*EFFECTS OF TEACHER ATTENTION ON DIGIT-REVERSAL
BEHAVIOR IN AN ELEMENTARY SCHOOL CHILD¹*

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Teacher attention was systematically manipulated to modify digit-reversal behavior in an elementary school child. Almost invariably, the child reversed the order of digits (*e.g.*, writing 21 as the sum of $5 + 7$) when adding numbers yielding a two-digit sum. The child, along with classmates, was given 20 addition problems a day for the duration of the study, and the number of reversals was recorded. During an initial baseline period, the teacher responded to digit reversals by marking them as incorrect and then giving the child "extra help" until all sums were correctly ordered. The child's present and previous teacher had both responded to reversals in this manner for approximately one year before the present study began. An experimental period followed during which the rate of reversals decreased sharply. During this period, all sums were marked as correct (whether reversed or not); "extra help" with reversals was discontinued; and correct, *i.e.*, non-reversed, response forms were responded to with a smile, a pat on the back, and a brief comment. A reversal period followed, during which the teacher responded to reversals as she had in the first baseline period. An increase in the rate of reversals to baseline level occurred within three days. A final period, replicating the first experimental period followed, and was characterized by a sharp decrease in the rate of reversals.

The failure to acquire academic behaviors at a rate commensurate with that of one's peers has long been recognized as a significant problem by parents, educators, and the social community in general. Kessler (1966) estimated that three-fourths of all elementary school-age students are referred for individual study and treatment because of academic behavior problems. If this estimate is accurate, then certainly the problem is one of considerable scope. Unfortunately, the problem has been approached from limited perspectives. One approach has been to view the problem as a technical one, although only in

the sense of materials and methods of presenting them. Another approach, frequently taken in the face of repeated failures at modification, has been to attribute the problem to some characteristic of the student, such as stubbornness, retardation, or a learning disability. Seldom have such problems been approached from the viewpoint of an experimental analysis of behavior.

An experimental analysis of academic behavior problems would necessitate consideration of all of the components of the reinforcement contingencies operative in the classroom. Hence, such an analysis would pay a good deal of attention to the consequences provided for student behavior and would attempt to identify and control reinforcing events. Certainly, such an analysis should address itself not only to the arrangement of reinforcement contingencies that will facilitate the development of academic behavioral repertoires, but should examine as well the role of mismanaged or accidental contingencies in the etiology of academic behavior problems.

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One class of reinforcing events, likely to be operative in any classroom, involves aspects of the teacher's behavior. The reinforcing effects of teacher attention, for example, have been demonstrated in a number of recent studies. Teacher attention has been systematically manipulated to modify classroom behavior problems (Becker, Madsen, Arnold, and Thomas, 1967; Thomas, Becker, and Armstrong, 1968; Thomas, Nielsen, Kuypers, and Becker, 1968) and to increase the rate of "academic" behaviors (Hall, Lund, and Jackson, 1968; Zimmerman and Zimmerman, 1962). Given the results of these studies, it would seem advisable to analyze other classroom situations that typically involve contingent teacher attention.

One classroom situation likely to involve contingent teacher attention occurs when a student has difficulty learning some set of responses, such as are involved in adding a column of numbers. The teacher may give such a student individual attention until the responses in question are made appropriately. Differential reinforcement of incorrect response forms might occur in such a situation, particularly if they became discriminative stimuli controlling the teacher's attending behavior to the child. Zimmerman and Zimmerman (1962) reported on such a situation in the area of spelling behavior. The child in their study made repeated errors when called upon to spell a word that had been studied and drilled previously. As a consequence of this behavior, the teacher gave considerable time and attention to the child in an attempt to modify this behavior. While this procedure was ineffective, appropriate spelling behavior did develop when incorrect responses were ignored and correctly spelled responses were differentially attended to by the teacher. Thus, the study demonstrated a situation in which inappropriate academic behavior was maintained by the establishment of an accidental reinforcement contingency between incorrect spelling responses and teacher attention. The present study reports on a similar situation. In the study, the effects of teacher attention on maintaining and modi-

fying digit-reversal behavior in an elementary school child were analyzed.

METHOD

Subject

Bob, an 8-yr-old boy, was enrolled in a Basic Skills class in the Ontario-Montclair (California) School District. While considered by his teacher to be one of her most capable students, Bob had specific difficulty in adding numbers yielding a two-digit sum. Almost invariably, he would reverse the order of digits in the sum, *e.g.*, writing 21 as the sum of $5 + 7$. He had exhibited this behavior for approximately 1 yr before the present study began. As a result of this behavior, Bob received several neurological and visual examinations, and was given considerable "extra help" by his present and previous teacher. The failure of this extra help to modify the behavior led his present teacher to consider her role in maintaining the behavior.

Several factors suggested that teacher attention might be reinforcing Bob's digit-reversal behavior. First, Bob was able to discriminate easily between numbers containing the same but reversely ordered digits, such as 12 and 21. Second, he often pointed out reversals on his own paper to the teacher when she failed to notice them. Finally, he was observed on several occasions erasing correctly ordered sums and reversing the order of the digits contained.

