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Problem solving of children with intellectual disabilities: Interrogative strategies and solution time rates

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PROBLEM SOLVING ABILITIES OF CHILDREN WITH INTELLECTUAL DISABILITIES: INTERROGATIVE STRATEGIES AND SOLUTION TIME RATES.

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Abstract

Possible differences in problem solving abilities between children with intellectual disabilities and regular class children were studied. A comparison was made between the children with intellectual disabilities and regular class children of comparable developmental level (mental age). The children with intellectual disabilities were also compared with regular class children of comparable chronological age.

Subjects completed a preliminary task to determine mastery of the required skills before attempting an experimental problem solving game. The game required subjects to ask questions in order to achieve a problem solution. Each subject's level of motivation to solve the problem was also measured using a Likert-type scale. Three main dependent variables which examined solution time rates and interrogative strategies were generated by the experimental game: (i) time taken to solve the problem, (ii) total number of questions needed to solve the problem, and (iii) type of question generated to solve the problem. A fourth dependent variable, level of motivation to solve the problem, was employed as a moderating variable in other analyses. ANCOVA and ANOVA were used to determine if performance differences existed among the groups on the dependent variables. Single *df* tests were then carried out to identify between-group differences.

The most significant finding was that there were no differences between the children with intellectual disabilities and the regular class children of comparable mental age on any of the dependent variables. A significant difference was shown between the children with intellectual disabilities and regular class children of similar chronological age on each of the dependent variables. No significant differences were found between students in terms of gender on any of the variables. These results indicate that children with intellectual disabilities and regular class children of comparable mental age employ much the same problem solving strategies and have similar solution time rates when involved with problem solving of game-like tasks. These findings support Zigler's developmental theory of mental retardation.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date 27/4/1995

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Table of Contents

		Page
Abstract		ii
Declaration		iv
Acknowledgements		v
List of Tables		ix
List of Figures		x
CHAPTER		
I.	**INTRODUCTION**	1
	Developmental and difference theories of mental retardation	4
	Outcome variables	7
	Purpose of the study	9
II.	**LITERATURE REVIEW**	11
	Developmental/Difference theories	12
	Developmental/Difference literature	13
	Time taken to solve the problem	18
	Questions asked during problem solving	22
	Motivation and problem solving	27
	Gender differences in problem solving	31

III.	METHODOLOGY	35
	Design of the study	35
	Subjects	36
	Instruments	38
	PST questions classification	43
	Procedure	44
	Data analysis	48
	Research hypotheses	49
IV.	DATA ANALYSIS	53
	Results	54
	Time to complete the task	54
	Total questions needed to solve the problem	56
	Types of questions generated to solve the problem	59
	Motivation to complete the task	61
	Summary	63
V.	DISCUSSION	65
	Significance of the results of education	71
VI.	REFERENCES	75
VII.	APPENDICES	84
	(I) Summary tables, time to complete the task	84
	(II) Summary tables, total number of questions covariate motivation B	85

(III)	Summary tables, total number of questions no covariate	86
(IV)	Summary tables, types of questions (redundant questions)	87
(V)	Summary tables, types of questions (redundant questions)	88
(VI)	Graph, motivation to complete task	89
(VII)	Summary tables, motivation to complete task	90

List of Tables

		Page
Table 1.	Subject data.	37
Table 2.	Mean results (and standard deviations) in seconds for the dependent variable "Time to complete the task."	56
Table 3.	Mean results (and standard deviations) for the dependent variable "Total questions to complete the task."	58
Table 4.	Mean results (and standard deviations) for the dependent variable "Types of questions" (redundant).	61
Table 5.	Mean results (and standard deviations) for the dependent variable "Motivation to complete task."	62

List of Figures

		Page
Figure 1.	Motivational probe.	40
Figure 2.	The array of house designs used in the PST.	42
Figure 3.	Graphs of dependent variable "Time taken to solve the problem."	55
Figure 4.	Graphs of dependent variable "Total number of questions needed to solve the problem."	57
Figure 5.	Graphs of dependent variable "Types of questions generated to solve the problem (redundant questions)."	60
Figure 6.	Graphs of the dependent variable "Motivation to solve the problem."	89

CHAPTER I

Introduction

Increasing emphasis has been given to problem solving in curriculum over the last two decades. Problem solving is now considered to be inherent in many domains of knowledge, and has a significant role in most school curricula. Problem solving is used in a variety of guises by most members of society. Rowe (1985) highlights the importance of problem solving as a life skill, noting that "the ability to solve problems is a central prerequisite for human survival" (p. 3). This view is interpreted in educational terms by Gagne (1977) who observes that "educational programmes have the important ultimate purpose of teaching students to solve problems - mathematical and physical problems, health problems, social problems, and problems of personal adjustment" (p. 177).

Problem solving is most often described in contextual terms as a sequential procedure employed to solve conundrums in verbal, numerical, figural and other domains (Mercer, 1992; Education Department of WA, 1983). De Bono (1994) classifies problem solving in practical terms as anything from identifying an antibiotic to take to cure a sore throat, finding the pin in the cushion which is making sitting in a chair uncomfortable, to analysing a high rate of inflation and working out methods by which to reduce it. Woolfolk (1987) discusses problem solving with reference to information processing

theory and identifies four stages of general problem solving. These are stated as (i) understanding and representing the problem, (ii) selecting or planning the solution, (iii) executing the plan and (iv) evaluating the results. While these stages are taken into account, Woolfolk's simpler definition of problem solving as "formulating new answers, going beyond the simple application of previously learned rules to create a solution" (1987, p. 283) is more appropriate to the present study. More specifically, the problem identified for the present study was a *figural problem task*, in that it consists of representational figures made up of a variety of pictorial, diagrammatic, or visual images.

A considerable body of research investigating the problem solving strategies of children in regular classes and special education settings indicates the importance of this subject to researchers (Hughes, 1992; Lacioni, Smeets & Olivia, 1987; Belmont & Mitchell, 1987; Borkowski, Carr & Pressley, 1987). Bray and Turner (1987) highlight the significance of research in this area, reasoning that "by more clearly defining the range of strategic capabilities of mentally retarded individuals, their limitations will be better understood" (p. 49). Despite this apparent wealth of research, Ferretti and Butterfield (1989) maintain that little is known about the differences in cognitive skills between children of different ability levels, and more specifically that there exists "few data about the scientific problem solving strategies of mentally retarded children" (p. 424). Therefore, it would appear that more research into the problem solving strategies of children with intellectual disabilities is warranted.

A greater understanding of the problem solving characteristics of children with intellectual disabilities will impact upon teaching

theory and practice in relation to this population. It will allow teachers to plan more effective curricula and carry out interventions to facilitate the development of problem solving skills. Developing problem solving skills in children with intellectual disabilities may also promote integration into mainstream classrooms where problem solving has become a curriculum priority. Given that problem solving is a skill vital for the individual's successful functioning in society, more knowledge about problem solving is likely to assist teachers in their work in guiding students with intellectual disabilities to fulfil their potential and become contributing members of society.

In order to examine problem solving in relation to the cognitive skills of children with intellectual disabilities, a variety of key concepts need to be defined. These include concepts pertaining to the theoretical framework which underlines the present research and the dependent variables of the study. Major terms used in the study will also be defined.

First of all, it is important to note that the terms *intellectual disability* and *mental retardation* are used synonymously throughout the present study. Although mental retardation has traditionally been delineated by IQ scores (Marozas & May, 1988), Woolfolk (1987) asserts that an IQ score alone is not sufficient to classify a person as having mental retardation. Morgenstern and Klass (cited in Matson & Mulick, 1991) note the increasing support of this view, and point out that a multidimensional approach to assessment incorporates all aspects of behaviour and forms the framework for current assessment practices.

The American Association on Mental Retardation (1992) provides the most recent definition:

> Mental retardation refers to substantial limitations in present functioning. It is characterised by significantly subaverage intellectual functioning, existing concurrently with related limitations in two or more of the following applicable adaptive skill areas: communication, self-care, home living, social skills, community use, self-direction, health and safety, functional academics, leisure, and work. Mental retardation manifests itself before age 18. (p. 1)

The theoretical framework of the present study is related to an ongoing debate within special education known as the developmental - difference controversy. The major point of dispute between developmental and difference theorists is whether the learning of retarded children who have no sign of organic brain dysfunction can be best explained by applying the principles of developmental psychology usually applied to nonretarded children, or whether this learning is symptomatic of more substantive cognitive differences unrelated to general intellectual ability.

<u>Developmental and Difference Theories of Mental Retardation</u>

The central premise of the *developmental theory* of mental retardation is that the performance on cognitive tasks of cultural-familial retarded and nonretarded persons of equivalent developmental level (MA) will be equal, or that any performance

differences occurring between retarded and nonretarded persons of the same MA will be due to motivational and personality factors, not cognitive factors (Zigler & Balla, 1982). Within this context, the term *cultural-familial* is defined as a "form of retardation...involving a combination of environmental (cultural) and genetic (familial) causes" (Zigler et al, 1982, p. 3). Developmental theorists regard people with cultural-familial retardation as normal, in that they fall within the expected distribution of intelligence as determined by the gene pool. Cultural-familial retarded persons typically have mild to moderate mental retardation and are considered to possess the same "basic cognitive equipment" (Zigler & Hodapp, 1986) as nonretarded persons. It is possible that cultural-familial retarded persons differ from nonretarded persons in their rate of development and their ultimate achievement levels.

The difference theory opposes key concepts in the developmental theory. The *difference theory* of mental retardation hinges upon the tenet that retarded and nonretarded persons of equivalent developmental level (MA) will differ in their performance on cognitive tasks due to intrinsic differences in the processing of information by retarded persons which are unrelated to intellectual ability (Zigler et al, 1982, p. 4). The difference theory is also known as the *defect* theory of mental retardation, in that it implies that persons with mental retardation are different, or defective, in some critical aspect of cognitive functioning.

Mental age (MA) must be taken into account when conducting research which is based on the developmental position of mental retardation. This is most simply defined as "a [intelligence test] score

based on average abilities for that age group" (Woolfolk, 1987, p. 139). The concept of mental age is based on the premise that children's mental abilities usually increase with age. For example, on a test of mental age, an average ability 7-year-old child can be expected to perform at a level typical of a 7-year-old, while a 7-year-old with an intellectual disability may perform at a level typical of an average 4-year-old. In this case, the 7-year-old with an intellectual disability would be said to have a mental age of 4 years. The term *MA-match* is also essential to the developmental theory of mental retardation. An MA-match is effected when a child with an intellectual disability is paired with a nonretarded child of a similar intellectual level. Therefore, to provide a nonretarded MA-match to the 7-year-old with an MA of 4 years, it would be necessary to identify a nonretarded child with a chronological age of 4 years.

Two other terms commonly used in research on learning in mental retardation, are most often connected with the difference theory of mental retardation. Chronological age (CA), being a person's actual age in years from the time they were born, is used to effect a *CA-match* in research design, where two subjects are paired because they were born at a similar time. Mental age is usually disregarded in a CA-match. Ellis (1969) notes the significance of chronological age match design to research based on the difference theory of mental retardation, reasoning that "retardates exhibit retarded behaviour...they have defective behaviour when compared to others of a similar chronological age living in their culture" (p. 189). Closely linked to the concepts of MA and CA matching is the *IQ deficit*, which is the lower

level performance of retarded subjects when compared with nonretarded subjects of the same MA on cognitive tasks.

Outcome Variables

The present study examines three major outcome variables. The relevant variables are: (i) time taken to solve the problem, (ii) total number of questions needed to solve the problem, and (iii) types of questions generated to solve the problem. A fourth variable, student motivation to solve the problem, is used primarily as a moderating variable (a covariate) in this study.

Time taken to solve the problem is considered a measure of problem solving efficiency. This is based on the assumption that more effective problem solvers will be able to assess the problem at hand and arrive at a solution more rapidly then ineffective problem solvers, thus supporting the commonly held view that "in the solving of intellectual tasks speed of performance is often considered a characteristic of individuals of high ability" (Rowe, 1985, p. 171). It is also assumed that the nonretarded and older subjects in the sample will be more efficient problem solvers; that is, they will take less time to solve the problem.

The second dependent variable, *total number of questions needed to solve the problem,* is simply the final number of questions the subject asks to complete the problem. All subject questions relating to solving the problem are included in the total, whether they are ineffective or effective. Procedural questions such as "Can I take a guess?" or "Have I asked that question already?" are not included in the total.

The third dependent variable, *types of questions generated to solve the problem,* uses questions classification based on the work of Mosher and Hornsby (cited in Denney, 1974). The four types of questions which can be generated when solving the experimental problem are: (i) hypothesis seeking questions, (ii) constraint seeking questions, (iii) pseudo-constraint seeking questions, and (iv) redundant questions. Within the context of the problem, hypothesis seeking and constraint seeking questions are considered the most effective questions to ask, pseudo-constraint seeking and redundant questions are ineffective and will not lead to rapid problem solution. These classifications allow each subject's interrogative strategies to be examined closely. A full definition of these question types will be given later in the thesis.

Another measure will be included as a moderating variable in this study. *Level of motivation to solve the problem* is considered in two ways. It is examined as an individual dependent variable and is also used as a covariate in the analyses of time taken to solve the problem and total number of questions needed to solve the problem. Accounting for motivation in these analyses provides a stronger research design in relation to the developmental theory of mental retardation, which states that any differences in performance levels by mentally retarded subjects and their MA equivalent nonretarded peers on cognitive tasks will be due to motivational factors. By partialling the effects of motivation from the analyses we are more accurately able to determine the nature of differences between groups.

Purpose of the Study

The purpose of this study was to investigate the differences in problem solving abilities between children with mild mental retardation and regular class children in terms of their performance on a figural problem solving task. The developmental theory of mental retardation, which is part of the developmental/difference controversy, is the theoretical basis of this research. The developmental framework requires that retarded subjects be compared with nonretarded subjects of an equivalent developmental level (MA). Any influences of motivation are partialled in the analyses. Comparing the retarded subjects with nonretarded subjects of an equivalent chronological age provided another point of reference with which to determine differences in performance levels.

