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THE USE OF PROGRAMMED MATERIALS IN THE ANALYSIS OF ACADEMIC CONTINGENCIES[1]

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Programmed handwriting materials were used to examine the effects of different reinforcement contingencies on the academic performance of six public school kindergarten children. The children's responses to these materials provided an educationally relevant dependent variable for the analysis of factors that affected the accuracy of their responses and the attainment of criterion performances. Variations in the complexity of most academic materials, which confound the analysis of contingencies, were eliminated by the programmed sequence so that the differential effects of three reinforcement conditions were observed. The three conditions were: baseline without tokens, tokens contingent on correct writing responses, and noncontingent tokens. It was consistently observed that the children were more accurate when their correct responses produced tokens, and that noncontingent tokens reduced accuracy below baseline levels.

Most experimental analyses of classroom behavior have considered problems of classroom management (Hall, Lund, and Jackson, 1968; Madsen, Becker, and Thomas, 1968; Schutte and Hopkins, 1970), while academic performance has received comparatively little attention. One possible explanation for the lagging development of explicit performance contingencies may be the difficulty in specifying a suitable dependent variable.

Most instructional materials present sequential problems that are extremely variable in difficulty, or response requirement. In arithmetic, for example, a section of time-consuming, complex story problems may be followed by a section of rapidly completed computation exercises. Because of this variability, performance shifts due to altered contingencies are hard to untangle from shifts due to changes in problem format. Similarly, when children are advanced as a group in nonprogrammed materials, the relative increase in the difficulty of the step is not the same for each child. More-skillful children will make the step easily. For the less-skillful children, the new step will be comparatively more difficult. This also introduces a source of variability that can confound the apparent effects of different contingencies. As a consequence, studies of academic performance have often used such indirect measures as achievement test gains to substantiate effects rather than direct performance measures (Staats and Butterfield, 1965; Wolf, Giles, and Hall, 1968). Analyses of the function of consequences and changes in consequences on academic performance will profit from procedures that control other sources of variance.

Variations in the response requirements of instructional materials can be eliminated by using the same set of problems over and over, but the results of such a solution may not be directly relevant to the problems of an operating classroom.

Another possible solution involves the use of control groups doing the same work at the same

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pace. Glynn (1970) exemplified the use of a control group as a daily standard to evaluate the effects of experimental variables on performance. This is often a complex and time-consuming method, however, that relies on statistical rather than manipulative comparisons for evaluation.

Pedagogically, the use of programmed instructional materials offers a more attractive solution to this methodological problem. By design, an instructional program moves the learner in small steps of (theoretically) comparable difficulty from some entry level to a more advanced performance. To the extent that a program's steps are of equivalent difficulty, it can be used to examine the effects of various academic contingencies. The self-pacing feature of an instrumental program offers an additional research advantage. If children are working at their own rates, they can be expected to be at different points in the sequence whenever an experimental manipulation is introduced. Changes in performance that are related to a change in contingency, but unrelated to position in an instructional sequence can lead to stronger conclusions. The extent to which a program meets these assumptions should determine its suitability for use as a dependent variable.

The present study attempted to use a handwriting program of presumed equally difficult steps as the dependent variable to measure some of the effects of different token contingencies on children's performances.

METHOD

Subjects and Materials

Six public school kindergarten children served. The three boys and three girls ranged in age from 5 yr two months to 5 yr six months at the beginning of the study.

The handwriting program used was based on the work of Miller and Schneider (1970). The first step of the program consisted of 20 horizontal cylinders 0.25 in (0.65 cm) in diameter by 1.25 in. (3 cm) in length. In Steps 2, 5, 6, and 8, this cylinder form was presented in various positions of rotation and its diameter was reduced to 0.125 in. Steps 3 introduced curved tubes 0.375 in. in diameter that were similarly rotated and reduced in diameter over Steps 4, 7, and 9. A correct response for the first nine steps was a single unbroken line that extended from inside the circle on one end of the item into the opposite circle without crossing any of the outside lines.