Procedures

The basic datum of the study was the number of digit reversals made by Bob each day. For the duration of the study, Bob (along with other class members) was given 20 addition problems at the same time each morning. It was common classroom procedure to do a number of such problems daily, and hence, the study necessitated few deviations from normal classroom routine. All problems were designed to yield two-digit sums. Numbers yielding a sum of 10 or sums composed of two identical digits such as 11 or 22, were not used. This left a

population of 80 sums composed of different digits. Addition problems were designed by first dividing these 80 sums into four groups: 12 to 32, 34 to 54, 56 to 76, and 78 to 98. Five sums from each group were chosen to comprise the problems for a given day. By choosing five different sums from each group on consecutive days, over a four-day period all 80 sums were used and none were repeated. Over the four weeks of the study, each sum was thus used seven times. On a given day, sums were chosen from each group such that no reversely ordered sums, such as 18 and 81, appeared. For any sum, the possible permutations of numbers yielding that sum is equal to the sum minus one. Thus, even for the lowest sum used, that of 12, eleven permutations of numbers exist that will yield that sum when added. By randomly selecting permutations without replacement, it was thus possible to provide 20 different addition problems each day, even though each sum was repeated seven times in the course of the study.

On each day of the study, Bob would raise his hand as soon as he had completed all 20 problems. The teacher would then proceed to Bob's desk and check his worksheet. For the first seven days of the study, the teacher marked all correct responses with a "C". All digit-reversals were marked as incorrect with an "X", and were pointed out to Bob by the teacher with the comment: "This one is incorrect. You see (pointing), you reversed the numbers in the answer." After all 20 problems had been scored in this manner, all digit reversals were returned to, and Bob was provided with "extra help" in solving each problem. This "extra help" had two basic components: one, Bob was taken through the adding processes involved in each problem, using a variety of teaching aids, such as counters and number lines; and two, verbal and physical prompting of correct response forms for those problems was provided. This constituted Baseline Period 1 of the study.

For the next seven days, all digit reversals were marked as correct with a "C". This procedure was adopted in consideration of the fact

that marks for incorrect responses might have developed conditioned reinforcing properties. No other comments were made concerning the reversals, no "extra help" was given with them, and statements pointing out such errors were ignored. Correctly written sums were likewise marked as correct with a "C", but were also followed by characteristic teacher consequences, consisting of a smile, a pat on the back, and the comment: "This one is *very* good." This combination of procedures had the effect of withholding all teacher attention for digit reversals (other than marking item as correct) and making more attention contingent upon correct response forms. After each problem had been scored and responded to, the teacher returned to her desk without further comment to Bob. This constituted Experimental Period 1 of the study.

Baseline Period 2 and Experimental Period 2 followed. Each was seven days in length and replicated the previous baseline or experimental period.

It should be emphasized that throughout the study, Bob's daily performance was evaluated and responded to only after all 20 problems were completed. Hence, any change in the digit-reversal behavior would not be evident until the day(s) following a change in the teacher-attention contingency.

RESULTS

All of Bob's worksheets were rescored by an independent judge on each day of the study. Before rescoring, all of the teacher's marks were removed from the worksheets. Worksheets were then scored for correctly and reversely ordered sums. Two other scoring categories were possible, but were never used. These categories were for correctly and reversely ordered, inappropriately added sums. Reliability was computed by dividing the number of agreements between teacher and judge in scoring correctly and reversely ordered sums by 20, the number of possible agreements. This fraction was then

multiplied by 100% to determine the percentage of agreement between scores. In all cases, the percentage of agreement was 100%.

The number of digit reversals made by Bob on each day of the study is graphed in Figure 1. It can be seen that in the first baseline period, digit reversals were made at a significantly high rate, varying between 18 and 20 and averaging 19.4 per day.

When the teacher-attention consequences of this behavior were discontinued, Bob continued to make reversals at a high rate for three days (Days 8 through 10 in Figure 1). The rate then dropped off dramatically, varying between 0 and 5 and averaging 2.5 reversals per day for the next four days (Days 11 through 14 in Figure 1). It should be noted that on Days 8 and 9, Bob failed to order any digits correctly. Consequently, the teacher was unable to respond differentially to correct response forms until Day 10. The significant drop in rate on Day 11 is thus indicative of the sensitivity of the behavior to the consequences provided by the teacher.

Fig. 1. Number of digit reversals per day under baseline and experimental conditions.

After the sixteenth day, when teacher attention was again made contingent upon digit reversals, the number of digit reversals jumped to 20 and remained at that level for the duration of the second baseline period. The average number of reversals per day for the last five days of

this period was thus slightly higher than the daily average observed during the first baseline period.

