DOCUMENT RESUME

ED 172 473 EC 114 838

AUTHOR Lupart, Judy L.; Mulcahy, Robert F.
TITLE A Look at the Memory Performance of Retarded and Normal Children Utilizing the Levels of Processing Framework.
PUB DATE Apr 79
NOTE 77p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, California, April, 1979, Session 24.07)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Attention; *Cognitive Processes; *Educable Mentally Handicapped; Elementary Education; *Exceptional Child Research; *Memory; Mentally Handicapped; Recall (Psychological)

ABSTRACT

Memory performance differences of mental age matched (9-12 years) educable mentally retarded (EMR) (n=56) and normal (n=56) children were examined in two experiments using the F. Craik and R. Lockhart levels of processing framework. In experiment 1, Ss were randomly assigned to an incidental, intentional, or planned intentional learning condition, to determine the effect on recall, as well as to explore metamemorial abilities and memory strategy usage. In experiment 2, heart rate was additionally recorded during task performance (incidental condition) to examine the possibility of an attention deficit affecting EMR performance. Although all Ss displayed recall improvement over levels and learning conditions, the generally inferior performance of EMRs did not appear to be due to attention deficit. (SBH)

ED172473

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

A Look at the Memory Performance of Retarded and Normal Children Utilizing the Levels of Processing Framework

Judy L. Lupart, and Robert F. Mulcahy
University of Alberta
Edmonton, Alberta T6G 2E1

*Presentation at the American Educational Research Association Convention in San Francisco, April 1979.

Session # 24.07

EC114838

Abstract

Memory performance differences of MA matched (9-12 years) educable mentally retarded (n = 56) and normal (n = 56) children were examined in two experiments using the Craik and Lockhart (1972) levels of processing framework. In experiment one, subjects (S_s) were randomly assigned to an incidental, intentional or planned intentional learning condition, to determine the effect on recall, as well as to explore metamemorial abilities and memory strategy usage. In experiment two, heart rate was additionally recorded during task performance (incidental condition) to examine the possibility of an attention deficit affecting EMR performance. Although all S_s displayed recall improvement over levels and learning conditions, the generally inferior performance of EMR's did not appear to be due to attention deficit.

A Look at the Memory Performance of Retarded and Normal Children Utilizing the Levels of Processing Framework

Comparison studies of retarded and intellectually average childrens' memory performance, be they a chronological age (CA) or mental age (MA) matched design, typically result in superior performance for the latter group. For some theorists and researchers interest has been directed toward the search for specific or structural deficits, an orientation which purposedly serves to define mental retardation. On the other hand, professionals in the field of education have been more practically concerned with the problem of improving or facilitating the learning and memory performance of the retarded child. Although both orientations have yielded valuable insight, neither approach is sufficient by itself to resolve a problem which is paramount in the field at this time. As Brown (1974) has described it, the problem is one of sorting out those factors which are structurally or developmentally delimiting and those factors which can benefit or facilitate the retarded individual's memory performance.

Researchers who are concerned with recall or information processing characteristics in memory, have frequently adopted a "modal" model of memory. This framework emphasizes specific temporal-structural components of the memory system [i.e. sensory store, short term store (STS), and long term store (LTS)] and the transfer of information from one store to the next. In the area of mental retardation research and theory, the modal model has been highly influential (Ellis, 1970; Fisher and Zeaman, 1973). Indeed, the inferior memory performance of mentally retarded persons has been widely attributed to a defective short term store (Ellis, 1970; Scott and Scott, 1968). It is of interest to note that the utilization of the modal memory model has resulted in a strong bias toward a structural (i.e. deficit) orientation.

In the past few years, however, considerable interest has been directed toward Craik and Lockhart's (1972) alternate approach to memory research. In brief, the levels of processing model focuses upon the perceptual analysis of incoming stimuli. These analyses may be directed toward the domains of physical (i.e. orthographic features of the stimuli), phonemic (i.e. acoustic features of a stimulus) or semantic (i.e. meaningfullness features of a stimuli) processing. Depth of processing follows the order of physical < phonemic < semantic. Of these, the semantic level of processing constitutes the deepest or most elaborate analysis and results in the strongest memory trace.[3]

Brown (1974) sagaciously points out that the crucial distinction between the levels of processing and modal memory model is found in the status of short term memory. She indicates 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" (Brown, 1974, p. 58).

In other words, the levels of processing approach to memory is characterized by a deliberate de-emphasis on structural features and the STS specifically is replaced with the notion of optional strategies employed by the subject. More importantly, the emphasis is given to the qualitative, as opposed to quantitative, aspects of analyses performed on stimuli and the relation to subsequent memory trace strength. Such a memory framework therefore, holds considerable promise as a viable method for the investigation of those factors which both facilitate and delimit the memory performance of the EMR child.

The levels of processing model has been formulated on the basis of several investigations carried out by Craik and his associates (Craik and Lockhart, 1972; Craik and Tulving, 1975; Lockhart, Craik and Jacoby, 1975; Craik, 1973) and the distinction of three qualitatively different levels of processing has largely been substantiated with adult subject populations. The major purpose of this study was to determine whether the levels of processing would be similarly distinct with subjects who are developmentally or cognitively immature. In addition, when the accepted language superiority of the intellectually average child is considered, we would ask whether the performance of MA matched samples of non-retarded and educable mentally retarded (EMR) children would thus be differentiated utilizing the levels of processing framework.

The recent developmental literature relating to children's memory performance suggests that the development of intention might be a crucial factor to consider. With respect to memory research, the intentional learning condition refers to an experimental paradigm in which subjects are informed of post-task recall or recognition requirements before commencing the experimental task. Within the incidental learning condition, subjects are only informed about the experimental task requirements.

There is a strong indication that intention to memorize becomes a critical strategy in the course of memory development which enhances the memory performance of older children and adults. This might be further inextricably tied to the concepts of production deficiency (i.e. an inadequate use of available memory enhancing strategies) and mediation deficiency (i.e. a subjects is unable to employ a potential mediator even when he is specifically instructed to do so) which have been identified in developmental studies with non-retarded children (Flavell, 1970; Moely, Olson, Halwes, and Flavell, 1969) and EMR adolescents (Brown, 1974). Whereas this relationship has been established with respect to developmental research (cf. Meacham, 1972), the research is essentially void with respect to the effects of incidental and intentional learning conditions for mentally retarded children.

In contrast to developmental researchers, Craik and

Lockhart (1972) assume a position which minimizes the indidental/intentional distinction and suggest that it is the level of processing which is the primary predictor of subsequent memory. In an effort to explore this issue more fully, incidental, intentional, and planned intentional learning conditions were incorporated into the design of experiment one.

In referring back to the primary purpose of this research -- to sort out those factors which structurally or developmentally limit and those factors which enhance the memory performance of EMR children -- the experiment one findings were most fruitful in the latter regard. As it was anticipated, both S_s groups demonstrated recall performance increases following deeper levels of processing and the pattern of memory performance improvement was markedly similar for EMR and non-retarded S_s over the three differential learning conditions. However, other than the significant groups x levels interaction, there was limited information revealed to account for the significant group differences in recall that accrued in this experiment.

