10 seconds. A complete trial lasted twenty seconds, and the total task constituted thirty trials.

The slide stimuli were projected with a Kodak carousel slide projector mounted with an electro-mechanical shutter to control stimulus exposure. The sequence of onset and duration of experimental stimuli were automatically controlled by Hunter Decade Interval Timers. The Hunter Timers simultaneously activated the projector shutter for the imperative word stimulus exposure, as well as an electronic luminous digital display stop clock which was used to measure reaction time. The responding apparatus consisted of a metal box with two protruding buttons. The clock was stopped by the subjects button press response, which was indicated by the lighting of one of the two lights (indicating a "yes" or "no" response). The experimental stimuli were projected onto a wall approximately four feet in front of the subject.

Pilot Study

A pilot study was conducted at a city Separate school to assess subject comprehension of the levels of processing task questions and word stimuli, and to determine the adequacy of questions selected for the pre and post task interviews. Subjects of chronological age (CA), mental age (MA) and intelligence quotient (IQ) similar to those involved in experiment one and two were examined. Three learning conditions were designated. The incidental condition subjects (Ss) were told that they were to respond to the orienting questions and matching word stimulus as quickly as possible; they were not forewarned of the memory aspect of the task. Both intentional and planned intentional subjects were informed prior to task administration of the recall requirement at task completion. Planned intentional subjects (Ss) were also interviewed prior to task administration to induce them to plan strategies to increase subsequent recall performance.

The distribution of subjects was as follows:

	incidental	intentional	planned intentional
Normal	5	5	5
EMR	5	5	5

Subjects were examined individually, and were seated across a table from the experimenter. The children were informed of the task procedure and asked if they understood what was required. The experimenter read the orienting question to the subject and then presented the imperative word stimuli which was typed on 3" x 5" index cards. The subject responded by answering yes or no and the response was recorded by the examiner. Both the intentional and planned intentional condition participants were interviewed upon completing the recall task to explore the kinds of strategies they actually employed in preparation for subsequent recall. The interview questions are listed in Appendix B.

The level of recall was determined by requesting the subject to name as many words as he could remember from the experimental task. The results of the recall task indicated a hierarchically arranged (e.g. physical < phonemic < semantic) level of processing effect and substantial performance differences between normal and EMR children. Only slight indication of a conditions effect was indicated.

The average number of correct responses was 28.40/30 for the EMR children and 29.73/30.00 for the normal children. The orienting question for trial #15 was revised as a result of the examination of subject errors. The word "spinach" in the question "Does this word rhyme with spinach?" was too difficult for subjects to read and was likely misinterpreted by its graphic similarity to the corresponding word stimuli "lettuce". With the substitution of the word "radio" for "spinach" the task battery was assessed to be adequately comprehensive for both subject groups.

Subject protocols of the interview responses were assessed to determine the clarity of the questions and the revised interview questions are listed in Appendix C.

Instructions

As mentioned previously, subjects were randomly assigned to one of three experimental conditions (incidental, intetidnal and planned intentional). The instructions given to the Ss in the incidental condition were:

> "I am going to ask you to do a task which includes 30 questions about 30 words. The questions and words will be presented on slides and the question will be read to you. When the word appears on the screen, I want you to answer the question "yes" or "no" as quickly as you can by pressing the correct button."

The intentional group was given identical instructions with the addition of being informed of the recall requirement. The addition to the above consisted of the following:

> "I also want you to try and remember as many of the words as you can. After the task I will ask you to tell me all the words you remember."

The same instructions were given to the planned in[illegible]tional group, with specific information about the t[illegible]added. The additional information given to this group was:

> "Now, there are five words in each type or category of words. The six types of words are weapons, clothing, fruit, furniture, vehicle and vegetable. Do you have any questions so far about what you are to do in this task?" If there were no questions, the examiner responded: "Okay, first I want to ask you a few quesions" and would then proceed with the pre-test interview questions.

In presenting the planned intentional group with additional category information, it was anticipated that this would provide an extra option for strategy planning to effect the most efficient recall of words, as compared to participants in the other two conditions.

Procedure

The experiment was conducted in small, quiet rooms in each of the schools. The lights remained dimmed throughout the subject's stay in the experimental room to allow maximum clarity of stimuli presentation and to provide the subject an opportunity to adjust to the reduced light during the reading of instructions.

The subjects were seated directly in front of the examiner, facing a screen approximately four feet in front of him. The subject was positioned to allow comfortable manipulation of the response buttons and the appropriate yes and no button was indicated. The appropriate instructions were then read to the subject. Practice trials consisting of each of the orienting question types (i.e 3 levels x 2 response types) were given and the subject was asked to indicate his response decision by pressing the yes or no button. When three consecutive correct responses were made, the examiner would say, "Okay, now we will begin the task." The examiner then positioned the initial slide for the experimental task on the Kodak carousel slide projector. The response decision and reaction time was recorded by the examiner for each trial.

At the end of the 30 trials the subject was requested to tell the examiner all the words he could recall. All recalled words were recorded by the examiner. After the recall interval the subjects in the intentional and planned intentional condition were interviewed, and all subjects were asked not to inform future subjects that a memory task was part of the experiment.

Scoring

1. Response decisions: The responses indicated by the button-press of the subject were recorded during task presentation and incorrect responses were indicated by circling the trial number on the subject's protocol sheet. At task completion the total number of correct and incorrect responses were recorded for the 30 questions. There were 15 "yes" and 15 "no" correct responses.

2. Recalled words: The words recalled, were dictated by the subject and recorded on the back of the subject's protocol sheet. The words were later categorized in terms of the corresponding orienting question. The percentage of words recalled out of the 10 possible in each of the physical, phonemic, and semantic categories were computed for each subject.

3. Reaction time: The reaction times in milliseconds for the 10 questions in each of the physical, phonemic and semantic categories were averaged for each subject. The

averaged scores from each of the three categories were then used in the data analysis.

Analysis and Discussion

Previous studies utilizing samples of young children have often found an interaction of sex differences and experimental variables. For this reason, an initial analysis was carried out to check for possible sex difference effects in this study. Main effects due to sex were examined utilizing a 2 (groups) x 3 (conditions) analysis of variance (ANOVA) with recall and reaction time as dependent variables. The results indicate that there were no significant differences for sex in either normal or retarded samples on recall or reaction time. See Appendix D for ANOVA results. Thus further analysis of the recall and reaction time data was carried out on groups collapsed over sex. The results of a comparison check for correct responses, were 28.76/30 for normals and 29.30/30 for EMR's.

Recall: Results

Recall performance differences were examined utilizing a 2 (group) x 3 (conditions) x 3 (levels) analysis of variance. Table 1 presents the results of this analysis. As it was anticipated, the results indicate a significant main effect for groups ($F = 19.084$, $df = 1/78$, $p \leq .001$). The mean percentages recall, collapsed over conditions and levels were: 22.09 percent for normals and 14.43 percent for EMR. This

Table 1

ANOVA for Normal VS EMR Differences
in Recall: Experiment I

Source	df	MS	F	p
Between				
Groups	1	45.43	19.084	$\leq .001$
Conditions	2	9.24	3.885	$\leq .05$
Groups x Conditions	2	.19	.082	NS
Error	78	2.38		
Within				
Levels	2	124.51	99.634	$\leq .0001$
Levels x Groups	2	6.72	5.376	$\leq .01$
Levels x Conditions	4	.99	.795	NS
Levels x Groups x Conditions	4	1.32	1.056	NS
Error	156	1.25		

n = 14

analysis further revealed a significant group x levels interaction in recall performance ($F = 5.376$, $df = 2/156$, $p \leq .01$). The mean recall for groups by level, collapsed over conditions is graphically depicted in Figure I. Examination of the graphic display of EMH and normal recall performance differences would suggest that the semantic level of analysis most readily differentiates the two groups. In order to determine the specific nature of the groups x levels interaction separate Scheffe T-tests were carried out. The means comparisons across levels between groups, reveals significant differences at the phonemic ($F = 8.46$, $df = 1/78$, $p < .004$) and semantic ($F = 20.36$, $df = 1/78$ $p \leq .00002$) levels. From this, it would seem that processing that requires minimal analysis (physical) results in similar retention for both normal and EMH subjects; whereas the higher levels of processing (phonemic and semantic) which are more cognitively demanding appear to be sensitive in discriminating between groups of differing IQ levels.

The analysis of variance of recall scores yielded a highly significant main effect for levels ($F = 99.634$, $df = 2/156$ $p \leq .0001$) (see Table 1). The means for levels collapsed over conditions and groups were: physical 12.1 percent, phonemic 11.2 percent, and semantic 32.7 percent. The overall levels effect is consistent with the results of previous studies (Craik and Tulving, 1975; Shangi, Das and Mulcahy, 1977 (in press); Lawson, 1976). The recall performance for

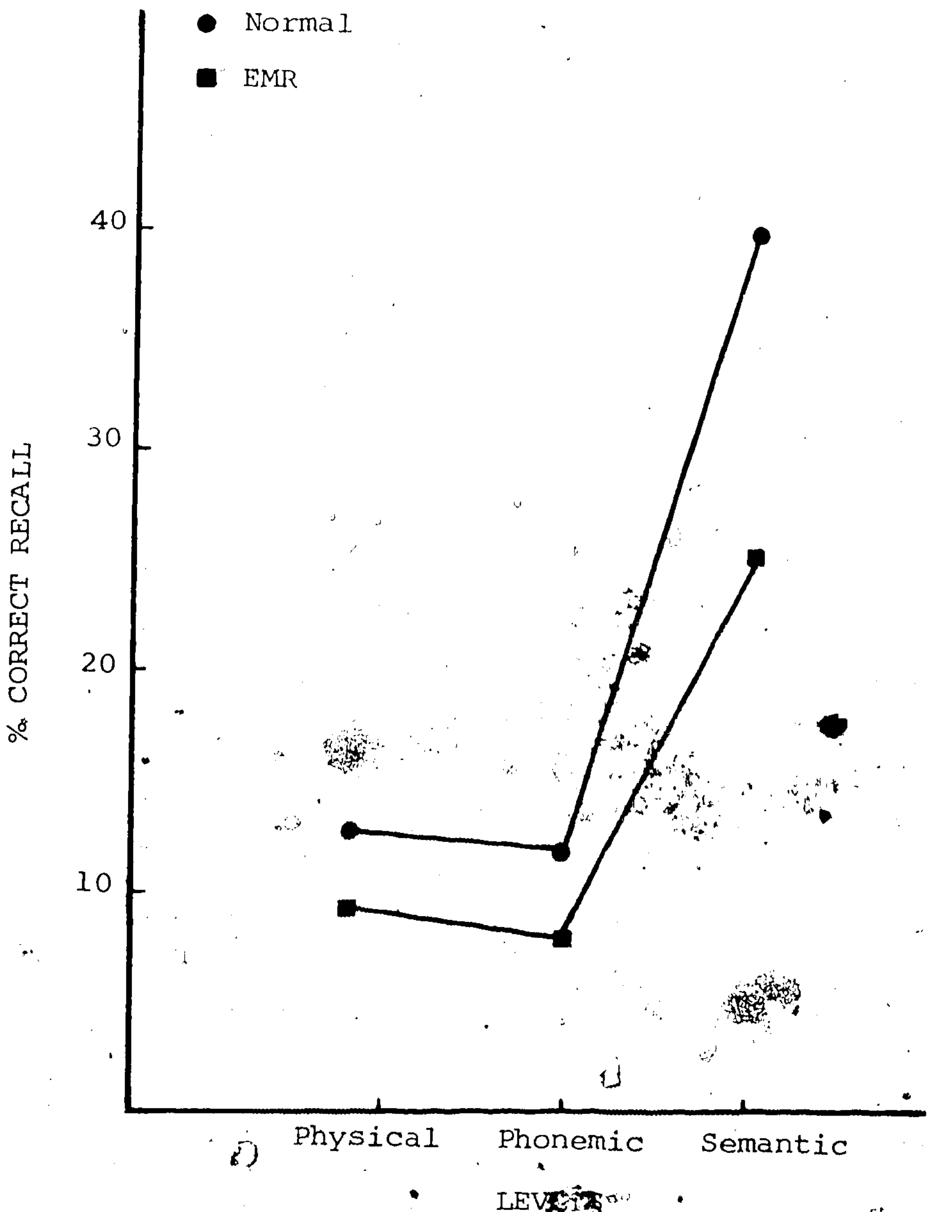


Figure 1. Recall means of groups x levels (collapsed over conditions)

both groups in all conditions increased with deeper levels of processing. However, closer examination of the level means reveals differences somewhat contrary to the predictions of Craik and Lockhart (1972). The levels of processing model postulates that retention subsequent to qualitatively differing encoding will follow a distinct pattern or hierarchy. Thus physical processing is expected to effect the poorest retention; phonemic processing should result in better retention; and the highest retention should follow semantic processing.

The extensive series of experiments reported by Craik and Tulving (1975), confirmed the hypothesis of qualitatively distinct levels of processing in the recognition experiments (1, 2, 5, 9, 10) and in the recall experiments (3 and 4) when the words were processed twice. However, the proportion of words recalled by level on one presentation (experiments 3 and 4) do not follow a distinct levels hierarchy. This lack of distinctiveness in recall performance was a major issue raised by Lawson's (1976) study. The evidence from his findings do not clearly and consistently support the notion of three qualitatively distinct levels of processing.

In order to evaluate the degree of distinctiveness in recall performance between the three levels of processing in this study, the data was subjected to a correlated T-test comparison of means analysis. Table 2 gives the probabilities of T's for differences between means for normal and EMR groups,

Table 2

Probabilities of Correlated T's for Differences between Means Recall for Normal and EMR Subjects, Collapsed over Conditions

	Normal				Mentally Retarded		
Means	14.5	14.1	40.2	Means	9.8	8.3	25.2
Levels	Physical	Phonemic	Semantic	Levels	Physical	Phonemic	Semantic
Probabil- ities							
Physical	-	0.83	0.0	Physical	-	0.48	0.0
Phonemic		-	0.0	Phonemic		-	0.0

n = 14

collapsed over conditions. For both normal and EMR groups, a pattern of clear statistical distinction in recall between physical and semantic, and phonemic and semantic levels is evident; however there were no significant differences in recall between the physical and phonemic levels of processing for either group. Therefore, the results only partially support the notion of qualitatively distinct levels of processing.