Program Steps 10 through 13 presented dashed lines that extended 1.125 in. between starting and stopping dots. Two of the dashed-line steps presented straight lines in different positions, and two presented curved lines. Steps 14, 15, and 16 consisted of straight and curved dashed lines on a sheet containing guidelines 1.125 in. apart. A correct response for these steps was a single unbroken line that touched each dash and extended from the beginning dot to the ending dot.

From Step 17 on, the straight and curved lines were combined into letter forms between guidelines. In this final stage, the task was to make lines that touched all the dashes without crossing either the top or bottom guidelines.

The first 24 steps of the program are illustrated in Figure 1.

The children were given their day's materials in a packet at the beginning of each session. The packet consisted of eight sheets of the same program step. Although a few of the early sheets contained only 10 items, most required responses to 20 items. The children were required to complete at least one sheet at 80% accuracy to advance to the next step in the program. Since the sheets were not completely graded until after the session, a child could not advance from one step to the next during a session.

Grading Criteria

Each paper was graded at the end of each session according to one of three rules. Each of the rules applied to a different stage of the program.

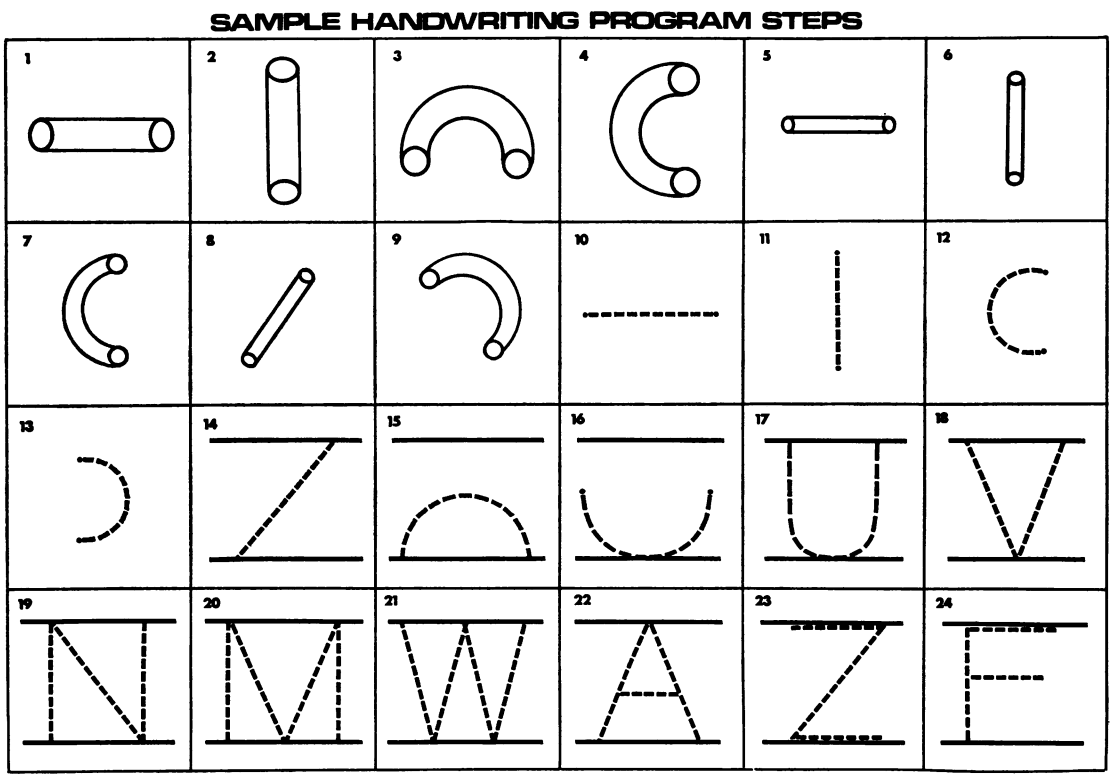

Fig. 1. Sample figures from 24 of the 32 steps in the handwriting program.[2]

Rule 1 (for cylinder items): a single, unbroken line extending into both circles without crossing any outside lines.