With this background in mind, a second experiment was planned to more closely examine those (structural) factors which may distinguish the memory performance of non-retarded and retarded children. When the often found performance discrepancies between retarded and intellectually average persons are considered, a hypothesis of attention deficit in mental retardates is often postulated. Evidence to support this notion has been generated in a variety of experiments, using differing formats, tasks, and dependent measures. With respect to Western research, both the Zeaman and House (1963) discrimination learning and the Baumeister and Kellas (1968) reaction time studies are well known examples. On the basis of psychophysiological studies, Soviet researchers such as Luria and Vinogradova (1963) have similarly found evidence to indicate an attention deficit in mentally retarded subjects. More specifically, Luria (1963) suggested that peculiarities of the orientation reflexes and arousal systems distinguish the mentally retarded learner from the intellectually average learner. However, Western replicative studies have failed to support Soviet research in its entirety (Clausen, 1973; Stern and Janes, 1973). The more recent psychophysiological research (Clausen, Lidsky and Sersen, 1976) indicates that autonomic responding patterns vary widely 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 between Soviet and Western research, Das (1976) and Das and Bower (1971) have pointed out that S_s utilized in Luria's and other Soviet investigations, were of significantly lower mental age and intelligence in comparison with retardate subjects typically employed by Western researchers. In addition to the above, the majority of Soviet and Western studies have utilized only simple stimuli such as light flashes and tones.

There is at present 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, 1975; Bernstein, 1969; and Tursky, Schwartz, and Crider, 1970). The several reported investigations 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 research, it would be expected that the presumed attentional deficit of the EMR subjects would be reflected in the comparison of autonomic response patterns with normal subjects, as well as recall performance. For these reasons, autonomic measures (heart rate) were utilized during performance on the levels of processing task in experiment 2 of the study.

In summary, the specific purposes of this study reported here 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 (S_s).

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

Experiment I

Subjects

There were eighty-four S_s in the sample; half were intellectually average children enrolled in upper elementary grades (i.e. 4, 5, and 6) at an Edmonton, Alberta Separate school. The remainder of the sample comprised 42 educable mentally retarded (EMR) students, who were all attending a "special" school which combines academic and vocational instruction. Preliminary screening involved the examination of school records and consultation with the school teachers and counselors in order to exclude subjects with any sensory, emotional or organic anomolies. The sample characteristics of the experiment one groups are given in Table I.

Insert Table I about here

Subjects were randomly assigned to one of the following experimental conditions:

1. Incidental condition - S_s were only given a description of the experimental task.

2. Intentional Condition - S_s were given a description of the experimental task as well as information regarding the recall requirement at task completion. Subjects here were interviewed following the recording of words recalled.

3. Planned Intentional - S_s were 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 was given to induce the subject to devise strategies to improve their recall performance. Subjects were also interviewed following the recall task, in an effort to determine the strategies employed by them.

There were 14 retarded (EMR) and 14 non-retarded children in each condition and male and female subjects were equally represented.

Stimuli and apparatus

The task involved the presentation of 30 slide mounted orienting questions and corresponding imperative word stimuli. The word stimuli were selected from the Rosch (1975) goodness-of-example ratings of semantic categories. From each of the chosen six categories (i.e. clothing, furniture, fruit, vehicle, vegetable, and weapon), five high ranking words were selected and randomized. The words were then paired with a 'yes' or 'no' value and a physical (e.g. Does with word start with a "t") phonemic (e.g. Does this word rhyme with "boat"?) or semantic (e.g. Does this word mean a type of fruit?) orienting question, and then randomly reordered. Although the order was randomized, each type of orienting question (e.g. physical) appeared 10 times in the experimental task, and for five of the questions the correct response was "yes", and for the other five questions the correct response was "no".

A 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 to focus S_s attention and to ensure that the orienting question was not misread and thus misinterpreted. An interstimulus interval of four 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 responding apparatus consisted of a metal box with two protruding buttons which were pressed by the subject to indicate his response decision. All subjects were told to hold their index finger ready between the response buttons, as they waited for the imperative word stimuli. Answers were indicated to the experimenter by the lighting of one of the two lights (indicating a 'yes' or 'no' response). The slide stimuli were projected onto a wall approximately four feet in front of the subject.

Procedure

The S_s were individually tested in a small room within each of the schools. The lights remained dimmed throughout the task 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 instructions given to subjects in the incidental condition were: "I am going to ask you to do a task which includes 30 questions and about 30 words. The questions and words will be presented on slides and the questions 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 was as follows: "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".

All the above instructions were given to the planned intentional group, with specific information about the task added. The specific addition 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 questions" 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.

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 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 by pressing the appropriate button. When three consecutive correct responses were made, the examiner would say, "Okay, now we will begin the task". The initial slide for the experimental task was then positioned on the Kodak carousel slide projector. The response decision and reaction time was recorded by the examiner for each trial. At the completion of the 30 trials, the subject was requested to tell the examiner all the words he could recall, and these were recorded. Following the recall interval all subjects were asked not to inform future subjects that a memory task was part of the experiment.

Only the planned intentional groups were interviewed prior to the levels of processing task, and it was arranged to engage S_s in the other two learning condition groups in casual conversation for a roughly equivalent time period (approximately 4-5 minutes). The interview questions were formulated after those outlined in the structured interview technique described by Kreutzer, Leonard and Flavell (1975). The interview focuses on the subject's own awareness of the mnemonic ability and limitations; his assessment of task demands involved in retrieval situations; and how the child might use a repertoire of deliberate and conscious memory strategies particularly in confrontation of an expected recall requirement. Essentially the pre-task interview questions were given to encourage S_s to utilize self-generated memory enhancing strategies during the experimental task. The pre-task interview questions were as follows:

Pre-task interview 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? For 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?

Post-task interviews were carried out with all subjects in the intentional and planned intentional groups, in an attempt to determine the actual memory strategies that were employed. These post-task interview questions were as follows:

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?

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 subjects' 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. Recall: 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 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

An initial 2(group) x 3 (conditions) analysis of variance using recall and reaction time as dependent variables revealed no significant sex differences. Thus, further analyses were carried out on groups collapsed over sex. The results of a comparison check for correct responses were essentially identical with mean scores of 28.78/30 for non-retarded children and 29.30/30 for retarded children.

Recall: Results

Recall performance differences were examined utilizing a 2(group) x 3(conditions) x 3(levels) analysis of variance. Table 2 presents the results of this analysis. As was an-

Insert Table 2 about here

ticipated 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 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 noraml recall performance differences would suggest that the semantic level of analysis most readily differentiates the two groups. In order to determine the specific

Insert Figure I about here

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 ($F = 8.46$, $df = 1/78$, $p \leq .004$) 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 EMR 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 ($F = 99.634$, $df = 1/156$, $p \leq .0001$) (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, 1978; Lawson, 1976). The recall performance for 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 levels distinctiveness in recall performance was a major issue raised by Lawson's (1976) study. Similar to the present 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. For both non-retarded 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 2). 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 intellectuallly average and EMR 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

Insert Figure 2 about here

in recall means between the incidental and planned intentional condition ($F = 3.93$, $df = 2/78$, $p \leq .02$). 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 had been anticipated that non-retarded S_s would be most likely to benefit by the addition of the intentional learning condition and the opportunity for pre-planning of word recall. However, there was essentially no group differences found in comparison of the percentage increase in recall performance across conditions (7 percent for non-retarded and 6 percent for EMR's). Thus, it would appear that the ability to utilize strategic memory and control processes may be associated with mental age level.