It was interesting to note that in examination of the actual percentage increases between conditions across levels, the intentional conditions most clearly benefitted physical recall. The respective percentage recall increases from the incidental to the intentional conditions were 8.03 percent, 3.93 percent, and 4.64 percent for physical, phonemic and semantic levels of processing.

The anticipated increased recall performance due to differential learning conditions is confirmed with a significant main effect for conditions ($F = 3.885$, $df = 2/78$, $p \leq .05$) (See Table 1). The means for conditions, collapsed over levels and groups were: 15.0 percent for incidental, 19.6 percent for intentional, and 21.4 percent for planned intentional. Figure 2 shows that when recall means are separated for normal and EMH groups, the pattern of increased recall performance across conditions is notably similar. Although there were no significant interactions for conditions, Scheffe T-tests revealed significant differences in recall means between the incidental and planned intentional condition (F =

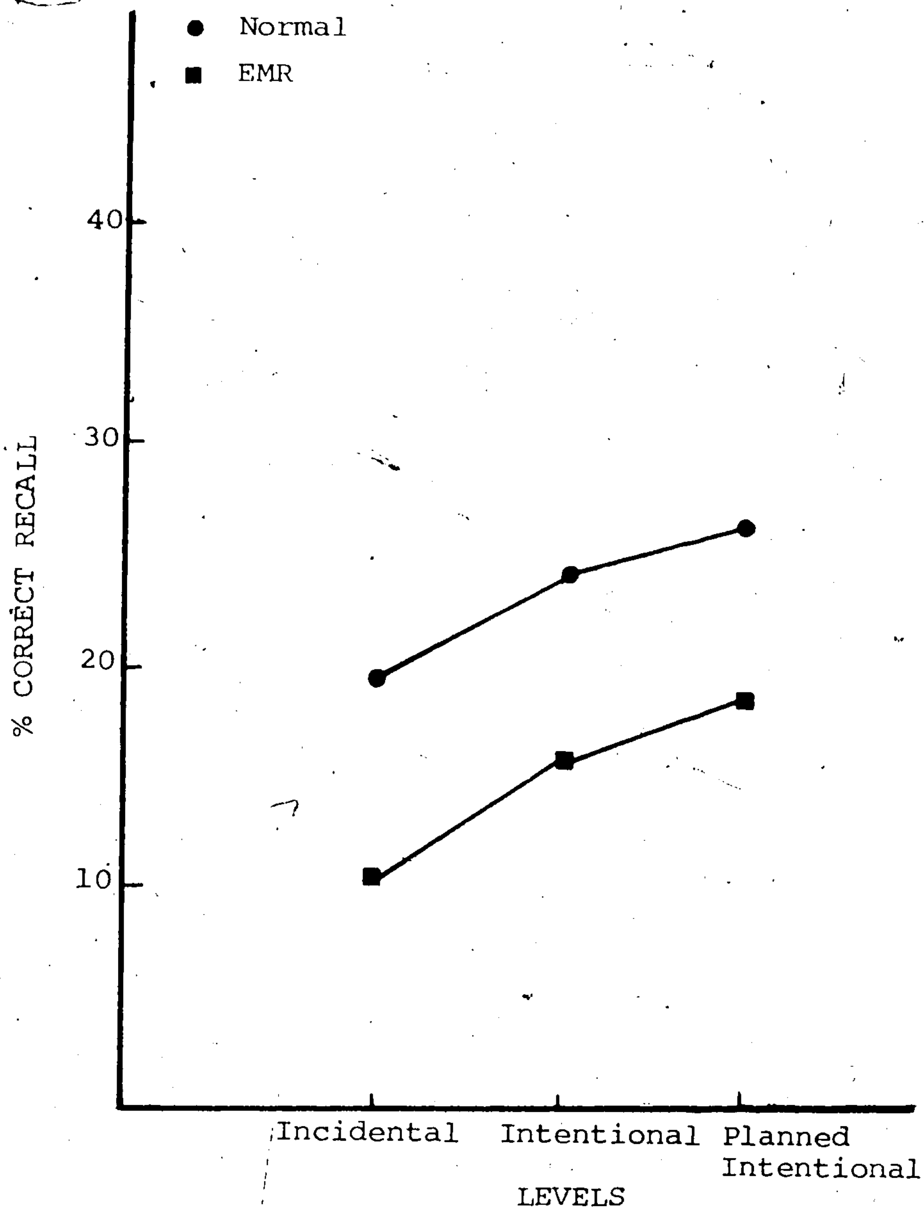


Figure 2. Recall means of groups x conditions (collapsed over levels)

3.93, df = 2/78, p ≤ .02). These results would suggest that although both EMR and normal children in this study were able to increase recall performance through self-initiated memory control processes under the intentional learning condition, the most significant improvement accrued from strategic pre-planning in the planned intentional condition.

It was anticipated that normal Ss would be most likely to benefit by the addition of the intentional learning condition and the opportunity for pre-planning of word recall strategies. However, there was essentially no group differences found in comparison of the percentage increase in recall performance across conditions (7 percent for normals and 6 percent for EMR's). Thus, it would appear that the ability to utilize strategic memory and control processes is associated with mental age level.

A brief discussion of the pre- and post-task interview results may be instrumental at this time. In the previous chapters, it was argued that the incorporation of the interview component into this study would extend the utility of the research in terms of focusing on the subjects own awareness of his mnemonic ability and limitations, and provide insight into the repertoire of deliberate and conscious memory strategies available to the Ss. The specific interview questions for the pre- and post-task interviews may be found in Appendix C. Although the interview response data was not amenable to statistical analysis, a brief subjective summary of responses is included in Appendix E.

As outlined previously, only the planned intentional group was interviewed prior to the experimental task, for the purpose of inducing Ss toward strategic planning for remembering. Examination of subject response protocols revealed distinct similarities for normal and EMR Ss in terms of:

1) their self assessments of being good rememberers,
2) recognizing that memory is usually better if told to remember,
3) and in terms of the variety and types of strategies suggested to facilitate memory.

Group differences were evident however, in response to question four of the pre-task interview. The normal subjects appeared to display more confidence in their ability to remember the words in the experimental task and offered more suggestions for ways to approach the task. (See Appendix E-1 and E-2)

Post-task interviews were carried out with both intentional and planned intentional groups. With regard to the post-task interview results of the planned intentional group, EMR and normal Ss responses to question 1 and 2 (concerning memory strategies utilized during the task and what else they would do if they had to do the task again) were fairly consistent, although the more efficient strategy of remembering words according to category was only suggested by one normal subject.

A comparison of responses to the question concerning whether they thought they remembered more words because they were told to remember them, suggests that the retarded subjects, upon completing the task, decided (contrary to their prediction in the pre-task interview) that intention did not help them to remember. The majority of normal subjects retained their positive pre-task prediction. More EMR subjects admitted that it was hard to remember the words in the task and both groups suggested that specific words, rhyming words, and mostly specific categories of words were most difficult to remember.

Perusal of the post-task interview responses of the intentional groups, indicates an essentially similar pattern of responding. The EMR subjects were once again more inclined to believe that their memory performance was no different as a result of being told to remember the words, whereas, the majority of normal subjects thought that their memory performance improved as a result of intention. Counter to the response differences found in question 4 for the planned intentional group, the intentional groups were similarly inclined to admit that it was hard to remember the words in the task.

In summary, the overall similarity of responses for both groups and experimental conditions, would suggest that increased memory performance due to intentional learning conditions and utilization of memory strategies is primarily a function of mental age as opposed to IQ. The above statistical analysis which resulted in a main effect for conditions but no interaction for conditions by groups would tend to support this suggestion.

Recall: Discussion

In general, the analysis of recall results provide only partial support for Hypothesis 1 which postulated that over all experimental conditions, recall performance would be positively related to depth of processing. While the proposal that depth of processing influences the durability of memory is supported by the results, the definition of depth in terms of qualitatively distinct processing domains is not. The superiority of semantic processing over both physical and phonemic was statistically verified, while differences in recall performance between physical and phonemic processing were minimal. This lack of distinction between the three levels found in this study and other similar studies (Craik and Tulving, 1975; Lawson, 1976), would suggest that the free recall procedure may only be sufficiently sensitive to detect gross qualitative differences in the nature of the memory trace.

Hypothesis 3 predicted that differential learning conditions would improve the recall performance of both normal and EMR children. It was anticipated that the intentional learning condition groups would recall more words than the incidental condition groups, and that the planned intentional groups would achieve the highest level of recall. The prediction for greater recall in intentional conditions was based on the assumption that knowledge of the recall requirement would induce subjects to employ memory strategies and processes during task performance, and thus raise their level of recall. The hypothesis was partially verified in that a significant main effect for conditions was obtained.

However, a comparison of condition means revealed that although the difference in recall levels between incidental and planned intentional conditions was significant, the incidental versus intentional conditions failed to yield a significance difference in recall performance. These results would suggest that the intention to remember alone may not be sufficient to increase memory performance at this MA level, and that significant improvement in recall requires specific strategic planning. Moreover, since the ability to improve memory performance through strategic planning was demonstrated by the planned intentional groups, it would appear that the intentional learning groups performance was due to a production deficiency.

The postulation of significantly better recall performance for normals in comparison with EMR's in Hypothesis 1.1 was verified by a significant main effect for groups. Further analysis of group means revealed that the groups' performance differed significantly for the phonemic and semantic levels of processing which involve higher level cognitive analysis. Thus it appears that the levels of processing model provides a useful basis of comparison to differentiate the memory performance of subjects of differing IQ levels.

Hypothesis 3.1 similarly predicted that performance increases resulting from differential learning conditions would be greater for normals than for EMR's. Surprisingly, this hypothesis was not confirmed in this experiment. The gains in recall performance across conditions were essentially the same for both EMR and normal groups. Since the normal and EMR samples were equated on the basis of mental age, these results would suggest that the ability to enhance memory performance through the adoption of differential memory strategies may be specifically related to mental age as opposed to IQ.

In general, these findings demonstrate the efficacy of utilizing the levels of processing model in identifying some qualitative memory performance differences in EMR and normal children as well as a potential utility for reinterpretation and follow-up of Brown's (1972, 1974, 1975) crucial investigations in this area.

<u>Reaction time: Results</u>

Reaction times were averaged for each level per subject. The median reaction times were submitted to a 2 (groups) x 3 (conditions) x 3 (levels) analysis of variance. A significant main effect for levels ($F = 23.950$, $df = 2/156$, $p \leq .001$)

was obtained and means across levels were 1.661, 1.874, and 1.983 respectively for physical, phonemic and semantic levels of processing. (See Table 3) These results indicate, that for the most part, deeper levels of processing are associated with longer reaction times. This pattern is correspondent with results reported from adult subject research on the levels of processing, employing a reaction time paradigm (Craik and Tulving, 1975: Experiments 1-4).

There was no main effect for learning conditions (incidental, intentional, and planned intentional) nor for group differences (EMR and normal) but there was a significant interaction for levels x groups ($F = 5.201$, $df = 2/156$, $p \leq .01$). This interaction is graphically depicted in Figure 3 and shows that decision latencies appear to differentiate groups at the phonemic and semantic levels of processing. In order to statistically test this observation, the data was subjected to Scheffe T-test analysis. The results reveal that group differences only reach significance at the phonemic level of processing ($F = 6.245$, $df = 2/78$, $p = \leq .014$) although a definite trend was shown at the semantic level ($F = 3.178$, $df =$ $2/78$, $p \leq .076$). Failure to reach significance between groups at the semantic level, may possibly be attributed to the utilization of very salient word categories. The familiarity of both subject groups toward these categories may have enhanced semantic processing and facilitated shorter response latencies for both groups.

Table 3

ANOVA for Normal VS EMR in Reaction Time: Experiment 1

Source	df	MS	F	P
Between				
Groups	1	2.59	2.973	NS
Conditions	2	.02	.025	NS
Groups x Conditions	2	.47	.540	NS
Error	78	.87		
Within				
Levels	2	2.26	23.950	≤ .001
Levels x Groups	2	.49	5.201	≤ .01
Level x Conditions	4	.05	.533	NS
Levels x Groups x Conditions	4	.03	.370	NS
Error	156	.09		

n = 14

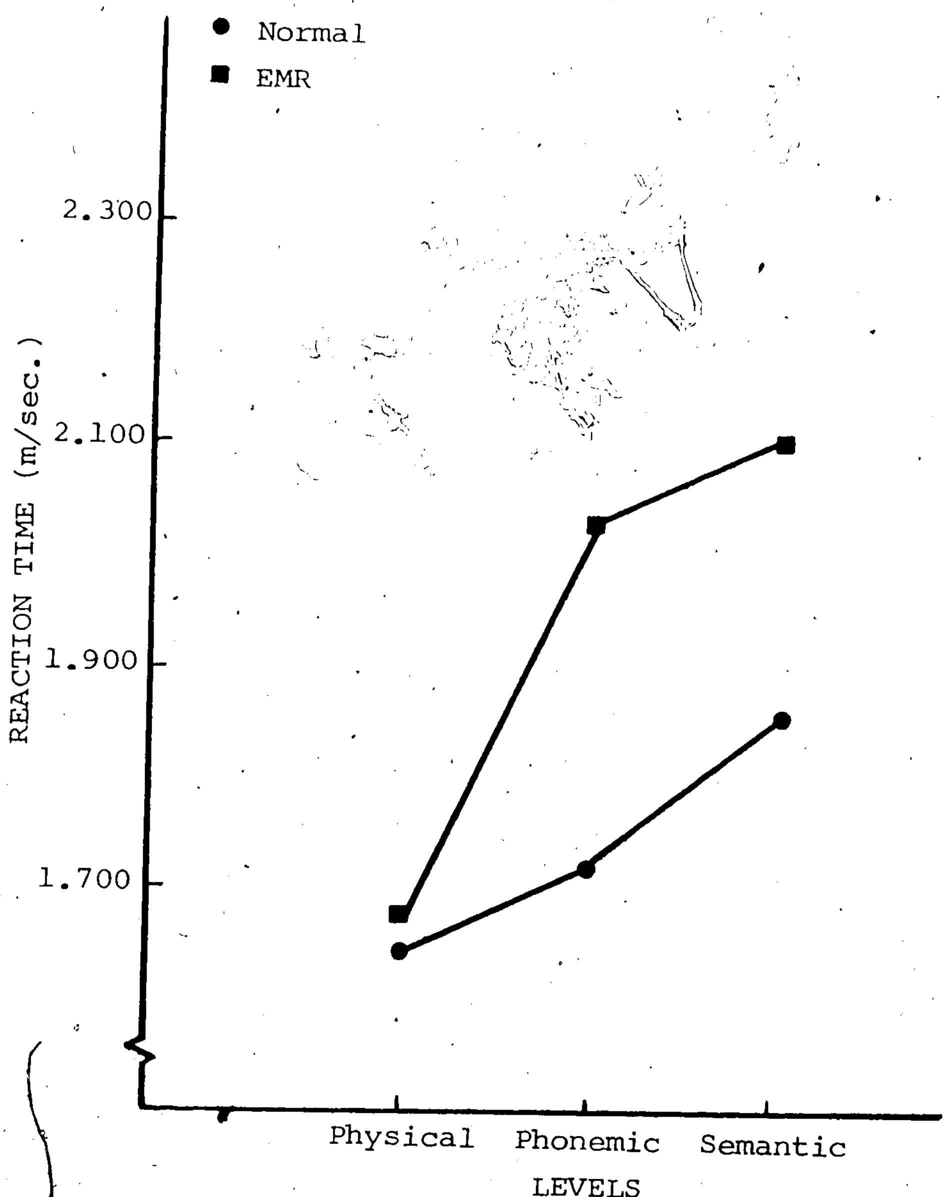


Figure 3. Reaction time means of groups x levels (collapsed over conditions)

