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AUTHOR Cameron, Roy
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ABSTRACT

This study of problem solving and conceptual tempo had two objectives: (1) to begin to clarify the underlying deficiencies which contribute to the less efficient information processing of impulsive children (as compared with reflective children) during problem solving; and (2) to demonstrate the utility of using a task analysis as a clinical-research strategy for analyzing cognitive performance deficiences in children. A task analysis was conducted to identify sources of inefficient performance on the Neimark-Lewis pattern matching problem among children aged 7, 9, and 11 years. Data indicated that failure to adequately retain orienting instructions, failure to formulate an efficient solution strategy and failure to consistently implement an efficient strategy once formulated all represented potential sources of performance inefficiency. Conceptual tempo was not associated with failure to retain task instructions. However, "reflective" children were more likely than "impulsives" to formulate high quality solution strategies and consistently implement such strategies once formulated. These data appear to contribute to the clarification of the cognitive mechanisms underlying reflectivity and impulsivity. The task analysis diagnostic procedure yielded an individual "deficiency profile" for each child, thus demonstrating its potential clinical-research utility for analyzing cognitive performance deficits in children. (Author/MS)

Source of problem solving inefficiency in relation to conceptual tempo

Roy Cameron

Department of Psychology

University of Saskatchewan

Saskatoon, Saskatchewan

Paper presented at the biennial meeting of the

Society for Research in Child Development

New Orleans, Louisana

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Abstract

This study had two objectives. The first was to begin to clarify the underlying deficiencies which contribute to the less efficient information processing of impulsive vs reflective children during problem solving. The second was to demonstrate the utility of using a task analysis as a clinical-research strategy for analyzing cognitive performance defiencies in children. A task analysis was conducted to identify sources of inefficient performance on the Neimark-Lewis pattern matching problem among children aged seven, nine, and eleven years. The data indicated that (a) failure to adequately retain orienting instructions (b) failure to formulate an efficient solution strategy and (c) failure to consistently implement an efficient strategy once formulated, all represented potential sources of performance inefficiency. Conceptual tempo was not associated with failure to retain task instructions. However, "reflective" children were more likely than "impulsives" to (a) formulate high quality solution strategies and (b) consistently implement such strategies once formulated. These data appear to contribute to the clarification of the cognitive mechanisms underlying reflectivity and impulsivity. The task analysis diagnostic procedure yielded an individual "deficiency profile" for each child, thus demonstrating its potential clinical-research utility for analyzing cognitive performance deficits in children.

Source of problem solving inefficiency in relation to conceptual tempo[1]

A number of recent studies have indicated that there is an association between conceptual tempo (as assessed by performance on the Matching Familiar Figures -- MFF -- Test) and efficiency of information processing during problem solving. On a variety of problem solving tasks which are amenable to solution via focusing or constraint-seeking strategies, as described by Jerome Bruner and his colleagues (Bruner, Goodenough, & Austin, 1956; Bruner, Olver, & Greenfield, 1966), reflective children have been found to make greater use of efficient solution strategies than impulsive children (Ault, 1973; Cameron, 1976; Denney, 1973; Haskins & McKinney, 1976; McKinney, 1973; McKinney, Haskins & George, 1975; McKinney, Haskins & Mason, 1974; Nuessle, 1972). While some negative results have been reported (e.g. Cameron, 1973; McKinney et al, 1974), the combined results of these studies suggest that this association between reflectivity and efficiency in problem solving may be found at all age levels over the range of six years (the youngest children studied) to fourteen years (the oldest children studied).

The present study had two objectives. The first was to begin to analyze the underlying causes of the inefficient problem solving of impulsive children. A second objective was to demonstrate that the task-analysis research strategy could be productively adapted for studying sources of problem solving inefficiency in children. The task analysis approach to identifying sources of performance deficits emphasizes that performance on tasks, such as the problem solving tasks employed in the studies cited above, is complex; effective performance depends upon the

integration of a number of relevant psychological subprocesses. The task analysis begins with "a logical analysis of the psychological demands at a particular task and an analysis of the sequentially organized set of cognitive processes that the subject must emit to perform adequately on a task" (Meichenbaum, 1975, pp. 8-9). The diagnostician-researcher then attempts to determine which link(s) in this chain of psychological subprocesses is (are) deficient. After critically reviewing clinical-research strategies which have been employed to investigate underlying causes of performance deficits, both Kinsbourne (1971) and Meichenbaum (1975) have concluded recently that the task analysis approach is most productive. To repeat, then, the present study was designed to analyze the source of the inefficient problem solving performance of impulsive children via a task analysis diagnostic strategy.