Although the interview response data was not amenable to statistical analysis, a brief discussion of the pre- and post-task interview results may be instrumental at this time. 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 S_s response protocols revealed distinct similarities for non-retarded and EMR S_s 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 that non-retarded subjects offered more suggestions for ways to approach the task.

Post-task interviews were carried out with both intentional and planned intentional groups and for the most part, responses were similar for both EMR and non-retarded S_s. However a comparison of responses of planned intentional groups to the question concerning whether they thought they remembered more words because they were told to remember them, suggests that the retarded S_s, 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 non-retarded subjects, however, 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 group, 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 interview responses for both groups and experimental conditions, is consistent with the aforementioned statistical analysis which resulted in a main effect for conditions but no interaction for conditions by groups.

Recall: Discussion

In general, the analysis of recall results provide only partial support for the hypothesis 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, Snart, (note I)] would suggest that the free recall procedure may only be sufficiently sensitive to detect gross qualitative differences in the nature of the memory trace.

A major prediction of this study was that differential learning conditions would improve the recall performance of both intellectually average 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 performace 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 lower recall performance was due to a production deficiency.

The postulation of significantly better recall performance for intellectually average children in comparison with EMR children 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.

It was 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 non-retarded groups. Since, the non-retarded and EMR samples were roughly 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 intellectually average children.

Reaction time: Results

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

Insert Table 3 about here

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 non-retarded children), 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 differ-

---

Insert Figure 3 about here

---

entiate groups at the phonemic and semantic levels of processing. In order to statistically test this observation, the data was subjected to Scheffe test analysis. The results reveal that group differences only reach significance at the phonemic level of processing ($F = 6.245$, $df = 2/78$, $P \leq 0.14$) 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.

In general the results obtained here are only minimally discrepant with respect to predicted outcomes, and would not pose a threat to the levels of processing model. Moreover, Craik and Tulving (1975) have determined that processing time would not, by itself, reflect a totally reliable index of depth.

Reaction time: Discussion

The above reaction time performance findings support Craik and Tulving's (1975), in that reaction time measures are positively related to depth of processing. Statistical analysis supported the notion of hierachial differentiation between levels for non-retarded 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 non-retarded and EMR children examining reaction times (Baumeister and Kellas, 1968; Bower and Tate, 1976), it was predicted that EMR S_s 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 intellectually average S_s reaction times increased according to the amount of analysis required at successively deeper levels (i.e. physical $<$ phonemic $<$ semantic), the EMR S_s had longest response latencies for phonemic and shortest reaction times for physically processed words. It would appear that although EMR S_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.

Experiment II

Subjects

The subjects (intellectually average 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 non-retarded children sample comprised 14 subjects with a mean chronological age of 10.4 years; a mean intelligence quotient of 102.2 (range 94-110); 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.

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 lasted 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 electromechanical shutter to control stimulus exposure time. The stimuli were projected at eye-level through a one-way mirror onto a screen located four feet directly in front of the subject. Reaction time (RT) 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 electordes 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 Laboratory 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 afternoon 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 memory component of the experiment. 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.

Heart 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 continuous recording of the heart rate beginning three seconds prior to orienting question onset and ending three seconds after the imperative 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 preceeding the onset of the orienting questions and the remaining 28 one-second intervals.

Per cent 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 divided by the prestimulus beats per minute.

Analysis and Discussion

As in experiment one, the data was initially subjected to an analysis of sex differences on the dependent 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 $F = .61$, $df = 1/12$, $p \leq .488$). The response latency data for one EMR subject was ommitted 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 (non-retarded $F = .61$, $df = 1/12$, $P \leq .449$; EMR $F = 2.84$, $df= 1/10$, $p \leq .122$). Subsequent reaction time and recall analysis was collapsed over sex.

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 4 presents the results of this analysis. Similar to the recall

---

Insert Table 4 about here

---

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 signficant main effect for levels ($F = 23.860$, $df = 2/52$, $p \leq .001$) (See Table 4). 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

Insert Figure 4 about here

performance for both EMR and non-retarded groups across the three 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.

A correlated T-test comparison of means analysis revealed that the pattern of differences found in experiment one were similarly evident in experiment two. Although the data from experiment two confirm Craik and Tulving's (1975) predictions of a significant increase in recall, following a hierarchical pattern (i.e. physical $<$ phonemic $<$ 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 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 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

Insert Figure 5 about here

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).

Recall: Discussion

In general, the recall results obtained in the present study support those reported by Craik and Tulving (1975). As in experiment one, recall performance was 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. 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.

The predicted superior recall performance for non-retarded subjects was confirmed in this experiment. The overall recall performance analysis resulted in a significant main effect for groups. A concomitant pattern of group means by level was obtained for 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 experimental 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.

Reaction time: Results

Reaction times were (as in experiment one) 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 5). A significant main effect for levels was obtained ($F = 4.288$, $df = 2/48$, $P \leq .01$) and means across

Insert Table 5 about here

levels were 2.720, 2,954, 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. As it was predicted, physical processing resulted in the shortest reaction time, however, decision latencies for phonemic processing were greater than semantic in this experiment, whereas the reverse order had been anticipated for these two levels (see Figure 6). These results are similarly in contrast with the experiment one findings which did coincide with the predictions

Insert Figure 6 about here

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 subject's deliberate attempts during the 17 second interstimulus interval to predict the associated rhyming word stimuli.

Reaction time: Discussion

The above findings provide only partial support for the prediction 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 sucessively 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 time analyses support this conclusion.

As outlined previous, prior investigations using reaction time paradigms, have indicated that retarded subjects demonstrate longer reaction times in comparison with both CA and MA matched non-retarded 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. Therefore it was predicted that non-retarded S_s would demonstrate significantly shorter decision latency times in this study. However, 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) suggested that the hypothesis may hold only for CA as opposed to MA group comparisons.

Heart Rate: Results

The following analyses of the heart rate data were carried out to explore the possibility that the inferior memory performance of EMR S_s in comparison with MA matched intellectually average S_s might be related to an attention deficit. Although the data might be analyzed and interpreted in a number of ways, 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 terms of the amount of heart rate deceleration (attention to the external environment) prior to the imperative word stimuli onset. If retarded subjects suffer from an attentional deficit, it would therefore be anticipated that non-retarded S_s would display a greater amount of heart rate deceleration (i.e. % deceleration) that EMR S_s. 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 (Krupski, 1976). The second area 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). It was anticipated that the greatest % of HR deceleration would occur in preparation for responding to semantic orienting questions since studies have indicated that deeper levels of cognitive analysis progressively demand greater attention for successful processing. 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 affect 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. Thus, any group differences which were found were not attributable 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 Table 6 and Table 7. As it was anticipated, the second-by-second BPM heart rate change scores analyses resulted in a

---

Insert Tables 6 and 7 about here

---

main effect for the last 15 seconds of the trial continuum. ($F = 7.777$, $df = 14/364$, $p \leq .001$). There were no other main 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 for the 28th, 29th and 30th seconds reflect the greatest amounts of heart rate change. The results concur with the prediction that the greatest HR deceleration should occur at the same second interval in which the imperative word stimulus appeared on the screen. Second 29 of the trial continuum coincides with the onset of the imperative 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 S_s 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.

Insert Figure 7 about here

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 8) reveal a significant main effect for early versus late trials

Insert Table 8 about here

($F = 8.506$, $df = 1/26$, $p \leq .01$). 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 ($F = 3.450$, $fg = 1/26$, $p \leq .07$). 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) increase from early to late trials might be attributed to a possible increased effort 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.