The second experimental period (Days 22 through 28 in Figure 1) was also characterized by a drop in the rate of reversals. By the second day of this period, the number of reversals had dropped to three. The average number of reversals per day for the last six days of this period was two, slightly lower than during the final four days of the first experimental period. The significant changes in the rate of reversals occurring in the second baseline and experimental periods provide further evidence of the strong control exerted over this behavior by teacher attention.

DISCUSSION

The results indicate clearly that Bob's digit-ordering behavior was under the control of teacher attention. This finding closely parallels that of Zimmerman and Zimmerman (1962) with spelling behavior. In both studies, inappropriate academic behaviors were maintained, modified, and perhaps developed by teacher-controlled consequences. While many studies testify to the role of teacher attention in the modification of behavior problems, and in the development of appropriate classroom behavior, the present findings and those of Zimmerman and Zimmerman suggest that teacher attention may also be implicated in the development of learning difficulties in the classroom. It is not suggested that all such academic problems are developed in this manner or that the procedures used in this study should be applied to all children experiencing similar problems. However, it is a typical teaching practice to give a student individual attention when learning problems develop, and hence, the possibility of reinforcement of inappropriate academic behaviors exists. The teacher should remain aware of this possibility and attempt to determine which student behaviors are discriminative for her attending behavior.

The present findings take on additional significance when the typical ways of conceptualizing the determinants of academic problems, such as seen in this study, are considered. Given exposure to some standard set of teaching procedures, difficulties in learning to read, write, *etc.*, are likely to be attributed to intra-organismic factors. The student is said to be suffering from mental retardation, brain damage, a learning disability, or some other abnormal organic condition. The term "learning disability" is used when the difficulty is specific, and/or the response is unusual in form, *e.g.*, reversed or backwards. The digit-reversal behavior of the child in this study would thus qualify as a learning disability. It is appealing to attribute such behavior to some organically based process that interferes with normal information processing, input assimilation, *etc.*, as if what is "perceived" is also reversed or backwards. Conceptualizations of this sort discourage investigation of the role of environmental events in determining such behavior. Teaching, when attempted, is typically restricted to the manipulation of stimulus events (note the components of the extra help given to the child in this study), presumably, to help the student overcome information processing problems.

The results of this study demonstrate the advantages of viewing behavior as a function of contingencies of reinforcement and teaching as the arranging of such contingencies. Should a student display behavior of the type reported here, it is due presumably to the fact that the contingencies of reinforcement have not been arranged properly. Any explanation of such behavior should therefore take into account all of the variables composing the contingencies of reinforcement. Learning difficulties and disabilities, such as the subject's digit-reversal behavior, are probably related in many cases to an inappropriate presentation of stimulus events, but the present results demonstrate how reinforcement variables can also be involved. The present results suggest then that further research in the area of learning disabilities might find it profit-

able to adopt the viewpoint of an experimental analysis of behavior. Further research on the relationship of reinforcement variables to the development and modification of learning disabilities certainly seems warranted. Additionally, experimental analyses of the various methods and materials developed for use in learning disabilities, of the "extra help" which special education teachers provide, *etc.*, might provide a useful starting point for extending the principles and techniques of applied behavior analysis to an area of obvious need.

It should be clear that further analyses of the phenomena reported in this study are also needed. Obvious constraints are placed upon the data by having a single subject. Additionally, the functional relationship of teacher attention to the subject's behavioral change is not entirely clear. Baseline and experimental conditions differed in more than one respect. In the baseline conditions, little attention was provided for correct responses, while reversals resulted in a good deal of attention. In the experimental periods, reversals were ignored, and the amount of attention provided for correct responses was increased. Hence, the decrease in digit reversals during the experimental periods may reflect the reinforcement of correct response forms, the extinction of digit reversals, or a combination of these effects.

While the present design did not allow for systematic analysis of the effects of differential marking procedures, the results raise some interesting questions concerning the effects of such procedures. Certainly, differential marking procedures had been in effect for some time before the present study began without eliminating digit reversals. Given the results of the study, it is quite possible that marking a response as incorrect may even have developed conditioned reinforcing properties by virtue of being discriminative for the teacher's attending behavior. That the teacher's marks developed discriminative stimulus properties is also suggested by the data from Experimental Periods 1 and 2. During the first experimental period, no changes in

Bob's digit-reversal behavior were observed until a correctly ordered sum was differentially attended to, even though changes in the marking procedure had been in effect for two days. On the other hand, the rapid change in the subject's behavior in the second experimental period occurred simply as a function of the change in marking procedures before a correctly ordered sum had been differentially attended to. What this suggests then is that the effects of marking procedures may be variable depending on the contingencies that exist between marks and other reinforcing events. While further investigation of the effects of marking procedures is called for, the present findings point out, at the very least, the dangers inherent in assuming what is reinforcing or punishing for a particular student. In fact, any teacher attention seemed to be reinforcing. Similar findings have been reported by Thomas, Becker, and Armstrong (1968) with other student behaviors. Hence, whenever a teacher attends to a student, it is possible that some behavior is being reinforced.

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