The study sought to examine differences on the dependent variables generated by the problem solving task between the retarded subjects and the two groups (MA equivalent and CA equivalent) of nonretarded subjects, after the effects of motivation had been partialled from the analyses. Performance on the dependent variables was examined to determine whether successful problem solvers typically used different strategies or showed different patterns of performance than unsuccessful problem solvers.

The study was structured to determine if children with mild mental retardation are less effective problem solvers than nonretarded children of equivalent MA, and whether these differences can be attributed to motivational effects. The study would also determine where these differences occurred by examining four measures

generated by the problem solving task. If differences were found between the groups and could not be attributed to motivation, the retarded subjects would display an IQ deficit and the study would be supportive of the difference theory of mental retardation. A result which showed no difference between these groups, or a difference which could be due to motivation, would lend support to the developmental theory of mental retardation.

CHAPTER II

Literature Review

The present study was conducted within the framework of assumptions underlying Zigler's (1969) developmental theory of mental retardation. This theory proposes that the cognitive abilities of cultural-familial mentally retarded children can be explained with the principles of developmental psychology. Given that "at least 75% of all those identified as retarded have no evidence of organic brain dysfunction" (Zigler & Balla, 1982, p. 3) the importance of the developmental position to research on mental retardation is clear.

Opposing this position is the difference theory of mental retardation, the main tenet of which is that mentally retarded persons have specific differences in their cognitive functioning which are inherent to general intellectual slowness. These two theories form the developmental/difference controversy, and this chapter will review research relevant to this conceptual issue. This chapter also contains a review of problem solving research. It includes an examination of literature focussing on problem solving measures of time taken to solve prescribed problems, total number of questions needed to solve the problems, types of questions generated to solve the problems, and motivation to solve the problems. Finally, gender differences in problem solving abilities will be considered.

Developmental/Difference Theories

The central premise of the developmental theory of mental retardation, as advanced by Zigler, is that "the performance of [a cultural-familial] retarded person and a nonretarded person of equivalent developmental level (most typically defined by mental age [MA] on an IQ test) on a cognitive task should be exactly the same" (Zigler & Balla, 1982, p. 3-4). Any performance differences that do occur between these groups are thought due to motivational differences between retarded and nonretarded persons, and the common experience of failure which leads to a lowered expectancy of success in retarded individuals.

Contained within the developmental theory are two hypotheses which relate to theoretical constructs derived from the Piagetian literature. The first is the similar-sequence hypothesis, which holds that retarded and nonretarded children span the same stages of intellectual development, but differ in the rate of progress and the upper level of achievement attained. The second tenet, the similar structure hypothesis, is an extension of the central premise of the developmental position, and holds that retarded and nonretarded persons matched for general intellectual development will "be similar with respect to the kinds of cognitive structures described by Piaget" (Weisz, Yeates & Zigler, 1982, p. 217).

In direct opposition to the to developmental theory is the difference position on mental retardation, which maintains that MA-matched retarded and nonretarded subjects will display differing levels of performance on cognitive tasks due to "intrinsic differences over

and above intellectual slowness" (Zigler & Balla, 1982, p. 4). Ellis (1969) has emphasised the resilience of these differences:

> The probability that [retarded persons] will continue to be different, in varying amounts, from normal people in the future is quite high...it seems evident that we are not likely to find a panacea that will normalise retarded behaviour through alterations in "cognitive", "motivational" or other processes. (p. 191).

The difference theorists oppose the developmental position on the grounds that it places too great an emphasis on motivational factors in mental retardation, thus dismissing important cognitive dimensions related to ability level (Milgram, 1969). Conversely, developmental theorists assert that the developmental position is supported on theoretical grounds, especially in cases where etiology is taken into consideration (when all subjects have cultural-familial mental retardation as opposed to organic brain dysfunction). The difference position is often supported if etiology is not seen to be a fundamental consideration in the choice of the research sample (Zigler & Balla, 1982).

<u>Developmental/difference literature</u>

Weisz (1977) found the results of a study of MA-matched retarded and nonretarded subjects on problem solving supported Zigler's developmental position on mental retardation. Subjects were identified at IQ levels of 70, 100 and 130 (Stanford-Binet) and at MA

levels of 5.6, 7.6 and 9.6 years. Subjects were first required to identify the shape, colour, relative size, and letter name of pairs of stimulus cards that differed in these four described dimensions. Subjects were given feedback about their levels of success. The same problem was set for the second condition, and subjects were given feedback about their success at intervals. In the final phase this feedback was scripted and given regardless of the real result of subjects' efforts.

Analysis of resultant data from the Weisz (1977) study revealed non-significant results for the main effect of IQ, implying that subjects of a similar developmental level displayed similar cognitive skills on the experimental task, a finding in accordance with the Piagetian similar sequence hypothesis. Weisz also found that retarded children from regular classrooms were less likely to employ efficient strategies to solve the problem than retarded children from special education classrooms. This suggests that retarded children in specially designed settings may be receiving instruction more relevant to their needs than retarded children integrated into the regular classroom setting. Weisz speculated the results may be due to more realistic expectations of retarded children in the special education classrooms. Performance expectations, so obviously linked with motivation, were seen to be integral to the developmental theory of mental retardation.

Hore and Tryon (1989) also found in favour of the developmental position and the similar structure hypothesis after comparing the performance of mentally retarded adults and nonretarded MA-matched subjects on Piagetian tasks. These tasks were considered to provide a direct measure of cognitive development. The researchers controlled for some of the factors that have been found to

affect motivation by choosing subjects from a population of noninstitutionalised, lower SES, black males and then providing an experience of success, a tangible reinforcer and a pretest to ensure all subjects could comprehend verbal instructions. Subjects with "gross sensory difficulties" (Hore & Tryon, 1989, p. 184) were not included to ensure congruent etiology. The Piagetian tasks were classification into some/all and class inclusion, transivity of length and weight, and conservation of length, weight and area.

Initial analysis of the results found a significant difference between retarded and nonretarded subjects on classification of some/all, transivity of weight and conservation of area, supporting the difference position. However non-significant results were revealed for class inclusion, transivity of length and conservation of length and weight, establishing overall results in support of the developmental position. Results of the transivity of weight and length tasks were discounted after subsequent consideration of task validity, revealing a 4:1 support of the developmental position of mental retardation in the final analysis.

Hayes and Taplin (1993) found that cultural-familial retarded children lagged behind nonretarded chronological age and MA-matched subjects on tests of conceptual knowledge development. Subjects were required to identify visual figures which had been presented to them in 8-second intervals from an array of patterns. Under the test condition retarded subjects relied on information which was more likely to limit successful completion of the task than nonretarded subjects, although the authors speculated that the retarded

subjects may display more complex skills at a much later stage in their development.

Similarly, a study of verbal mathematics problem solving performance of retarded adolescents and MA-match nonretarded children by Bilsky and Judd (1986) revealed significantly inferior performance from retarded subjects. This result occurred despite both groups displaying a comparable performance level on a screening test of computation. Subjects were required to solve mathematical problems, some of which were given verbally in story form and some without the story. Half of all subjects had memory aids (number cards), the other half were only instructed to listen closely to the problem.

Results of the Bilsky and Judd (1986) study revealed that all groups found subtraction problems most difficult, and this effect was magnified for the retarded subjects. A non-significant effect was reported for the memory aids groups. The retarded groups had more difficulty grasping salient aspects of the problems to facilitate successful solution. The authors concluded that the type of problem examined in the study underlined the importance of "ability to understand and represent problems as a source of intelligence-related differences" (p. 402).

Byrnes and Spitz (1977) found a considerable IQ deficit between the performances of institutionalised retarded adolescents and nonretarded MA-match children on the Tower of Hanoi problem. Subjects were presented with 2-and 3-disk problems, and were required to reach a variety of goal states starting from differing pegs. Retarded subjects had difficulty with the 2-disk tasks, and most were unable to

complete the 3-disk tasks. Their efforts were characterised by perseveration and violation of game rules. Although the authors suggested that the retarded adolescents may not have understood the requirements of the game, they concluded that "retarded people perform many years below MA expectation on tasks requiring foresight and logic" (Byrnes & Spitz, 1977, p. 561).

In contrast to the findings of Hore and Tryon (1989) and Weisz (1977), in which retarded and nonretarded MA-match subjects were found to perform at comparable levels on Piagetian tasks, Weiss, Weisz and Bromfield's (1986) meta-analysis of non-Piagetian tests of the similar structure hypothesis revealed overwhelming support for the difference position on mental retardation. The authors reviewed 24 studies, all of which comprised cultural-familial, noninstitutionalised retarded persons matched on MA with nonretarded persons. The studies examined retarded and nonretarded subjects performance on a variety of information processing measures including tests of memory, paired-associate learning, input organisation, selective attention, discrimination learning and learning set, incidental learning, concept usage and matching, hypothesis testing behaviour and humour.

Initial inspection of the studies found the similar structure hypothesis, and therefore the developmental position, supported by slightly more than half of the group comparisons. Weiss, Weisz and Bromfield (1986) argued that the similar structure hypothesis was essentially a null hypothesis in that it predicted no difference between groups, and should therefore be tested against an expected normal distribution of group differences.

A chi-square analysis and meta-analytic procedures were carried out on the data. Results showed a significant deviation from the distribution expected to support the similar structure or null hypothesis. In finding for the difference position, the authors concluded that "for at least some cognitive processes, the nature of basic deficit(s) in mental retardation should be construed as something more profound than merely a slowed pace and lower ceiling of development" (Weiss, Weisz & Bromfield, 1986, p. 173).

In summary, the review of research has revealed equal support for the developmental and difference positions on mental retardation. It is noticeable that studies which control carefully for etiology and developmental level (MA) matching are more likely to produce results supportive of the developmental theory. Studies of performance on Piagetian tasks also favour the developmental position. Conversely, research into non-Piagetian tasks, and studies which are not consistent in etiology or MA-matching of the research sample, tend to favour the difference position on mental retardation. While the present study includes measures to ensure consistency of etiology and developmental level within the research sample, the problem-solving task subjects are required to complete is non-Piagetian. Considering the findings of the studies in this review, there is only partial support for the developmental and the difference theories of mental retardation.

Time taken to solve the problem

The dependent variable, time needed to complete the task, is viewed as a measure of problem solving efficiency in the present study. The subject is considered a more efficient problem solver if he/she

solves the problem in a shorter amount of time than other subjects. It should be noted that several of the studies reported in this section (Spitz, Minsky & Bessellieu, 1985; Sternberg, Waldron & Miller, 1982) consider that a longer planning time is indicative of problem solving efficiency, "because the ability to plan ahead is essential for successful solution of...problems, it is reasonable to assume that planning time will be positively related to performance" (Spitz, Minsky & Bessellieu, 1985, p. 46). Searches of the literature have uncovered few studies of time to complete tasks, but literature has been found on planning and reaction time comparisons between mentally retarded and nonretarded subjects. This is relevant to the present study as planning and reaction time are components of the total time taken to complete a task, and will therefore give some indication of expected performances on this variable.

Spitz, Minsky and Bessellieu (1985) compared mentally retarded institutionalised young adults of three levels of IQ, and nonretarded children matched on MA to the three groups of retarded subjects on the amount of planning time they required when solving the Tower of Hanoi problem. It was hypothesised that planning time would be positively related to performance as the ability to plan ahead was considered vital to the successful solution of transformation problems like the Tower of Hanoi. Subjects attempted to solve three-disc problems requiring four, five, six and seven moves and had only one path to solution, and also attempted six-move problem which had two possible paths to solution.

Results showed that the retarded group had as long or longer planning time than the nonretarded group. It was also revealed that

planning time was not significantly correlated to achievement, which negated the author's suggestion that "retarded persons are too impulsive and therefore do not pause long enough to plan an adequate solution strategy" (Spitz, Minsky & Bessellieu, 1985, p. 55). It was suggested that what took place during planning time was more important to successful problem solving than the actual length of the planning time.

Sternberg, Waldron and Miller (1982) reported similar results from an examination of the relationship between cognitive tempo (the tendency to pause or to give a quick response when presented with a task) and cognitive level in mentally retarded children. Subjects completed the Matching Familiar Figures Test, a test of cognitive tempo, and also completed the Essential Math and Language Skills Inventory, a test of cognitive level. No significant relationship between cognitive tempo and cognitive level was found, indicating that the tendency toward impulsivity or reflectivity was not a predictor of achievement level on cognitive tasks.

Kail's (1992) review of studies on response times of mentally retarded and nonretarded subjects on information processing tasks revealed that the response times of retarded subjects increased relative to the response times of nonretarded subjects under corresponding conditions. Kail found that "these results are consistent with the view that differences in processing speed between persons with and without mental retardation reflect some general (i.e., nontask specific) component of cognitive processing" (p. 333). It was suggested that these global differences could be attributed to retarded persons having fewer resources to allocate to tasks which resulted in slower performance, or

that retarded individuals had a slower "cycle" or cognitive processing time associated with increased time to complete cognitive tasks.

Merrill (1992) also examined response times in relation to resource allocation in subjects with and without mental retardation. Subjects were required to identify matching pairs of stimulus cards containing line drawings of common objects and nonsense forms, while also retaining a full or half memory load of digits. Stimulus pictures were presented asynchronously at varying intervals. In a second condition, subjects were required to respond as quickly as possible to an auditory stimulus in addition to attending to the stimulus cards as in the first condition. Results of the first condition revealed that retarded and nonretarded subjects were influenced by the size of the memory load they were required to carry. Both conditions showed that retarded subjects had fewer attentional resources to allocate to the task and were therefore slower than nonretarded subjects, a result supportive of Kail's speculations about the cognitive resources of mentally retarded subjects.

A much earlier study by Baumeister and Kellas (1968) indicated that the reaction times of mentally retarded individuals were characterised as much by inconsistency as by general slowness of reaction. The researchers analysed several hundred responses to a simple reaction time task from each of six mentally retarded subjects and six nonretarded subjects. Although the retarded subjects were able to produce reaction times comparable with nonretarded subjects in single instances, they were not able to maintain this performance level. This lack of consistency produced a significantly longer mean response time for retarded subjects as compared with nonretarded subjects.