Heart Rate: Discussion

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.

It had also been predicted that since words for deeper levels of processing are expected to require greater analysis and therefore greater attention, that 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. It was hypothesized 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 Ss, it was further predicted 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 winners 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 attributed 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.

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 non-retarded 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; Craik 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 these aspects as well.

Differential Learning Conditions

The results of this study indicate that recall performance can be significantly 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 or storehouses, 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) has 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 deficiences; 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 non-retarded and EMR Ss, 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 normal children. Both groups were able to significantly increase their recall performance under the condition of planned intentional learning. It is interesting to note that with the addition of strategic planning, the EMR Ss were able to increase their level of recall to that achieved by the non-retarded Ss 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 intellectually average 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 Vygoysky (1963) suggests: "What the child can do today with adult help, he will be able to do independently tomorrow" (p. 30). 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 EMR and non-retarded 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 analyses 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. EE 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).

Reference Notes

1. Snart, F. A Developmental examination of recall and recognition in a levels of processing paradigm. Paper presented at A.E.R.A, San Francisco, April, 1979.

References

Baumeister, A. A., & Kellas, G. Reaction time and mental retardation. In N. Ellis (Ed.), International review of research in mental retardation, Vol. 3. New York: Academic Press, 1968, pp. 163-193.

Berkson, G. An analysis of reaction time in normal and mentally deficient young men: Variation of complexity in reaction time tasks. Journal of Mental Deficiency Research, 1960, 4, 59-67.

Bernstein, A. J. To what does the orienting response respond? Psychophysiology, 1969, 6(3), 338-350.

Bower, A. C., and Tate, D. L. Cardiovascular and skin conductance correlates of a fixed foreperiod reaction time task in retarded and non-retarded youth. Psychophysiology, 1976, 13, 1-9.

Brown, A. L. The role of strategic behavior in retardate memory. In N. R. Ellis (Ed., International review of research in mental retardation, Vol. 7. New York: Academic Press, 1974, pp. 55-111.

Butterfield, E. C. On studying cognitive development. Paper presented at Lake Wilderness, Washington in June, 1976 as part of a Conference on Applications of Observational-Ethological Methods to the Study of Mental Retardation, 1976.

Clausen, J. Arousal theory in mental deficiency. In M. Hammer, K. Salzinger, and S. Sutton (Eds.), Psychopathology: Contributions from the social, behavioral and biological sciences. New York: Wiley, 1973.

Clausen, J., Lidsky, A., and Sersen, E. Meaurements of autonomic functions in mental deficiency. In R. Karrer (Ed.), Developmental psychophysiology of mental retardation. Springfield, Illinois, Charles C. Thomas, 1976, pp. 39-91.

Coles, M. G. H. Physiological activity and detection: the effects of attentional requirements and the prediction of performance. Biological Psychology, 1974, 2, 113-125.

Coles, M. G., and Duncan-Johnson, C. C. Cardiac activity and information processing: the effects of stimulus significance and detection and response requirements. Journal of Experimental Psychology: Human Perception and Performance, 1975, 55, 75-84.

Craik, F. I. M. A "levels of analysis" view of memory. In P. Pliner, L. Krames and T. Alloway (Eds.), Communication and affect: language and thought. New York: Academic Press, 1973, pp. 45-65.

Craik, F. I. M., and Jacoby, L. L. A process view of short-term retention. In F. Restle, R. M. Shiffrin, N. J. Castellan, H. R. Lindman and D. Pison (Eds.), Cognitive Theory: Volume 1. New York: Erlbaum, 1975.

Craik, F. I. M., and Tulving, E. Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General 1975, 104, 268-294.

Craik, F. I. M., and Lockhart, R. S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.

Das, J. P. Orienting responses of normal and retarded children to verbal stimuli. In R. Karrer (Ed.), Developmental psychophysiology of mental retardation. Springfield, Ill.: Thomas, 1976, pp. 140-183.

Das, J. P., and Bower, A. C. Orienting responses of mentally retarded and normal subjects to word-signals. British Journal of Psychology, 1971, 62, 89-96.

Ellis, N. R. Memory processes in retardates and normals. In N. R. Ellis (Ed.), International review of research in mental retardation, Vol. 4. New York: Academic Press, 1970, pp. 1-32.

Fisher, M. A., and Zeamon, D. An attention-retention theory of retardate discrimination learning. In N. R. Ellis (Ed.), International review of research in mental retardation, Vol. 6. New York: Academic Press, 1973, pp.171-251.

Flavell, J. H. Developmental studies of mediated memory. In H. Reese and L. Lipsitt (Eds). Advances in Child Development and Behavior (Vol. 5). New York: Academic Press, 1970.

Graham, F. K., and Jackson, J. C. Arousal systems and infant heart rate responses. In H. W. Reese and L. P. Lipsitt (Eds.), Advances in Child Development and Behavior Vol. 5. New York: Academic Press, 1970, pp. 59-114.

Johnson, L. C., and Lubin, A. On planning psychophysiological experiments: Design, measurement and analysis. In N. S. Greenfield and R. A. Sterabach (Eds.), Handbook of Psychophysiology, New York: Holt, Rinehart and Winston, Inc., 1972, pp. 125-153.

Jones, D., & Benton, A. L. Reaction time and mental age in normal and retarded children. American Journal of Mental Deficiency, 1968, 73, 143-147.

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

Krupski, A. Heart rate changes during a fixed reaction time task in normal and retarded adult males. Psychophysiology, 1975, 12, pp. 262-267.

Krupski, A. Heart rate changes during reaction time: An approach for understanding deficient attention in retarded individuals. In R. Karrer (Ed.), Developmental psychophysiology of mental retardation. Springfield, Ill.: Charles C. Thomas, 1976, pp. 92-118.

Lacey, J. I. Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley and R. Trumbull (Eds.), Psychological stess: Issues in research. New York: Appleton-Century-Crofts, 1967, pp. 14-44.

Lawson, M. J. An examination of the levels of processing approach to memory. Ph.D Thesis, 1976, University of Alberta.

Liebert, A. M., & Baumeister, A. A. Behavioral variability among retardates, children and college students. Journal of Psychology, 1973, 83, 57-65.

Lockhart, R. S., Craik, F. I. M., and Jacoby, L. L. Depth of processing in recognition and recall: Some aspects of a general memory system. In J. Brown (Ed.), Recognition and recall. London: Wiley, 1975, pp. 75-101.

Luria, A. R. "Psychological studies of mental deficiency in the Soviet Union. In N. R. Ellis, (Ed.), Handbook of Mental Deficiency. New York: McGraw-Hill, 1963.

Luria, A. R., and Vinogradova, D.S. Peculiarities of the orientation reflexes in child oligophrenics. In A. R. Luria (Ed.), The mentally retarded child. New York: Pergamon Press, 1963.

Lynn, R. Attention, arousal and the orienting reaction. Oxford: Pergamon Press, 1966.

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

Moely, B. E., Olson, F. A., Halwes, T. G., and Flavell, J. H. Production deficiency in young children's clustered recall. Developmental Psychology, 1969, 1, 26-34.

Rosch, E. Cognitive representations of semantic categories. Journal of Experimental Psychology - General, 1975, 104(3), 192-233.