Rule 2 (for transitions from cylinders to letters): a single unbroken line touching each dash and extending from (touching) the beginning and ending dots.

Rule 3 (for capital letters): a series of unbroken lines, corresponding to the number of strokes needed to produce the letter, touching all dashes without crossing top or bottom guidelines.

Grading Reliability

Grading reliability was established in three ways. First, the grader checked reliability with himself by randomly selecting sheets and regrading them. Before regrading, all previous grading marks were masked. Grade-regrade reliability was 94.5%. A second method compared the grader's scores with those obtained by two other graders. The average reliability for this method was 92%. Third, the two reliability graders each graded a randomly selected group of papers and their scores were compared. The average reliability was 91%. All reliability scores were based on item-by-item comparisons.

Token Delivery

Two methods of token delivery were used, contingent and noncontingent. Contingent tokens were given to the children for "correct" responses as they worked. The teacher was asked to monitor the children's behavior and deliver a token and praise for every fourth or fifth response that met the appropriate criterion. She also placed a check mark by all responses on a page that she judged to be correct.

[2]This program has been modified and expanded for regular classroom use. The complete program on spirit masters may be obtained from Don Bushell, Jr., Follow-Through Project, Department of Human Development, University of Kansas, Lawrence, Kansas 66044.

Beginning with Session 27, a "row contingency" was introduced. The teacher was asked to check the children's performance row by row. If three of the five responses in a row were correct, one token was given for that row. If all five of the responses were judged correct, the teacher gave two tokens for that row. All contingent tokens were placed in a cup in front of the child and delivered along with some form of praise for the child's good work, *e.g.*, "That's very good writing, Sallie. See if you can do the next row just as well."

Noncontingent token delivery consisted of giving the child 10 tokens at the beginning of the session. Although no further tokens were delivered during the session, the teacher was asked to praise all of the children equally for their attention and correct responding during the session.

Token Exchange

Beginning with Session 12, the backup activities for the day were announced before work started. The announcement consisted of posting large (18 by 36 in.) photographs and drawings of the backups on the blackboard. These activities were typical of those familiar to kindergarten children: coloring, painting, playing in a playhouse area, playing an inside game, playing an outside game, going to the gym, and going on a walk. Prices (the number of tokens required for an activity) ranged from 1 to 10, and were posted at the end of the session. The children exchanged their tokens for the activity of their choice at the end of each session. Excess tokens could be exchanged for cookies at snack time about half an hour later.

Procedure

The five phases were baseline; contingent tokens for Group A, noncontingent for Group B; noncontingent tokens for Group A, contingent for B; contingent for A, noncontingent for B; and contingent tokens for both groups.

Baseline. The packets of materials were introduced in Session 1, and no tokens were given during the first nine sessions. All backups were freely available, and the teacher was asked to attend to and praise the children's correct work during the sessions.

Contingent tokens for Group A, noncontingent for B. Beginning with Session 10, the children were classified into two groups of three students each. The children were not separated by groups, but remained seated around the teacher in the usual manner. The students of Group A were given tokens contingent on correct responses and the students of Group B received 10 tokens at the beginning of the session. The teacher was again asked to attend to and praise all of the students equally for their correct work.

Noncontingent tokens for Group A, contingent for B. During Sessions 16 through 23, tokens were given to the three children of Group B contingent on correct responding and the children of Group A received 10 tokens at the beginning of each session.

Contingent tokens for Group A, noncontingent for B. The conditions of Phase 2 were reinstated for Sessions 24 through 31. Beginning with Session 27, the row contingency was introduced for token delivery.

Contingent tokens for Group A and Group B. In the final phase of the study Sessions 32 through 38, all six children received their tokens during the session for correct responding. The row contingency was used for both groups.