In order to determine the degree of differences between reaction times associated with each of the three levels of processing, the data was submitted to a correlated T-test comparison of means analysis. Table 4 shows the probabilities of T's for differences between means in reaction time for normal and EMR subjects, collapsed over conditions. Close surveyance of these results reveals that responding times were significantly differentiated across levels for normal subjects; whereas responding for EMR subjects was limited to statistically significant differentiation between the physical level in comparison to the phonemic and semantic levels. Although it is virtually impossible to determine the specific reason for this discrepancy, the results would support the notion that normal subjects are more efficient information processors (Holden, 1970; Thor, 1971). Whereas normal subjects conformed to the predictions of amount of analysis necessary for all levels of processing, the EMR subjects demonstrated processing efficiency only toward gross qualitative differences (i.e. shallow processing (physical) was significantly faster than deeper (phonemic and semantic) levels of processing.) This minor discrepancy, would not pose a threat to the theoretical levels of processing model, as Craik and Tulving (1975) have determined that processing time would not by itself, reflect a totally reliable index of depth.

Table 4

Probabilities of Correlated T's for Differences between Means: Reaction Time for Normal and EMR Subjects Collapsed over Conditions

	Normal				Mentally Retarded		
Means	1.647	1.721	1.845	Means	1.674	2.027	2.121
Levels	Physical	Phonemic	Semantic	Levels	Physical	Phonemic	Semantic
Probabilities							
Physical	-	.027	.000	Physical	-	.000	.000
Phonemic		-	.001	Phonemic		-	.250

n = 14

Reaction time: Discussion

The above reaction time performance findings support hypothesis 2 which predicted that reaction time measures would be positively related to depth of processing. Statistical analysis supported the notion of hierarchial differentiation between levels for normal subjects; and partially for the EMR subjects. There was a clear distinction between the lower level and higher levels of processing, but the difference between phonemic and semantic processing for the EMR subjects was not significant.

On the basis of findings from previous studies with MA matched normal and EMR samples examining reaction times (Baumeister and Kellas, 1968; Bower and Tate, 1976), Hypothesis 2.2 predicted that EMR subjects would display longer response latencies. Counter to expectations, there was no significant main effect obtained for groups in reaction time performance. However, the examination of reaction time means by level revealed group differences in the order of increasing reaction times. Whereas the normals reaction times increased according to the amount of analysis required at successively deeper levels (i.e. physical < phonemic < semantic); the EMR Ss had longest response latentices for phonemic levels and shortest reaction times for physically processed words. It would appear that although EMR's are no different in terms of simple responding to imperative word stimuli, they lack efficiency in ascertaining information processing demands, and discriminate only in terms of gross qualitative differences.

CHAPTER IV

EXPERIMENT TWO

Rationale

The experiment one results have shown that even though both EMR and normal children demonstrate superior recall for words semantically processed and an increase in performance under planned intentional learning conditions, the overall recall performance of the EMR sample is markedly inferior to that of their MA matched normal peers. Therefore, the purpose of this experiment is to examine the levels of processing task performance of MA matched normal and EMR samples in an incidental learning condition, and to explore the possibility of an attentional deficit in EMR's which may account for such performance differences.

The theoretical and empirical literature provide ratification of the notion that the development of memory and attention are complimentary processes. They mutually function to enhance the quality or efficiency of the person's incorporation of information from the external environment and exhibit stage specific improvement throughout the course of development. Fishbein (1976) has suggested that the attention of the young infant is controlled by the random bombardment of stimuli in the environment and is gradually improved as the child develops the abilities to control his systematic exploration of the environment. Attentional processes improve as a result of selectively attending to task relevant information and being able to sort out the incoming information as relevant or irrelevant. Numerous experimental studies employing a wide variety of behavioral indices at various age levels, have been reported that would support a developmental maturational context of attentional processes (Zinchenko, Chzhi-tsin, and Tarkanov, 1963; Abravanel, 1968; Vurpillot, 1968; Maccoby and Konrad, 1966; Lehman, 1972). Immature or deficit attentional abilities have also been widely noted in the theoretical and empirical investigations of researchers in the area of mental retardation (Baumeister and Kellas, 1968; Denny, 1966; Luria, 1963; Zeamon and House, 1963).

The above discussion has direct ramifications in regard to the levels of processing memory model utilized in this study. Craik and Lockhart (1972) have indicated that attention is a necessary component for efficient memory performance, and is considered a central feature of primary memory. The postulates of the levels of processing model have been experimentally tested using normal adult subjects whom we assume possess mature attentional abilities. The question that arises is: "What would happen if subjects with presumed attentional immaturity (pre-adolescent children) or deficit attentional ability (mental retardates) were subjected to this experimental paradigm?"

On the basis of the literature review, it would be anticipated that children's memory performance will be negatively affected as a result of mental age (developmental level); and that the performance of mentally retarded children will further be negatively affected as a result of an "attentional deficit." Therefore, in a general sense, recall performance differences obtained (i.e. the qualitative levels of processing differences in EMR and normal children) would also reflect a somewhat peripheral index of attentional differences. However, the indexing of such attentional differences would, in the context of this study appear to warrant closer examination.

The study of attentional processes has been extensively examined within a psychophysiological context. The orienting reaction (OR) and arousal mechanisms play an important role in facilitating the organism's ptimal perception of incoming stimuli. Indices such as heart rate (HR) and reaction time (RT) have been reliably indexed in relation to the OR and the organism's attention to the internal and external environment.

With respect to the role that heart rate plays in reference to information processing and attention, Lacey's (1959) "intake-rejection" hypothesis suggests that: 1) Attention to the external environment (intake) is associated with the HR decrease; and that 2) Rejection of the external environment or attention to the internal environment is associated with

HR increase. These changes are believed to have functional significance in that they can influence the sensory receptivity of the organism and thus, attentional performance.

The literature review reveals substantial theoretical and empirical evidence to indicate an impairment of attentional processes in retardates due to inadequate OR and arousal functioning. Similar observations have been reported for younger children. From this, it might be suggested that the efficiency of OR and arousal functioning may be cognitively based. In terms of Lacey's (1959) hypothesis, such OR and arousal function deficits should be reflected in differences in degree of HR deceleration and acceleration, as well as, in the processor's inability to effectively co-ordinate the intake and rejection mechanisms.

A developmental study reported by Sroufe (1971) supports this hypothesis. The phenomenon of cardiac-rate deceleration prior to stimulus onset, within the context of a fixed foreperiod reaction time task, was examined in male subjects of six, eight and ten years of age. A linear relationship between age and anticipatory cardiac rate deceleration was found; with older children showing greater and more reliable decelerations during the five second preparatory interval (PI). However, the deceleration was not reliable when a longer (10 second) PI was imposed on the task at any age level. It was further noted that in the simple RT task, the anticipatory HR deceleration correlated significantly with the speed of response. These results suggest a developmentally related improvement in the ability to maintain attention, as reflected by differences in the magnitude of the HR deceleration (attention to the external environment) during the PI. Similar findings have been reported by Elliot (1970) in comparing children with adults; Krupski (1976) in comparing normal and EMR adults; and Sroufe, Sonies, West and Wright (1973) in comparing clinical learning disabled subjects with normal control subjects.

Other studies, utilizing the fixed foreperiod reaction time paradigm, provide convincing data which suggests that increased HR during the PI may be related to covert rehearsal (Tursky, Schwartz and Crider, 1970) or reflective of the degree of processing or decision making demands (Coles, 1974; and Coles and Duncan-Johnson, 1975); that HR deceleration reaches its nadir (lowest point) during the second in which the attentive subject is to respond (Chase, Graham and Graham, 1968); and that the magnitude of HR deceleration at the end of the PI varies according to information processing, detection and response requirement (Walter and Porges, 1976).

As previously discussed the evidence supporting attentional deficit in MR's (in a psychophysiological context) is inconclusive due to the fact that investigations have largely focused on the utilization of simple stimuli rather than tasks involving stimuli of higher, or more complex informational value. However, the previously described findings of

Sroufe (1971) and Freeman (1972) would suggest that attentional differences of MR and normal children in information processing tasks would be apparent.

On the other hand, there is an abundance of empirical evidence to support the hypothesis of retardate attention deficit on the basis of reaction time studies. Consistent findings of slower reaction time performance for MR's in comparison with normal subjects have widely been interpreted as reflecting immature attentional processes; inability to sustain attention; or inability to maintain an appropriate preparatory set (Berkson, 1960; Clausen, Lidsky and Sersen, 1976; Baumeister and Kellas, 1968; Liebert and Baumeister, 1973; Krupski, 1975).

Baumeister and Kellas (1968) for example, in their comprehensive overview of the studies concerning RT and mental retardation, suggest that the retardate is unable to maintain the level of attention that is required for fast RT performance; whereas Denny (1966) suggests that the retarded lack the ability to produce "self-initiated sets". The retardate cannot initiate a set or "readiness to respond" as easily as the normal because the MR is more stimulus bound. Denny (1966) further suggests that the retardate is "more at the beck and call of each and every stimulus change" (p.5). Other studies have reported a greater incidence of intra-individual variability in retardate responding (Liebert and Baumeister, 1973; and Berkson, 1961); and both Holden (1970) and

Thor (1971) have demonstrated that retardates process stimuli more slowly than normals. These collective findings would suggest that retardates will display slower RT's in comparison with either CA or MA matched normal subjects. On the other hand, Jones and Benton (1968) found the MR's to differ only within a CA matched condition as opposed to an MA matched condition.

The experimental evidence provided in the works of Krupski (1975, 1976) lends further insight into retarded and normal Ss performance differences in tasks utilizing heart rate and reaction time measures. In a study examining heart rate changes during a fixed reaction time task, in normal and EMR adult males, Krupski (1975) reports results consistent with previous research findings. The EMR group had significantly slower RT scores, and were generally more variable as a group than normals even with IQ taken into account. More significant, was the finding that both groups exhibited expected HR deceleration during the shorter preparatory interval but within the 13 second interval no such pattern was found for the EMR's. The majority of MR's instead typically displayed a HR deceleration during the second after the signal stimulus. This may reflect the MR's difficulty in maintaining attention throughout the extended PI. Elliot (1970) and Sroufe (1971) have reported similar findings in studies with young children and suggest that this phenomenon is a function of development. Krupski (1975, 1976) provides an alternate interpretation for these results, in suggesting that the MR subjects are simply misjudging the length of the PI. This being the case, such innaccurate perception of the temporal cues would clearly interfere with the ability to make a fast RT.

In concluding this section, the evidence outlined here suggests that the inclusion of heart rate and reaction time measures into the levels of processing study should provide an adequate measure to examine attentional differences of EMR and normal subjects. Close examination of HR response protocols and RT scores, should reveal crucial areas of attentional malfunction in EMR children, if indeed such a deficit exists.

These areas could collectively or specifically include such factors as:

1) inadequate preparation in anticipation for responding;
2) inadequate sense of timing of the preparatory interval;
3) longer-processing times (RT):
4) lesser magnitude of HR responding;
5) undifferentiated responding to qualitatively differing stimuli.

The specific objectives for this study are:

1) To investigate memory performance differences in normal and retarded children on the basis of recall, utilizing the induced levels of processing paradigm.

2) To further explore differentiations (in normal and retarded children) in performance that may

occur as a result of inadequate attentional abilities by means of heart rate and reaction time measures.

Definitions

<u>Orienting response</u> - A reliable system of psychophysiological and skeletal changes within an organism, in response to a condition or discrepancy between a neuronal model and stimulus.

<u>Arousal</u> - The general state of the organism's psychophysiological activity.

Hypotheses

The hypotheses concerning recall and reaction time are similar to those advanced in experiment one. They are advanced in an attempt to test the generality of the basic assumptions of the levels of processing memory model, in an incidental learning condition, for EMR and normal children.

The examination of the interaction of attentional ability during performance of the levels of processing task is also a primary consideration in this experiment. The exploration of these interrelationships is undertaken on the basis of observed heart rate (HR) response patterns and reaction times during performance of the levels of processing task. The relation between predicted HR response patterning and RT can be associated with concommitant attentional processes through the examination of a trial continuum. With the exposure of the orienting question, the attention of the subject is drawn toward the external environment and thus should initially result in HR deceleration (Lacey, 1959). As the information is incorporated there should be HR acceleration indicating the internalization of response requirements (Lacey, 1959; Coles and Duncan-Johnson, 1975). Over the subsequent 17 second preparatory interval (PI) further HR acceleration would likely be attributed to continued attention or rehearsal of task demands and the summoning of analysis abilities appropriate to task execution. Toward the end of the PI, the HR should gradually decelerate and reach its nadir (lowest point) at the exact second of the imperative word stimulus onset (Coles, 1974; Coles and Duncan-Johnson, 1975; Walter and Porges, 1976; Chase, Graham and Graham, 1968). This HR deceleration near the end of the PI interval would evidence the subject's optimal preparedness for processing the imperative word stimulus and the magnitude of deceleration should reflect the degree of attention (Coles, 1975; Coles and Duncan-Johnson, 1975; Walter and Porges, 1976). Since deeper levels of processing command greater analysis and therefore increased attention (Craik and Lockhart, 1972), it is further anticipated that the level of processing should be reflected by the amount of magnitude deceleration (i.e. physical $<$ phonemic $<$ semantic). Further, it is this specific period which should most readily differentiate EMR and normal subjects in terms of attentional abilities. Performance during early trials for both groups would likely consist of Ss trying out or anticipating task demands. As more trials are experienced, a learning effect should take place and responding should be much more clearly differentiated. This could be the result of a gradual adjustment on the part of the subject to most effectively carry out task demands and/or increased attention or effort in order to counter habituation, or task boredom. The interaction of the levels of processing task and the patterning of attentional and psychological processes in a trial continuum should therefore be reflected in the following hypotheses.