Scott, K. G., and Scott, M. S. Research and theory in short-term memory. In N. R. Ellis (Ed.). International review of research in mental retardation, Vol. 3. New York: Academic Press, 1968, 135-163.

Shangi, L. M., Das J. P., and Mulcahy, R. Heart rate, recall and reaction time measures of levels of processing. Perceptual and Motor Skills, 1978, 46, 187-198.

Stern, J. A., & Janes, C. L. Personality and psychopathology. In W. F. Prokasy and D. C. Raskin (Eds.), Electrodermal activity in psychological research. New York: Academic Press, 1973.

Tursky, B., Schwartz, G. E., and Crider, A. Differential patterns of heart rate and skin resistance during a digit transformation task. Journal of Experimental Psychology, 1970, 83, 451-457.

Vygotsky, L. S. Learning and mental development at school age. In J. Simon and B. Simon (Eds.), Educational psychology in the U.S.S.R. Stanford, California; Stanford University Press, 1963, pp. 21-34.

Zeaman, D., and House, B. J. The role of attention in retardate discrimination learning. In N. R. Ellis (Ed.), Handbook of Mental Deficiency. New York: McGraw-Hill, 1963, 159-223.

Table I

Sample Characteristics
Experiment I

SAMPLE	CHRONOLOGICAL AGE (CA)	MENTAL AGE (MA)	INTELLIGENT QUOTIENT (IQ)
42 nonretarded students	mean = 10.2 years (range 9.0 - 12.0 years)	mean = 10.4 years (range 9.0 - 11.9 years)	mean = 102.6 (range 90 - 114) Lorge-Thorndike
42 EMR students	mean = 14.3 years (range 13.2 - 16.7 years)	mean = 10.3 years (range 9.0 - 11.11 years)	mean = 72.5 (range 63 - 80) WISC

Table 2

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	$\leq .0$[illegible]
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

Table 3

ANOVA for Normal VS EMR in Reaction Time: Experiment I

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

Table 4

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 = [illegible]4

Table 5

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	≤.01
Levels x Groups	2	.29	3.001	≤.06
Error	48	.10		

n = 14

Table 6

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 7.

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

Table 8

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

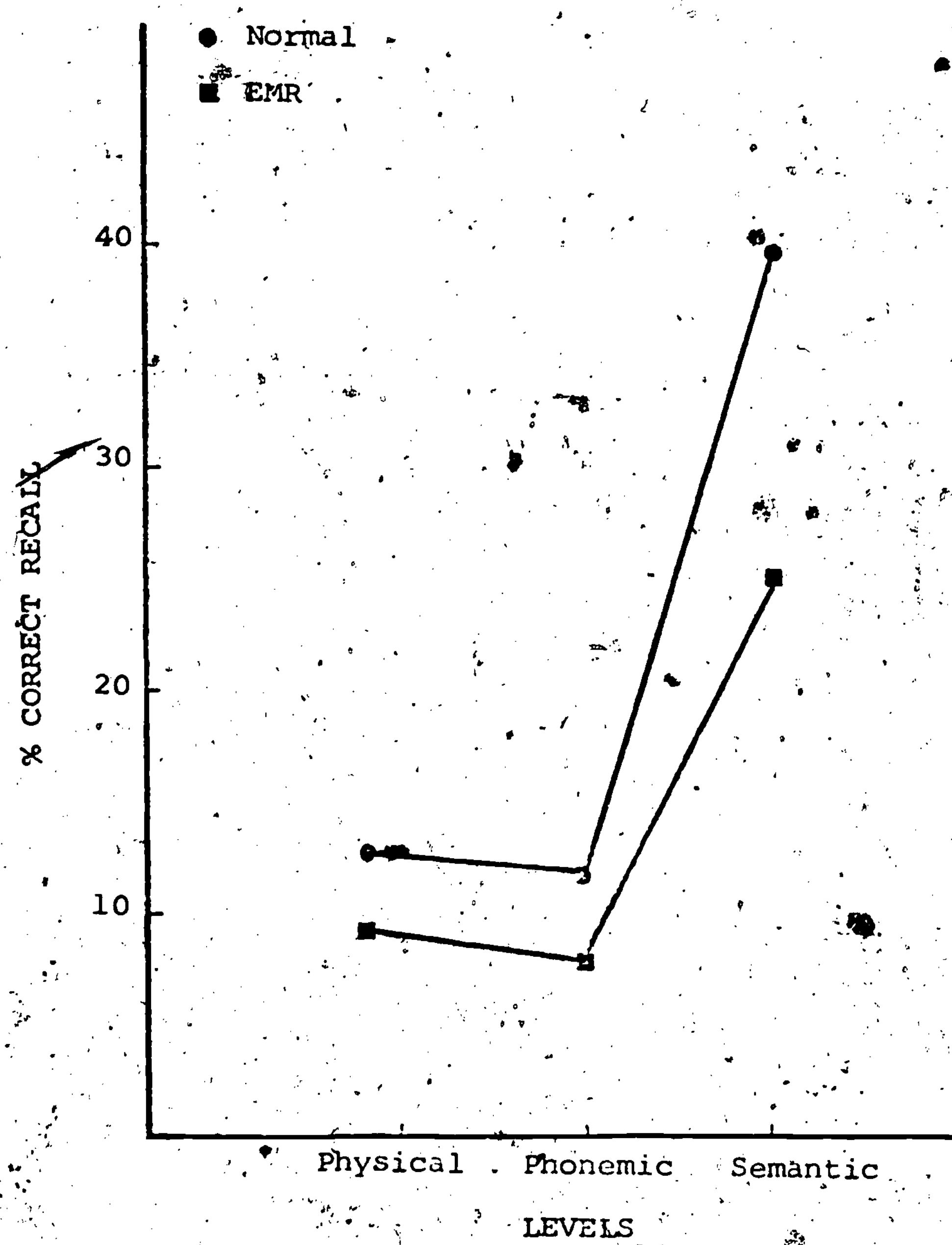


Figure 1. Recall means of groups x levels (collapsed over conditions)