RESULTS

The principal findings are displayed in Figure 2, which shows the mean per cent accuracy for each group during the last four days of each condition. The children's accuracy consistently increased when tokens were delivered contingent on correct responding, and decreased when the tokens were delivered noncontingently at the beginning of the session. This effect can be seen in sequential comparisons of contingent and noncontingent phases, and in simultaneous comparisons between groups within phases. For

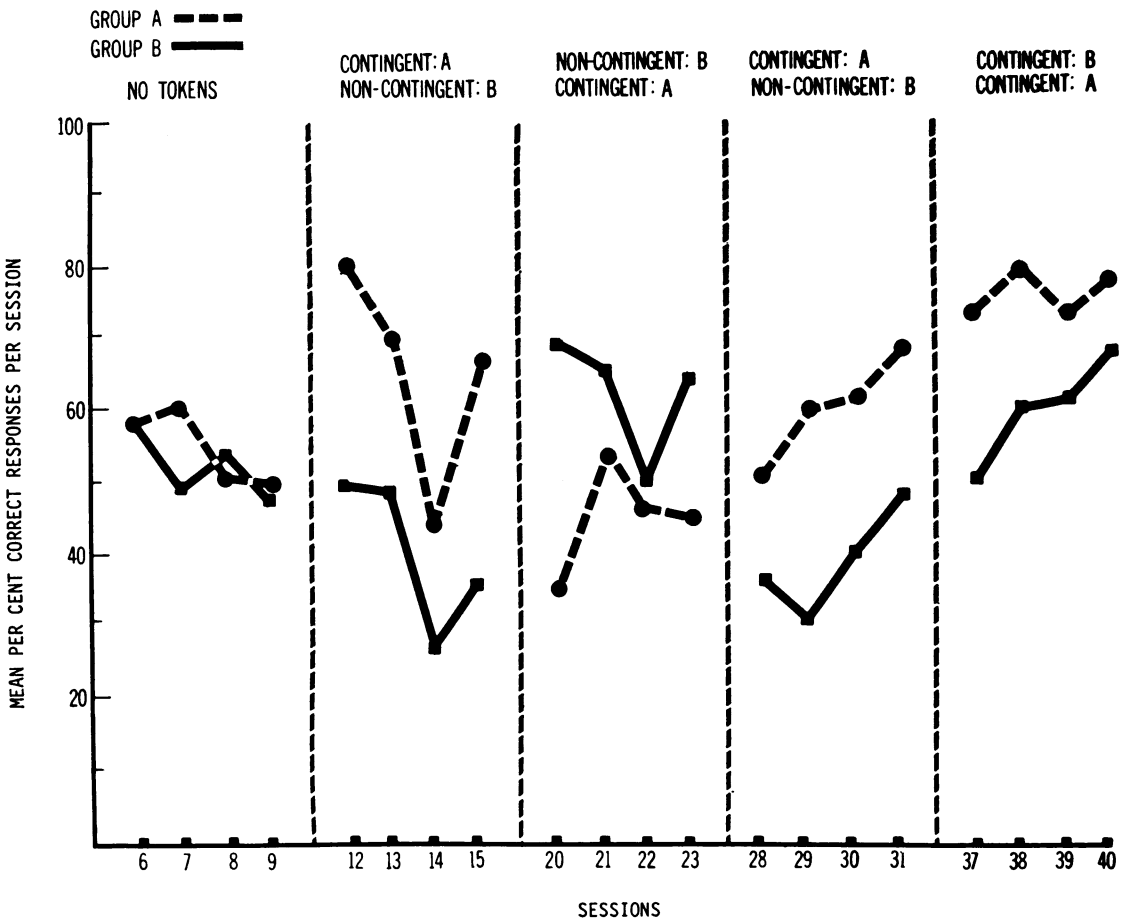

Fig. 2. Mean per cent correct handwriting responses for the children of Group A and Group B during the last four days of each condition.

Group B, there was a systematic decrement in the accuracy of their performance compared to baseline when noncontingent tokens were introduced. Simultaneously, Group A's performance improved over baseline when they were given tokens contingently. When the procedure was reversed, Group A's accuracy fell below its baseline level, and Group B's performance exceeded its original level.