Specifically, the study examined sources of problem solving inefficiency of seven - (n = 50), nine - (n = 48) and eleven-year-old (n = 56) children on the pattern matching task introduced by Neimark and Lewis (1967).[2] The child is asked to figure out which of the pattern alter-

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Slides 1, 2, 3; Figures 1, 2

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natives is behind the problem board screen, opening as few windows as possible.

Children in the present study used five distinct strategies for solving this problem. Because of time constraints, only the three most important strategies will be described. The most sophisticated strategy is the <u>focusing strategy</u>: the child opens windows which ensure that

exactly half of the alternatives will be eliminated with each move. A second, somewhat less efficient, strategy is the avoidance of non-informative moves strategy: the child using this strategy checks to make certain that a move he is considering will lead to the elimination of at least one alternative before actually making the move. In this way, he avoids making moves which yield no information. Some children used task irrelevant "strategies": they opened windows randomly, and had no task relevant solution rule.

In order to develop a task analysis diagnostic procedure to investigate sources of inefficient performance on this task, a logical analysis of the task requirements was conducted. It seemed logical to believe that successful performance on this task required (a) comprehension and retention of task instructions, (b) formulation of an appropriate solution strategy (i.e., a rule for deciding which windows to open or avoid opening) and (c) consistent implementation of such a rule, given that a rule was formulated. Inefficient performance, then, could result from (a) failure to retain task instructions, (b) failure to formulate an appropriate solution strategy or (c) failure to consistently regulate behavior in accordance with an appropriate solution rule once such a rule had been formulated. The task analysis then proceded with an examination of each child's level of functioning in each of these three key areas.

To assess the child's retention of task instructions, he was asked to explain how to "play the game, the way it was explained to you" in a playful, role-playing situation. The child was prompted if he failed to include any of the key instructions. Deficient retention of instructions was common only among seven-year-old children. (Even these children

retained the mechanical instructions -- open the windows one at a time, cover eliminated alternatives; the instructions for which they did not evidence retention were orienting instructions -- e.g. the idea is to figure out which pattern is behind the board; make as few moves as possible; some moves are more helpful than others). The seven-year-olds who failed to evidence adequate retention of instructions had lower Peabody IQ's (average IQ of 101.2) than their peers who retained instructions more fully (average IQ of 114.2; $t = 3.14$, 48 d.f., $p < .01$). However, the two groups did not differ in their MFF scores. Thus, failure to retain task instructions (which <u>was</u> associated with poor problem solving efficiency) was <u>not</u> associated with conceptual tempo, but was related to IQ.

The second potential source of performance breakdown which was postulated was failure to formulate an efficient solution strategy. In order to assess possible deficiencies at this level, the children were asked to describe their solution strategies under conditions intended to maximally facilitate their ability to communicate their strategy. Preliminary analyses indicated a strong relationship between the quality of the strategy the child gave and his efficiency in problem solving. To assess the relationship between the quality of the child's strategy and conceptual tempo, the five strategies were rank-ordered according to their quality and assigned a numerical value on this basis. There were significant

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Slide 4; Table 1

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correlations between the quality of the child's strategy and MFF variables at all three age levels, indicating that "reflectivity" (i.e. high MFF

latency scores, low MFF error scores) was consistently associated with the formulation of higher quality solution strategies. The correlation coefficients between "reflectivity" and the quality of the solution strategy remained substantially unchanged when IQ was partialed out (See Table 1b). These data suggest that impulsive children are less efficient problem solvers than reflective children because they are less likely to generate appropriate cognitive mediators in the form of high quality solution rules as they solve this sort of problem.

The third potential source of problem solving inefficiency which was postulated was a failure to consistently implement an appropriate solution rule, given that such a rule had been formulated. To assess breakdowns at this level, children who had professed using either "focusing" or "avoidance of non-informative moves" strategies were given two additional problems to solve after they had declared the strategy they were going to use to solve the problems. A number of children did, in fact, make inefficient moves which were inconsistent with the efficient strategies they had indicated they would use. The tendency to make inefficient moves in violation of a professed efficient strategy was associated with "impulsivity".