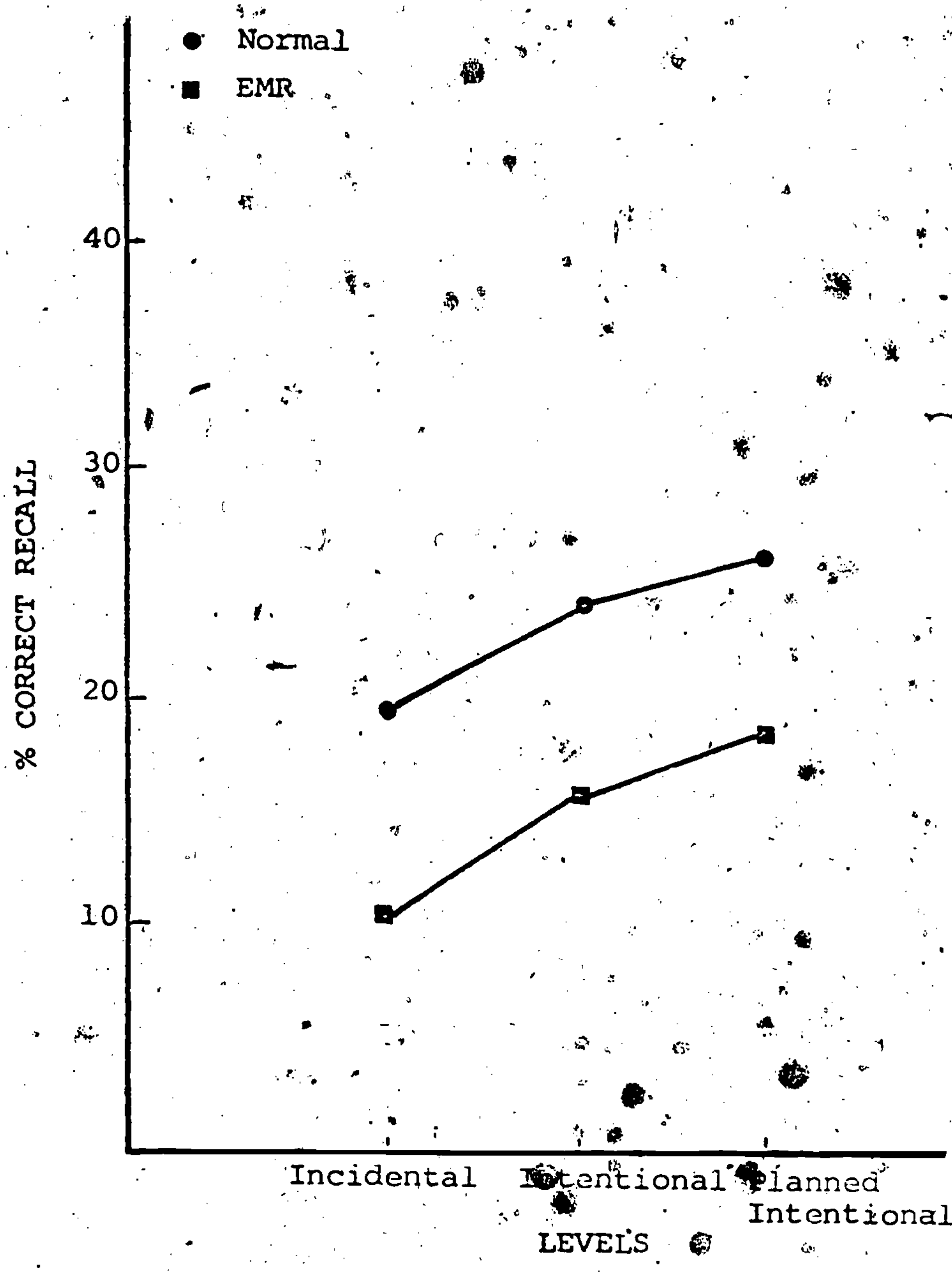


Figure 2. Recall means of groups x conditions (collapsed over levels)

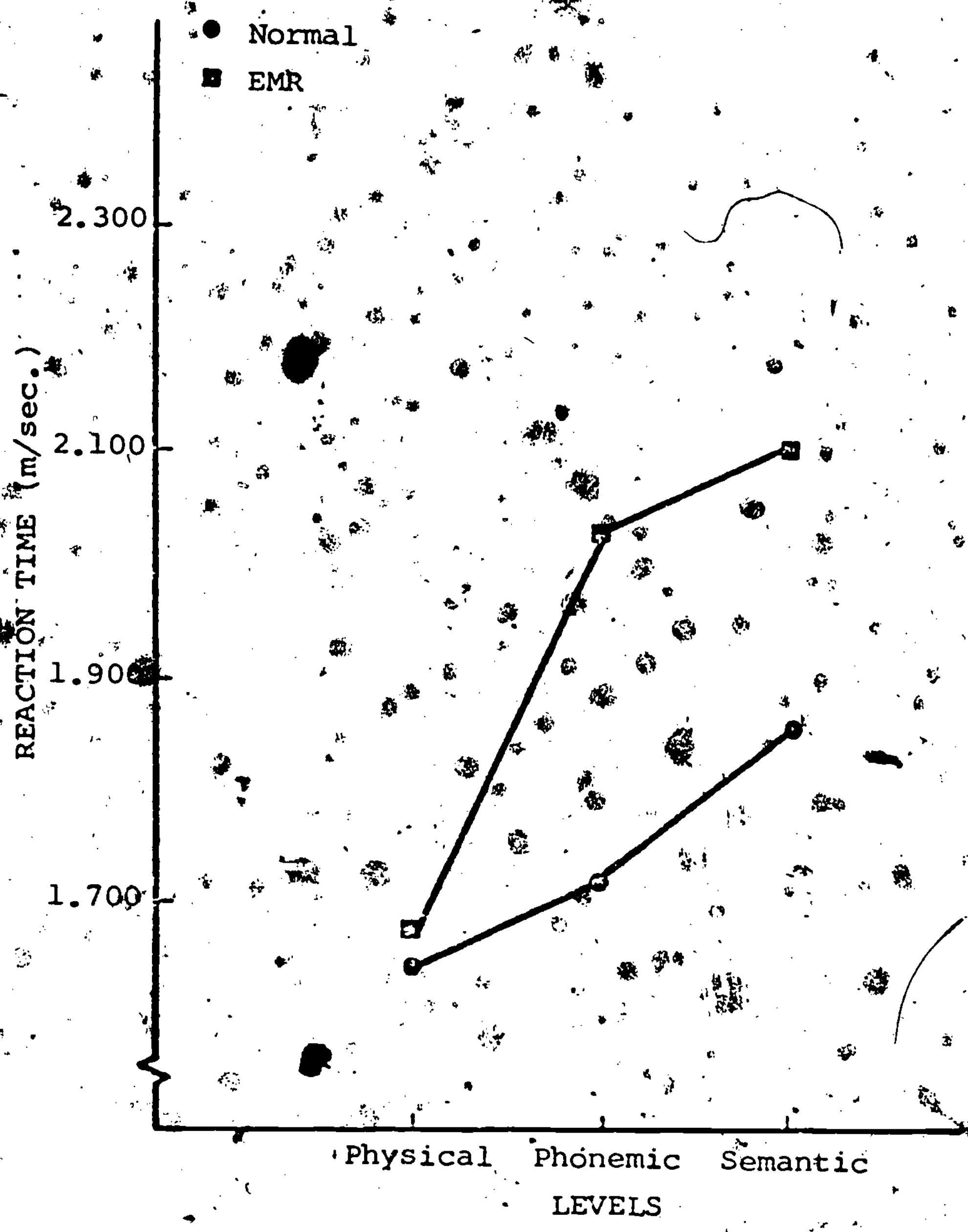


Figure 3. Reaction time means of groups x levels (collapsed over conditions)