Hypothesis 1: Recall performance for both groups (normal and EMR) will be positively related to deeper levels of processing (i.e. physical < phonemic < semantic).

Hypothesis 1.1: Recall performance for normal subjects will be significantly greater than that of EMR subjects.

Hypothesis 2: Reaction time latencies will be positively related to deeper levels of processing (i.e. physical < phonemic < semantic) for both groups (normal and EMR).

Hypothesis 2.1: Reaction time latencies will be significantly shorter for normal subjects in comparison with EMR subjects.

Hypothesis 3: The % HR deceleration for both groups will increase with deeper levels of processing (i.e. physical < phonemic < semantic).

Hypothesis 3.1: Both groups (normal and EMR) will display a significant increase in % HR deceleration from early to late trials.

Hypothesis 3.2: The % HR deceleration from early to late trials will be significantly greater for normal subjects in comparison with EMR subjects.

Method

Subjects

The subjects (normal and educable mentally retarded children) involved in this experiment were selected from the same schools as the experiment one participants. The vice-principals, school counsellors, and teachers were consulted in order to eliminate those children with suggested emotional or sensory impairments. The school records of the children were also checked to eliminate children having medically diagnosed skin conditions or heart problems. Letters were then sent to parents or legal guardians to obtain written consent for their child to participate in the experiment. The analysis of one subject was not included in the final sample, as a result of mechanical failures in the HR recording equipment.

The final normal sample comprised 14 subjects with a mean chronological age of 10.4 years; a mean intelligent quotient of 102.2 (range 92-110); and a mean mental age of 10.4 years (range 9.0 - 11.10). The EMR sample included 14 subjects with a mean chronological age of 14.3 years; a mean intelligence quotient of 72.9 (range 64 - 80); and a mean mental age of 10.4 years (range 9.0 - 11.10). Each sample comprised equal numbers of male and female subjects. Only the incidental learning condition was examined in this study in order to tap the basic attentional demands and the interaction with levels of processing task performance, without interference of self-initiated memory control processes or memory strategies that a subject may be induced to employ in an intentional or planned intentional learning condition.

Stimuli and Apparatus

The experimental stimuli utilized in this study, was identical to that described in experiment I. A complete listing of the orienting questions and related imperative word stimuli may be found in Appendix A.

The temporal intervals were extended in this study to allow for complete physiological response recording to stimuli. A trial began with the exposure of the orienting question for a period of eight seconds. An interstimulus interval of 17 seconds followed and the imperative word stimulus was exposed on the screen for one second. The time interval from imperative word stimulus onset to onset of the next orienting question was 22 seconds. A complete trial took 48 seconds.

The experimental stimuli sequencing was automatically regulated by Hunter Decade Interval Timers. The stimulus slides were projected onto a screen, with a Kodak carousel slide projector, outfitted with an electro-mechanical shutter to control stimulus exposure time. The stimuli were projected at eye-level through a one-way mirror onto a screen located four feet directl in front of the subject. Reaction time measures were taken with an electronic luminous digital display stop clock. The responding apparatus was wired to the RT apparatus and the subject's button press stopped the clock. The metal response box was taped to the right arm of the chair in which the subject was seated, and one of the two protruding buttons were pressed to indicate the subject's response decision. The subject's response was indicated to the researcher, by the simultaneous lighting of one of the two bulbs (indicating a yes or no response decision). The experimenter monitored all recording and control apparati in a separate room adjacent to the experimental chamber. Movement artifacts were detected through a one-way mirror, and were noted on the polygraph paper, as they occurred.

A Hewlett-Packard model 1500 polygraph with an integrated cardiotachometer was utilized in the continuous recording of each subject's heart rate. The equipment was adjusted to allow automatic marking on the polygraph paper when a response decision (button press) was made. The paper ran at a constant speed of 5mm/second.

Heart rate measures were obtained by use of silver-silver chloride electrodes 0.5 inches in diameter, attached to the subject's third left rib and sternum with a neutral ground on the right elbow. The subject's right hand was positioned for response execution. The electrodes were filled with Beckman sodium chloride electrode paste (0.5 concentration) and were attached to the recording sites with adhesive collars.

Procedure

All subjects were provided transportation to the University and back to their schools. The experiment took place in an electrically shielded, sound proofed laboratory and temperature was controlled at 70°F. The samples were counterbalanced for morning and afternon experimental participation.

Upon entering the experimental laboratory, the subject was seated in a padded leatherette armchair, and was asked to position himself comfortably. While the sites of electrode placements were being prepared and electrodes attached, the subject was invited to ask questions about the equipment and electrode apparatus. Once rapport was established, the subject was instructed in usage of the response box and told that he would be required to answer the questions which appeared in front of him on the screen. Subjects were requested to respond as quickly as possible. The average preparatory time prior to actual task onset, was approximately ten minutes per subject. The time period was considered sufficient for stabilizing of the heart rate response readings.

A total possible of six practice trials (three question types x two response types) were given prior to the experiment onset. After three consecutive correct responses, the experimental task was begun. During task implementation, response decisions and reaction times were immediately recorded upon response execution. At the completion of the 30 trials, the subject was asked to recall as many of the word stimuli as he could. Before leaving the experimental laboratory, subjects were requested not to inform their classmates of the recall task. The total time in the laboratory was a maximum of 25 minutes for each subject.

Scoring

The performance measures of response decision, words recalled, and reaction time were computed in the same manner outlined in experiment one (see p. 76).

Heat rate measures

Second-by-second heart rate change: For each subject, 31 second-by-second heart rate measures were obtained for each of the 30 trials. These values included a continuous recording of the heart rate beginning three seconds prior to the orienting question onset and ending three seconds after the word slide onset. The second-by-second heart rate change scores in beats-per-minute (BPM) were determined by the difference between the mean BPM for the three seconds preceding the onset of the orienting question and the remaining 28 one-second intervals.

Percent deceleration: Percentage decrease in heart rate: % decrease = 100 x (prestimulus beats per minute), less the mean of the two lowest beats per minute in the last 15 seconds of a trial. This is then dividied by the prestimulus beats per minute.

Analysis and Discus

As in experiment one, the data was initially subject to an analysis of sex differences on the dependant variables of recall and reaction time. A 2 (groups) x 3 (levels) analysis of variance indicated that there was no significant effect for sex found on recall data (normals F = 23, df = 1/12, $p \leq .6413$; EMR F = .51, df = 1/12, $p \leq .488$). The response latency data for one EMR subject was omitted from analysis due to a combination of erratic responding and mechanical difficulty. The 2 (groups) x 3 (levels) ANOVA for reaction time resulted in no significant sex differences (normals F = .61, df = 1/12, $p \leq .449$; EMR F = 2.84, df = 1/10, $p \leq .1222$). Subsequent reaction time and recall analysis was collapsed over sex. The results of a comparison check for correct responses were 27.46/30 for normals and 26.85/30 for EMR's.

Recall: Results

In this experiment, only the incidental learning condition was utilized. Recall performance scores were subjected to a 2 (groups) x 3 (levels) analysis of variance. Table 5 presents the results of this analysis. Similar to the recall findings in experiment one, a significant main effect for groups was found (F = 8.699, df = 1/26, $p \leq .01$). The mean percentages recall collapsed over levels were: 21.7 percent for normals and 12.4 percent for EMR's. This same analysis yielded the anticipated significant main effect for levels (F = 23.860, df = 2/52, $p \leq .001$) (see Table 5). The means for levels collapsed over groups were: physical 7.1 percent, phonemic 13.6 percent, and semantic 30.4 percent. Examination of Figure 4 reveals a hierarchical improvement in recall performance for both EMR and normal groups across the three

Table 5

ANOVA for Normal VS EMR Differences
in Recall: Experiment II

Source	df	MS	F	P
Between				
Groups	1	18.11	8.699	$\leq .01$
Error	26	2.08		
Within				
Levels	2	40.23	23.860	$\leq .001$
Levels x groups	2	2.61	1.546	NS
Error	52	1.69		

n = 14

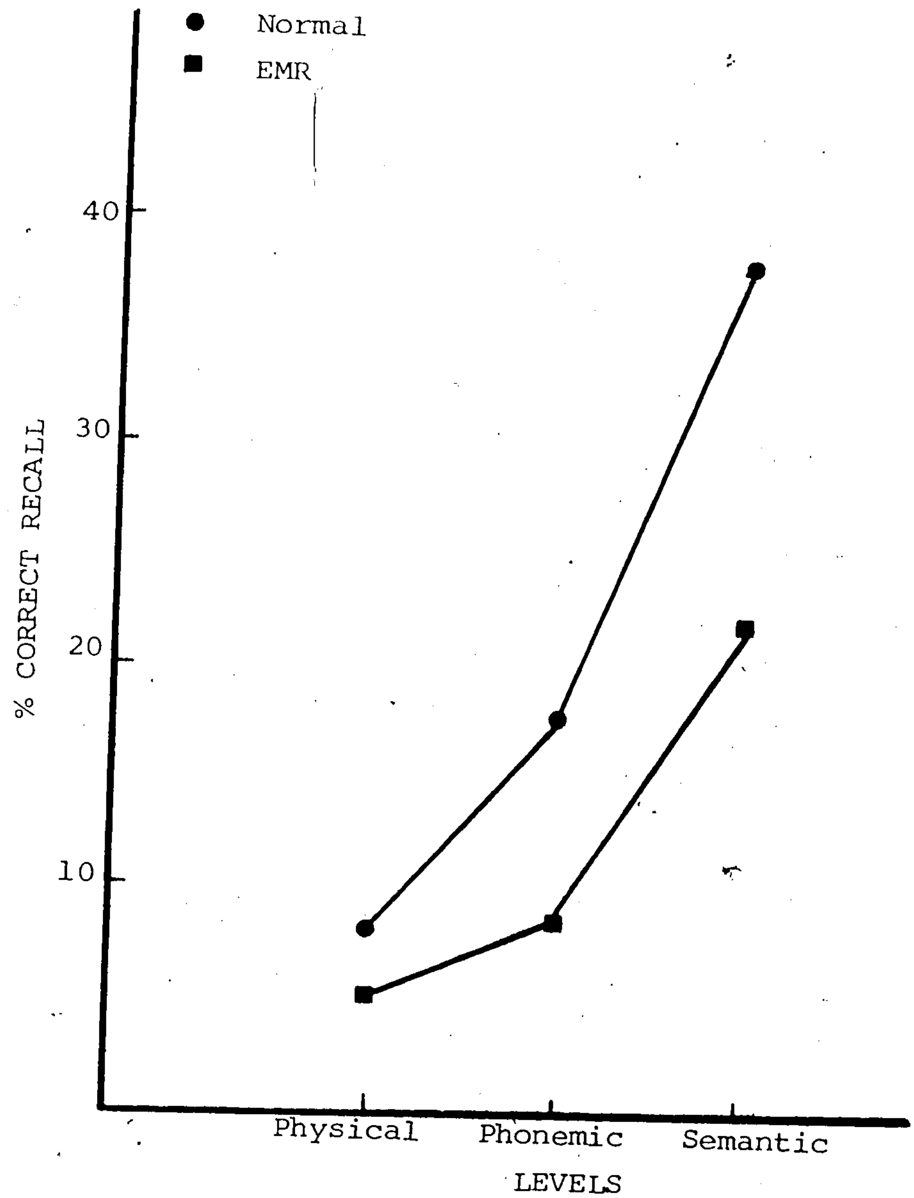


Figure 4. Recall means of groups x levels

levels. These results are consistent with the predictions of Craik and Lockhart (1972) and the experimental findings of Craik and Tulving (1975). Retention subsequent to qualitatively differing encoding was positively related to deeper levels of processing.

The notion of three qualitatively distinct levels of processing was examined in experiment one and the results (correlated T-test comparison of means analysis) were somewhat contrary to the hypotheses advanced by Craik and Tulving (1975). Although a clear pattern of significant difference in recall between physical and semantic as well as phonemic and semantic levels was obtained, there was no significant difference between the physical and phonemic levels of processing for either group. In order to determine whether the same pattern would emerge with the experiment two data, a correlated T-test comparison of means analysis was carried out. Table 6 gives the probabilities of T's for differences between means for normal and EMR groups. The analysis reveals that the pattern of differences found in experiment one were similarly evident in experiment two. Whereas the data from experiment two confirm Craik and Tulving's (1975) predictions of a significant increase in recall, following a hierarchical pattern from physical to phonemic to semantic levels of processing, the notion of three distinct levels of processing was not substantiated in either experiment. Only the physical and semantic, and the phonemic and

Table 6

Probabilities of Correlated T's for Differences between Means Recall for Normal and EMR Subjects, Collapsed over Conditions

	Normal				Mentally Retarded		
Means	.857	1.857	3.786	Means	.571	.857	2.286
Levels	Physical	Phonemic	Semantic	Levels	Physical	Phonemic	Semantic
Physical	-	.07	.000		-	.302	.009
Phonemic	-	-	.001		-	-	.015

n = 14

semantic levels were significantly different.

Whereas it is acknowledged that the experimental conditions of experiment one and experiment two differ widely, it is interesting to note that in comparing level means of the incidental condition in experiment one, with experiment two (incidental condition), the pattern of recall performance is similar in that it increases with deeper levels of processing (see Figure 5). For both incidental conditions (experiment one and two) physical processing resulted in the least recall, phonemic processing resulted in improved recall performance, and recall after semantic processing is markedly superior. These results are in agreement with the experimental findings reported by Craik and Tulving (1975).

