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ABSTRACT
        This study explored the effects of overt and covert
verbalization instructions on problem solving in high school
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groups instructed to either (1) say a reason for each move they made
(overt verbalization), (2) think of a reason for each move as if they
were going to say it (covert verbalization), or (3) work the problems
silently (control). Consistent with previous findings, subjects
instructed to overtly verbalize were superior to control subjects on
a transfer task requiring no overt verbalization. No significant
differences, however, were observed between overt and covert
verbalizers. This finding was interpreted to indicate that, in
adults, covert verbalization can be as effective in mediating problem
solving behavior as talking aloud. It was suggested that this may not
hold true for children, however. (For related document, see PS 005
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Overt and Covert Verbalization in Problem Solving

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Report from the Project on Variables and
Processes in Cognitive Learning

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STATEMENT OF FOCUS

The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement fo related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Working Paper is from the Project on Variables and Processes in Cognitive Learning in Program 1, Conditions and Processes of Learning. General objectives of the Program are to generate knowledge ond develop general taxonomies, models, or the development of curriculum materials and procedures. Contributing to these Program objectives, this project has these objectives: to ascertain the important variables in cognitive learning and to apply relevant knowledge to the development of instructional materials and to the programming of instruction for individual students; to clarify the basic processes and abilities involved in concept learning; and to develop a system of individually guided motivation for use in the elementary school.

CONTENTS

FIGURE LIST

v/vi

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ABSTRACT

This study explored the effects of overt and covert verbalization instructions on problem solving in high school subjects. A series of three-circle problems were administered to groups instructed to either (1) say a reason for each move they made (overt verbalization), (2) think of a reason for each move as if they were going to say it (covert verbalization), or (3) work the problems silently (control).

Consistent with previous findings, subjects instructed to overtly verbalize were superior to control subjects on a transfer task requiring no overt verbalization. No significant differences, however, were observed between overt and covert verbalizers. This finding was interpreted to indicate that, in adults, covert verbalization can be as effective in mediating problem solving behavior as talking aloud. It was suggested that this may not hold true for children, however.

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INTRODUCTION

The relationship between thinking and verbal processes is a compelling issue confronting many behavioral scientists. Problem-solving paradigms, which seemingly require higher-order learning, have occasionally been used to examine this relationship. For example, Gagné and Smith (1962) studied the effects on learning and transfer of having subjects verbalize while solving problems. They also examined the effect of instructions to search for a general principle to be stated verbally upon completion of the problems.

The Gagné and Smith experiment was based on a series of three circle tasks which required that the subject transfer a number of discs of graduated diameter from one of the circles to another, moving only one disc at a time. While the principle of solution remained the same, the problems increased in complexity from a two-through a five-disc task. One of the groups in this study was instructed to state aloud a reason for each move as it was made, a second group was instructed to search for a general principle, a third received both instructions, and a fourth, the control group, was simply informed of the rules and worked silently. On the transfer task (a six-disc problem performed silently by all groups),

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verbalizers were highly superior to both the group instructed to search for a general principle and the control group, as indexed by total time to solution and moves taken in excess of the minimum required to solve the problem. In interpreting their findings, Gagné and Smith noted the lack of theory relevant to their findings, but suggested that requiring subjects to verbalize "somehow forced them to think" during the practice trials.

Another line of research related to verbalization has developed quite independently of the problem-solving literature. This latter group of studies, for the most part utilizing verbal learning paradigms, has emphasized the role of overt verbalization in learning (Carmean & Wier, 1967; Mechanic, 1964; Murray, 1965, 1966, 1967; Wilder, in preparation). Carmean and Wier, for example, found that pronouncing the correct response in a discrimination task is superior to rehearsing the correct response silently. The authors concluded that "overt verbalization has a memorial effect which influences both learning and recall" (p. 549). Four possibilities as to why overt verbalization has a facilitative effect were offered, but the "scanty evidence available" for explaining this effect was noted.

While Gagné and Smith (1962) operationally defined "verbalization" as talking aloud during task performance, the perspective mentioned above emphasizes the vocal component in verbal behavior. Thus, while a subject's speech is a convenient index of his covert verbal behavior, studies examining spoken versus silent learning suggest that speech may have a function quite apart from communicating with

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experimenters while solving problems.