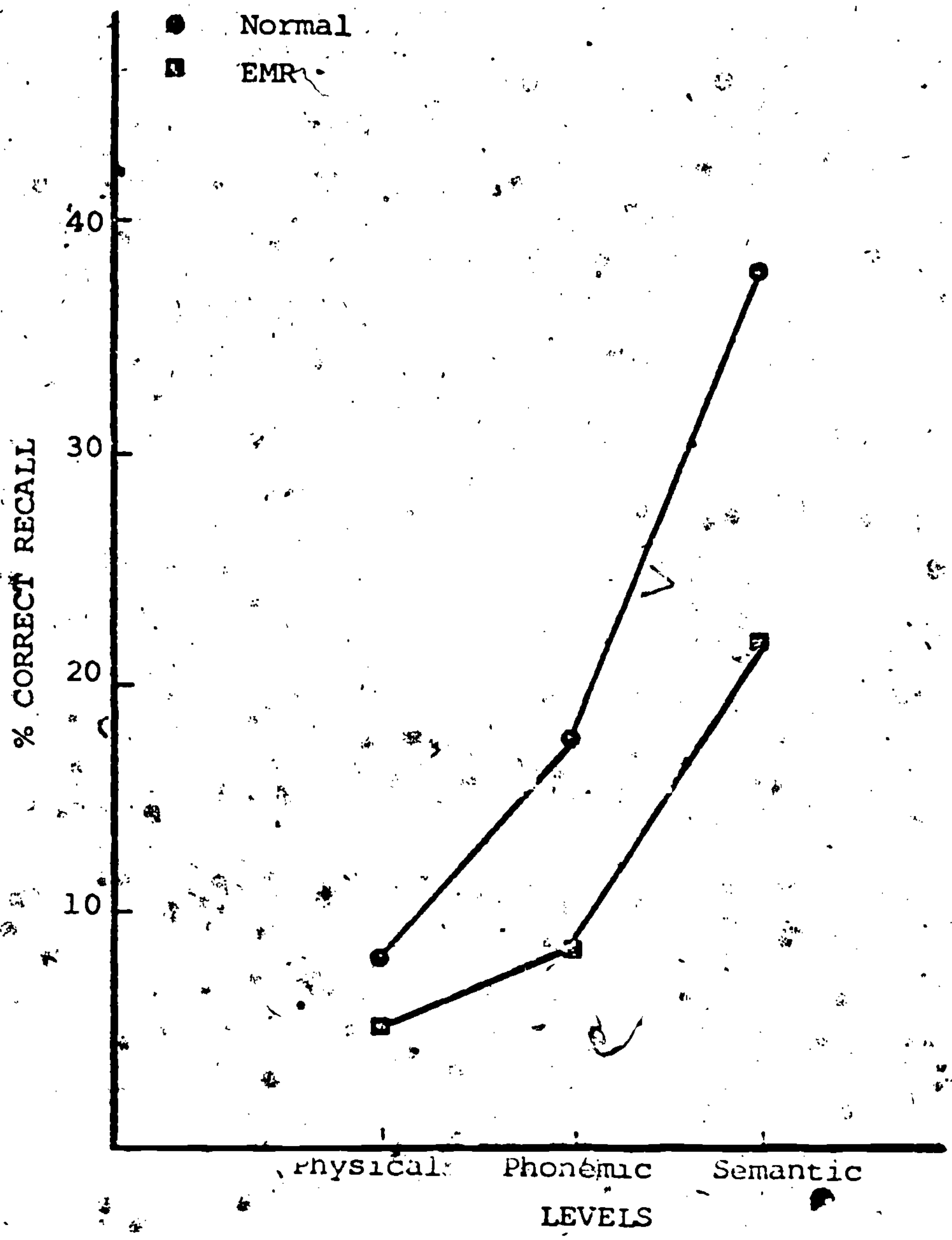


Figure 4. Recall means of groups x levels

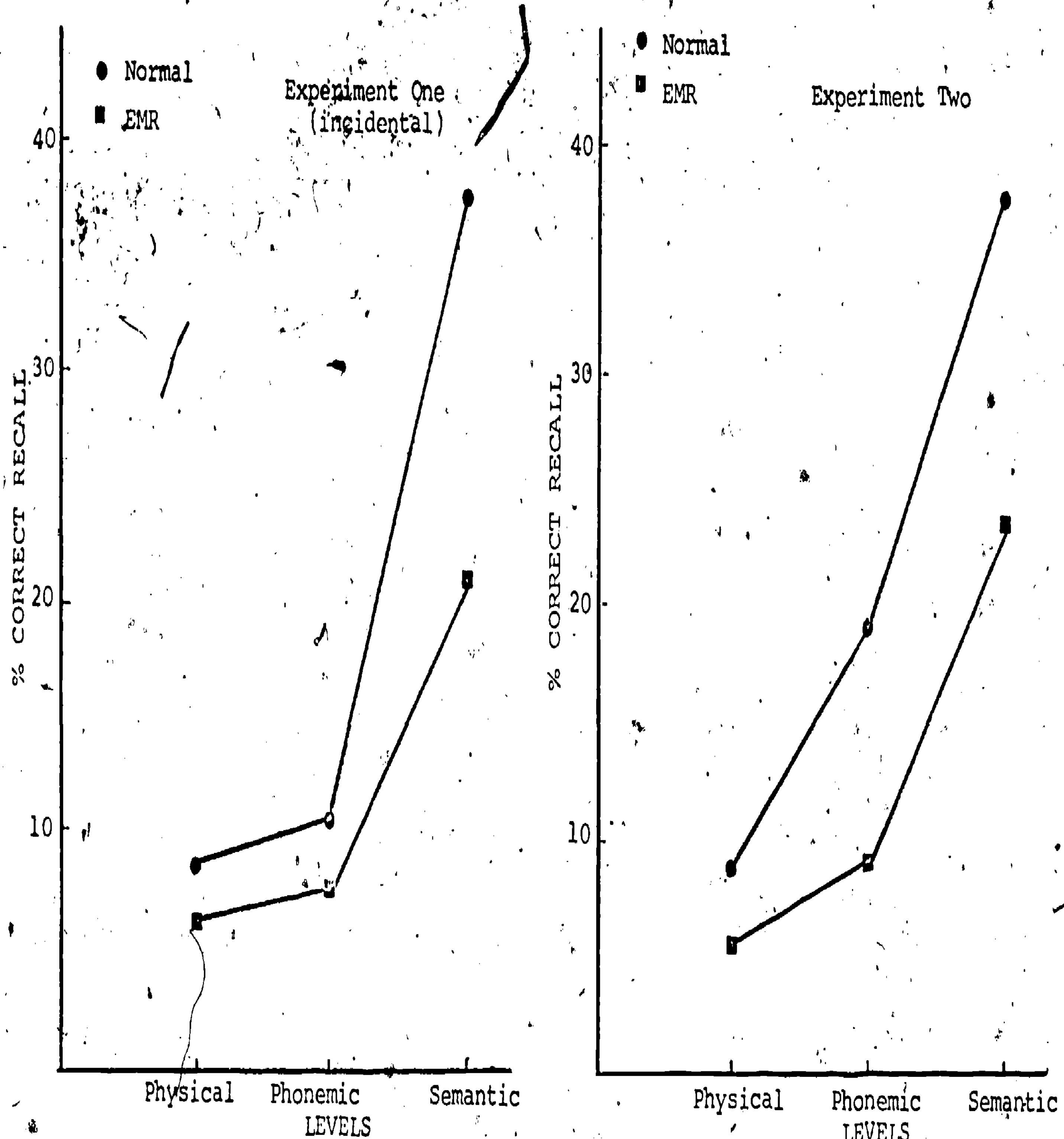


Figure 5. Recall means of groups x levels: Incidental conditions

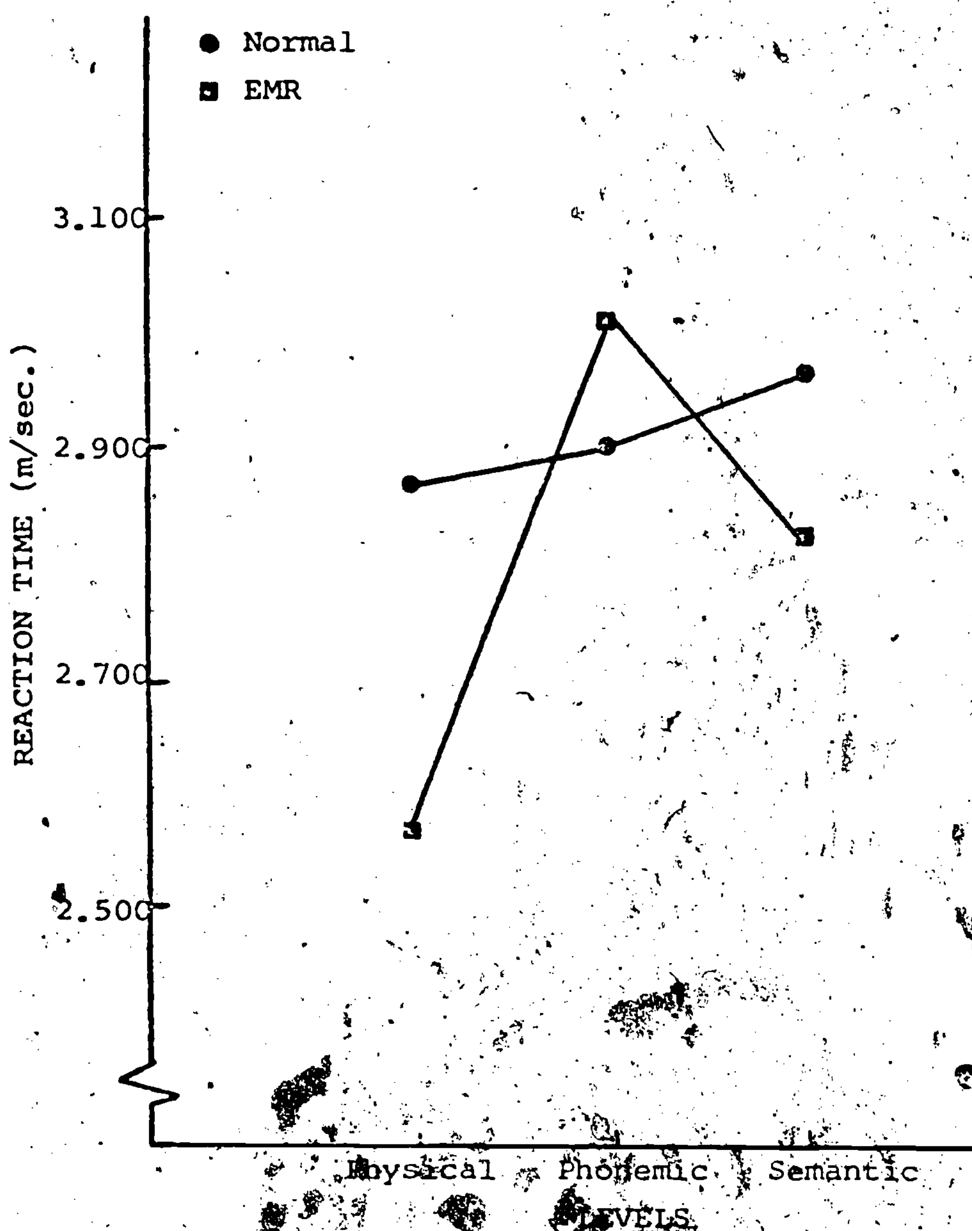
