AN ELEMENTARY STUDENT AS A BEHAVIORAL ENGINEER¹

PAUL R. SURRATT,² ROGER E. ULRICH, AND ROBERT P. HAWKINS

KALAMAZOO VALLEY INTERMEDIATE SCHOOL DISTRICT
AND WESTERN MICHIGAN UNIVERSITY

Four first-grade public school students exhibited non-study behaviors during a period when all children were to study individually. A fifth-grade student modified the maladaptive behaviors of the four first-grade students. Lights on the four students' desks, which were associated with opportunity for reinforcement, rapidly brought study behavior under stimulus control. Differential reinforcement of other behaviors dramatically decreased studying. Reinforcement was reinstituted and studying returned to a high and stable rate. Surreptitious post-experimental observation using closed-circuit TV indicated that the behavioral changes effected during the experimental phases were partially maintained by the regular classroom environment. A replication of the baseline phase with the observer in the classroom produced an increase in the rate of study behavior, indicating that the observer's presence acted as a discriminative stimulus for studying. An additional contingency requiring improved academic behavior was imposed before the fifth grader was given the opportunity to engage in the behavior modification experiment.

The use of behavior modification techniques in regular public school classrooms has recently received considerable attention (Hall, Lund, and Jackson, 1968; Thomas, Becker, and Armstrong, 1968; Madsen, Becker, and Thomas, 1968). In each of these cases, the teacher was utilized as a behavioral engineer, which necessitated that he or she selectively observe the behavior of each of the children in question. Within a normal classroom, there are times when such observations are not practical. For example, when a teacher is working intensively with a small reading group, it is frequently not possible to attend closely to the

behaviors of other class members located in another part of the room.

If time, personnel, and adequate funds were available, the optimal condition within a school would be for a trained behavioral therapist to work with children who are exhibiting mild problems. Because of the prohibitive cost involved in hiring special personnel and the lack of individuals with sufficient training, many problems are allowed to exist and to develop until it is only after a severe behavioral problem is well established that any student is given professional attention.

In a setting where the teacher is unable to work with the behaviors in question, he or she must utilize the resources at hand. In the typical school setting, an abundant resource available for the modification of student behavior, is other students.

It has been shown that nurses and hospital attendants (Ayllon and Michael, 1959), parents (Zeilberger, Sampen, and Sloane, 1968; Hawkins, Peterson, Schweid, and Bijou, 1966), as well as many other diverse populations can be trained effectively in a short period of time to modify the behavior of others (Ulrich, Stachnik, and Mabry, 1966; Homme, 1966). Ulrich and Kent (1966) have suggested the use of college students as instructors for less advanced students.

Many behavior modification studies (*i.e.*, Hawkins *et al.*, 1966) have attempted to assess

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²Reprints may be obtained from Paul R. Surratt, Rehabilitation Institute, Southern Illinois University, Carbondale, Illinois 62901.

the long-term effects of their experimental manipulations by returning the observer to the setting in which the manipulations took place. That observer then records the behavior that is occurring and these data are presented as the residual effect of the experimental manipulations. It would seem feasible that in varying degrees an observer-modifier could become a discriminative stimulus for the behavior in question. The validity of standard post-check methodologies would be in some doubt if such a discriminative function could experimentally be attributed to the presence of the observer-manipulator within the classroom.

The present study investigated the behaviors of four first-grade students in response to controls exerted by a fifth grader functioning as a student engineer. In addition, the effect of the presence of the student engineer during post-check was assessed.

METHOD

Subjects

Four students, enrolled in the first grade of a rural public school, had been described by the teacher as students who did not complete work assignments during study times, but engaged in incompatible behaviors such as talking, walking around the room, and "day dreaming". All four of these children were reported to be experiencing some trouble with their classwork. Two of the four had repeated at least one grade and were being considered by school personnel as candidates for a special remedial classroom. The behavioral engineer in the present study was a fifth grader from the same school.

Apparatus

The experiment was conducted in the first-grade room of a public school which was equipped with the usual classroom facilities and accommodated 29 students and a teacher.