Similarly, Larson and Alderton (1990) reported a strong relationship between high variability of reaction times to intelligence. After testing young adult males on a variety of speeded tasks, results showed that high variability of "worst performance" scores was predictive of lower general intelligence. It was proposed that high variability may be reflective of a "genuine cognitive deficit" (p. 322), or that variability in response times on problem solving tasks indicates lapses in the chaining of working memory operations.

In general, the literature has shown that speed of task completion is predictive of achievement level on problem solving tasks for retarded and CA-matched nonretarded children. However, for comparisons of retarded and MA-matched nonretarded children, this distinction does not apply. Other studies have revealed that retarded children's performance on speeded tasks is most often characterised by inconsistency, rather than impulsivity or general slowness in cognitive processing. From these studies it can be predicted that analysis of the variable time taken to solve the task will not reveal a significant effect in the present study. It is also reasonable to assume that the retarded group (ES) will show a higher degree of variability on solution time rate than the MA or CA groups.

Questions asked during problem solving

The problem solving task employed in the present study required subjects to ask questions of the interviewer to reach a problem solution. Seminal studies employing a student questioning game similar to the one used in the present study to investigate children's problem solving and interrogative strategies were conducted by

Mosher and Hornsby (1966). Nonretarded children aged from six to 11 years were given warm-up picture identification exercises before completing a picture problem requiring student questioning in order to be solved. Students were also tested on a verbal questioning problem. Mosher and Hornsby found that older children asked more complex questions and therefore were more effective at solving this type of problem than younger members in the sample.

Based on this work by Mosher and Hornsby, Denney (1974) employed the student questioning game to compare the interrogative strategies of nonretarded children and mentally retarded children of similar MA. Denney found that in completing the 20-questions task in which subjects asked questions in order to gain information to solve a problem, constraint seeking strategies increased at higher grade levels and with improved mental age. Differences were identified between the way retarded and nonretarded children employed constraint seeking questions and their efficiency in problem solving through the use of that resultant information. The question type classifications identified by Denney are used in the present study.

Borys (1979) also employed the 20 questions procedure to study institutionalised mentally retarded young adults and nonretarded children of similar or lower MA than that of the young adults. Performance of the fourth graders exceeded that of first graders. Retarded young adults were equal or poorer than the first graders, revealing a considerable IQ deficit in this aspect of problem solving. It was found that the younger and retarded subjects asked noninformative (redundant) questions when presented with a negative response to a question. Borys noted that this was supportive

of the findings on concept development by Bruner, Goodnow and Austin (cited in Borys, 1979) which hold that in studies of concept attainment "subjects typically do not effectively utilise examples that tell what something is not...subjects prefer to transfer it into a more direct (i.e., positive) form" (p. 286). Borys also found that the fourth graders asked a comparative number of constraint seeking questions to that of the first graders, whereas Mosher and Hornsby found the first graders asked almost no constraint seeking questions.

Johnson, Gutkin and Plake (1990) used the 20 questions game to investigate the use of modelling procedures to teach constraint seeking interrogative strategies to nonretarded seven and 11 year-olds. Subjects listened to a tape-recording of another child solving the problem before attempting the problem themselves. Three experimental groups were assigned tape recordings that gave varying levels of information about the game, and a control group heard a tape recording that contained mostly redundant information about the game.

Results showed that the three experimental groups asked more of the target constraint seeking questions than the control group. The group exposed to the intermediate information tape asked significantly more constraint seeking questions than the group exposed to the low information tape. There was no difference in the number of constraint seeking questions generated by the groups exposed to the intermediate and high information tapes.

Spitz and Borys (1977) administered logical problem solving tasks incorporating questioning to mentally retarded adolescents and nonretarded children of similar MA to the retarded group. Performance by the retarded subjects was significantly poorer than that

of the nonretarded subjects, leading the authors to state that "there is a profound deficiency in low IQ individuals on certain tasks requiring logic and foresight, and MA markedly overestimates their performance relative to the performance of nonretarded individuals" (p. 415). It was also noted that the retarded and young nonretarded subjects had difficulty asking the right questions to generate the information required to solve the problems. The authors suggested that although the young nonretarded subjects would certainly develop this skill, it was doubtful that the retarded adolescents ever would.

Despite these assertions, Knapczyk (1989) showed that mildly handicapped fourth graders could successfully learn and generalise question-asking strategies from the special education classroom to a regu'ar education setting. Treatment comprised the use of videotaped exemplars from the regular education mathematics classroom, which were used to create opportunities for response rehearsal for the subjects. Frequency of question asking rose from less than two questions per subject during the baseline phase to as many as eight questions per subject during the treatment and follow-up phases. A strong relationship was revealed between the frequency of questions asked by the subjects and their achievement level on assigned mathematics work.

Van der Meij (1990) found that prior knowledge had a significant effect on the number and type of questions students asked in a comprehension exercise. Nonretarded 11 year-olds were identified as having much vocabulary prior knowledge or little vocabulary prior knowledge. In the first experimental condition, students were given a choice of global and specific questions to help them find the correct

synonyms for words. Students were encouraged first to give a provisional answer, then provide their final answer after selecting questions which the experimenter would answer. The same format was used for the second experimental condition, except that students were instructed to generate their own questions rather than choose from a predetermined set.

Results of the first condition revealed a negative relation between prior knowledge and the number of questions asked. It was also found that prior knowledge predicted the pragmatic significance of the questions chosen. The second experiment confirmed that subjects with little prior knowledge asked fewer specific questions and more global questions when required to generate the questions themselves. Student-generated questions also lacked sophisticated information gathering and communicative qualities. Van der Meij noted that, in the second condition, pupils would typically begin to formulate a global question and then, failing to pursue this line of reasoning, attempt to generate a specific question. After failing to ask either question in a successful manner, it was concluded that "knowing that you do not know is not enough to frame a question" (Van der Meij, 1990, p. 510). The author suggested that training in schools was needed to help students become more effective question-askers and thus, more effective problem solvers.

Overall, there is strong evidence in the literature to suggest that retarded children have weaker interrogative skills than nonretarded children. Although retarded children can be successfully taught question-asking strategies, it seems that they are unable to develop these skills without assistance and do not possess compensatory

strategies to facilitate effective problem solving. As a result, retarded children ask more redundant or ineffective questions than nonretarded children and tend to persevere with unsuccessful methods. It is probable that the retarded subjects in the present study will ask more ineffective questions (redundant and pseudo-hypothesis seeking) and fewer effective questions (constraint seeking and hypothesis seeking) than the defined MA and CA groups.

Motivation and Problem Solving

In the present study, motivation to solve the problem was employed as a dependent variable, and was also used as a covariate in the context of analyses of other variables. Motivation is a central concept to the developmental position on mental retardation, as differences in the performance levels of retarded and nonretarded MA-matched children on problem solving tasks are ascribed to motivational factors in the retarded children.

Zigler and Balla (1982) recognised the importance of motivation to academic performance in both retarded and nonretarded individuals. The researchers identified the factors influencing motivation in retarded persons as encompassing social deprivation such as a lack of continuity of care, abuse, neglect and institutionalisation; a high expectancy of failure; the atypical values accorded to certain reinforcers; the heightened sensitivity to external cues when problem solving (outerdirectedness); a low self-concept; and an increased desire for social reinforcement coupled with a notable reluctance to interact with adults.

Most pertinent to the present study is Zigler and Hodapp's (1986) example of typical investigations into the effects of failure and success expectancies on problem solving. The authors describe the most common task in these investigations as a three-choice discrimination problem in which only one item is reinforced intermittently while the other two items are not reinforced. When presented with this task, children with a low expectancy of success are more likely to persist in choosing the partially reinforced item, thus theoretically maximising their chances of success. Children with a high expectancy of success do not display this behaviour, indicating they are more confident to try novel strategies in the hope of being correct more often. It is observed that retarded children also exhibit more of this maximising behaviour than nonretarded children.

These findings are also supported by Zigler, Lamb and Child (1982), who note that "children who experience many failures adopt a life-style oriented toward the avoidance of failure rather than the achievement of success....[and] develop a style of problem solving characterised by dependence, outerdirectedness, and a willingness to be satisfied with limited accomplishments" (p. 68).

Kreitler, Zigler and Kreitler (1990) ascribed performance differences between retarded children and MA-matched nonretarded subjects on tests of mental rigidity to motivational factors, thus supporting the developmental position on mental retardation. Subjects were required to complete seven tasks, in increasing order of difficulty. These comprised changing the arrangement of puzzle pieces, matching marbles to the corresponding "hole" they should be placed in, changing the arrangement of toys portraying a street, changing the

drawing of lines representing routes, suggesting changes in a picture, suggesting changes in a sentence, and card sorting.

The groups did not differ in their performance on the first three easier tests, but did differ on the last four difficult tests, indicating that retarded individuals may not behave in an inherently rigid way until tasks become too complex for them. The authors chose to explain this difference between groups in motivational terms, citing the retarded individuals' expectations of failure as likely to decrease their level of problem solving success. It was also noted that the desire to be correct for the sake of being correct was a stronger motivator for nonretarded children than for retarded children, and this may have been a significant factor in the less rigid performance by the nonretarded subjects.

Pokay and Blumenfeld (1990) studied the relationship between students' motivation and their use of learning strategies, and how these two factors affect achievement. High school geometry students completed a questionnaire designed to measure their perceptions of ability and value, expectations of success in geometry, and their use of learning strategies. The questionnaire was administered at the beginning of the school semester, in the middle of the semester, and again near to the end of the semester. Copies of tests and teacher grading marks were examined to determine actual achievement levels.

The researchers found that early in the semester, motivational factors of expectation and perceived value of geometry were predictors of the use of strategies, and that actual achievement was influenced by the use of these strategies and expectation of achievement. Later in the semester, the perceived value of geometry predicted strategy use, and

achievement was predicted by the use of metacognitive strategies and geometry self-concept. Pokay and Blumenfeld concluded that there was a "change in the relative influence of motivation and use of strategies on grades" (1990, p. 48) over time, implying that different strategies assumed importance depending on how new the material is to the learner.

Durrant, Cunningham and Veolker's (1990) study of the perceived competencies of regular class children, children with learning disabilities, and children with learning disabilities who displayed behavioural disorders, found that subjects with behavioural disorders were more likely to have lower self-concepts than the regular class and learning disabled groups.

Analysis of the data gained from a self-concept measure showed a significant main effect for group, which revealed that the learning disabled subjects with behavioural disorders had a significantly lower overall self-concept than either the regular class subjects or the learning disabled subjects without behavioural disorders. The groups with behavioural disorders also had significantly lower scores on measures of cognitive, social and general self-concept.

In summary, the literature indicates that retarded children are more likely to have lower levels of motivation than CA-matched and even some MA-matched nonretarded children, in some part fostered by negative experiences which set up expectations of failure. It is difficult to apply these findings directly to the retarded children of the present study, as they have not been subjected to many of the detrimental experiences identified in the literature. The retarded children of the present study were not institutionalised, and were all

schooled at education support centres and units which are designed to provide successful and rewarding experiences for these students. Thus, the ES students may display a comparable level of motivation to the ES and CA groups, although the literature indicates that this is unlikely.

Gender differences in problem solving

The present study sought to determine whether any differences existed between male and female children, both retarded and nonretarded, on the specified problem solving task. Although the literature presents divided evidence of gender differences on problem solving tasks, it was initially thought that the present study would reveal males as significantly superior problem-solvers when compared with females.

In a study of the relationship of figural complexity to mental rotation tasks, Bryden, George and Inch (1990) found that males were able to complete mental rotation tasks faster than females. In the first experiment, nonretarded male and female adults were required to identify rotated views of three dimensional figures which were either outline or solid block drawings. The second experiment employed the same procedure with the solid block drawings only.

The researchers found that, although women take more time to perform spatial rotation tasks, they "employ the same general strategy as men" (Bryden, George & Inch, 1990, p. 475). The study was unable to provide clear reasons as to the consistent differences between males and females on the task.

In another examination of mental rotation abilities, Birenbaum, Kelly and Levi-Keren (1994) found small differences

between males and females on some tests, and nonsignificant results on other tests. Subjects completed a pencil-and-paper rotation test, as well as tests relating to numerical and verbal ability, inductive reasoning, associative memory, perceptual speed and accuracy, and speed of closure. Gender differences in speed and accuracy of performance on these tasks were examined.

Results showed that while certain rotation tasks were difficult for both sexes, females were slower and less accurate on the pencil-and-paper test than males. Males also outperformed females on the numerical skills test, while females scored better than men on the associative memory task. Females performed at a slower rate overall then males, which the authors attributed to caution and "obsessive correctness", traits identified by Just and Carpenter (cited in Birenbaum, Kelly & Levi-Keren, 1994) in a complete cognitive analysis of mental rotation tasks.

In contrast to this, Majeres (1990) found females performed faster then males on speeded tasks of matching strings of digits and numerals. In the first experiment, college students were required to identify matching strings of two, three and four digits. A combination of horizontal and vertical examples were given. The second experiment used the same format, but digit strings consisted of eight, 10 and 12 numbers. In a third experiment subjects were required to match strings of three, six and nine upper case letters.

Females performed significantly faster than males on the tasks of matching digit strings, and females also made less errors than males in the first condition. Results showed that vertical matches were more easily made than horizontal matches on the first and second

experiments. Females were once again faster on the task of matching letter strings, and the vertical strings of letters resulted in significantly more matches than the horizontal strings. Majeres concluded "there appears to be a specific sex difference in comparison and decision processes which may be enhanced by differences in encoding processes" (1990, p. 369).

Warrick and Naglieri (1993) also found that females outperformed males on several cognitive tasks. Regular class students aged nine, 12 and 15 years completed tests of planning, attention, simultaneous, and successive (PASS) cognitive processes. The PASS model, as developed by Luria (cited in Warrick & Naglieri, 1993), states that there are "three functional units that provide three classes of cognitive processes responsible for all mental activity" (Warrick & Naglieri, 1993, p. 694).