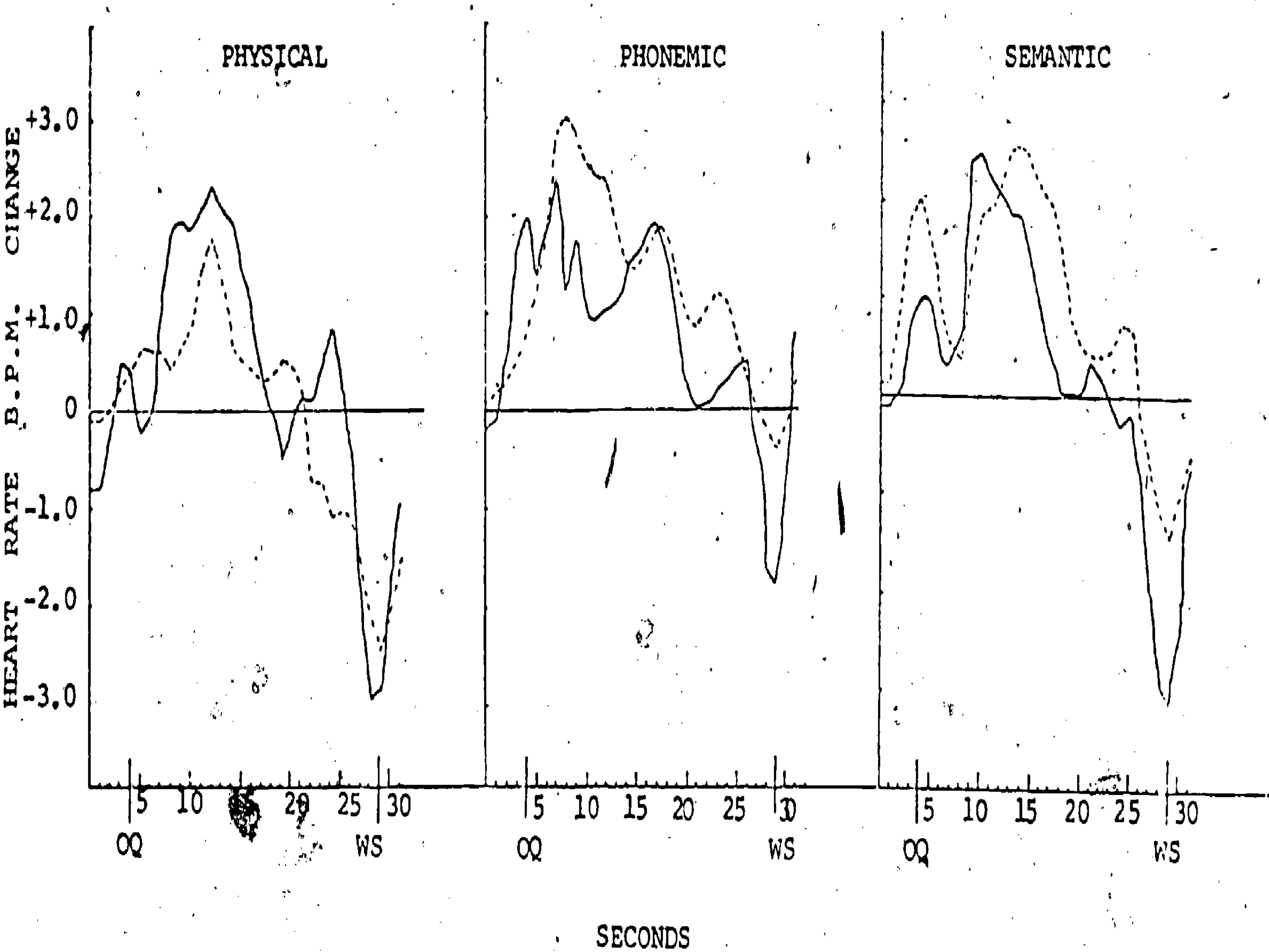


Figure 6. Reaction time means of groups x levels

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 CQ 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 - - - - - -