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ABSTRACT

Two samples of 31 educable mentally handicapped (EMH) children differentiated by IQ level were given a test of verbal problem solving in order to identify the effect of three parameters upon verbal problem-solving performance. The three parameters studied were existential quantification, superordinate set identification, and extraneous information. Eight problem conditions were created, reflecting systematic inclusion or exclusion of each parameter. Six single-step addition problems (addends less than ten) were composed for each of the conditions. Presence of a distractor (extraneous information) was significant (p less than .01). Higher IQ EMH children significantly outperformed lower IQ EMH children on the tasks (p less than .01), but failed to demonstrate expected performance on problems with extraneous information. The findings were felt to suggest a rote computation habit, rather than active processing of verbal information, as the problem solving style of many EMH children at all IQ levels. The need for carefully developed programs in verbal problem solving was indicated. (Author)

Verbal Problem Solving Among Educable Mentally Retarded Children*

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ABSTRACT

Two samples of thirty-one educable mentally retarded (EMR) children differentiated by IQ level were given a test of verbal problem solving in order to identify the effect of three parameters upon verbal problem solving performance. The three parameters studied were existential quantification, superordinate set identification, and extraneous information. Eight problem conditions were created, reflecting systematic inclusion or exclusion of each parameter. Six single-step addition problems (addends less than 10) were composed for each of the conditions.

Data analysis was completed using a one between-subjects, three within-subjects factors analysis of variance. Presence of a distractor (extraneous information) was significant ($p < .01$). Higher-IQ EMR children significantly outperformed lower-IQ EMR children on the tasks ($p < .01$), but failed to demonstrate expected performance on problems with extraneous information. These findings suggest a rote computation habit, rather than active processing of verbal information, as the problem solving style of many EMR children at all IQ levels. The need for carefully developed programs in verbal problem solving is indicated.

The ability to solve a verbal problem dealing with quantity must be considered as one terminal goal of any comprehensive curriculum effort with the slow learner. Deficits in the performance of low-IQ children in solving written story problems when compared with their computation ability is well documented (Kirk, 1964). In addition, evidence supporting a specific deficit on the arithmetic subtest of the WISC by low-IQ children (Benton, 1964) may be interpreted as a deficit in solving orally presented story problems.

The purpose of this study was to identify the effect of three variables upon the verbal problem solving performance of two samples of educable mentally retarded (EMR) children differentiated by IQ level. The three variables chosen for study were existential quantification, supraordinate set identification, and extraneous information.

Existential quantification refers to the use of an introductory sentence in the problem (Some dogs are in the cage.) which focuses attention first on the total set, rather than the disjoint sets to be added. Supraordinate set identification refers to the use of different names to identify the disjoint sets as proper subsets (dogs, cats) of the total set (pets). Extraneous information refers to an additional disjoint set which is not a proper subset of the total set.

Steffe (1967) explored the effects of existential quantification and set identification on the verbal problem solving of average-IQ first grade children. Steffe believed that the theory of cognitive development offered by Piaget (1952) formed the basis for prediction that any simultaneous thinking of the total set and subsets could lead to confusion in young children. This confusion could exist even if children understood the definition of sets. Contrary to prediction, only supraordinate set identification led to significantly impaired problem solving.

Cruickshank (1948) found that retarded children were most deficit in comparison to average-IQ children in verbal problem solving, when the child was asked to extract the needed facts for a problem from superfluous information.

It was predicted in this study that older educable mentally retarded children ($\bar{X}$ chronological age = 12.58 years) would perform similarly on written story problems as Steffe's first grade children performed on oral story problems. That is, no significant main effect would be found for existential quantification, while a significant main effect for supraordinate set identification would occur. Additionally, it was predicted that extraneous information in problems would significantly impede performance. Finally, it was predicted that higher-IQ EMR children would outperform lower-IQ EMR children, with no significant sample-variable interactions.

METHOD

Subjects. Sixty-two children diagnosed as educable mentally retarded and placed in seven intermediate special classes in a metropolitan school district served as subjects. Individually administered IQ (WISC or Stanford-Binet, 1960 revision) and reading level (California Achievement Test) scores were available for all children. The sample included all children who attended these classes, exclusive of absentees on the testing date and non-readers.

The children were split into two groups for purposes of analysis by median IQ. The lower-IQ group (n=31) had a mean IQ of 57.77 (SD=5.75), mean reading level of 2.26 (SD=.77), and mean chronological age of 12 years-3 months (SD=12.47 months). The higher-IQ group (n=31) had a mean IQ of 74.55 (SD=5.37), mean reading level of 2.71 (SD=.81), and mean chronolgical age of 12 years-7 months (SD=13.9 months).

Materials. Eight conditions accommodated a factorial design which allowed the presence or absence of a variable to be significant. Six problems were composed for each of the eight conditions. To the extent possible, all problems were linguistically managed in order to control syntax and vocabularly difficulty. All problems were single-step direct addition with addends less than ten. Examples of each of the eight conditions are found in Table 1.

TABLE 1 ABOUT HERE

Twenty-four subtraction or no-operation problems were included in the task to impede formation of a habit set in addition. The correct answer to all problems followed the problem as one of the four multiple choices. In order to facilitate two testing sessions to minimize fatigue and boredom, the task was randomly split into two equivalent forms of 24 test problems (three of each condition) and 12 distractor problems. Problem order was randomized within each of the two equivalent forms.

Procedures. The children received the tasks in their regular classroom grouping administered by their teachers. The order of task administration was randomized across all children. Children having difficulty in reading the problems were given aid in word identification. It was stressed by the teachers that these problems were being "tested" and not the children, with no grades being recorded.