The PASS cognitive processing tasks examined by Warrick & Naglieri included planning tasks such as making planned connections between items to create a sequence, a visual search for matching pairs from an array of images and developing a code. Simultaneous tasks consisted of identifying an image based on a verbal description, reproducing a geometric shape after the stimulus was removed, and the MAT-EF test, which requires the subject to select an option to best complete a figural problem. Successive tasks required repeating nonsensical sentences, answering contextual questions about the nonsensical sentences, and repeating strings of words presented verbally by the examiner. Attention tasks comprised finding specific numbers from a page which contained various distractors, recalling

colours and colour names from printed cards, and identifying matching pairs of letters from a page, including varying distractors.

Results showed a significant main effect for age, indicating a strong developmental trend as subjects PASS scores increased across the three groups. A significant main effect was also revealed for gender, and it was found that girls outperformed boys on attention and planning tasks with the greatest difference between 9 year old males and females. The authors speculated that these results could provide insight into the greater number of males diagnosed with attention deficit disorders (PASS attention processes) and could also help explain the success of females in reading achievement (PASS planning tasks).

In summary, the literature shows that gender differences are often dependent on the type of task set. It is also shown that females outperform males on many aspects of problem solving, particularly on speeded tasks and problems requiring comprehension. However, males display superior skills on problems requiring the understanding and application of spatial relationships. From this information, it can be predicted that females in the present study will take less time to solve the problem, but it is not possible to predict whether any qualitative differences will be revealed between the sexes on the problem solving task.

CHAPTER III

Methodology

This chapter contains an outline of the design of the study. The dependent and independent variables are specified. The chapter includes a discussion on subject selection, details the instruments used in the study, the methods used to test the hypotheses and data collection procedures. It concludes with a statement of the null and alternative hypotheses.

Design

The hypotheses were investigated using a two-factor research design on the sample, with one additional repeated measures factor. The first independent variable was identified as *achievement group,* from which subjects were drawn (three levels). These achievement groups were defined as follows:

I. children with mild mental retardation

II. equal mental age regular class children

III. equal chronological age regular class children.

Following the composite *F* test, two single-degree-of-freedom contrasts were effected. The group of subjects with mild mental retardation was compared with the equal mental age regular class

group, and then compared with the equal chronological age regular class group.

The second independent variable was *gender* (two levels). Each group comprised equal numbers of male and female subjects. There was one repeated measures factor included, *trials*. This was tested at three levels, defined as Trial 1, Trial 2 and Trial 3.

The four dependent variables identified as relevant to the study were as follows:

1. time taken to solve the problem
2. total number of questions needed to solve the problem
3. types of questions generated to solve the problem
4. level of motivation to solve the problem.

Subjects

Subjects were drawn from seven Western Australian government primary schools and their adjoining Education Support Centres in the Perth metropolitan region. All students in the sample were tested and six groups within a 3 x 2 factorial design were identified. A total of 26 students were randomly selected from the larger population for each group. Each of the three achievement groups contained 13 males and 13 females, thus creating six groups of 13 subjects. In addition, students were omitted from the total sample if their mental age was below 5.3 years (50th percentile) on Raven's Coloured Progressive Matrices (1990). This applied to students from the Education Support Centres. Table 1 shows the mean mental ages and chronological ages for the groups.

Table 1. Subject data (and standard deviations).

Group	Mean mental age	Mean chronological age
ES males	7 years 6 months (0.84)	10 years 2 months (0.74)
ES females	7 years 6 months (1.23)	10 years 3 months (0.68)
MA males	7 years 9 months (0.87)	7 years 1 month (0.65)
MA females	7 years 5 months (0.93)	7 years 1 month (0.78)
CA males	10 years 2 months (1.94)	10 years 1 month (0.62)
CA females	10 years 8 months (1.77)	9 years 11 months (0.81)

The first group contained males from Education Support Centres (ES males), identified as those scoring around the 10th percentile for their age on Raven's Coloured Progressive Matrices. The second group comprised females from the same classrooms, also scoring around the 10th percentile on Raven's Coloured Progressive Matrices (ES females). The third and fourth groups were boys and girls respectively, of appropximately the same mean mental age (MA males and MA females) as the first and second groups (ES males and ES females). Groups three and four (MA males and MA females) were younger in age than groups one and two (ES males and ES females).The fifth group was made up of males from regular classrooms (CA males) which contained subjects with approximately the same mean chronological age as the first group (ES males). The sixth group comprised females from regular classrooms (CA females)

which contained subjects with approximately the same mean chronological age as the second group (ES females).

Instruments

The sequence of tasks involved a motivational probe, a preliminary task and an experimental game titled The Problem Solving Task (PST). Raven's Coloured Progressive Matrices test was administered to determine the subjects' mental ages.

Raven's Coloured Progressive Matrices

The Coloured Progressive Matrices (CPM) test is a modified version of the Standard Progressive Matrices test. The CPM was chosen for this study because it measures figural reasoning skills. The CPM has three sets of 12 items, providing opportunities for subjects to develop a consistent theme of thought. The items require identification of salient features in figural patterns, a process similar to one of the abilities required to solve the more extended experimental problem solving task. The test has shown a test-retest reliability of almost 0.9, and split-half reliability of 0.9 for 9 year olds (Raven, 1990). The 1987 Dumfries standardisation of the test was used to assess subjects in this study. This standardisation population includes children with intellectual disabilities.

The subjects' average figural mental ages were calculated by matching their raw CPM score with a 50th percentile score on the score conversion table. For example, a subject may be 9.6 years old and have a raw CPM score of 17. This would place the subject at the 7th percentile for someone of the same chronological age. However, the

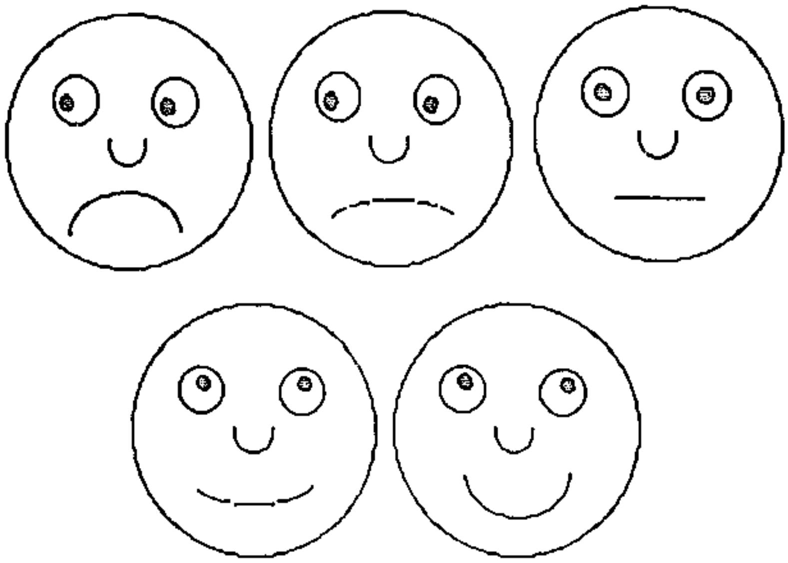
same raw score would place 6.6 year old subject at the 50th percentile for someone of comparable chronological age. Thus, although the subject may have a chronological age of 9.6 years, they have an average mental age (figural) of 6.6 years. Sets A, Ab and B (book form) of the CPM were administered to all subjects.

Motivational Probe

The motivational probe was developed to assess motivation to complete the set problem solving task. The materials used in this exercise required five round "faces" measuring 5cm diameter were printed on an A4 sheet of paper. The faces represented a Likert-scale type graduation from *very unhappy, unhappy, neutral, happy* to *very happy* and these were placed randomly on the page. Subjects were required to point to a face that corresponded with their motivation to complete the task. For scaling purposes the faces were numbered 1 to 5 for very unhappy to very happy, with the number 3 given to the neutral category. An example of the motivational probe is depicted in Figure 1.

Specific instructions regarding the administration of the scale are provided later in the chapter. The probe was judged to have good content validity, considering that responses were borne out by corresponding behaviour in pilot studies. In depth questioning during pilot studies showed children had a good grasp of the levels of like and dislike represented by the faces and understood the connection between the faces and their willingness to continue a task. It was stressed to subjects that they were not expected to choose the "very happy" category to please the researcher.

Figure 1. Motivational probe. The faces represent *very unhappy, unhappy, neutral, happy, very happy* feelings.



Preliminary task

Two matching sets of five cards measuring 8cm x 12cm were made. Each card displayed an enlarged colour image of a house from the experimental game on one side and was undecorated on the other side. The preliminary task was designed as a smaller version of the PST. Mastery was defined as solving the preliminary task three times out of a possible five.

Experimental game - The Problem Solving Task (PST)

The PST apparatus was constructed from the board of a commercially available similar game, Guess Who? (Milton Bradley,

1987). The plastic gameboard measured 30cm x 24.5cm and housed an array comprising 24 hinged frames set as three rows of eight frames. The frames measured 3.5cm x 6cm, and each contained a printed card measuring 3cm x 4.5 cm. The frames could be moved to reveal or conceal individual cards. Each frame contained a simple image of a house, created using square, oblong and trapeze shapes. An example of the figures used in the game is depicted in Figure 2.

The houses had seven dimensions, which were further divided into colour attributes as follows:

Dimension 1. Roof colour	(red, brown, blue, yellow)
Dimension 2. House colour	(red, blue, yellow, green)
Dimension 3. Door colour	(red, blue, yellow, green)
Dimension 4. Chimney colour	(blue, yellow, green)
Dimension 5. Number of windows	(one, two or three)
Dimension 6. Number of chimneys	(none or one)
Dimension 7. Smoke from chimney	(none or some)

Combinations of these dimensions were organised so that no two houses were exactly alike, and houses differed in one or several dimensions. For example, the array contained two green houses, each with a blue roof, two windows and no chimney. The houses differed in that one house had a red door, the other was yellow.

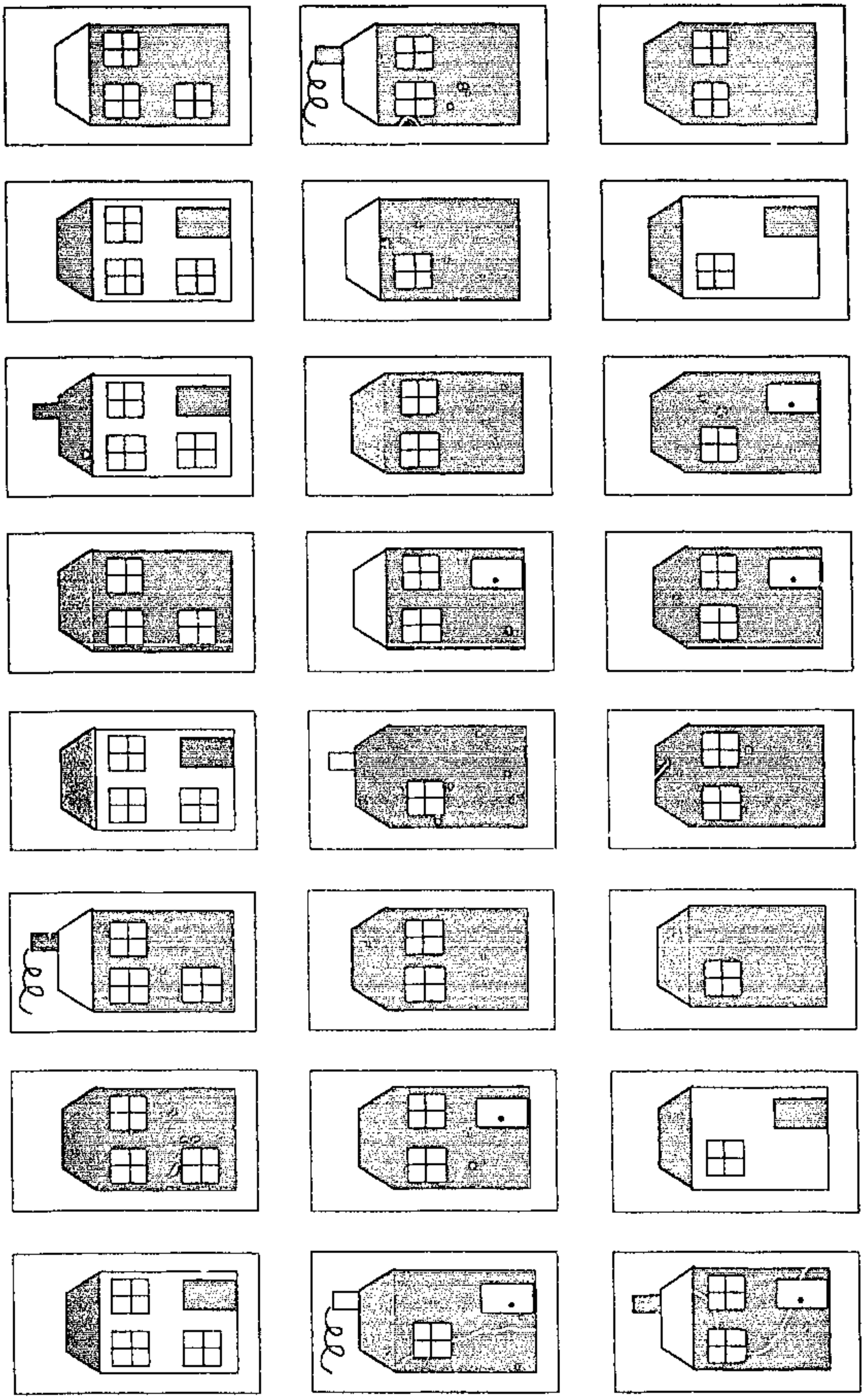


FIGURE 2
The array of house designs used in the PST game.