It seems presumptious to assert that the subjects (Ss) in the Gagné and Smith control group were verbalizing silently while performing the three-circle problem, and that this covert verbalization was not as efficient as overt verbalization. Therefore, the present study attempted to elicit covert verbalization with a bit more assurance, and to compare the effects of instructions to covertly verbalize with instructions to talk out loud while solving the three-circle problem. If there are unique facilitative effects associated with instructions to overtly verbalize, then overt verbalization subjects should be superior to subjects instructed to covertly verbalize, or to subjects given no verbalization instructions.

Using the same three-circle problem and procedures reported by Gagné and Smith, this study examined training (two- through five-disc problems) and transfer (six-disc problem) effects of overt and covert verbalization instructions, in addition to instructions containing no verbalization requirement. One limitation of the Gagné and Smith study was that while they counted the number of moves during the training problems, they did not record the time to solution for these problems. Nevertheless, they reported that, during the two- through five-disc problems, "the making of moves was slower for those Ss who were required to verbalize" (p. 14). Consequently, it could be argued that the superior performance of verbalizers was due to the greater amount of time spent on the training tasks. To clarify this issue, time to solution for each training task was recorded in the present study.

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METHOD

Subjects

Gangé and Smith (1962) used 14- and 15-year-old male volunteers. In the present study, the 30 subjects were 17- and 18-year-old male volunteers who were attending summer clinics in Speech and Journalism at the University of Wisconsin. The only requirement for participation was that the subject had no previous knowledge of the three-circle problem.

Materials

The three-circle problem cited by Gagné and Smith was constructed according to similar specifications. The discs were cut from 3/32-inch aluminum and graduated in diameter from 3/4 inch to 2 inches. The discs were numbered one through six in order, from the smallest to the largest. Three circles of 4 inches in diameter were drawn on a piece of light grey construction paper with their centers at the apexes of an equilateral triangle having 6-inch sides. The circles were lettered A, B, and C.

Procedure

The procedures were similar to those described by Gagné and Smith. Each subject was shown the materials and informed of the rules of the game. The three- and four-disc tasks were then administered

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until each was carried to final solution. During these warm-up trials, subjects were encouraged to ask any questions pertaining to the instructions and were permitted to retrace a wrong move as far back as the beginning. The purpose of this exercise was to fully acquaint the subjects with the problem, as well as to establish a relaxed experimental atmosphere.

Each subject was then randomly assigned to one of three experimental conditions, each containing ten subjects. The control group received the following instructions:

> You will see on the table three circles, A, B, and C. A number of discs will be placed on Circle A. The largest disc is on the bottom, the next largest is next to the bottom, etc., so that the smallest is on top. Your task is to transfer these discs to Circle B in the least number of moves possible so that they will be in the same order. You may move only one disc at a time. You may move only discs that are on top of a pile or that are alone. You must not place a larger disc on a smaller. A disc moved from one circle must be placed in one of the other circles. The number of moves it takes you to complete the problem and the time will be recorded. There is no time limit, however, so do not hurry your moves. You may back up at any point and retrace your moves.

Overt verbalization subjects received the same instructions as the Control group plus the following:

> State out loud a full reason for each move as completely as you can. If you are not certain of the reason for a specific move do not hesitate to say so. If you choose to back up at any point be sure to verbalize a reason for each move as you retrace your steps.

Covert verbalization subjects received the same instructions as the Control group plus the following:

> Carefully consider each individual move. Think of a full reason for each move as if you were being asked to report

your reason out loud. Do not move until you feel confident
there is a good reason for the move you are about to make.
Remember to approach each move as if you were being required
to state your reason out loud.

The subjects wer_ then presented with the two-, three-, four-,
and five-disc tasks in succession which they worked through to com-
pletion. A 1-minute interval followed each task through the five-
disc trial. These short rest periods were filled with casual conver-
sation generally unrelated to the problem situation.

Immediately preceding each task, overt verbalization subjects
were reminded to approach each consecutive move as if they were being
required to verbalize a complete reason. Control subjects were simply
reminded not to place a larger disc atop a smaller or to move only
one disc at a time. All subjects were informed of the minimum num-
ber of moves possible for solution of each task $(2^n - 1)$. A 3-minute
interval preceded the final six-disc transfer task. All subjects
were told to work silently on the final task and to approach the
problem in whatever manner they chose.