RESULTS

The data were analyzed utilizing a one between-subjects, three within-subjects factors analysis of variance (Myers, 1966). The hypothesized between-subjects main effect for IQ level was significant ($F=7.42$, 1/60 df, $p < .01$). As anticipated the main effect for presence of an existential quantifier failed to reach significance ($F=.94$, 1/60 df, $p > .05$); and, the main effect for presence of a distractor was highly significant ($F=99.50$, 1/60 df, $p < .001$).

Contrary to prediction, the main effect of the presence of supraordinate set identification failed to reach significance ($F=2.16$, 1/60 df, $p > .05$). In addition, a significant ordinal interaction arose between IQ-level groups and presence of extraneous information in the problems ($F=4.12$, 1/60 df, $p < .05$). The nature of this interaction can be observed from the cell means found in Table 2. The difference in performance between IQ-level

TABLE 2 ABOUT HERE

groups on problems with no extraneous information was significantly greater than the difference in performance on problems with extraneous information. No other second, third, or fourth order interaction reached significance.

DISCUSSION

One of the three distractors present for problems with extraneous information was the correct answer if all three disjoint sets were joined. It was apparent from informal analysis of the incorrect responses that, indeed, this distractor was the incorrect choice in most cases. It appeared that the children identified the operation as addition and proceeded to add all numbers found in the problem. These results lead to the interpretation that many EMR children do not, in fact, "read" verbal addition problems, but rather select all numbers contained in the problem and perform rote computation.

The higher-IQ sample did not demonstrate the expected superiority in solving problems which contained no extraneous information. EMR children in this study, regardless of IQ level, experienced difficulty with extraneous information in the problems.

The rote computation habit was not impeded by the manner in which the disjoint sets were labelled. If two numbers appeared in the problem, and the operation was addition, a high probability existed that the correct sum would be chosen. If three numbers appeared in the problem, the majority of the time all three numbers would be added. The absence of a significant supraordinate set-extraneous information interaction indicates that even the presence of two sets with the same name as the total set, with the extraneous set having a different, unrelated label, failed to deter rote computation.

Presence of an initial sentence which focuses attention upon the total set again was found not to be a significant factor in verbal problem solving. Possibly, such information is immediately recognized as irrelevant and discarded from the immediate problem solving process.

These findings suggest that a more carefully developed program in verbal problem solving which focuses upon recognition of extraneous information must be built for educable mentally retarded children. This would provide a sharp contrast to present curriculum practices in mathematics education for EMR children with its overwhelming stress on development of computation skills. The feasibility of a structured approach to verbal problem solving utilizing cartoon aids to facilitate recognition of extraneous information has recently been demonstrated in a pilot study (Goodstein, 1970). More research and demonstration projects in this important curriculum area are presently underway.

In conclusion, a rote computation habit has been demonstrated to impede the problem solving performance of EMR children. This habit manifests itself in the inability of EMR children at two IQ levels to satisfactorily solve written story problems with extraneous information.

TABLE 1

EXAMPLES OF PROBLEMS BY CATEGORY

1. 1 cat is in the cage
   3 cats are in the cage.
   How many cats are in the cage?

2. 4 bees are near the flowers.
   3 ants are near the flowers.
   How many bugs are near the flowers?

3. Some kites are in the park.
   4 kites are in the park.
   3 kites are in the park.
   How many kites are in the park?

4. Some children are in the yard.
   3 boys are in the yard.
   1 girl is in the yard.
   How many children are in the yard?

5. 4 cats are in the cage.
   6 dogs are in the cage.
   3 cats are in the cage.
   How many cats are in the cage?

6. 3 boys are in the yard.
   2 dogs are in the yard.
   5 girls are in the yard.
   How many children are in the yard?

7. Some apples are on the table.
   5 apples are on the table.
   2 apples are on the table.
   3 bananas are on the table.
   How many apples are on the table?

8. Some toys are in the park.
   2 kites are in the park.
   5 balloons are in the park.
   6 trees are in the park.
   How many toys are in the park?

* * * * *

1. No extraneous information, no existential quantifier, no supraordinate set.
2. No extraneous information, no existential quantifier, supraordinate set.
3. No extraneous information, existential quantifier, no supraordinate set.
4. No extraneous information, existential quantifier, supraordinate set.
5. Extraneous information, no existential quantifier, no supraordinate set.
6. Extraneous information, no existential quantifier, supraordinate set.
7. Extraneous information, existential quantifier, no supraordinate set.
8. Extraneous information, existential quantifier, supraordinate set.

TABLE 2

SUMMARY OF MEAN NUMBER OF CORRECT PROBLEMS BY CELL

Higher-IQ Sample / Low-IQ Sample

Extraneous Information

	Higher-IQ: Supra-Ordinate Sets	Higher-IQ: No Supra-Ordinate Sets		Low-IQ: Supra-Ordinate Sets	Low-IQ: No Supra-Ordinate Sets
Existential Quantifier	2.42	2.52	Existential Quantifier	2.06	2.16
No Existential Quantifier	2.61	2.68	No Existential Quantifier	2.16	2.19

No Extraneous Information

	Higher-IQ: Supra-Ordinate Sets	Higher-IQ: No Supra-Ordinate Sets		Low-IQ: Supra-Ordinate Sets	Low-IQ: No Supra-Ordinate Sets
Existential Quantifier	5.74	5.90	Existential Quantifier	4.08	4.45
No Existential Quantifier	5.68	5.87	No Existential Quantifier	4.45	4.29

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