PST Questions Classification

The PST required subjects to ask questions to solve the problem. These questions were classified using the same procedure reported by Mosher and Hornsby in Denney (1974) for their work with a similar 20 questions problem solving task. The classifications were:

1. *Hypothesis seeking questions.* These test a specific, self-sufficient hypothesis bearing no relation to previous questions. For example: Is it this house with the brown roof, one window and a chimney?

2. *Constraint seeking questions.* These are general questions which can eliminate a number of alternatives from the array. For example: Does it have a blue roof?

3. *Pseudo-constraint seeking questions.* These sound similar to constraint-seeking questions but in fact only refer to one item in the array. For example: Does it have a blue roof? asked when one house with a blue roof and three houses with red roofs are left standing.

A fourth classification was added after it was noted in pilot studies that subjects occasionally generated questions which either furnished a repeat of information they had already acquired, or gave information which did not contribute to solving the game. These were identified as redundant questions, defined as follows:

4. *Redundant questions.* These questions can sound similar to constraint seeking questions but the answer provides the subject

with no additional information to solve the problem. For example: Does it have a blue roof? asked when only houses with blue roofs are left standing.

Procedure

All children were tested individually. Wherever possible, testing took place in a comfortable room at a desk provided with two chairs, one for the researcher and one for the subject. An individual data-recording sheet was used to record responses to Raven's CPM, the preliminary task and the motivationai probe. The three trials of the PST were tape recorded and results were transcribed onto the data-recording sheet at a later time. The testing session lasted approximately 25 minutes for each child.

The interviewer first thanked each subject for taking the time to come and do some work with the experimenter. Subjects were told they might find some of the problems very easy, and they might find some of the other problems quite difficult. The examiner made it clear to each subject that it did not matter how well or how poorly they did at the work, they should "try their hardest". The Raven's Coloured Progressive Matrices test was given first in accordance with testing instructions. Each subject's responses were recorded by the researcher. This allowed subjects to concentrate more fully on completing the test and aided those who may have had difficulty writing their own responses. The level of (figural) mental age was then identified by matching the child's raw CPM score with a corresponding 50th percentile age on the standardised data.

Children were then given the first motivation probe. The interviewer used the following explanation with each subject:

> These faces show different feelings. This one (researcher indicates position) is very unhappy, this one is quite unhappy, this one is in-between, when you're not feeling too happy or too sad. This face is happy, and this face is very happy. I'm going to ask you to point to the face that best shows how you feel about something. Remember, I want you to be very truthful about this. You don't have to point to the face you think I want you to point to. I want you to tell me the truth - and I promise I won't tell your teacher which ones you point to. For example, could you point to the face that shows me how you feel about eating ice-cream? Could you point to the face that shows how you feel about being made to eat mud?

Subjects were then asked to respond to two questions in reference to completing the Ravens CPM test: "Would you like to do more of this sort of thing?" and "Would you like to do harder ones of this sort of thing?" by pointing to one of the five faces on the motivational probe which best showed their level of motivation. The interviewer recorded the number (1 to 5) allocated to the face the subject chose on the subject's data sheet.

The preliminary task, comprising two sets of cards with pictures of houses on them, was given after the first motivation probe. The interviewer laid out one of the sets of cards one by one in front of the

subject. Subjects were randomly asked: "What colour is this roof?" and "How many windows does this house have?" This was done to ensure they were familiar with the basic pictorial elements that characterised the houses. The interviewer said to each child:

> I've got exactly the same set of cards here as you have (showing child the second set of cards). I'm going to choose one card, and I'm not going to let you see which one I've chosen. Right, I've chosen my card. Now on my card is a picture of a house, and it's exactly the same as one of the houses you've got in front of you. You have to find out which house I've got here by asking me questions about my house. You can only ask me about one thing at a time, and I can only say yes or no to you. For example, you might ask me 'Does your house have a blue roof?' and I will either say *yes*, my house has a blue roof or *no*, my house does not have a blue roof. If you know it cannot be a certain house, you turn that picture over. The way you win is to have all houses turned over except one. If you've got it right, the one house left standing at the end of the game will be the same as the house I have in my picture here. Remember that I will only say yes or no to your questions, and you must keep asking questions until you have turned over all the cards except one.

Children were required to solve the preliminary task three times out of five chances in order to reach mastery and progress on to the

PST. This was recorded as a successful/unsuccessful attempt on the recording sheet. The same answers (houses) were given to each child in the same order. All subjects tested were able to reach understanding of the requirements of this task.

Children next completed three trials of the PST. They were shown the array of houses on the gameboard and given the following instructions:

> This is just like the game with the cards, but it has more houses. Take your time to have a good look at all the houses. You need to ask the same sort of questions to solve this problem. The way you win is to have only one house left standing. Instead of turning cards over, this time you flip the pictures down. Remember, I will only give yes or no answers, and you must keep asking me questions until only one house is left standing. We will play this game three times. I'm going to turn on a tape recorder now and record what you and I say. It's nothing to worry about, it just makes it easier for me to work out later what we did.

The three trials of the PST were tape recorded. The trials were later transcribed onto each of the subject's data recording sheet. The questions generated by the subjects to solve the problem were identified according to the classifications described earlier. The length of time to complete each trial was determined by timing the tape recording of the length of time it took the child to solve the problem

and thus complete the task. Timing commenced after the examiner said "Ask me a question about my house" and finished when the last picture was heard to be turned down. The same three correct answers (houses) were given to each child in the same order.

After the three trials of the PST, children were again shown the motivation probe. The interviewer explained:

> This is the last thing you have to do for me. We're going to look at these faces again (indicating probe). Remember the big game we've just played three times, and I want you to be very truthful here because you know it's very important to me. Can you please point to a face that best shows how you would feel about doing *more* of that big game? (record response). Now point to a face that best shows how you would feel about doing a *harder* type of that big game.

Subjects were praised for their hard work and given a small token for participating in the study.

Data Analysis

Analysis of covariance, analysis of variance and one-way analysis of variance were used to test the hypotheses. Motivation was the covariate in selected instances, so that the effects of motivation could be partialled from the analysis. This is in keeping with the developmental theory of motivation, which holds that any differences in performance on cognitive tasks between retarded children and nonretarded children of a similar developmental level will be due to

personality and motivational factors. By partialling motivation from the analyses, it is possible to determine whether the data is in accord with Zigler's (1969) developmental theory of problem solving in this context.

Research Hypotheses

(1) *Null Hypothesis (H_0):* There will be no significant interaction between the factors of achievement group and trials, after motivation has been partialled from the analysis. This hypothesis will be applied to the three dependent variables: time taken to solve the problem, total number of questions needed to solve the problem, and types of questions generated to solve the problem.

H_1: There will be a significant interaction between the factors of achievement group and trials on each of the dependent variables, after motivation has been partialled from the analysis.

Statistical test: ANCOVA was the statistical procedure used to test the hypothesis.

Significance Level: Alpha was set at 0.05.

(2) *Null Hypothesis (H_0):* There will be no significant interaction between the factors of achievement group and gender, after motivation has been partialled from the analysis. This hypothesis will be applied to the three dependent variables: time taken to solve the problem, total number of questions needed to solve the problem, and types of questions generated to solve the problem.

H_1: There will be a significant interaction between the factors of achievement group and gender on each of the dependent variables, after motivation has been partialled from the analysis.

Statistical test: ANCOVA was the statistical procedure used to test the hypothesis.

Significance Level: Alpha was set at 0.05.

(3) *Null Hypothesis (H_0):* There will be no significant main effect for the factor of trials on each of the dependent variables, after motivation has been partialled from the analysis.

H_1: There will be a significant main effect for the factor of trials on each of the dependent variables, after motivation has been partialled from the analysis.

Statistical test: ANCOVA was the statistical procedure used to test the hypothesis.

Significance level: Alpha was set at 0.05.

The key hypotheses for this thesis are (4), (5), (6), and (7).

(4) *Null Hypothesis (H_0):* The average score of the ES, MA and CA groups on the time related variable will be the same for each group, after motivation has been partialled from the analysis.

H_1: The average score of the ES, MA and CA groups on the time related variable will differ across groups, after motivation has been partialled from the analysis. Single-degree-of-freedom tests of subsidiary hypotheses is appropriate if H_0 is rejected. The ES group will be individually compared with the MA and CA groups.

Statistical test: ANCOVA was the statistical procedure used to test the hypothesis.

Significance level: Alpha was set at 0.05.

(5) *Null Hypothesis (H_0):* The average score of the ES, MA and CA groups on the total questions variable will be the same for each group, after motivation has been partialled from the analysis.

H_1: The average score of the ES, MA and CA groups on the total questions variable will differ across groups, after motivation has been partialled from the analysis. Single-degree-of-freedom tests of subsidiary hypotheses is appropriate if H_0 is rejected. The ES group will be individually compared with the MA and CA groups.

Statistical test: ANCOVA was the statistical procedure used to test the hypothesis.

Significance level: Alpha was set at 0.05.

(6) *Null Hypothesis (H_0):* The average score of the ES, MA and CA groups on the types of questions variable will be the same for each group.

H_1: The average score of the ES, MA and CA groups on the types of questions variable will differ across groups.

Statistical test: The chi-square test was the statistical procedure used to test the hypothesis.

Significance level: Alpha was set at 0.05.

(7) *Null Hypothesis (H_0):* The average score of the ES, MA and CA groups on the motivation variable will be the same for each group.

H_1: The average score of the ES, MA and CA groups on the motivation variable will differ across groups.

Statistical test: ANOVA was the statistical procedure used to test the hypothesis. Single-degree-of-freedom tests are appropriate if H_0 is rejected.

Significance level: Alpha was set at 0.05.

These are the key hypotheses. It is presumed all other effects, including the three-factor interactions, will reveal non-significant findings.

CHAPTER IV

Data Analysis

Children from education support centres were matched with a group of regular class children of a similar mental age, and also with a group of regular class children of a matched chronological age. All children played a problem solving game on three occasions and were tested individually. The game required children to ask questions of the interviewer to determine which was the chosen picture from an array of similar images. The experimenter could only answer "yes" or "no" to the questions. The data gained from this is represented as the four dependent variables of the study:

1. Time taken to solve the problem
2. Total number of questions needed to solve the problem
3. Types of questions generated to solve the problem
4. Motivation to solve the problem.

The independent variables were group, gender and trials. For the first and second analyses (time and total number of questions respectively) the data were examined using ANCOVA. Kruskal-Wallis One-Way ANOVA was used for the third analysis (types of questions). The fourth analysis (motivation) was carried out using ANOVA. Motivation to complete the task was also used as a covariate for the first

and second analyses. All data were analysed on the SPSS (Norussis, 1993) program.

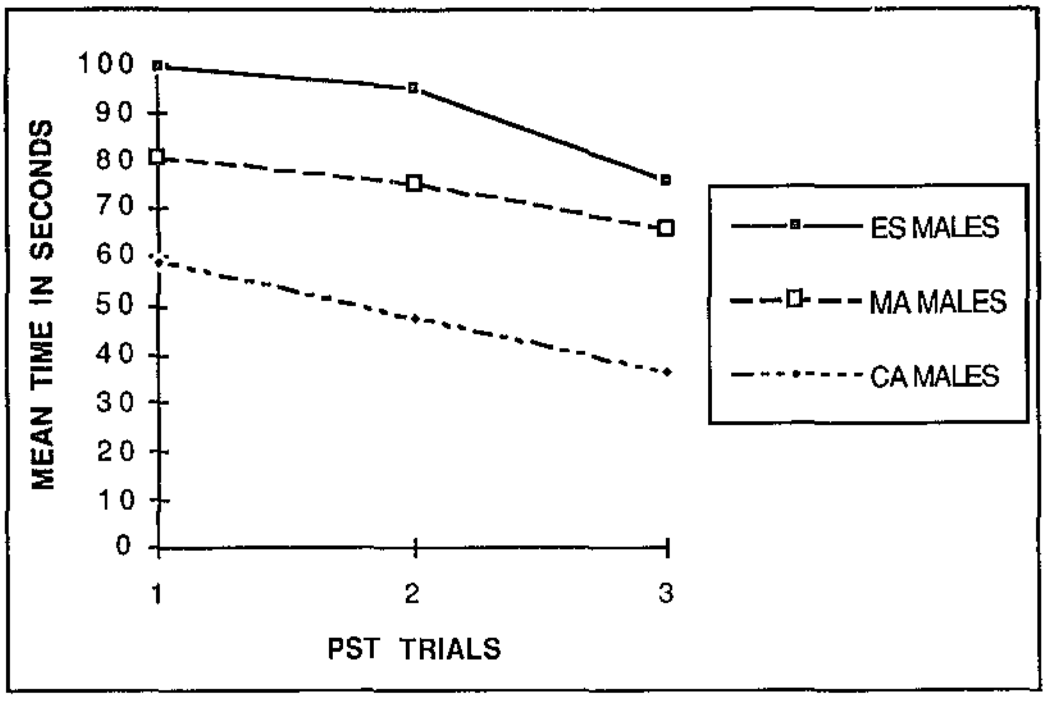
Results

The results reported in this section will be on each of the four analyses in the following order: (1) time (2) total questions (3) types of questions (4) motivation.