Slide 5; Table 2

With the data collapsed across age-groups (this was necessary to provide adequate n's for statistical analysis), it was found that of the 36 impulsive children who had professed using either of the two efficient strategies, 10 made inconsistent moves while solving the subsequent two problems; by contrast, only 2 of the 48 reflective children who professed using one of the efficient strategies made inconsistent moves on the next two problems. In other words, about 28% of the impulsive children who had declared they

used an efficient strategy violated their own solution rule at least once while solving two subsequent problems; by contrast, only about 4% of the reflective children who were using an efficient strategy violated their decision rule on these trials. A X^2 test indicated that there was a significant association between impulsivity and failure to regulate behavior in accordance with a professed solution strategy ($X^2 = 11.4$, 1 dif., $p < .001$). It might be noted parenthetically that children who made moves which were inconsistent with their strategy did not differ in IQ from children who did not make such moves.

In sum, the data suggest that the inefficient problem solving performance of impulsive children is related to (a) failure to formulate an appropriate, high quality solution rule and (b) failure to consistently regulate behavior with such a rule given that a rule has been formulated. There was no evidence that failure to retain task instructions was related to conceptual tempo. The task analysis diagnostic procedure yielded an individual "deficit-profile" for each child; this approach to analyzing performance deficits thus appears to lend itself to studying problem solving inefficiency in children in a manner which is both scientifically interesting and clinically relevant.

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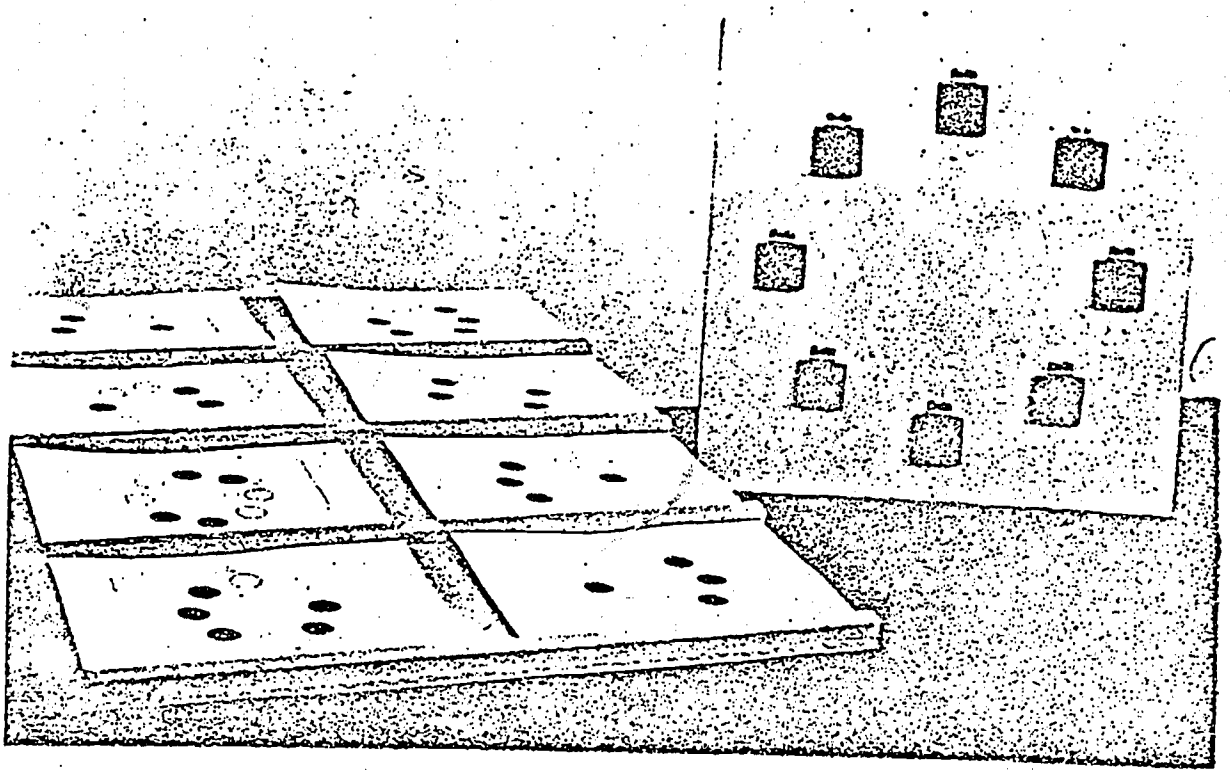

Figure 1 Photogragh of pattern matching test materials similar to those used in the present study. The slide from which this figure was derived was supplied by Dr. J. D. McKinney.