There were no interactions found in the analysis of the recall data for experiment two; whereas it will be recalled that a significant groups x levels interaction was obtained in experiment one. Further analysis of the experiment one data (Scheffé tests) had indicated that the EMR and normal groups were significantly different on the more cognitively demanding levels of processing (phonemic and semantic), whereas the difference between groups at the physical level of processing was non-significant. In order to determine whether a similar pattern would be apparent in the recall performance between groups in experiment two, Scheffé T-tests were carried out. The means comparisons across levels, between groups reveals a similar (though not as predominant) pattern as that

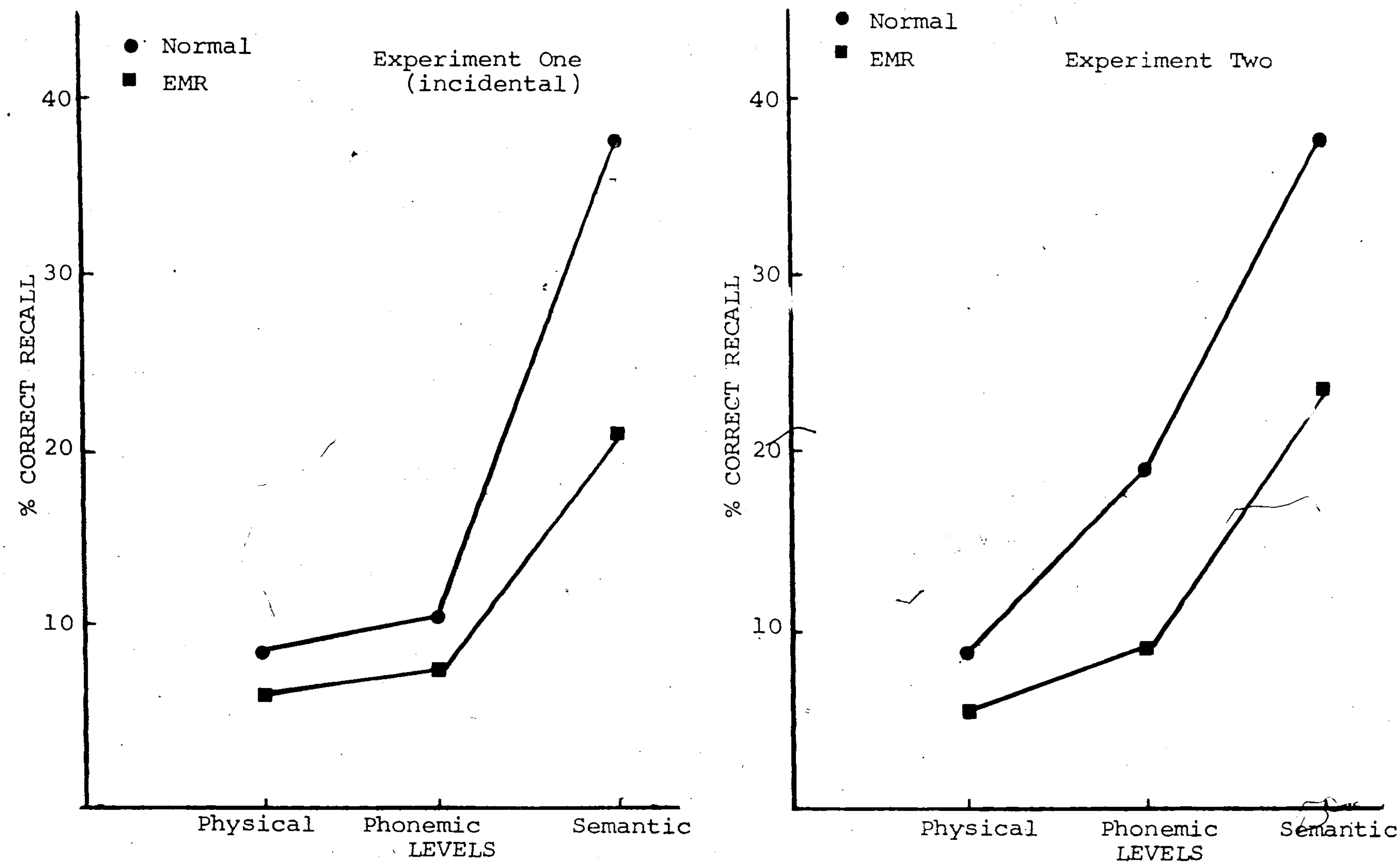


Figure 5. Recall means of groups x levels: Incidental conditions

obtained in experiment one. While there was no significant difference found at the physical level of processing ($F = .68$, $df = 1/26$, $p < .430261$); significant group differences were apparent at the phonemic ($F = 4.86$, $df = 1/26$, $p \leq .0364$) and the semantic ($F = 5.04$, $df = 1/26$, $p \leq .0334$) levels of processing.

Recall: Discussion

In general, the recall results obtained in the present study support hypothesis one. In accordance with the empirical results reported by Craik and Tulving (1975) it was anticipated that recall performance would be positively related to deeper levels of processing. A significant main effect for levels was derived and for both groups, level recall means increased with deeper levels of processing. The mean recall was lowest for words physically processed, then somewhat greater for words phonemically processed, and notably superior for words that were processed at the semantic level. However, similar to the findings in experiment one, this experiment provided evidence contrary to the notion of three qualitatively distinct levels of processing. Whereas, a significant difference was obtained between the physical and semantic, as well as phonemic and semantic levels of processing, the difference between the physical and phonemic levels was not significant. Lawson (1976) has previously questioned the distinctiveness of the three levels of processing and a similar recall pattern was reported in the Craik and Tulving (1975) experiment three. Although the authors fail to report any statistical analysis of their data concerning levels distinction, the graphic representation of the data (Figure 3, p. 277) for words presented once, suggests little difference between physical and phonemic level recall means. Semantic processing on the other hand, consistently yields superior retention effects. Craik and Tulving (1975) in discussion of their experimental findings, suggested that the effects of semantic (deep level) processing were "both robust and large in magnitude" (p. 278) and the results of the two experiments reported here confirm the generalization of the effects. However, the collective findings also seem to indicate that the free recall procedure may only be sufficiently sensitive to detect gross qualitative differences in the nature of the memory trace.

Hypothesis 1.1, which predicted superior recall performance for normal subjects was confirmed. The overall recall performance analysis resulted in a significant main effect for groups. A concommitant pattern of group means by level was obtained for both experiment one and experiment two. In both experiments, no differences between groups were manifested at the physical level of processing, though significant group differences were derived at phonemic and semantic levels. Thus, despite very different experiment conditions, both experiments yielded consistent main effects and similar recall patterns. Indeed the combined findings attest to the fact that the basic phenomenon under study appears to be a robust one, as well as providing a useful framework for comparison of memory processing differences of populations of differing IQ levels.

Reaction Time: Results

Reaction times were averaged for each level per subject. The averaged scores in milliseconds were then submitted to a 2 (groups) x 3 (levels) analysis of variance (see Table 7). A significant main effect for levels was obtained ($F = 4.288$, $df = 2/48$, $p \leq .01$) and means across levels were 2.720, 2,954, and 2.918 respectively for physical, phonemic, and semantic levels of processing. These results fail to wholly support the notion that deeper levels of processing are associated with longer reaction times. Craik and Tulving (1975) have conducted a number of experiments which indicate that decision latencies increase as more processing is required. Therefore, shallow processing (physical level) would require minimal analysis and should result in the fastest reaction time. Phonemic processing should necessitate a greater amount of stimulus analysis and thus be reflected in a relative increase in processing time. The greatest amount of processing would be required for semantic levels and therefore would be expected to effect the longest decision latency. These predictions were confirmed in Craik and Tulving's (1975) experiments one to four. The results from the present experiment support only the first prediction, in that physical processing resulted

Table 7

ANOVA for Normal VS EMR in Reaction
Time: Experiment II

Source	df	MS	F	P
Between				
Groups	1	.21	.176	NS
Error	24	1.20		
Within				
Levels	2	.41	4.288	$\leq$.01
Levels x Groups	2	.29	3.001	$\leq$.06
Error	48	.10		

n = 14

in the shortest reaction time. Decision latencies for phonemic processing were greater tha semantic in this experiment, whereas the reverse order would be anticipated for these two levels. These results are similary in contrast with the experiment one findings which coincided with the predictions advanced by Craik and Tulving (1975). A possible explanation for the discrepant findings in the present experiment may be attributed to the extended preparatory interval. A readiness to respond to the phonemic orienting question may have been countered by the subjects' deliberate attempts during the 17 second interval to predict the associated rhyming word stimuli. Such attempts to predict word stimuli for physical and semantic processing questions, would not be expected in that the Ss chances of correct prediction of the word stimuli would not be as likely as in the case of predicting ssociated rhyming word stimuli.

The 2 (groups) x 3 (levels) ANOVA failed to yield any further main effects or interactions, although a trend toward a groups x levels interaction was indicated. This groups x levels interaction did reach significance in experiment one, and further analysis revealed that group differences were predominant for phonemic (significant difference) and semantic (trend) levels of processing. In order to determine whether a similar pattern would emerge in experiment two, the data was subjected to a T-test comparison of means analysis; though group differences failed to reach significance at any of the levels of processing. It is most likely that the extended preparatory intervals in experiment two obliterated the groups x levels interaction effect obtained in experiment one. (see Figure 6)

Reaction time: Discussion

The above findings provide only partial support for Hypothesis 2 which predicted that reaction time measures would be positively related to depth of processing (i.e. physical < phonemic < semantic). The anticipated hierarchical increase in decision latency times with deeper levels of processing was not obtained for phonemic and semantic processing levels. Phonemic level processing resulted in the longest decision latency time in this experiment. It should however be noted, that whereas Craik and Lockhart (1975) initially predicted and experimentally confirmed their own hypothesis that deeper levels of analysis require successively increasing amounts of processing time, further experimental investigation led them to advance an important qualification to this relationship. They found that even when subjects were deliberately required to respond to complex physical processing questions (e.g. Could this word be characterized as CCVVC?) and easy semantic questions, the subsequent recall results were significantly greater for semantically processed words. Craik and Tulving (1975) thus concluded that although processing time may be partially predictive of word recall, it is the qualitative nature of the task which determines memory performance above all other determinants. Indeed, the above recall and reaction

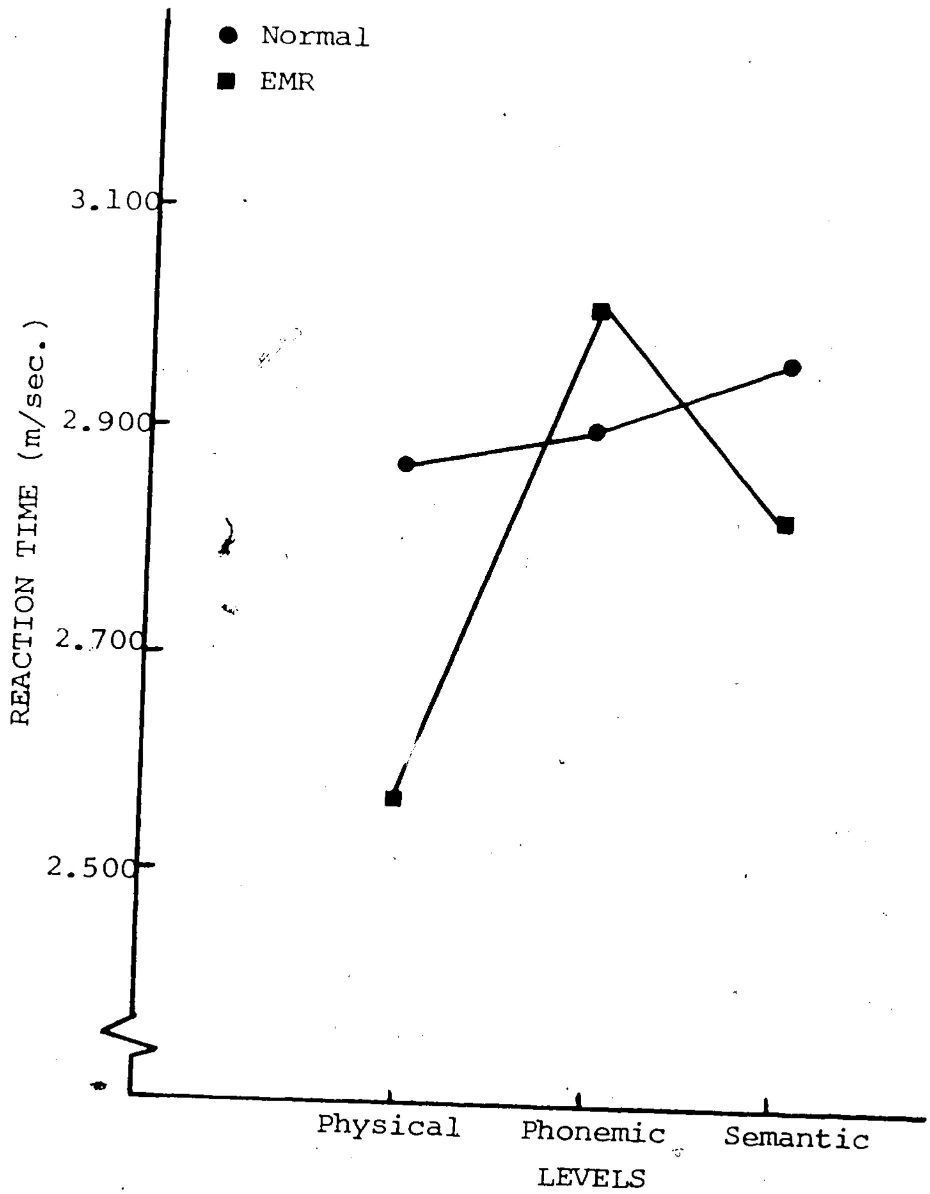


Figure 6. Reaction time means of groups x levels

time analyses support this conclusion.