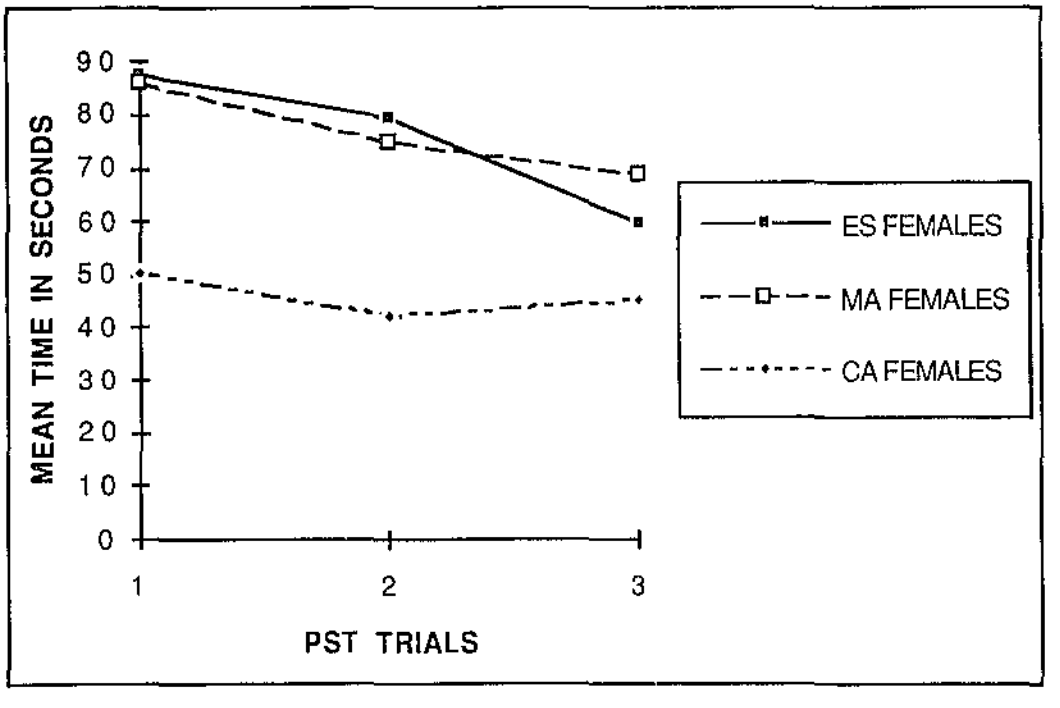
Time to complete the task

This variable, considered by the researchers to be a measure of problem solving efficiency, was analysed in relation to the independent variables, with motivation B (the result of the second motivation probe) as the covariate. This allowed motivation to be partialled from the analysis. The unadjusted mean times to complete the task are shown in Table 2 by group. Figure 3 depicts a graphical display of the data.

Despite a superficial appearance of differences revealed in the graph (Figure 3), the hypothesised interaction between group, time to complete the task and gender, analyses revealed a non-significant (F (2, 71) = .94, $p > .05$) effect. A non-significant main effect (F (1, 71) = .72, $p > .05$) was shown for gender, and there were no significant interactions between gender and other factors (see summary table, Appendix I). This allowed the ES, MA and CA groups to be considered without the constraint of gender effects. A non-significant result (F (4, 144) = .96, $p > .05$) was also revealed for Trials x Group, although inspection of the graphs (Figure 3, A and B) gives an initial impression of a significant interaction. A significant main effect (F (2, 71) = 14.19, $p < .05$) was revealed for group.



Graph A. Dependent variable "Time taken to solve the problem."



Graph B. Dependent variable "Time taken to solve the problem."

FIGURE 3

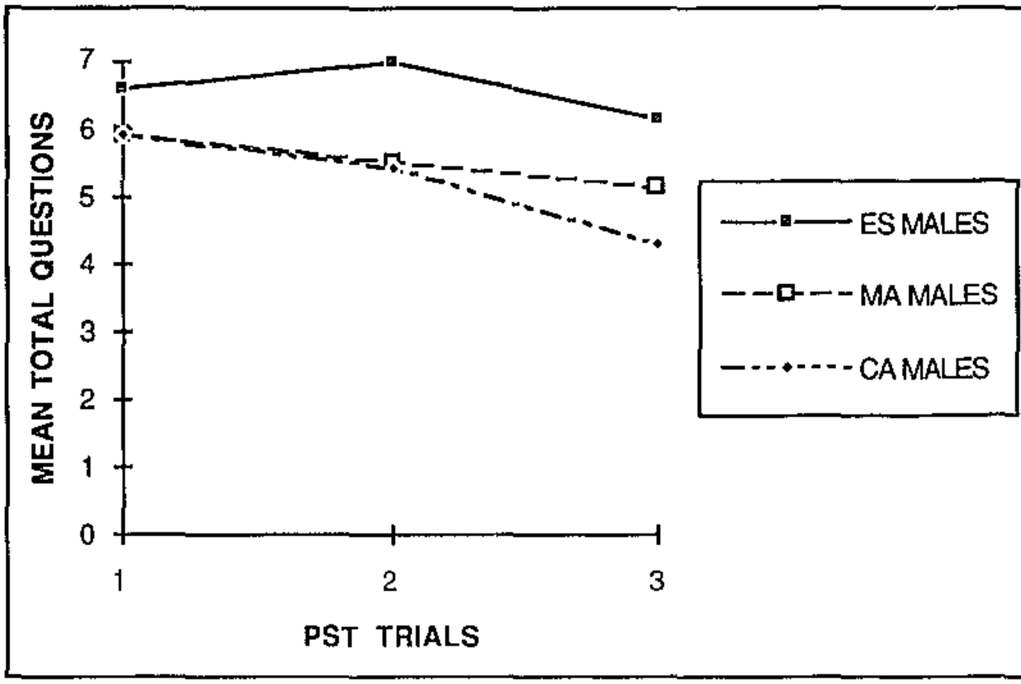
Table 2
Mean results (and standard deviations) in seconds for the dependent variable "Time to complete task".

Repeated Measure	Group ES	MA	CA
Trial 1	93.65 (35.89)	83.38 (27.30)	54.62 (20.88)
Trial 2	87.46 (49.71)	74.85 (24.15)	44.88 (17.17)
Trial 3	67.35 (29.88)	66.92 (21.93)	40.85 (13.75)

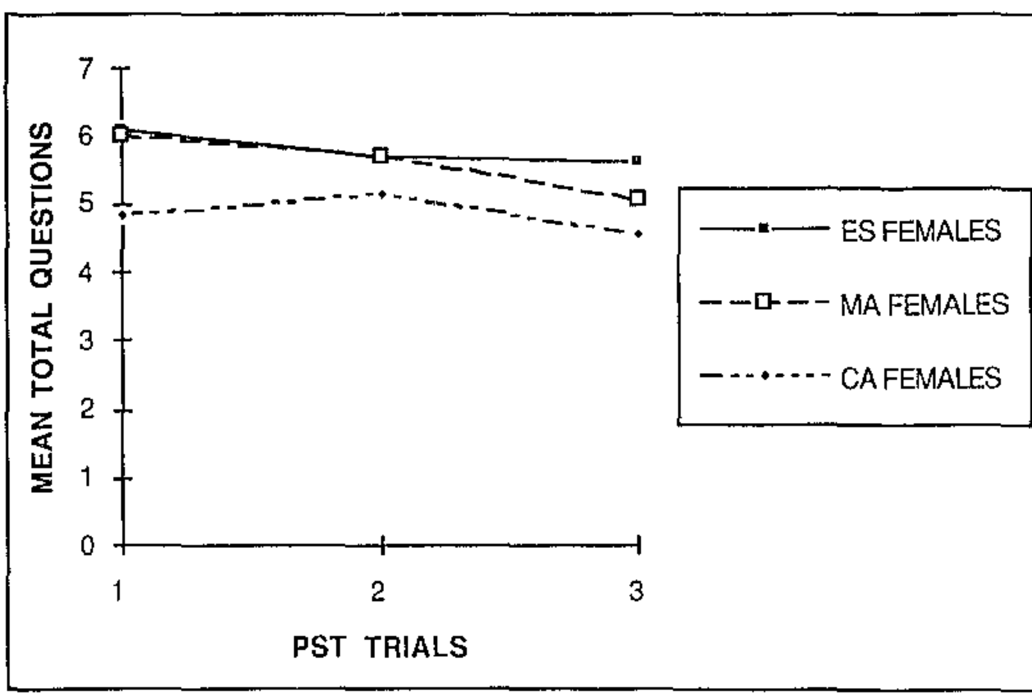
Single-*df* tests show this difference to be between the ES group and the CA group ($t = -5.13$, $p < .05$). A significant main effect was also found for trials ($F\,(2, 144) = 13.14$, $p < .05$). This was shown to be between trials one and two ($F\,(1, 72) = 26.58$, $p < .05$). This analysis reveals a significant difference between the performance of the ES group and the CA group on the dependent variable, time to complete the task. The fact that there is a non-significant difference between the ES group and the MA group gives support to Zigler's assumption that these two groups will display essentially the same performance level on a problem solving task of this type, after partialling out the effects of motivation.

Total questions needed to solve the problem

The dependent variable was analysed in relation to group and gender. Table 3 shows the unadjusted mean results over the period of the three trials. Figure 4 depicts these data.



Graph A. Dependent variable "Total number of questions needed to solve the problem."



Graph B. Dependent variable "Total number of questions needed to solve the problem."

FIGURE 4

Table 3.
Mean results (and standard deviations) for the dependent variable "Total questions to complete task".

Repeated Measure	ES	Group MA	CA
Trial 1	6.35 (3.19)	5.96 (1.84)	5.38 (1.83)
Trial 2	6.35 (2.65)	5.62 (1.55)	5.31 (1.44)
Trial 3	5.88 (3.02)	5.12 (1.66)	4.42 (1.06)

No significant two- and three-factor interactions were revealed for this analysis, allowing main effects to be considered without constraint. A non-significant main effect (F (1, 71) = 1.05, $p > .05$) was revealed for gender. Summary tables represented in Appendix II and III shows a non-significant main effect (F (2, 71) =2.61, $p > .05$) for group with motivation as a covariate. However, when the data were analysed without adjusting for motivation (see summary tables, Appendix 2), a significant main effect (F (2, 72) = 3.48, $p < .05$) was shown for group. Single-*df* tests (without the covariate) revealed a significant difference between the ES group and the CA group (t= -2.63, $p < .05$). Comparison of the analyses, with and without the covariate, indicate that there was no significant difference between the ES and MA groups on this variable.

A significant main effect was also revealed for trials, both when motivation was partialled from the analysis and when it was not. When motivation was included as a covariate, the effect for trials was significant (F (2, 144) = 3.83, $p < .05$). Once again a significant difference was revealed

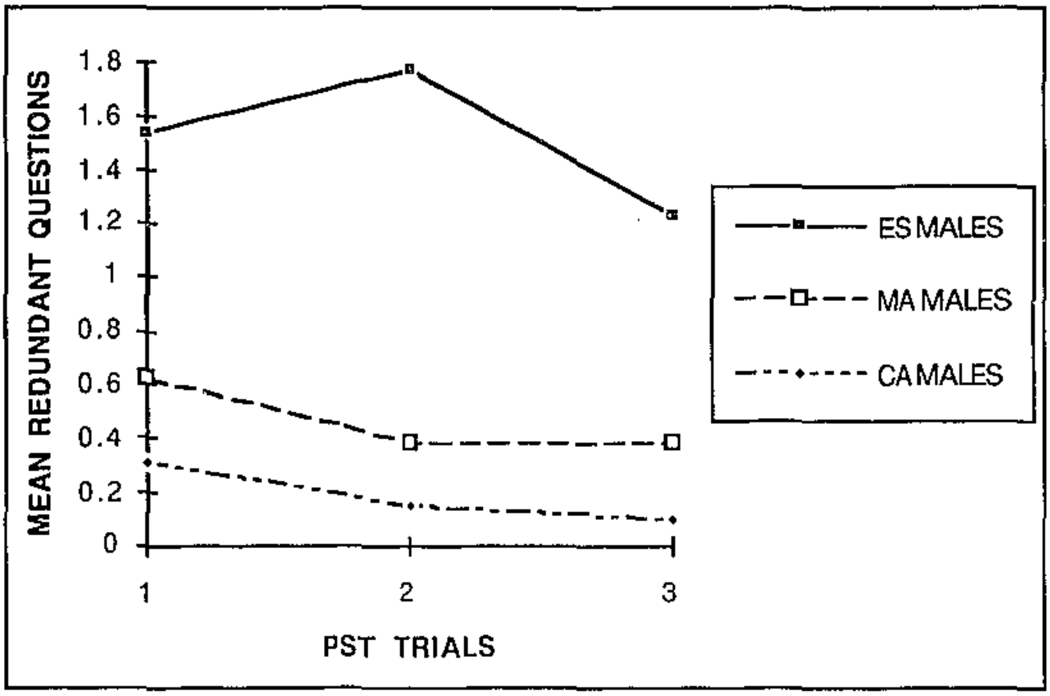
between trials one and two ($F(1, 72) = 7.02, p < .05$). Analysis of the means indicates that subjects improved their problem solving efficiency over the trials, in that they needed to ask fewer questions to solve the problem successfully. Subjects were able to isolate the key elements of the game and use this knowledge to solve the problem more efficiently.

Types of questions generated to solve the problem

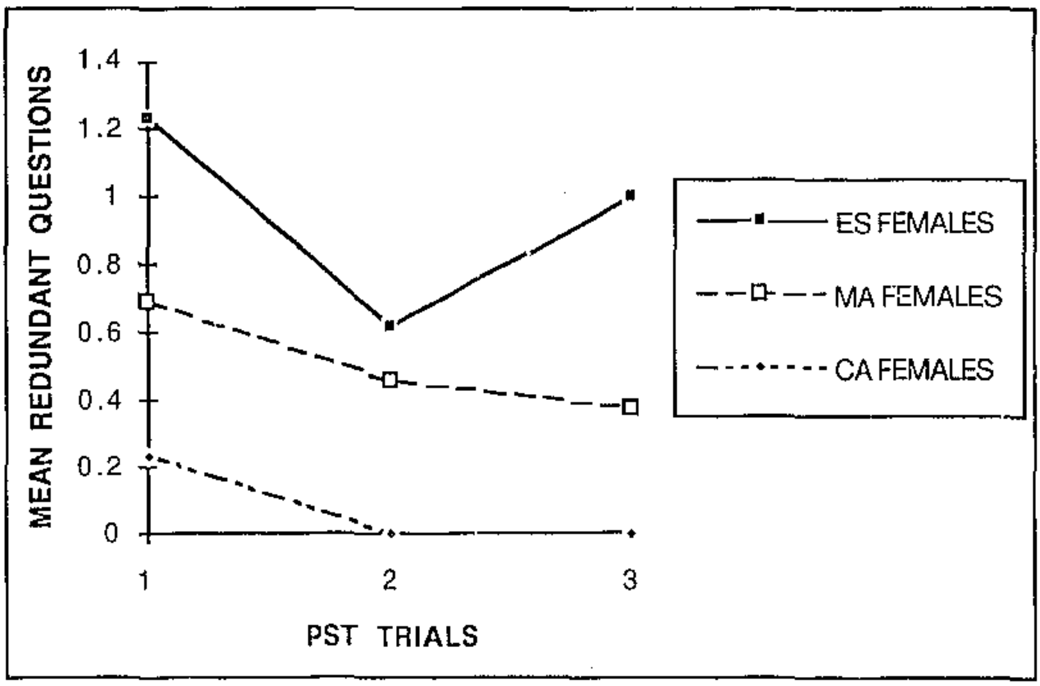
Non-parametric tests were used for this variable, as this sub-set of data did not fit a normal distribution. Unadjusted means for the number of redundant questions are shown in Table 4 by group. These data are depicted in Figure 5. Data for redundant questions are shown because a significant effect was revealed for this type of question.