The apparatus consisted of a console designed and constructed to record the behaviors in question and to give feedback to the subjects as to whether they were meeting criterion for those behaviors. Power to the entire console was controlled by a Gra-Lab Session Timer, Model 176, that determined session length. Four silent, single throw, mercury switches each controlled a Cramer Running Timer Meter, Model 636, as well as current to an outlet on the back of the console. When

Fig. 1. A schematic and line drawing of console.

a subject engaged in the behavior being monitored, the console operator would place that student's switch in the "ON" position, which would activate the running-time meter and provide current to the outlet for that particular student. During Phases II through VI, electric lights were plugged into the outlets on the console which were illuminated when the student's switch was in the "ON" position.

Throughout all phases, the student engineer wore dark sunglasses with narrow eye openings to prevent direct eye-to-eye contact between the engineer and the pupils being observed.

Procedure

Sessions were conducted each weekday morning between 9:40 and 10:00. During this time the teacher conducted a small reading group in one corner of the room and the remaining students were assigned arithmetic problems to be completed individually at their desks.

"Working" was the behavior recorded and was operationally defined as any of the following: (1) looking at the blackboard; (2) counting on fingers, pencils, crayons, *etc.*; or (3) writing on paper. When the student was engaged in any of these behaviors, his or her timer was turned "ON", and recorded "time working". When the student was engaged in behaviors other than "working", the switch was kept in the "OFF" position. These data were converted into "per cent time working" by dividing total number of minutes spent working by the total session length in minutes, times 100.

For several days before the first session, the student engineer operated the console within the classroom without lights in order to become proficient in its use and to allow the students to adapt to the observer's presence.

The study was conducted in eight phases, which will be discussed in order. During the first phase, baseline data were collected to determine the amount of time spent "working" during each session. In the second condition, lights were placed on the desks of Ricky and Dennis which were individually illuminated when either of the students met criterion for "working". Tim and Lisa, without lights, continued in the baseline phase. This phase allowed an assessment of: (1) the effect of response-contingent lights (with Ricky and Dennis) and (2) the effect of seeing another student receive response-contingent light (with Tim and Lisa).

During Phase III, Ricky and Dennis were told: "If you study a great deal during class today, you will get a little blue ticket. On that ticket you may write anything that you want to do tomorrow morning such as ____." In this blank the students could have written any activity in which they desired to engage, such as going to the gym, going to the playground, performing janitorial tasks around the school building, or any other activity that could be arranged by the experimenter. The duration of each of these activities was 15 min. On the first day, criterion for reinforcement for Dennis or Ricky was 12 min of work out of a total session length of 20 min. For the next three days, criterion was raised 2 min per day and on the fourth day was raised 1 min; thus, the successive criteria were 12, 14, 16, 18, and 19 min. From that point on, criterion remained at 19 min. That is, Ricky and Dennis had to emit working behaviors during 95% of the session in order to receive a blue ticket exchangeable for a chosen activity. At the onset of this phase, lights were placed on Tim's and Lisa's desks, but no reinforcement contingencies were stated; nor were reinforcements given for increased study time. This allowed for the assessment of the effects of response-contingent lights where reinforcement was not available and where the behaviors of the two other subjects were being reinforced for increased study time.

At the onset of the fourth condition, Tim and Lisa were told: "If you study a great deal during class today, you will get a little blue ticket. On that ticket you may write anything that you want to do tomorrow morning such as ____." The same increasing sequence of reinforcement criteria, beginning with 12 min

of working behavior, was utilized with Tim and Lisa as had been used with Ricky and Dennis.

During the fifth phase, a differential reinforcement of other behavior (DRO) contingency (Bijou and Baer, 1966) was put into effect for all four children. Under this contingency, all behaviors except "working" were reinforced.

Following the DRO condition, the reinforcement contingencies for appropriate "working" behaviors that had been in effect, were reinstated. When this phase was completed, the students and the student engineer were told that the study was completed. They were thanked for their help and participation, and the experimenters, with their equipment, left the building. After this phase and before the onset of the post-check TV condition, a time lapse of 37 days occurred. During this period, the four children, along with remaining class members, continued to work individually on arithmetic problems while the teacher was working with a reading group.