When the contingency was reversed again in Session 24 (not shown in the summary of Figure 2), Group A's accuracy percentage did not increase, even though they were again receiving contingent tokens. An analysis of their absolute response rates (both correct and incorrect responses) revealed that the children had nearly doubled their rates under the noncontingent procedures of the preceding phase. This high rate, when carried into the contingent phase, was sufficient to produce the usual number of tokens on the nonspecific schedule, even though accuracy was low. The introduction of the row contingency, which directly reinforced accuracy, appeared to have the immediate effect of increasing accuracy and decreasing rate. Group A's final accuracy level under the row contingency appeared to be high and stable. A similar effect was noted on the performance of Group B. It was not possible, however, to continue the study long enough to determine how high the accuracy level might have been for Group B under this procedure.

Throughout the study, the group curves were functionally representative of the individual

performances. That is, while the degree of change varried, the direction of change was consistent for every subject.

The program steps probably were not all of equal difficulty. Nevertheless, because the children progressed through the program steps at their own rates, changes in contingencies did not correlate in any systematic way with changes in the response measure (*i.e.,* easier program steps). On the first day of the study, the six children were on four different steps in the program, and on the final day they were at six different points. Regardless of their position in the program, however, the children's rate of completing steps to criterion was influenced by the contingency in effect.

DISCUSSION

The repeated finding of this investigation was that the delivery of tokens and praise contingent on correct responding raised accuracy above the no-token baseline, while noncontingent token delivery reduced accuracy below baseline. This finding is similar to those reported by Ayllon and Azrin (1965) and by Glynn (1970). Glynn reported comparable effects with a procedure he labelled chance reinforcement, in which tokens were delivered noncontingently.

The variations in the teacher's behavior during the several phases of this study were the subject of a study by Mandelker, Brigham, and Bushell (1970). Those data established that, even though she had been instructed to praise all children equally, differential teacher attention was given to the children who were receiving contingent tokens. Consequently, additional research is required to establish the relative effects of teacher attention and token delivery on shifts in accuracy. This remaining question does not, however, negate the demonstration of the effects of different contingencies that were independent of changes in the instructional materials.

The results obtained indicate that it should be possible to use children's responses to well-designed programs as the dependent variable in the analysis of factors affecting academic performance, much as the bar press has been used in the laboratory. This possibility should encourage a variety of investigations of the effects of reinforcement schedules on the academic performance of elementary school children.

REFERENCES

Ayllon, T. and Azrin, N. H. The measurement and reinforcement of behavior of psychotics. *Journal of the Experimental Analysis of Behavior,* 1965, **8,** 357-383.

Glynn, E. L. Classroom applications of self-determined reinforcement. *Journal of Applied Behavior Analysis,* 1970, **3,** 123-132.

Hall, R. V., Lund, D., and Jackson, D. Effects of teacher attention on study behavior. *Journal of Applied Behavior Analysis,* 1968, **1,** 1-12.

Madsen, C., Becker, W., and Thomas, D. Rules, praise, and ignoring: elements of elementary classroom control. *Journal of Applied Behavior Analysis,* 1968, **1,** 139-150.

Mandelker, A. V., Brigham, T. A., and Bushell, D., Jr. The effects of token procedures on a teacher's social contacts with her students. *Journal of Applied Behavior Analysis,* 1970, **3,** 169-174.

Miller, L. Keith and Schneider, Richard. The use of a token system in project Head Start. *Journal of Applied Behavior Analysis,* 1970, **3,** 213-220.

Schutte, R. C. and Hopkins, B. L. The effects of teacher attention on following instructions in a kindergarten class. *Journal of Applied Behavior Analysis,* 1970, **3,** 117-122.

Staats, A. W. and Butterfield, W. H. Treatment of nonreading in a culturally deprived juvenile delinquent: An application of reinforcement principles. *Child Development,* 1965, **4,** 925-942.

Wolf, M. M., Giles, D. K., and Hall, R. V. Experiments with token reinforcement in a remedial classroom. *Behaviour Research and Therapy,* 1968, **6,** 51-64.

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