There were no significant effects revealed for three of the types of questions which were identified in the study. These were hypothesis seeking questions, constraint seeking questions and pseudo-constraint seeking questions. As the hypothesis-seeking and constraint-seeking questions are considered the most effective types of questions to ask to solve the problem, it can be seen that the ES group asks the same amount of effective questions as the MA and CA groups. The ES subjects differ from the CA group in that they ask more of the ineffective redundant questions.

A non-significant main effect was found for gender, allowing the groups to be considered without this constraint. Summary tables (Appendix IV and V) revealed a significant effect for redundant questions on all three trials (Kruskal-Wallis One-Way Anova). Non-parametric tests (Mann-Whitney U) showed a significant difference between the ES groups



Graph A. Dependent variable "Types of questions generated to solve the problem (redundant questions)."



Graph B. Dependent variable "Types of questions generated to solve the problem (redundant questions)."

FIGURE 5

Table 4
Mean results (and standard deviations) for the dependent variable "Types of questions" (redundant).

Repeated Measure	ES	Group MA	CA
Trial 1	1.38 (2.32)	.65 (1.06)	.27 (.83)
Trial 2	1.19 (1.98)	.42 (.81)	.08 (.27)
Trial 3	1.12 (2.20)	.38 (.98)	.04 (.20)

and CA groups, but a non-significant effect between ES and MA groups. This indicates that while ES subjects asked more of the less effective redundant questions than the CA group, they did not ask significantly more redundant questions than the MA group. This result is once again in agreement with Zigler's theoretical view that there will be no difference between the performance of the ES group and the MA group on key problem solving indices.

Motivation to complete the task

Results of the second question in the motivation probe, "Would you like to do harder ones of this?" were analysed in relation to the independent variables. Table 5 depicts unadjusted mean scores for both the occasions this question was asked. These data are shown in Appendix VI.

A 3 x 2 analysis of variance with repeated measures was conducted on the data. There were no significant interactions between factors for this

Table 5.
Mean results (and standard deviations) for the dependent variable "Motivation to complete task".

Repeated Measure	ES	Group MA	CA
Motivation 1	2.73 (1.51)	2.85 (1.38)	4.00 (.85)
Motivation 2	3.08 (1.70)	3.27 (1.56)	4.50 (.76)

analysis. A nonsignificant main effect (F (1, 72) = .81, $p > .05$) was shown for gender. Summary tables in Appendix VII reveal a significant effect (F (2, 72) = 9.88, $p < .05$) for group, and single-*df* tests indicate a difference is between the ES group and the CA group (t= 4.06, $p < .05$). A significant effect was also found for trials (F (1, 72) = 9.19, $p < .05$). No significant difference was found between the ES group and the MA group on this variable. These results indicate that the ES group had a significantly lower level of overall motivation than the CA group, but the ES group had essentially the same level of motivation as the MA group.

When this result is considered with the results of the other analyses conducted in this study, overwhelming support is given to the developmental position on mental retardation. No significant differences were found between the performance levels or motivation levels of the ES and MA groups, indicating that these groups are at a comparable developmental stage in respect of ability and motivation to complete problem solving tasks of this type.

Summary

The data from the dependent variables were analysed in relation to group and gender, over three trials. The dependent variables were time taken to solve the problem, total number of questions needed to solve the problem, types of questions generated to solve the problem, and motivation to solve the problem. No significant interactions existed between the factors of achievement level and gender on the dependent variables, thus supporting the second null hypothesis.

In the analysis of the first dependent variable (time to complete task), the ES groups took a significantly longer time to solve the problem than the CA groups. A significant difference was found between the ES groups and the CA groups on the motivation variable, which revealed that the CA group subjects had a higher level of motivation to do the task than the ES subjects. The ES groups asked a significantly greater number of questions overall to solve the problem than the CA groups, and similarly asked a greater number of ineffective redundant questions.

There were no significant differences between the ES and MA groups on any of the four dependent variables. The ES and MA groups displayed a similar achievement level, taking comparable amounts of time to complete the task, asking a similar number of questions to solve the task, and asking the same types of questions when solving the task. The ES and MA groups also had comparable levels of motivation to complete the problem solving task prescribed for this study.

The results from the present study suggest that there is no difference between the performance of children with mild mental retardation and regular class children of a similar developmental level

(MA) on the specified figural problem-solving task. These results are supported by much of the literature in which subjects cultural-familial retarded subjects are compared with MA-equivalent nonretarded subjects. The findings of this study are consistent with the developmental theory of mental retardation, indicating that the ES children differ from the CA and MA groups only in their rate of cognitive development within their age level on specified problem solving tasks.

CHAPTER V

Discussion

The framework of this research was the developmental theory of mental retardation proposed by Zigler (1969). This theory states that there will be no substantive difference between the performance levels of cultural-familial retarded children and normal children of a corresponding mental age on problem solving tasks. Further, it is proposed that any differences that do occur between retarded and nonretarded persons will be due to motivational factors commonly associated with the adverse environmental and social experiences of individuals with mental retardation. These motivational factors include a history of failure and the lowered expectation of success typically experienced by children with intellectual disabilities in both the classroom and society in general. In accordance with this theory, comparison of persons with mental retardation and nonretarded persons should reveal nonsubstantive differences on problem solving tasks when the effects of motivation have been partialled from any analysis.

In the present study, subjects were required to play a problem solving game. Four dependent variables were prescribed as measures of the outcomes of the problem solving task. These variables were time taken to solve the problem, total number of questions needed to solve the problem, types of questions generated to solve the problem, and

motivation to solve the problem. Motivation was also included as a covariate in the analyses of time taken and total number of questions needed to solve the problem. In this way the motivational variable was controlled as specified by the developmental theory of mental retardation.

The major aim of the study was to examine the problem solving characteristics of three groups of subjects on the four variables. Subjects from Education Support Centres (ES group), subjects of a similar mental age to the ES subjects (MA group), and subjects of a similar chronological age to the ES group (CA group) were involved in the study. Each group comprised an equal number of males and females. Subjects were required to complete the problem solving task three times.

No significant interactions were found among or between the factors of group, gender and trials on any of the variables. This allowed main effects to be discussed without constraint.

The primary objective was to examine the results of the MA and CA groups and individually compare these with the results of the ES group, after partialling out the effect of motivation on subjects' performance. It was argued that this type of analysis would reveal if there were any significant differences in the pattern or level of processing between the ES group and the MA group. Comparing these two groups was crucial to the test of the developmental/difference debate.

The most important finding of this study was that there was no significant difference between the ES group and the MA group on the four variables after motivation was partialled from the analyses. This

is contrary to some of the previous research findings on problem solving (Borys, 1979; Borys, Spitz & Dorans, 1982; Spitz, Minsky & Bessellieu, 1985) which revealed a significant difference between ES and MA groups, indicating a considerable IQ deficit in the problem solving skills of ES subjects. It should be noted that none of the previously reported studies included motivation as a covariate in their analyses.

One major result of the present study provides strong support for the developmental theory of mental retardation. The absence of a significant difference between the ES and MA groups suggests that children with mild mental retardation perform at a similar level to regular class children of a comparative mental age on problem solving tasks. This is consistent with the findings of Weisz (1977) and Hore and Tryon (1989), who concluded that there was no difference between the performance levels of mentally retarded and MA-matched nonretarded children on problem solving tasks or other problems typically nominated as Piagetian tasks. If a significant difference had been revealed between the ES and MA groups, the result would have shown that the ES subjects were performing at a level lower than their mental-age peers on the specified task. This would have been identified as an IQ deficit in the ES group, and the results would have supported the difference theory of mental retardation.

The older, nonretarded CA subjects performed more efficiently than the retarded ES group on most aspects of the problem solving task. This was a predictable outcome, in that the CA children had higher mental ages than the ES children, and were therefore expected to gain a higher level of achievement on the problem solving task. A

significant difference was found between the ES and CA groups on the variables time taken to solve the problem, types of questions generated to solve the problem and motivation to solve the problem. Taken alone, these results are not supportive of the developmental or the difference position.

There was no difference between the ES and CA groups on the variable total number of questions needed to solve the problem when motivation was partialled from the analysis, a finding supported by Graesser and Person (1994), who concluded that the frequency of student questions is not significantly correlated with achievement in a learning situation. This suggests that asking fewer questions is not an indicator of greater problem solving efficiency, but the types of questions and the use of resultant information determines problem solving success. A significant difference between the ES and CA groups on the four variables was predicted, based on the assumption that the CA subjects would display more advanced problem solving skills than the ES group due to their greater mental age.

Several predictions made by the researcher about the ES group's performance on the four variables were not borne out by the results. It was predicted that the ES group would take a significantly longer time to solve the problem than the MA group, but this was not the case. It was also considered likely that the ES group would ask significantly more of the ineffective redundant and pseudo-constraint seeking questions than the MA group, which was also not observed. Instead, it would seem that on these two measures of problem solving efficiency (time to solve the problem and types of questions used to solve the problem), the ES group performed at a similar level to the MA group.

This, in effect, supports the null hypothesis and thus also the developmental theory of mental retardation (Weiss, Weisz & Bromfield, 1986). Thus, in relation to the problem used in this study, the children with mild mental retardation are equally efficient problem solvers as their regular class mental age equals.

Results for the motivation variable suggest that mentally retarded children may, in selected instances involving game-like tasks, have the same level of motivation to complete problem solving tasks as MA-matched regular class children. Analysis of motivation results revealed a significant difference between the ES and CA groups, but not between the ES and MA groups. These results may stem from the fact that it was easier for the CA group to solve the problem than the other groups, thus leading to a higher level of motivation in this group. It seems reasonable to suggest that, as these results indicate the ES and MA groups found the problem equally challenging, these groups also had the same level of motivation toward the task. This may imply a connection between level of intellectual function and motivation, a relationship that in this instance seems unconfounded by consideration of chronological age.

An alternative explanation of the finding that the ES and MA groups had a similar level of motivation toward the task can be made with reference to the motivational factors identified by Zigler (1969) in relation to the developmental theory of mental retardation. Zigler has identified institutionalisation, experience of failure and socio-economic status as factors which can have an adverse effect on the motivation levels of mentally retarded individuals. None of the ES subjects in the present study were institutionalised, and as they were

from the same schools as the MA and CA subjects, it is reasonable to assume all subjects were from a similar socio-economic background. The ES subjects were all from Education Support Centres which have been designed to provide a supportive and appropriate educational environment for students with special needs. These centres should therefore promote successful learning experiences for the ES students, thus decreasing experiences of failure and lowered expectations. It is important to note that Zigler's position would not have been confounded even if motivational differences were revealed between the ES and MA groups, as the effects of motivation were partialled from the analyses of data.

Other factors which may have led to a nonsignificant difference between the motivation levels of the ES and MA groups can be identified. The problem solving game was a brightly-coloured, manipulable apparatus which fostered a high level of interest from all subjects. The task was presented in a supportive environment in which each student received one-to-one contact for an extended period of time with the interviewer. As this situation rarely occurs in most classrooms, it is understandable that the children with mental retardation, who typically rely on external reinforcement when undertaking tasks (Zigler & Balla, 1982, p. 18), would find this situation highly motivating.

The results of the study also lend implied support to the similar structure hypothesis, in that the ES and MA groups appeared to use similar cognitive processes to solve the problem. The types of questions asked by the ES subjects were the same kind as those asked by the MA subjects, indicating that both groups employed similar

interrogative strategies. These findings have significant implications in providing appropriate education for children with mental retardation.

Significance of the results to education

The results of this study show that children with mild mental retardation perform at the same level as regular class children of a similar mental age on problem solving tasks, particularly those presented in a "game-like" format with a 1:1 teacher-student ratio. This finding is supportive of the "similar structure hypothesis" (Zigler & Hodapp, 1986) which states that children with mild mental retardation have similar cognitive processes to regular class children, but may develop these processes at a slower rate than regular class children.

It is important to examine how the results of studies such as the present one can affect teacher's views of children with mild mental retardation. Research findings which are supportive of the difference (or deficit) theory can encourage teachers to consider retarded students as being inherently impaired in a fundamental way. This notion may lead teachers to either seek out highly specialised methods to help students with mental retardation to overcome these deficits, or may give some teachers reason to provide retarded students with a less stimulating education than nonretarded students, in the belief that retarded students will never reach acceptable achievement levels because they are "deficient". The latter practice, if taken to the extreme, becomes an insidious form of segregation, in that children with mental retardation are effectively discriminated against in the classroom. If teachers give less attention to children with mental retardation, activities which they are not likely to succeed at, and by singling them

out as "different", the detrimental motivational factors identified by Zigler are perpetuated, and in this way these children become increasingly more retarded in the eyes of society.

Research findings which are supportive of the developmental theory will result in classroom practices which are in direct contrast to the difference scenario. By supporting the developmental theory, teachers are encouraged to assist children with mental retardation to develop sequential skills compatible with normal developmental milestones. It is obvious that this encourages more logical and equitable educational practices than those based on the difference theory of mental retardation.