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RESULTS

Total time to solution and total moves were analyzed in a 3 by
5 analysis of variance, with three levels of Verbalization (overt,
covert, control) and five Tasks (two, three, four, five, and six
discs). The Task factor was a within subjects variable.

The control group averaged 27.32 excess moves over all tasks,
while mean excess moves for overt verbalization and covert verbali-
zation groups were 12.88 and 12.30, respectively. This main effect
of verbalization conditions was significant (F = 18.63; df = 27;
p < .001). Scheffé pair-wise comparisons revealed significant dif-
ferences between the control group and each of the two verbalization
groups (p < .01). This finding indicates that verbalization subjects,
overt and covert, made significantly fewer excess moves on the
training and transfer disc problems than the control group. The con-
trast between the overt and covert groups did not approach signifi-
cance.

The Verbalization by Task interaction was also significant
(F = 7.25; df = 8,108; p < .001). This interaction is shown in
Figure 1. A trend analysis revealed a strong linear component to the
differences among the conditions as a function of the number of discs
(F = 5.99; df = 8,108; p < .001). The differences in quadratic,
cubic, and higher components were not sufficiently great to have

Figure 1. Mean Moves in Excess of Minimum for Overt, Covert, and Control Verbalization Groups on the Training and Transfer Problems
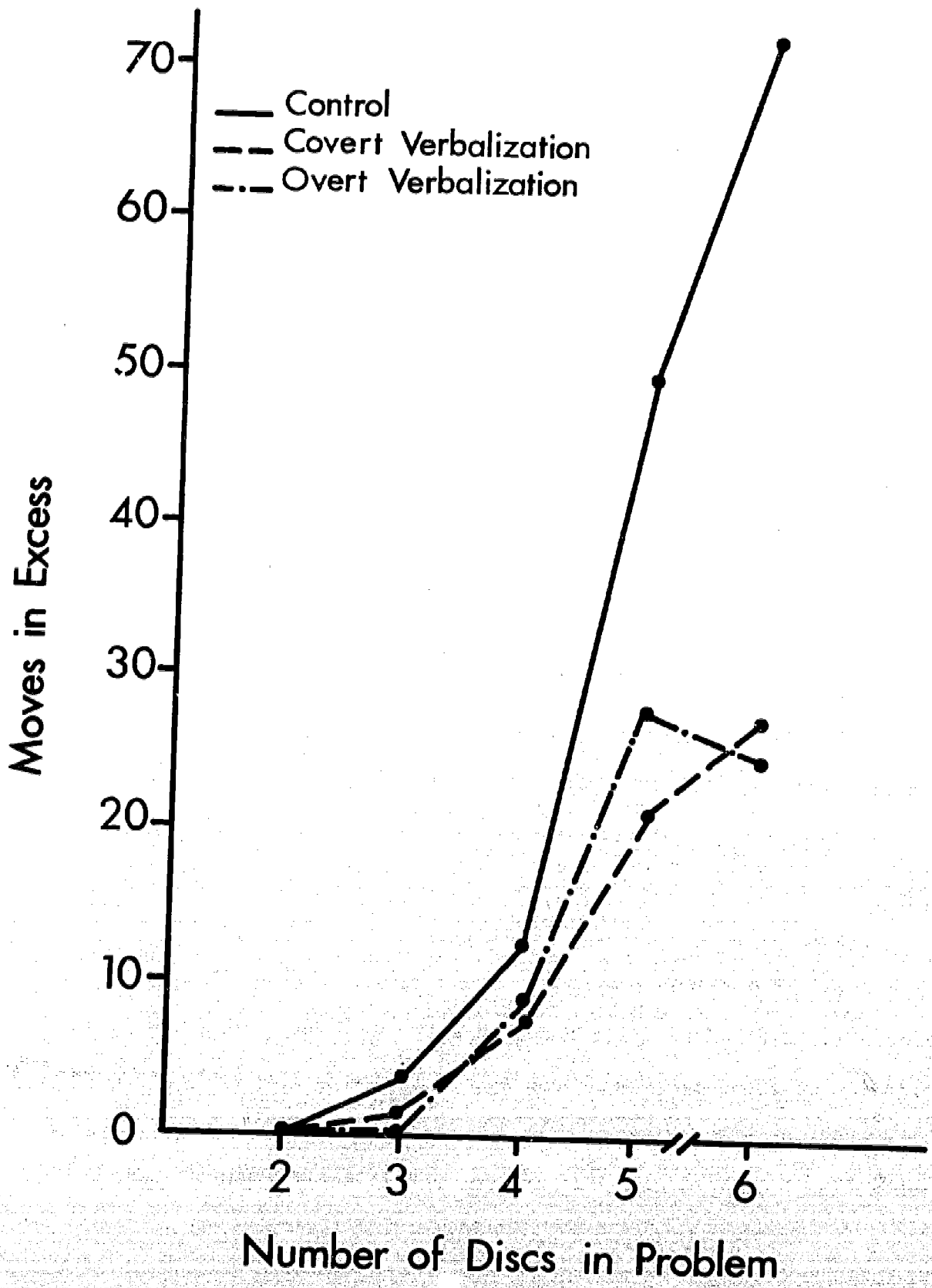
produced the significant interaction. Further, Scheffé pair-wise
comparisons indicated that the differences among conditions as a
function of the number of discs resulted from the difference between
the control group and each of the verbalization groups ($p < .01$).
There was no significant difference between the overt and covert
verbalization groups.