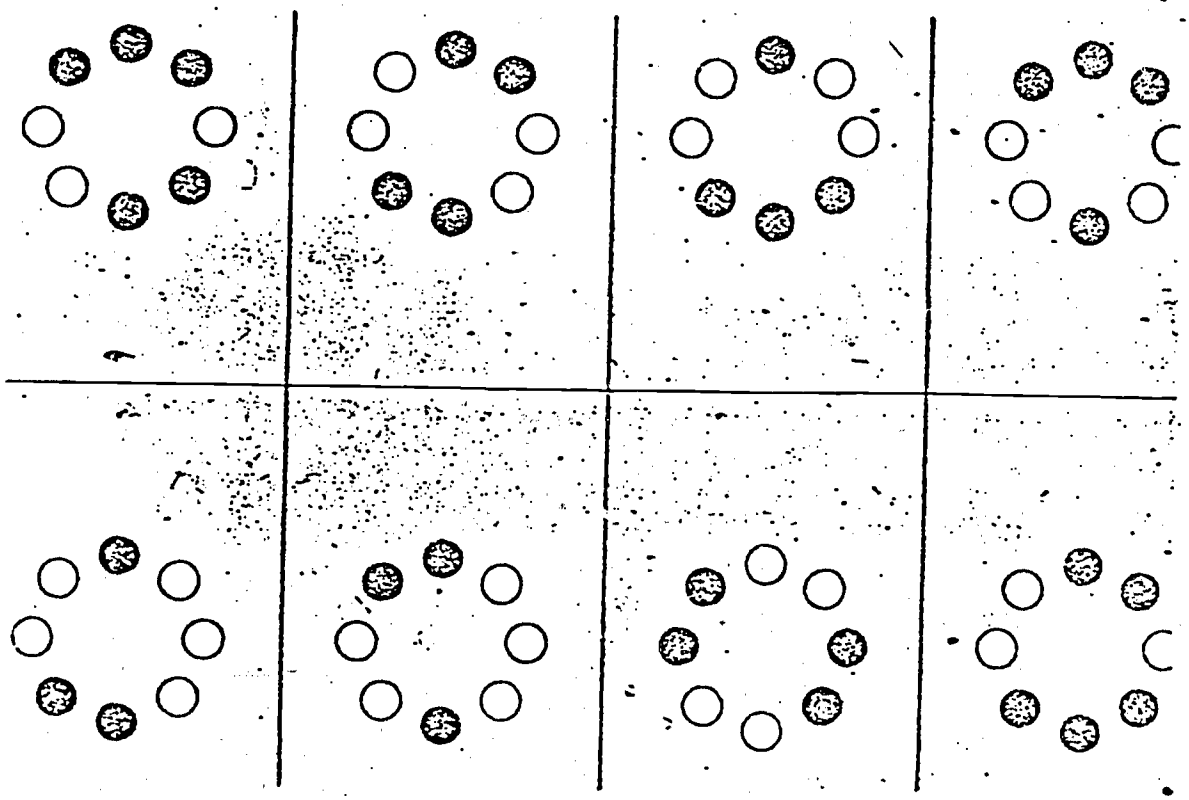

Figure 2 Pattern alternatives for a typical pattern matching test problem. The slide from which this figure was derived was supplied by Dr. J. D. McKinney.

Table 1

(a) Pearson correlations between quality of strategy *vs.* MFF latency, MFF errors, and IQ

	n	MFF Lat	MFF Err	IQ
Seven-year-old	50	.60***	-.55***	.33**
Nine-year-old	48	.27*	-.25*	.27*
Eleven-year-old	56	.25**	-.39**	.05

(b) Correlations between quality of strategy *vs.* MFF latency and MFF errors with IQ partialed out

	MFF Lat	MFF Err
Seven-year-old	.62***	.56***
Nine-year-old	.27	-.25
Eleven-year-old	.35**	-.39**

* $p < .05$
** $p < .01$
*** $p < .001$ (all tests are 1-tail)

Table 2

Distribution of the tendency to behave inconsistently with strategy across cognitive style groups

	Number giving Foc or AVNI Strat	Number consistent with strategy	Number inconsistent with strategy
Reflective	48	46	2
Impulsive	36	26	10
Fast-Accurate	7	4	3
Slow-Inaccurate	7	5	2
Total	98	81	17

Notes

[1]This paper is based on a portion of the author's doctoral dissertation. The author is grateful to Donald Meichenbaum, who contributed much to the research in his capacity of thesis supervisor; to Kenneth Bowers and Richard Steffy who served on the thesis committee; and to James D. McKinney and Jeremy Anglin who served as thesis readers. All of these people made helpful comments which have been much appreciated. The research reported was supported by Canada Council grant No. S73-0034 and a grant from the Ministry of Education, Ontario, to Donald Meichenbaum, and by an Ontario Mental Health Foundation Research Studentship to the author.

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