Hypothesis 2.1 predicted that normals would demonstrate significantly shorter decision latency times. As outlined previously, prior investigations using reaction time paradigms, have indicated that retarded subjects demonstrate longer reaction times in comparison with both CA and MA matched normal samples (e.g. Baumeister and Kellas, 1968). Such findings have been attributed to the retardate's immature attentional processes; inability to sustain attention, or inability to maintain an appropriate preparatory set (Berkson, 1960; Clausen, Lidsky and Sersen, 1976; Baumeister and Kellas 1968; Liebert and Baumeister, 1973; and Krupski, 1975). The analysis of reaction time data for both experiment one and experiment two, failed to yield significant main effects for group differences. If indeed, slow reaction times reflect attention deficit, the hypothesis of attention deficit for retarded subjects is totally unsubstantiated in this study. The results from a previous study (Jones and Benton, 1968) suggest that the hypothesis will hold only for CA as opposed to MA group comparisons. This possibility should become clarified in the analysis of the heart rate data which follows.

<u>Heart Rate: Results</u>

The following analyses of the heart rate data were carried out to explore the possibility that the inferior memory performance of the EMR subjects in comparison with MA matched normal subjects might be attributed to an attention deficit.

Although the data might be analyzed and interpreted in a number of ways, on the basis of the literature review, two major areas of analysis appeared appropriately salient for the purposes of this experiment. The primary indication of attention or readiness for responding to the orienting question would be apparent in the analysis of the amount of heart rate deceleration (attention to the external environment) prior to the imperative word stimuli. A learning or arousal effect should be revealed in comparison of early to late trials, and if the retarded subjects suffer from an attentional deficit, it would therefore be anticipated that normal subjects would display a greater amount of heart rate deceleration (i.e. % deceleration) than EMR subjects. An attentional deficit might further be evidenced, by the EMR subjects' inability to estimate properly the preparatory interval length, and as such would result in a less than optimal preparedness for response execution at the time of the imperative word stimulus onset. The second area to be explored in this study, is related to the notion that deeper levels of processing would require increasing amounts of stimulus analyses or attention (i.e. physical < phonemic < semantic). Therefore, it might be anticipated that the greatest % of HR deceleration would occur in preparation for responding to semantic orienting questions. The above considerations, are reflected in Hypotheses 3, 3.1, and 3.2. The statistical procedure followed in the heart rate analysis includes analyses of variance of the second-by-second beats per minute (BPM) change scores and percentage deceleration.

Previous investigations utilizing heart rate measures have shown that differences in the prestimulus heart rate level may effect the magnitude of response obtained for a stimulus (Graham and Jackson, 1970). Therefore a preliminary analysis of prestimulus heart rate using a 2 (groups) x 3 (levels) ANOVA was carried out to ensure that there were no initial group differences in autonomic responsivity. The analysis resulted in no significant main effects for groups (see Appendix F). Thus, any group differences which may be found are not due to the prestimulus level of HR.

The data was then subjected to a 2 (groups) x 3 (levels) x the first 16 (seconds) and a 2 (groups) x 3 (levels) x the last 15 (seconds) analysis of variance with the last factor repeated within. The results of these analyses are given in Tables 8 and 9. As it was anticipated, the second-by-second BPM heart rate change scores analyses, resulted in a main effect for the last 15 seconds of the trial continuum (F = 7.777, df = 14/364, $p \leq .001$). There were no other mian effects, or significant interactions yielded from this analysis. With regard to the main effect for the last 15 seconds of the trial continuum, the heart rate means collapsed over groups and levels, seem to indicate that the 28th, 29th and 30th seconds reflect the greatest amounts of heart rate change. The results concur with the prediction that the greatest HR

Table 8

ANOVA for Second-by-second Beats Per Minute (BPM)
Heartrate Change: 2 (groups) x 3 (levels)
x First 16 (seconds)

Source	df	MS	F	P
Between				
Groups	1	4.04	.014	NS
Error	26	295.94		
Within				
Levels	2	54.68	.515	NS
Levels x Groups	2	23.12	.218	NS
Error	52	106.11		
Seconds	15	28.89	2.468	NS
Seconds x Groups	15	1.22	.104	NS
Error	390	11.71		
Seconds x Levels	30	6.35	1.336	NS
Seconds x Levels x Groups	30	5.62	1.182	NS
Error	780	4.75		

n = 14

Table 9

ANOVA for Second-by-second Beats Per Minute (BPM)
Heartrate Change: 2 (groups) x 3 (levels)
x Second 15 (seconds)

Source	df	MS	F	P
Between				
Groups	1	49.88	.261	NS
Error	16	191.30		
Within				
Levels	2	141.80	1.104	NS
Levels x Groups	2	39.51	.308	NS
Error	52	128.48		
Seconds	14	77.67	7.777	.001
Seconds x Groups	14	5.53	.553	NS
Error	364	9.99		
Seconds x Levels	28	1.85	.434	NS
Seconds x Levels x Groups	28	2.68	.628	NS
Error	728	4.27		

n = 14

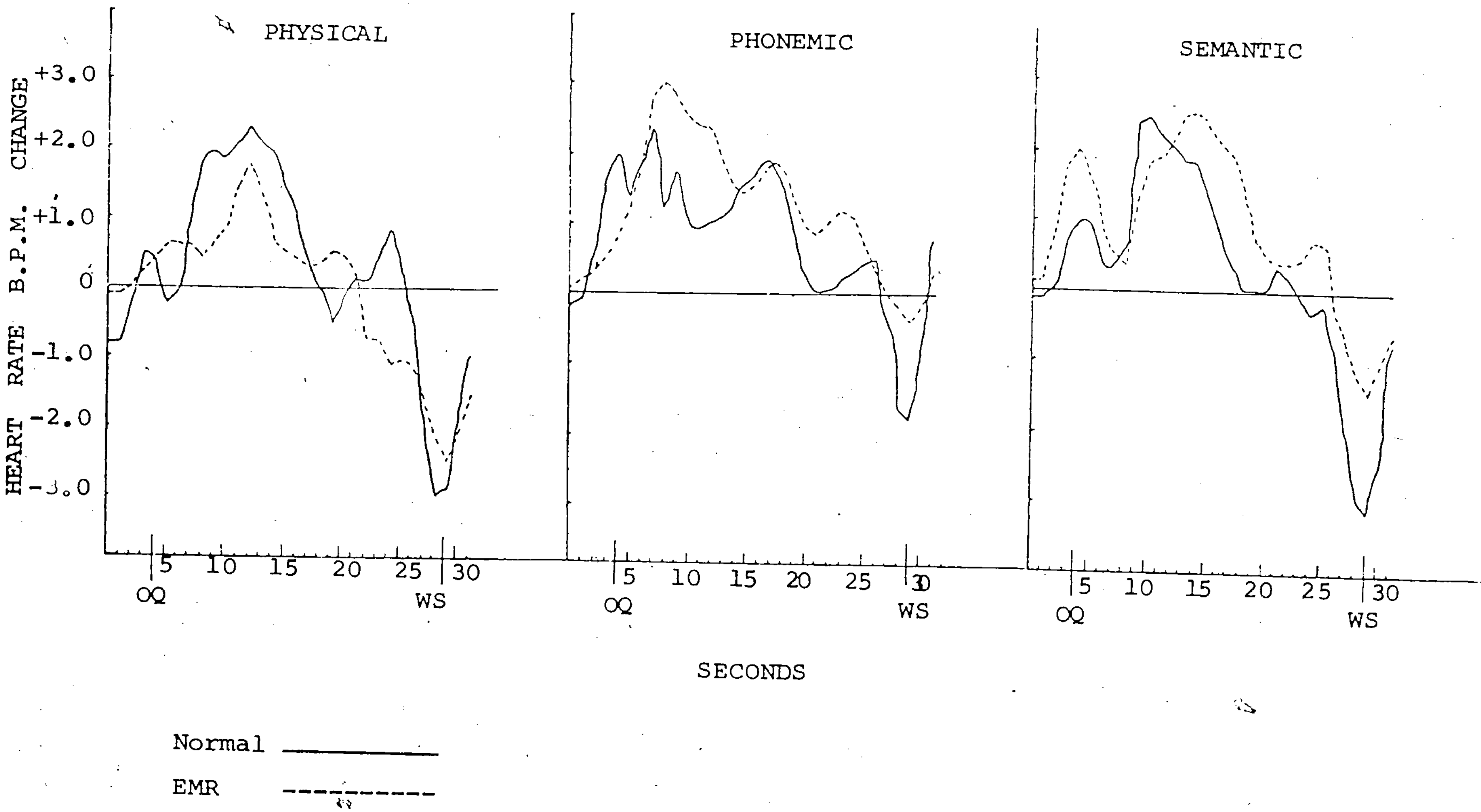
deceleration should occur at the same second interval in which the imperative word stimuli appeared on the screen. Second 29 of the trial continuum coincides with the onset of the word stimuli. Since there were no main effects or interactions for levels or groups, this analysis seems to indicate that contrary to expectations, both retarded and normal subjects displayed similar attention (i.e. heart rate deceleration or readiness to respond) at or near the nadir of the preparatory interval.

The graphic display (Figure 7) of the mean second-by-second BPM heart rate change scores for normal and EMR Ss over physical, phonemic and semantic trials, largely confirms this supposition in that the nadir (lowest point) HR decelerations for both groups fall precisely at the 29th second interval.

Whereas the overall patterning of mean rate change during physical, phonemic and semantic tria ɔe Figure 7) appears markedly similar for both groups, the magnitude of HR deceleration on visual inspection, appears generally greater for normal subjects. Although there was no significant main effect found for groups in the general analysis, it was anticipated that such group differences might become apparent in examination of early versus late trials over the last 15 seconds. The second-by-second BPM heart rate change data was, therefore blocked into early, mid and late trials, and subjected to a 2 (groups) x 3 (levels) x the last 15 (seconds) analy-

Figure 7. Mean heart rate sec x sec BPM change for three levels of processing.

(Each point represents the difference between the mean of the three prestimulus HR values and the HR values for each second. Points OQ and WS indicate onset of the orienting question and word stimuli respectively).


PHYSICAL
PHONEMIC
SEMANTIC
HEART RATE B.P.M. CHANGE
+3.0
+2.0
+1.0
0
-1.0
-2.0
-3.0
5
10
15
20
25
30
OQ
WS
SECONDS
Normal
EMR

sis of variance. Significant main effects for both seconds ($F = 8.187$, $df = 14/364$, $P \leq .001$) and trials ($F = 2.960$, $df = 2/53$, $p \leq .01$) were obtained, as well as a significant interaction for trials x seconds ($F = 2.209$, $df = 28/728$, $p \leq .01$). There were no main effects for groups (normal and EMR) or levels (physical, phonemic and semantic) (See Table 10). An examination of the graphic representation of HR means for EMR and normal Ss, over early and late trials for levels (physical, phonemic and semantic) (see Figure 8), reveals that the main effect for the last 15 seconds, is once again essentially due to HR nadir decelerations which range from second 27 to second 29 on early and late trials for both groups. With respect to the main effect for trials, the graphic comparisons of mean HR response patterning during early and late trials (see Figure 8) indicates that both groups (normal and EMR) display substantial HR differentiation for later trials at all levels of processing. The primary indication of increased differentiation on late trials appears to manifest from increased HR deceleration (attention to the external environment or readiness to respond) during the latter 15 seconds of the trial continuum. This finding of a significant increase in HR from early to late trials, would thus support the prediction of the occurrence of a learning effect (i.e. increased attention or readiness to respond) as Ss experienced more trials, and/or increased effort (attention) to offset task habituation or boredom. Since there were no significant group differences obtained in the analysis, this in

Table 10

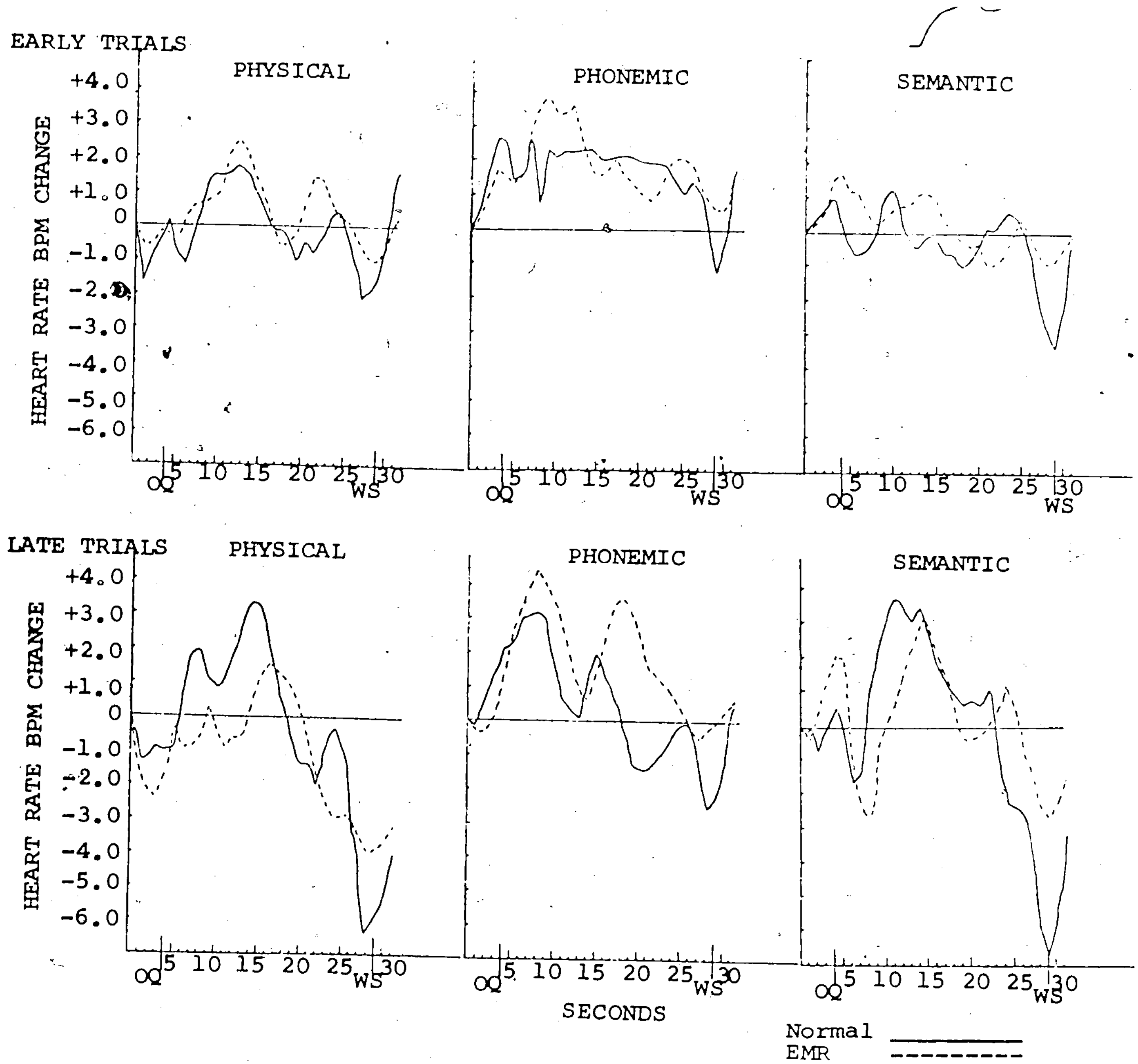
ANOVA for Second-by Second BPM Heartrate Change: 2 (groups) x 3 (levels) x 3 (early, mid, and late trials) x second 15 (seconds)