Before the post-check TV condition, a closed-circuit television camera, which scanned the seats of the four subjects, was installed in the classroom. This installation was accomplished on a weekend when classes were not in session. The camera and tripod were so concealed that the only portion visible to the class was an opening for the lens. The morning after the camera was installed, the teacher told the class that it was a piece of scientific apparatus to be used in a night class held in the room, and it was generally disregarded thereafter. In a small enclosed booth outside the classroom, a television monitor was installed whereby the student engineer, utilizing the console, again monitored time spent "working" by the four children for six consecutive school days without their knowledge.

In the final condition, a replication of baseline was conducted by having the student engineer walk into the room with the console and measure time "working". No lights were on the subjects' desks.

At the end of each session during phases when reinforcement was available, the students would gather around the console and compare their timer against their criterion time, which was written on the data sheet. If they met or exceeded criterion for reinforce-

ment, they were given the small blue ticket. The following morning, immediately after classes began, the children who had tickets from the day before were allowed 15 min in which to engage in the activity that they had chosen. To avoid social isolation, the children were given the option of taking a friend with them for the 15-min reinforcement periods. If, at the end of the daily sessions, the students had not met criterion, they were told: "I'm sorry, you did not keep your light on long enough today. Please take your seat." Thus, the following morning, they would not have the necessary blue ticket to be excused from class. After the four students returned from their reinforcing activity, the class was instructed in the daily arithmetic session and the experimental session commenced.

The student engineer was a fifth-grader whose own classroom was operated on a token economy. The student engineer evidenced a great deal of interest in his role in this study, which led the experimenters to speculate that the Premack Principle (Premack, 1965) could be utilized to modify his academic behavior. Thus, before each of the experimental sessions, each of his teachers was consulted about his academic performance for the previous day. If his performance was above average in all classes, he was given a token by the experimenter for good academic achievement and at the end of the session was given an additional token for operating the console. If, on any occasion, his work was not above average in any of his classes, he was not given a token for academic performance but was given a token for operation of the console. The student engineer was told also that he would not be allowed to operate the console if his teachers reported that his academic performance in any classes was less than above average for any two consecutive days. The latter situation never occurred.

Reliability checks were conducted throughout the study by having a second observer record "time working" for one of the four subjects. These observations were made by the classroom teacher and the experimenters. The larger of the two "times" thus derived was then divided into the smaller and the quotient multiplied by 100, yielding per cent agreement. Reliability checks for the entire study averaged 95% agreement, with a range of 89% to 99%.

RESULTS AND DISCUSSION

Figure 2 shows the percentage of time spent "working" for each of the four subjects. The results of the study will be presented and discussed in the successive order of the eight phases.

During the baseline, "working" time ranged from 15% to 78%, with a mean of 52.8%. In all four subjects there is a downward trend in "working" time as the baseline progresses. A possible explanation for this decline is that the introduction of the student engineer and the console into this classroom a few days before the baseline produced a "Hawthorne effect" on working behavior; that is, the mere change in the stimuli of the classroom brought on a temporary increase in productive be-

Fig. 2. Graph showing per cent "time working" for all students.

haviors. The baseline data of Fig. 2 would then represent the decline of this effect, or the gradual return to "normal" productivity as the subjects adapted to the new stimuli. The fact that the student engineer was in the classroom for less than an hour per day would be likely to make this adaptation gradual, as the data show the change to be.

The introduction of the lights for Ricky and Dennis, in the second phase, and their response-contingent operation appears to have produced a slight (and perhaps transient) increase in Ricky's working behavior and little or no effect on Dennis'. However, the effect on Ricky's behavior cannot readily be interpreted as evidence that the light's operation had a reinforcing function for this subject, because there was also an apparent increase in Tim's and Lisa's working behavior, even though there were no lights on their desks.

In the third phase, Tim and Lisa were given lights that were turned on when the subjects emitted "working" behaviors. This resulted in a clear increase in these behaviors from Lisa and a smaller (perhaps temporary) increase from Tim. It seems unlikely that all of this increase was due to the simple introduction of a novel stimulus. First, the lights could not be very novel because similar ones had been on Ricky's and Dennis' desks for six days. Second, it is improbable that the high performance produced in Tim and Lisa above their baseline performance in both cases would result from such a minor stimulus change. Therefore, it appears that at least part of the increase in Tim's and Lisa's performance in the third phase could be due to the response-contingent nature of the lights' operation. The turning on of the lights may have been a reinforcer in this phase for Tim and Lisa because they observed Ricky and Dennis being recognized and receiving reinforcements for increased "working" time, via the same light system. Thus, seeing Ricky and Dennis receive a reinforcing consequence may have served as a setting event (Bijou and Baer, 1966) that increased the reinforcing function of response-contingent lights alone for Tim and Lisa.