The findings of the present study have important implications for teachers of children with mild mental retardation, and for the development of appropriate teaching materials for children with intellectual disabilities. Because the results indicate that retarded children develop along a "normal" path, "knowledge about normal development becomes the bedrock upon which to base interventions for retarded children" (Zigler & Hodapp, 1986, p. 35).

Teacher awareness that children with mild mental retardation develop in much the same way as regular class children should help the profession develop realistic expectations of the mentally retarded child. Knowing that the student should be able to perform at a level similar to a younger regular class child will enable the teacher to plan for the student to experience success, and at the same time challenging the student sufficiently to ensure they make progress.

One difficulty may arise from this finding. Teachers have to find appropriate materials for the mentally retarded student. Educational

materials should be appropriate for the child's chronological age, yet at the same time they should be matched with the child's mental age. For example, a 12-year-old student with mental retardation should not be using teaching materials designed for use by a nine-year-old regular class student. Although the academic level of the materials may be suitable for the student, the material would probably not be age appropriate.

This knowledge also has important implications for the integration of children with mild mental retardation into the regular classroom setting. It is often the case that there are many similarities between the student classified as having mental retardation and below average students in the regular classroom who are just above the cut-off line for education support services. The child with mental retardation should not be considered as "different" from such below average students, rather they should be seen as students who are slower to reach academic goals than nonretarded children. For the teacher of a primary school class in which mentally retarded children are integrated, this means there is no need for a totally separate curriculum for teaching retarded students. Intervention can be designed to foster the normal development of skills based on logical sequences identified by Piaget and other developmental psychologists. These practices already form the core of many teaching interventions designed for low performing nonretarded students in the regular classroom.

The present study examined only a small number of students, and that these students were tested on only one type of problem solving task. It is possible that different types of tasks which require

differing skills could reveal significant performance differences between children with intellectual disabilities and MA-match regular class children. For example, sequential tasks, non-verbal mathematical tasks and tasks involving different metacognitive abilities or different components of memory may reveal significant differences between children with mental retardation and MA-matched nonretarded children on certain measures.

Even so, the results of the present study can be directly applied to the classroom in practical terms. As the problem solving task used for the study was a game-type task, it is reasonable to assume that the findings will be applicable to many problem solving game-type activities carried out in classrooms. This means that teachers who have both regular and integrated mildly retarded students in the class can confidently set game-type problem solving activities for all students, knowing that the children with mental retardation will be capable of completing such activities successfully.

CHAPTER VI

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CHAPTER VII

Appendices

APPENDIX I

Dependent variable time to complete task, covariate motivation B

Design on Sample

Tests of Between-Subjects effects

	SS	DF	MS	F	Sig of F
Within + Residual	101456.07	71	1428.96		
Regression	1077.42	1	1077.42	.75	.388
Group	40555.96	2	20277.98	14.19	.000
Gender	1033.83	1	1033.83	.72	.398
Group by Gender	2693.46	2	1346.73	.94	.394

Group

Parameter	Coeff.	Std. Er.	t-Value	Sig. t	Lower -95%	CI- Upper
2	-12.931796	10.50168	-1.23140	.22224	-39.18921	13.32562
3	-58.536136	11.39871	-5.13533	.00000	-87.03639	-30.03588

Repeated Measures Design

Tests involving "trials" Within-Subject effect

	SS	DF	MS	F	Sig of F
Within + Residual	76356.97	144	530.26		
Trials	13935.69	2	6967.85	13.14	.000
Group by Trials	2031.08	4	507.77	.96	.433
Gender by Trials	357.37	2	178.68	.34	.714
Group by Gender by Trials	940.89	4	235.22	.44	.777

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig of F
T2	13851.9231	37514.4615	13851.9231	521.03419	26.58544	.000
T3	83.76923	38842.5128	83.76923	539.47934	.15528	.695

APPENDIX II

Dependent variable total number of questions, covariate motivation B

Design on Sample

Tests of Between-Subjects effects

	SS	DF	MS	F	Sig of F
Within + Residual	537.13	71	7.57		
Regression	1.13	1	1.13	.15	.700
Group	39.54	2	19.77	2.61	.080
Gender	7.91	1	7.91	1.05	.310
Gender by Group	6.19	2	3.10	.41	.666

Group

Parameter	Coeff.	Std. Er.	t-Value	Sig.	t Lower -95%	CI- Upper
2	-1.0710745	.76411	-1.40172	.16535	-2.98159	.83944
3	-1.8726559	.82938	-2.25789	.02703	-3.94636	.20105

Repeated Measures Design

Tests involving "trials" Within-Subject effect

	SS	DF	MS	F	Sig of F
Within + Residual	474.36	144	3.29		
Trials	25.24	2	12.62	3.83	.024
Group by Trials	2.71	4	.68	.21	.935
Gender by Trials	1.80	2	.90	.27	.761
Group by Gender by Trials	6.56	4	1.64	.50	.738

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig of F
T2	22.31410	228.76923	22.31410	3.17735	7.02286	.010
T3	2.92521	245.58974	2.92521	3.41097	.85759	.358

APPENDIX III

Dependent variable total number of questions no covariate

Design on Sample

Tests of Between-Subjects effects

	SS	DF	MS	F	Sig of F
Within + Residual	538.26	72	7.48		
Group	52.06	2	26.03	3.48	.036
Gender	8.27	1	8.27	1.11	.296
Gender by Group	6.98	2	3.49	.47	.629

Group

Parameter	Coeff.	Std. Er.	t-Value	Sig. t	Lower -95%	CI- Upper
2	-1.0880832	.75833	-1.43485	.15566	-2.59978	.42361
3	-1.9985202	.75833	-2.63543	.01028	-3.51022	-.48682

Repeated Measures Design

Tests involving "trials" Within-Subject effect

	SS	DF	MS	F	Sig of F
Within + Residual	474.36	144	3.29		
Trials	25.24	2	12.62	3.83	.024
Group by Trials	2.71	4	.68	.21	.935
Gender by Trials	1.80	2	.90	.27	.761
Group by Gender by Trials	6.56	4	1.64	.50	.738

APPENDIX IV

Dependent variable Types of questions (redundant questions)

Kruskal-Wallis 1-Way Anova

ARedund
by Group

Mean Rank	Cases	
45.25	26	Group = 1 ES
41.06	26	Group = 2 MA
32.19	26	Group = 3 CA
	78 Total	

			Corrected for ties		
Chi-Square	D.F.	Significance	Chi-Square	D.F.	Significance
4.5008	2	.1054	6.4614	2	.0395

Kruskal-Wallis 1-Way Anova

BRedund
by Group

Mean Rank	Cases	
45.00	26	Group = 1 ES
40.38	26	Group = 2 MA
33.12	26	Group = 3 CA
	78 Total	

			Corrected for ties		
Chi-Square	D.F.	Significance	Chi-Square	D.F.	Significance
3.6352	2	.1624	6.6861	2	.0353

Kruskal-Wallis 1-Way Anova

CRedund
by Group

Mean Rank	Cases	
46.75	26	Group = 1 ES
38.90	26	Group = 2 MA
32.85	26	Group = 3 CA
	78 Total	

			Corrected for ties		
Chi-Square	D.F.	Significance	Chi-Square	D.F.	Significance
4.9211	2	.0854	9.9077	2	.0071

APPENDIX V

Dependent variable Types of questions (redundant questions)

Mann-Whitney U - Wilcoxon Rank Sum W Test

ARedund
by Group

Mean Rank	Cases	
30.75	26	Group = 1 ES
22.25	26	Group = 2 CA
	52 Total	

U	W	Z	Corrected for ties 2-Tailed P
227.5	799.5	-2.4833	.0130

Mann-Whitney U - Wilcoxon Rank Sum W Test

BRedund
by Group

Mean Rank	Cases	
30.27	26	Group = 1 ES
22.73	26	Group = 2 CA
	52 Total	

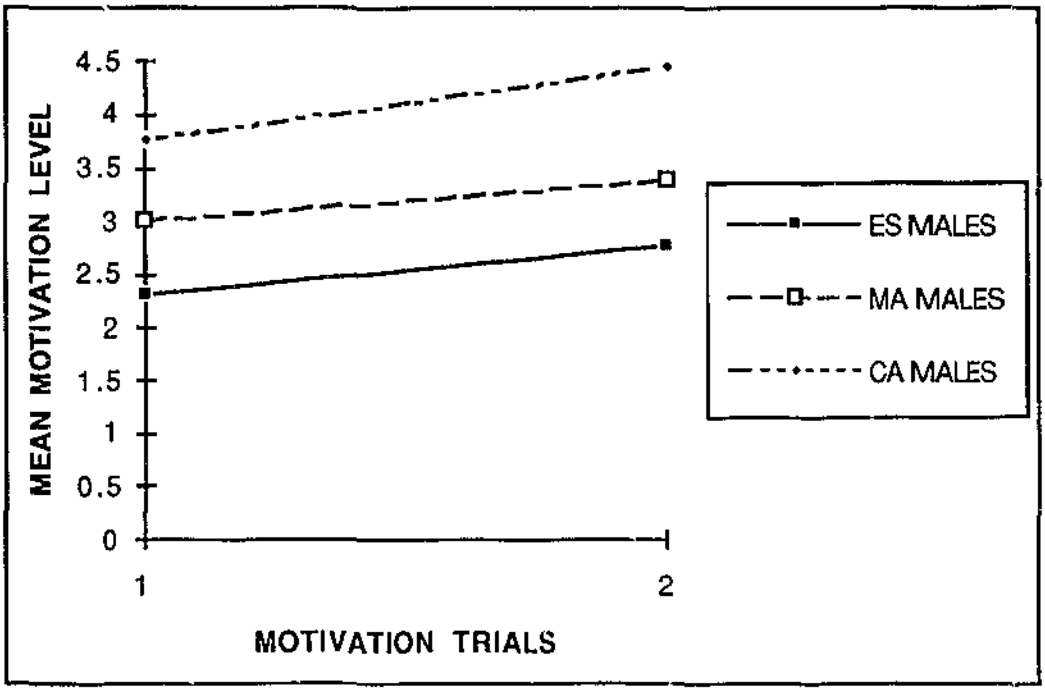
U	W	Z	Corrected for ties 2-Tailed P
240.0	787.0	-2.5131	.0120

Mann-Whitney U - Wilcoxon Rank Sum W Test

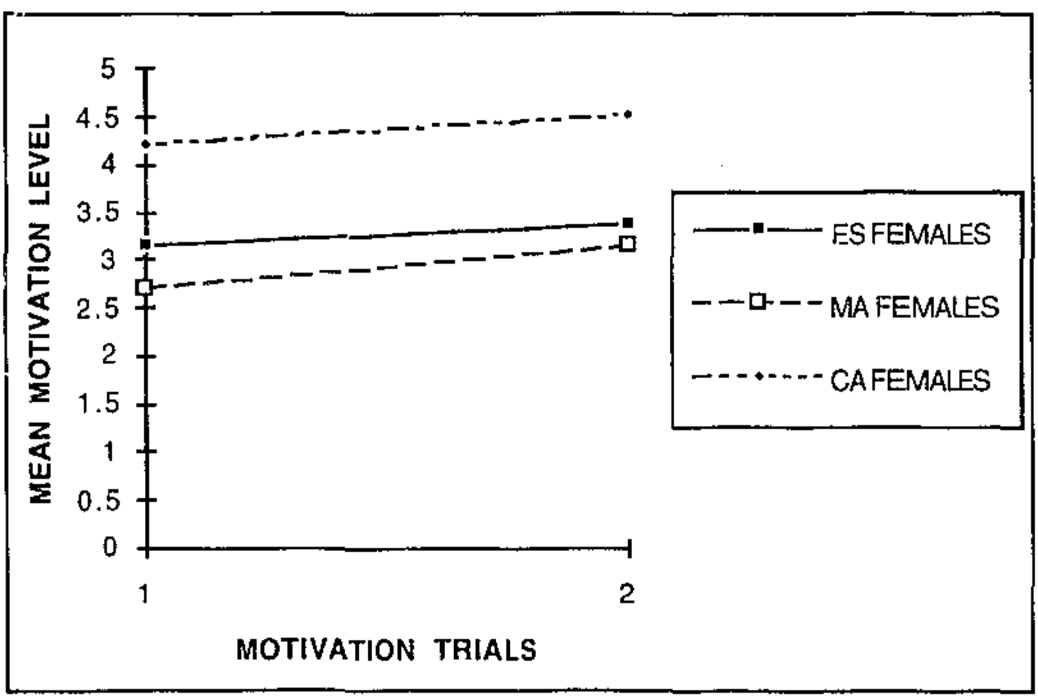
CRedund
by Group

Mean Rank	Cases	
31.12	26	Group = 1 ES
21.88	26	Group = 2 CA
	52 Total	

U	W	Z	Corrected for ties 2-Tailed P
218.0	809.0	-3.0786	.0021



Graph A. Variable "Motivation to solve the problem."



Graph B. Variable "Motivation to solve the problem."

FIGURE 6

APPENDIX VII

Dependent variable motivation to complete task

Design on Sample

Tests of Between-Subjects effects

	SS	DF	MS	F	Sig of F
Within + Residual	205.77	72	2.86		
Group	56.46	2	28.23	9.88	.000
Gender	2.31	1	2.31	.81	.371
Group by Gender	6.51	2	3.26	1.14	.326

Group

Parameter	Coeff.	Std. Er.	t-Value	Sig.	t Lower -95%	CI- Upper
2	.217571317	.46887	.46403	.64402	-.95440	1.38954
3	1.90374903	.46887	4.06029	.00012	.73178	3.07572

Repeated Measures Design

Tests involving "trials" Within-Subject effect

	SS	DF	MS	F	Sig of F
Within + Residual	54.69	72	.76		
Trials	6.98	1	6.98	9.19	.003
Group by Trials	.15	2	.08	.10	.904
Gender by Trials	.31	1	.31	.41	.522
Group by Gender by Trials	.36	2	.18	.24	.790