Source	df	MS	F	p
Between				
Groups	1	87.48	.145	NS
Error	26	602.00		
Within				
Levels	2	719.81	1.912	NS
Levels x Groups	2	138.28	.367	NS
Error	52	376.42		
Blocks	2	867.32	3.960	$\leq$.01
Blocks x Groups	2	300.85	1.374	NS
Error	52	219.00		
Seconds	14	237.09	8.187	$\leq$.001
Seconds x Groups	14	13.92	.481	NS
Error	364	28.96		
Levels x Blocks	4	223.14	.720	NS
Levels x Blocks x Groups	4	113.85	.351	NS
Error	104	323.97		
Levels x Seconds	28	6.09	.414	NS
Levels x Seconds x Groups	28	10.00	.679	NS
Error	728	14.73		
Blocks x Seconds	28	35.29	2.209	$\leq$.01
Blocks x Seconds x Groups	28	8.55	.535	NS
Error	728	15.97		
Levels x Blocks x Seconds	56	11.98	1.023	NS
Levels x Blocks x Seconds x Groups	56	15.48	1.321	NS
Error	1456	11.72		

N = 14

Figure 8. Mean heart rate sec x sec B.P.M. change for three levels of processing: early and late trials.

(Points OQ and WS indicate onset of the orienting question and word stimuli respectively)


EARLY TRIALS
LATE TRIALS
PHYSICAL
PHONEMIC
SEMANTIC
HEART RATE BPM CHANGE
+4.0
+3.0
+2.0
+1.0
0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
OQ
5 10 15 20 25 30
WS
SECONDS
Normal
EMR

turn would suggest that both groups were equally adaptive in demonstrating reasonably effective attentional abilities (or readiness to respond) particularly during later trials. In addition, both EMR and normal subjects display equal variability and relative accuracy for the preparatory interval sense of timing (as reflected by nadir/second HR deceleration comparisons) (See Figure 8).

Since the above analyses indicate that the greatest HR differences occurred during the latter 15 seconds, only this portion of the trial continuum was examined, using % HR deceleration, in a 2 (groups) x 3 (levels) analysis of variance for early and late trials. The results of the analysis (see Table 11) reveal a significant main effect for early versus late trials ($F = 8.506$, $df = 1/26$, $p \leq .01$). The respective means for early versus late trials collapsed over groups were 3.8% and 5.8% HR deceleration. There was also a trend toward significance for group differences ($F = 3.450$, $df = 1/26$, $p \leq .07$). Whereas the % HR deceleration for normal subjects was 4.8% for early trials and 7.3% for late trials, the deceleration percentages for EMR subjects were 2.7% and 4.3% respectively. From this it would appear that both normal and EMR subjects were able to capitalize on their attentional abilities as increasingly more trials were experienced. The significant % HR deceleration (attention to the external environment or preparedness to respond) inc[illegible]e from early to late trials might be attributed to a possible increased effort

Table 11

ANOVA - % Heart Rate Deceleration: 2 (groups) x 3 (levels) x 2 (early and late trials)

Source	df	MS	F	P
Between				
Groups	1	268.99	3.450	≤.07
Error	26	77.97		
Within				
Levels	2	75.80	1.968	NS
Levels x Groups	2	24.38	.633	NS
Error	52	28.52		
Blocks	1	172.06	8.506	≤.01
Blocks x Groups	1	9.04	.447	NS
Error	26	20.23		
Levels x Blocks	2	5.17	.109	NS
Levels x Blocks x Groups	2	15.72	.333	NS
Error	52	47.28		

n = 14

to maintain attention, and/or a learning effect. However, the evidence for a trend toward significance for group differences, would indicate that the learning and/or effort effects were substantially greater for normal subjects.

All of the above analyses failed to yield any significant main effects for levels (i.e. physical, phonemic, and semantic), even though it was predicted that deeper levels of analysis would require greater attention. With respect to the design of this study, it is most probable that the combined RT and word processing task, interfered with any effects resulting from HR differentiations due to qualitative differences in word processing.

<u>Heart Rate: Discussion</u>

In general, the results of the heart rate analyses provide little evidence to support a hypothesis of attentional deficit in EMR children. Both EMR and normal subjects displayed similar patterns of HR responding and showed equal variability and relative accuracy in anticipating the length of the PI interval and onset of the imperative word stimuli.

Hypothesis 3 predicted that since words for deeper levels of processing are expected to require greater analysis and therefore greater attention, then the amount of HR deceleration would increase with the depth of processing (i.e. physical $<$ phonemic $<$ semantic). However, neither the analyses of variance for second-by-second BPM, heart rate change scores, or for the % HR deceleration, yielded a significant effect for levels of processing. It would therefore appear that heart rate, as a dependent measure of attention, at least in this particular paradigm, may not by itself be a sensitive enough measure.

However, differences (as measured by HR) in attentional abilities necessary for the experimental task in this study, appear to be closely associated with a learning or effort effect which results as more trials are experienced and the preparatory set for responding becomes more stabilized. Hypothesis 3.2 predicted that a generalized effect (i.e. increase in % HR deceleration) would occur for both groups from early to late trials. This hypothesis is supported by the statistical analysis and from this it seems apparent that attention and preparedness to respond to imperative word stimuli improved for both groups from early to late trials. Moreover, in consideration of a possible attention deficit in EMR subjects, it was further predicted (Hypothesis 3.3) that the improvement or increased % HR deceleration would be greater for normal than EMR subjects. The statistical analysis, contrary to predictions, resulted in no significant effect for group differences, although a clear trend was indicated. Therefore, although the majority of the HR analyses failed to support a general notion of attentional deficit in EMR children, the latter analysis would suggest that the possibility of group (EMR and normal) differences remains, and that further experimental studies of a similar nature should be recommended. The point is well made by Johnson and Lubin (1972) who state:

> "There are large segments of biological research in which it is not customary to make formal significance tests. If we reject all results not bearing a certified confidence level, then we reject almost all our heritage of biological research, including most of the work done by the winner of the Nobel Prize. Formal significance tests may be helpful, informative and sufficient, but are they necessary?" (p. 153)

A possible explanation for the failure to obtain significant group differences in this study, may be due to the interactive effects due to simultaneous response execution (RT) and word stimuli processing. This made it impossible to discern and compare attentional differences that might accrue as a result of qualitative differences in word processing requirements, or differences due to preparation for responding (button press). In future investigations, attentional differences might be more clearly determined if the RT and word stimuli processing task were separated. This could be achieved by allowing 3 or 4 seconds for actual word processing and delaying the decision response (RT) until the appropriate signal to respond (e.g. a buzzer) is given. In addition, the utilization of additional autonomic measures (e.g. GSR, pupil dilation, etc) would allow greater sensitivity for the exploration of attentional differences between sample groups.

CHAPTER V

CONCLUSIONS

Levels of Processing Memory Model

The basic formulations of the levels of processing memory model, are generally confirmed by the results of this study. The phenomenon of a greater degree of semantic analysis at encoding resulting in better recall, was consistently demonstrated for both normal and EMR children, and across widely differing experimental situations (i.e. experiment one and experiment two). Although the notion of qualitatively distinct levels of processing was not fully substantiated by this investigation, the model appears to offer a heuristic framework for future research for a number of reasons.

The levels of processing model, as it is presently understood (Craik and Lockhart, 1972; Cr[illegible] and Tulving, 1975, Craik, 1973; Lockhart, Craik and Jacoby, 1975) retains the emphasis on the qualitative nature of processing carried out on stimuli, and the effect this has on subsequent retrieval. The emphasis on structural/temporal aspects in previous memory models, is replaced by the direct focusing on the psychological processes operative during memory task performance. In addition, the experimenter is able to exert considerable control over the subject in specifying the orienting question, and thus inducing a particular type of processing to occur. Within an incidental learning condition, this control is maximal. In more recent publications, (Lockhart, Craik and Jacoby, 1975; Craik and Tulving, 1975) the model has been revised and extended to incorporate the notion of increased depth of processing due to stimulus elaboration. This would entail any number of memory processes and strategies that a subject utilizes to increase the level of recall performance, and such elaborations would usually take place under intentional learning conditions. At present, the empirical investigation of this second type of depth of processing is extremely limited, although the results of this study would suggest that the area should be further explored. Lockhart, Craik and Jacoby (1975) have also formulated a distinction between episodic and semantic memory and the relationship between recall and retrieval in the revised levels of processing theory. Future investigations, based on the levels of processing memory model should therefore, attempt to examine all aspects of the theory.

Differential Learning Conditions

The results of this study indicate that recall performance can be significan y increased as a result of differential learning conditions. When intentional or planned intentional learning conditions are specified, the knowledge of a subsequent recall task and the subject's utilization of any number of facilitative memory strategies, interact with the basic levels of processing task. Although it is more difficult for the experimenter to assess the kinds of processes operant under intentional learning conditions, important aspects of the memory process in general can be ascertained.

For example, within the context of the present investigation it was possible to examine the facilitative effects of incidental, intentional and planned intentional learning on recall performance. The findings of a significant difference in recall performance under planned intentional conditions, suggests that subjects at the MA levels under study here (i.e. nine to twelve years), possess the ability to utilize memory enhancing strategies, but require specific instruction, or planning before such strategies are adopted. The condition of intentional learning alone was not sufficient to significantly increase recall levels, and therefore performance may have been reflective of a production deficiency. Such differences in performance then, do provide some evidence that memory is not merely a function of different capacities such as retentiveness, but rather appears to reflect the importance of levels of proficiency in selection and utilization of appropriate memory strategies.

The present study represents a very general test of the facilitative effects of memory strategy and memory control process usage, and no attempt was made to differentiate the effects of either of these. Butterfield (1976) had discussed at length, the problems that may be encountered in attempting to examine process differences among children of different ages or IQ's. He suggests that future investigations in this area, can eliminate some of the difficulty by 1) examination of interactions resulting from manipulations of variables; 2) isolating processes that develop; 3) utilization of direct measurements; 4) examination of mediation and production deficiencies; and 5) through analysis of metamemory and executive functions. Essentially, Butterfield (1976) points out the need for a symbiosis of observational and laboratory procedures. Although some of the above suggestions were adopted in this study, the emphasis was primarily given to laboratory procedures. In future investigations of normal and/or EMR children's memory processing, an attempt should be made to incorporate both observational and laboratory procedures, in order to more specifically determine the separate facilitative effects of memory control processes and memory strategies on memory performance. In assuming an experimental approach such as this, it will be possible to generate a clearer understanding of the conditions necessary to overcome mediation and production deficiencies, and how best to induce or train subjects to utilize their own metamemory and executive function abilities to enhance their own learning.

Memory Processing Differences in EMR and Normal Children

With respect to the experimental results obtained in this study, it would appear that the levels of processing model is sensitive to the memory processing differences of sample groups with disparate intelligence levels. Whereas the effects of physical processing resulted in similar recall for both normals and EMR's, the performance of the two groups was significantly differentiated at the phonemic and semantic levels of processing.

The performance increases due to differential learning conditions were however, essentially the same for both EMR and [illegible]hildren. Both groups were able to significantly incr[illegible]in recall performance under the condition of [illegible]entional learning. It is interesting to note that with the addition of strategic planning, the retardates were able to increase their level of recall to that achieved by the normal subjects in the incidental condition. These results might best be explained by Vygotsky's (1963) theory of development. He suggests that: "We must determine at least two levels of a child's development, otherwise we fail to find the correct relation between the course of development and potentiality for learning in each specific case" (p. 28). At the first level, the zone of actual development represents those mental functions that have been attained due to a specific or already accomplished course of development. The second level, the zone of potential development, represents a learning potentiality that may become actualized under the direction of adult guidance, demonstration or questioning. If this is the case, the results of the present study would suggest that whereas the normal subjects were able to independently process information efficiently (i.e. incidental learning condition), their MA matched EMR peers were only able to achieve this same level of proficiency through adult guidance and pre-task planning (i.e. planned intentional condition). Therefore performance differences might be attributed to differences in the zone of potential development, as opposed to differences in the zone of actual development. Moreover, a knowledge of how this zone of potential development becomes actualized, has direct ramifications for school related diagnostic and remedial concerns, as Vygotsky (1963) suggests: "What the child can do today with adult help, he will be able to do independently tomorrow" (p.20). Before the results of investigations such as the above can become useful in a practical teaching situation, we need to know more about the limitations and potentialities which characterize a given developmental level, and how best a teacher or an adult can facilitate the learning process. As Butterfield (1976) points out, this can only be achieved through the symbiosis of observational and laboratory procedure.

Attention Deficit

Differences in retardate and normal childrens' learning and memory performance have often been attributed to attention deficit. The possibility of attention deficit affecting EMR memory performance was explored in experiment two, utilizing reaction time and heart rate measures. In general, the analysis of these measures, failed to yield any significant group differences. The notion of EMR attentional deficit was unsubstantiated by the results of this study, and therefore the issue is still open to question. Future investigations, should attempt to separate information processing and reaction time requirements, in order to independently assess the effects due to qualitative differences in levels of processing and differences due to the button press response. It might be further suggested that heart rate measures alone, may not be sufficiently sensitive to detect subtle group differences in attention. Since an OR or attention can be detected by several autonomic measures (e.g. EEG measures, blood volume, heart rate, respiration, galvanic skin response, eye movement, and pupil dilation), the utilization of several autonomic measures may help tease apart such subtle attentional differences between groups, particularly in tasks employing differing levels of analysis of stimuli (Lynn, 1966).