Before and during this study, these four students were seated together in one portion of the room. Another plausible explanation, which might partially account for the increase in time "working" on the part of Tim and Lisa, is that Ricky and Dennis, who were now

working, provided fewer distractions. Typically, during the baseline phase when any one student began emitting deviant behavior, it appeared as if the other students attended to that behavior. In addition, many of the non-working behaviors, such as conversation, required two or more individuals. It could be that part or all of the increase in time "working" on the part of Tim and Lisa could be attributed to: (1) the fact that Ricky and Dennis no longer provided distractions, (2) that Ricky and Dennis did not attend to Tim or Lisa when they emitted some distracting behavior, or (3) a combination of these two.

For Ricky and Dennis, the response-contingent lights combined with the special privileges for studying "a great deal" clearly served to increase their working behavior during the third phase. They averaged 95.8% and 95.5% working time, respectively, in this phase.

In the fourth phase, the same conditions were continued for Ricky and Dennis and their high level of performance continued. The same conditions were also applied to Tim and Lisa, and their performance improved as well.

The DRO contingency, applied to all four subjects in the fifth phase, produced a rapid decline in "working" time for each child. In the last three sessions of this phase, the mean "working" time for the four subjects combined was 2.8%. This effect, combined with the effect of the conditions of the next phase, when lights and special activities were again contingent upon "working" behaviors, suggests that the reinforcement contingencies were highly effective and were indeed responsible for the high performance attained by the four subjects during reinforcement phases. In addition, the results of the DRO condition suggest that neither the presence of novel stimuli in the room nor the status of being singled out as subjects for special treatment were variables powerful enough (at this time in the study) to exert much control over the behaviors being measured. Any tendency of these variables to increase (or decrease) the behaviors was clearly overridden by the control exerted by the reinforcement contingency.

When the subjects were surreptitiously observed via closed-circuit TV approximately six weeks after the last application of the contingent lights and special activities, their per-

formance was generally better than it had been during the baseline. Mean "time working" was 76.7%.

To facilitate comparison between baseline performance and performance during the post-experimental follow-up, each subject's mean working time from the baseline is presented as a dashed line in the segment of Fig. 2 depicting the results of the TV follow-up. According to the data collected by TV, three of the four children showed a better performance six weeks after the experiment than during the baseline, suggesting that the brief application of special reinforcement contingencies during the experiment produced a lasting improvement in working behaviors.

Evidently the conditions existing before the experiment were insufficient to produce a high level of performance in these four children; but once sufficient contingencies were applied to strengthen working behaviors, the pre-experimental contingencies were adequate to maintain those working behaviors in moderate strength. This conclusion assumes, of course, that the environment after the experiment was essentially the same as it had been before. It is possible that the experiment inadvertently changed some important behavior of the teacher's, or of the subjects' peers, and that these new behaviors served to maintain the subjects' performance after the experimental contingencies were removed; however, no such changes were observed by the experimenters. Others in this class, who were described by the teacher as "good" students, were observed to be studying a comparable amount of time.

Patterson, Jones, Whittier, and Wright (1965) suggest that schedules of reinforcement and punishment on the part of parents and peer group can be critically important in maintaining behaviors of students within classrooms. It could also be that very subtle interactions were occurring along these lines that were not apparent to the experimenters.

In the second post-check, "time working" was generally found to be as high as it had been during the phases when "working" behaviors were being systematically reinforced. As is evident in Fig. 2, "time working" was lower during the TV post-check than during the post-check when the observer was present in the classroom. There are at least two possible explanations for the difference between the

results of the two follow-up phases, and both explanations would seem to hold implications for behavior modification research that utilizes observers to obtain data.