The time to solution measure yeilded no significant differences
among the verbalization and control groups ($F < 1$), and Verbalization
did not interact with Task ($F < 1$).

IV

DISCUSSION

These results were remarkably similar to those reported by
Gagné and Smith (1962). Overt verbalization subjects were superior
to control subjects as early as the three-disc problem (see Figure
1), and this difference in performance increased as more discs were
added. However, the time-to-solution measure yielded no significant
differences among the two verbalization groups and the control
group. This finding suggests that, while verbalization subjects
made fewer moves in excess of minimum over tasks than the control
group, all three groups took approximately the same amount of time
in solving each successive problem.

While Gagné and Smith did not measure time-to-solution on the
training tasks, they found overt verbalization subjects faster than
control subjects on six-disc performance. Perhaps the present re-
sults differ with the previous study because of instructions. While
Gagné and Smith reported that their subjects were informed of the
time-to-solution and the number-of-moves measures, subjects in the
present study were further told "there is no time limit, however, so
do not hurry your moves." Thus while the act of verbalization could
be expected to slow down overt verbalization subjects, the instruc-
tions not to hurry could have had similar effects on control and
covert verbalization subjects. Assuming this were the case, the pre-

sent study provides even stronger support for the facilitative effects
of verbalization, since it cannot be argued, as was the case in the
Gagné and Smith study, that overt verbalization subjects spent more
time on the training problems.

There was no significant difference between the performance of
overt and covert verbalization subjects as indexed by the excess-
moves and time-to-solution measures. These results imply that if
covert verbalization instructions were employed in the studies pre-
viously cited (which they were not), covert as well as overt verbali-
zation could be demonstrated to be superior to silent performance.

Thus, while Carmean and Wier (1967) stressed tentative hypotheses
concerning the unique effects associated with saying items out loud
during learning, the present study (using a different task) suggests
that covert verbalization may be the actual mechanism facilitating
learning, and having subjects talk out loud during experiments may
simply insure activation of this mechanism. This explanation is
consistent with Vygotsky's (1962) theoretical account of the internali-
zation of speech during the course of human development (See also
Flavell, Beach & Chinsky, 1966; Kingsley & Hagen, 1970; and Kohlberg,
Yaeger, & Hjertholm, 1968). According to Vygotsky, young children
need to talk to themselves during problem solving. This overt dia-
logue-with-self reflects the child's not yet fully developed internal
verbal connections which mediate problem-solving behavior at a later
stage of development.

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The results of the present study can be interpreted within this theoretical perspective. Verbal mediation (i.e., hypothesis testing, strategy, or whatever) aids performance on the three-circle problem. In high school students, this verbal mediation can be elicited by requesting the subject to talk while solving each successive problem, or by asking him to silently mediate. However, this may not be the case with young children, and perhaps speech as an _overt verbal process_ is an important stage in the development of verbal behavior.

The three-circle problem might yield useful data relevant to the role of speech in the development of verbal behavior. For example, from the above theoretical consideration, one might hypothesize that if no instructions about verbalization were given, younger children would spontaneously talk more during problem-solving than older children. Further, inhibition of this spontaneous verbalization in younger children should lead to decreased efficiency in task performance. Finally, instructions to verbalize covertly should not be facilitative in younger children.

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