Limitations and Implications for Future Research

1. The utility of this study is limited in that the beneficial effects of memory control processes and strategies, were indicated only in a very general sense by the improvement of recall performance over learning conditions. Although the subjective interview data gave some indication of the kinds of memory enhancing processes and strategies that were utilized, it could not be ascertained in this experiment which processes or strategies

best facilitated memory performance. One might be able to more directly assess and delineate these affects by specifying the subject to utilize one particular strategy or process and then comparing the recall performance of groups using different strategies or processes. Following this, the possibilities of training the usage of memory strategies and control processes or improving metamemory and executive functions need to be further explored.

2. The simultaneous observations of reaction time and imperative word stimuli processing, made it impossible in experiment two, to delineate attentional differences in groups arising from qualitative differences in processing demands, and the effects of preparation for the button press response. Future investigations should attempt to separate out these effects.

3. Even though the orienting questions were randomized, there was a chance clustering of three phonemic, and three semantic questions for the last six orienting questions of the experimental task. This may have resulted in increased recall due to both a levels of processing effect as well as a recency effect. However, this would not appear to be a major factor in that one would therefore have anticipated that this would have enhanced recall for phonemically processed words, as well as semantic words. There was little evidence in the data for a

significant effect for recency, as the amount of phonemic recall was basically the same as physical.

4. A final limitation of this study is that the utilization of heart rate measures alone, might not have been sufficiently sensitive to ascertain attentional differences between EMR and normal children in information processing tasks. Therefore, the utilization of a number of autonomic measures (e.g. GSR, pupil dilation, etc) would be recommended in future studies of a similar nature, as this would ensure the detection of attentional differences, if indeed such differences exist between EMR and normal children.

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APPENDIX A

Experimental Orienting Questions, Imperative Word Stimuli, and Correct Response in Order of Presentation

Appendix A

Imperative Word Stimuli		Orienting Question	Correct Response
1	carrot	Does this word rhyme with hunter?	No
2	orange	Does this word start with a "t"?	No
3	corn	Does this word end with a "p"?	No
4	bed	Does this word rhyme with shed?	Yes
5	knife	Does this word mean a type of weapon?	Yes
6	peach	Does this word mean a type of fruit?	Yes
7	dress	Does this word rhyme with star?	No
8	shirt	Does this word mean a type of fruit?	No
9	chair	Does this word mean a type of vehicle?	No
10	gun	Does this word start with a "g"?	Yes
11	train	Does this word end with an "n"?	Yes
12	bus	Does this word rhyme with fuss?	Yes
13	rifle	Does this word start with a "b"?	No
14	couch	Does this word mean a type of clothing?	No
15	lettuce	Does this word rhyme with spinach?	No
16	skirt	Does this word mean a type of vegetable?	No
17	desk	Does this word rhyme with book?	No
18	car	Does this word start with a "c"?	Yes
19	banana	Does this word mean a type of furniture?	No
20	apple	Does this word end with a "[illegible]"?	Yes
21	jeep	Does this word rhyme with "sheep"?	Yes
22	sword	Does this word start with an "l"?	No
23	pear	Does this word end with a "z"?	No
24	blouse	Does this word start with a "b"?	Yes
25	coat	Does this word rhyme with "boat"?	Yes
26	table	Does this word rhyme with "stable"?	Yes
27	taxi	Does this word mean a type of vehicle?	Yes
28	tomato	Does this word mean a type of vegetable?	Yes
29	pea	Does this word rhyme with sky?	No
30	bomb	Does this word mean a type of weapon?	Yes

APPENDIX B

Pre and Post-task Interview Questions

Appendix B

Pre-task Interview Questions

You have been told that you will be required to remember the words in this task. First, I would like to ask you some questions:

1. Do you remember things well - are you a good rememberer?
2. If you are told that you have to remember something, do you usually remember it better? e.g. If I say "look at these words" instead of "remember these words" will it make a difference?
3. What things do you do to try and remember things?
4. Can you think of some ways to remember the words in this task?

Post-task Interview Questions

1. What did you do to try and remember the words in this task?
2. If you had to do this again, what would you do to remember more words?
3. Do you think you remembered more words because you were told to remember them? Why?
4. Sometimes, although a person is a good rememberer, he can still remember some things better than others. Do you remember some things better than others?
5. Was it hard for you to remember the words in this task?
6. What words were hard to remember in this task?

APPENDIX C

Revised Pre- and Post-task Interview Questions

Appendix C

Revised Pre-task Interview Questions

You will be required to remember as many words as you can in this task. First, I would like to ask you some questions.

1. Do you remember things well - are you a good rememberer?
2. If you are told that you have to remember something, do you usually remember it better? Example. If I say "look at these words" instead of "remember these words" will it make a difference? Why?
3. What things do you do to remember?
4. Can you think of some ways to remember the words in this task?

Revised Post-task Interview Questions

1. What did you do to try to remember the words in this task?
2. If you had to do this again, what would you do to remember more words?
3. Do you think you remembered more words because you were told to remember them? Why?
4. Was it hard for you to remember the words in this task?
5. What type of words were hard to remember in this task?

APPENDIX D

ANOVAs for Sex Differences in Recall
and Reaction Time: Experiment I

Appendix D

ANOVA for Sex Differences in Recall: Experiment I

Source	df	MS	F	p
Between				
Groups (normal)	1	.116	.157	NS
Conditions	2	.178	2.416	NS
Error	38			
Between				
Groups (retarded)	1	.148	2.25	NS
Conditions	2	.114	1.73	NS
Error	38	.661		

n = 7

ANOVA for Sex Differences in Reaction Time: Experiment I

Source	df	MS	F	P
Between				
Groups (normal)	1	.656	.285	NS
Conditions	2	.113	.493	NS
Error	38	.229		
Between				
Groups (retarded)	1	.131	.320	NS
Conditions	2	.332	.081	NS
Error	38	.410		

n = 7

APPENDIX E

A Summary of the Pre- and Post-task Inverview Results for the Planned Intentional Groups (normal and EMR), and Post-task Interview Results for the Intentional Group (normal and EMR)

Appendix E.1

Pre-task Interview Results - for the Normal Planned Intentional Group

1. Are you a good rememberer?

Yes	9
No	1
Maybe, Dont know, Sometimes	4

2. If you are told that you have to remember something do you usually remember it better?

Yes	8
No	2
Maybe, Sometimes	4

If I say look at these words instead of "remember these words" will it make a difference"

Yes	8
No	6
Don't know	0

Why? (comments)

- look and remember mean the same thing.
- look at the words is not remembering.
- it makes you remember more.
- you just remember
- you can look and forget or look and keep the words in your brain.
- same thing practically.
- looking and remembering are different.
- look is watching, remember means you have to remember.
- look means just look, remember means you have to remember.
- looking is not keeping them in your mind.
- they mean the same.

3. What things do you do to remember?

- with your brain, say it a lot of time.
- say it in your mind.
- recognize and remember things.
- read over and see.
- repeat to yourself.
- keep on saying.
- remember them in your head.
- words that look the same.
- think.
- think of what the words are.
- recall the words, think back.
- think over and over again.

4. Can you think of some ways to remember the words in this task?

Yes	9
No	4
Don't know	1

Comments:

- say one word after another in your mind.
- think
- looking and remembering.
- read over and see.
- think them over, try to know that they mean, usefulness.
- think things that you will remind you of them (semantic).
- try to remember.
- after the question, remember the word.
- keep them in your mind.

Appendix E.2

Pre-task Interview Results for the EMR Planned Intentional Group

1. Are you a good rememberer?

Yes	10
No	3
Maybe, Don't know, Sometimes	1

2. If you are told that you have to remember something do you usually remember it better?

Yes	11
No	3
Maybe, Sometimes	0

If I say "look at these words" instead of "remember these words" will it make a difference?

Yes	5
No	7
Don't know	2

Why? (comments)

- you have to remember.
- they're not the same.

- looking and remembering are different things.
- because you can remember anyway.
- because you can remember.

3. What things do you do to remember?

- you have to know.
- say 2 or 3 times to self.
- look at them.
- practice.
- think about what you are going to remember.
- put them in your mind.
- say the words over.
- write them or ask someone to remind you.
- spelling.
- think.
- think.

4. Can you think of someways to remember the words in this task?

Yes	5
No	9
Don't know	0

Comments

- say them over a few times.
- spell them and say to yourself.
- put them in your mind and you remember.
- keep thinking.
- ones you know are easier, think about them.

Appendix E.3

Post-Task Interview Results for the Normal Planned Intentional Group

1. What did you do to try to remember the words in this task?

No Response = 0

- look and think
- said over and over
- looked at the words
- thought about them
- looked at and remembered
- said a few times to self
- said them over and over again
- kept on saying over and over
- look for type of words
- remembered words that rhyme

- tried to keep them in your mind
- relationship
- keep them in your head concentrate
- thought back at the words

2. If you had to do this again, what would you do to remember more words?

No Response = 2

- look and think
- say over and over and add on to list of words
- look again
- repeat words in your mind
- say a few times to self
- try to remember last [illegible] words
- say 5 times each word [illegible] next word comes.
- look for types of word
- try and think of more words
- try harder to keep them [illegible] mind
- keep in your head concentrate
- listen harder and look

3. Do you think you remembered more words because you were told to remember them? Why?

Yes	10
No	4
Maybe	0

Why? Comment:

- because I was told to remember
- it made you remember more
- because I remembered more
- I know that I have to remember the words
- when you're told you really remember
- because I was told to remember
- because it is a test

4. Was it hard for you to remember the words in this task?

Yes	8
No	5
Other	1 (know half of the words)

5. What type of words were hard to remember in this task?

- shed, carrot, peach
- long words, weapons
- tire, gun, fruits
- boat, gun, fruits, weapons, instruments
- vehicle
- fruits

- long words
- longer words
- vegetables, fruit, furniture
- furniture, weapons
- vegetables, weapons, furniture
- vegetables, weapons
- fruits, vegetables, weapons
- none

Appendix E.4

Post-task Interview Results for the EMR Planned Intention Group

1. What did you do to try to remember the words in this task?

No Response = 3

- say them over 3 times
- try to remember
- say them
- try to remember
- thought about them
- put them in your mind
- saying them over and over
- said to myself
- think about them
- look at the words
- it is hard

2. If you had to do this again what would you do to remember more words?

No Response = 4

- say them over 2 or 3 times
- get the words more carefully
- thin more
- memorize
- say more words over
- think about the words
- repeat the words in your mind more
- keep them in your mind
- get the easier ones first, think about them
- look at them better

3. Do you think you remembered more words because you were told to remember them?

Yes	5
No	7

No Response = 2

Why? Comment:

- I just wanted to remember
- I have a good memory

4. Was it hard for you to remember the words in this task?

Yes	12
No	2

5. What type of words were hard to remember in this task?

- words with the beginning written letters, long words
- clothing, vehicle, vegetable
- vehicle
- rhyming words
- vehicles, weapons
- clothing
- sheep
- all hard words
- vehicles
- all of them

Appendix E.5

Post-task Interview Results for the Normal Intentional Group

1. What did you do to try to remember the words in this task?

- remind self to remember — No Response = 2
- remember the type of word - like bomb or weapon
- think back and remember
- keep them in your mind
- think about them
- say them over a few times and think about them
- said them over and over again
- use your mind
- use your brains
- remember the question
- thought about them
- say them to yourself

2. If you had to do this again, what would you do to remember more words?

- remember what you have seen last time and say them again
- after the word, keep saying the word to yourself
- keep them in mind
- try to think of the rhyming ones
- look more carefully at the words
- you figure them our more carefully
- say more times
- more times to yourself
- think better, study words more
- by thinking

- try harder
- concentrate better
- think of the question and remember the word
- try to remember by saying to self

3. Do you think you remembered more words because you were told to remember them?

Yes	10
No	4
Maybe	0

Why? Comment:

- I tried to remember
- if you looked at the screen you couldn't memorize the words
- if someone says try to remember, you remember more words
- I was alert and tried to remember
- so that when the time comes, you can tell the words
- because if you didn't know, you wouldn't try to remember
- someone tell you to remember better
- hard to explain
- because you know them
- you wouldn't remember if no one told you
- because I remember words

4. Was it hard for you to remember the words in this task?

Yes	9
No	4
Other	1 (half and half)

5. What type of words were hard to remember in this task?

- rhyming words, wrong words
- clothing, vehicles
- rhyming words
- vegetables
- vehicles, vegetables
- vegetables, rhyming words
- vehicles
- vegetables
- vegetables, vehicles
- fruits, vegetables, vehicles
- ending in "e" clothing (blouse)
- fruits, vehicles
- blouse, clothing, vehicle, jeep

Appendix E.6

Post-task Interview Results for the EMR Intentional Group

1. What did you do to try to remember the words in this task?

No Response = 2

- listen, saw them
- looked at them and memorize - keep looking
- say them
- think of them
- keep them in my head
- think about the word
- thinking of the words all the time
- looked at them closely and harder
- think, going over the words
- think
- visualize and remembered
- remember them

2. If you had to do this again what would you to do remember more words?

No Response = 0

- look carefully
- study them
- think
- think about them
- say them over
- write them down
- study the words
- read them
- keep them in the back of my head, learn words by their family
- say to yourself
- write them
- pay more attention
- concentrate and remember words
- read it to self

3. Do you think you remembered more words because you were told to remember them?

Yes	6
No	7
No Response	1

Why? Comment:

- some were hard
- I wasn't really paying attention
- I spelled them out, said them
- it doesn't make a difference

4. Was it hard for you to remember the words in this task?

Yes	8
No	6

5. What type of words were hard to remember in this task?

- most of the words
- some were too hard
- vegetables, furniture, carrot
- all of them
- really, really hard words
- rhyming words
- taxi, rhyming, ooposites, vehicles, fruits
- none
- bomb
- rhyming
- rhyming words
- vehicles

APPENDIX F

ANOVA for Normal VS EMR: Prestimulus Heart Rate

Appendix F

ANOVA for Normal VS EMR: Prestimulus Heart Rate

Source	df	MS	F	P
Between				
Groups	1	615.39	1.579	NS
Error	26	389.66		
Within				
Levels	2	4.67	.913	NS
Levels x Groups	2	1.94	.379	NS
Error	52	5.11		

n = 14