The first explanation is that the student engineer and his console were discriminative stimuli whose presence occasioned working behaviors. The student engineer served both as an observer and a dispenser of consequences for the subjects, and would thus be likely to acquire a discriminative function. As each child took readings from the console at the end of the session to determine whether or not he or she had met criterion, it also seems feasible that the console itself could have acquired a discriminative function. If this explanation of the difference in the data of the last two phases is valid, it raises a question regarding the interpretation of certain previous studies. For example, Hawkins *et al.* (1966), in order to teach a mother to be therapeutic toward her own child, had the observer signal the mother when to reward or punish the child. In addition, they instructed the mother to limit the therapeutic procedures to the times when the experimenter-observer was present. These conditions could have resulted in the observer becoming a discriminative stimulus for appropriate behaviors, in which case the favorable data obtained by the same observer in a later follow-up may not have represented the child's "usual" behavior. These follow-up data may reflect, at least partially, the appropriate behavior occasioned by the observer's presence. This interpretation can be made of any follow-up data obtained by an observer whose presence has been (or may have been) correlated with experimental procedures (as in Hall *et al.*, 1968). Certainly it is highly probable that the student engineer in the present study would become a discriminative stimulus for the behavior in question, as he was directly connected with both the observation of the behavior in question and its subsequent reinforcement. While these data do not suggest that a more passive observer (*i.e.*, no direct contact with subjects) would become an equally strong discriminative stimulus in another setting, they do seem to raise some question as to whether and to what degree such events might occur. In order to separate the effects of observer presence, not only during post-check but throughout studies of this nature, the ideal observational

medium would seem to be one where the subject is unaware of the observer's presence. The TV method of obtaining data in the present study may be one solution to this problem.

The second explanation of the difference between the findings of the two post-experimental checks is that "working" behaviors may have been more difficult to discriminate via TV than by direct observation. To determine the feasibility of this hypothesis, additional data were recorded in a similar classroom by both TV and direct observation, allowing comparison between data obtained through these two media. The subject was an adult imitating the kind of behavior exhibited by the four subjects in the experiment. A TV camera was located in the room at approximately the same distance from the subject as had been employed in the experiment. Four sessions of approximately 5 min each were held and were recorded on videotape for later viewing. The subject's behavior was also recorded by an observer located approximately 10 ft away. At the end of a session, the observer did not look at the stopwatch on which he recorded "working" time, but handed it to the experimenter who made a record of the time. The observer then watched the videotape recording of the same session and again recorded the subject's "working" time, making it possible to determine intra-observer reliability. In addition, a second observer later viewed this same recording, making it possible to assess inter-observer reliability. This second measure of accuracy of data recording was considered important to control for any "practice effect" or retention of how a particular response had been recorded during the intra-observer reliability phase.

The four sessions, each with a new observer, all yielded intra-observer reliabilities above 99%. Inter-observer reliabilities in the four sessions were obtained with four different pairs of observers and were all above 97%. These results suggest that the "working" behaviors defined in the present experiment could be recorded as accurately via TV as they could be by direct observation. Thus, it appears that the performance of the four children in the second follow-up was actually better than during the TV follow-up, rather than an artifact of the difference in media of observation.

The "working" behaviors modified in the present experiment are assumed to be correlated with the actual accomplishment of assigned work and ultimately with academic achievement. Some evidence was obtained that this assumption may be valid. The teacher reported that the four children completed a greater number of problems, and that a higher proportion of problems completed were correct during the phases of the study when "working" behaviors were reinforced than during other phases (except the follow-up phase); and that these gains were at least partially maintained after the study terminated. She also reported that the subjects exhibited more "working" behavior and less disruptive behavior throughout the day than during the experiment. Surprisingly, Tim was considered by the teacher to have shown the greatest improvement outside the arithmetic period, even though his "working" behavior in this experiment showed the least improvement and he appeared rather apathetic about the blue tickets and the special activities obtained in exchange for them.

In general it appears that the present technique has considerable promise for helping some children in school settings. It is capable of modifying the behavior of several children at one time and yet involves very little professional time. In fact, it should tend to release the teacher from some of the time she spends attempting to stop disruptive behavior for the acceleration of more adaptive behaviors. Techniques based on this one should be useful to teachers, principals, school psychologists, school social workers, and others faced with the problem of helping children more consistently to exhibit more adaptive classroom behavior.

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