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# A COMPARISON OF TWO PROCEDURES FOR PROGRAMMING THE DIFFERENTIAL REINFORCEMENT OF OTHER BEHAVIORS

ALAN C. REPP, LYLE E. BARTON, AND ANDREW R. BRULLE

NORTHERN ILLINOIS UNIVERSITY

The relative effectiveness of two methods of programming DRO schedules of reinforcement was examined in two experiments. In these two methods, reinforcement is delivered if inappropriate responding is not occurring (a) at the end of an interval (momentary DRO), or (b) throughout the entire interval (whole-interval DRO). In Experiment 1, the effects of these schedules on disruptive responding of three retarded students were assessed in a multiple-baseline design. For two students, the momentary schedule occurred first and was ineffective, whereas the whole interval that followed was effective; for the third student, the whole-interval schedule occurred first and was effective, and reduced responding was maintained under the momentary schedule. In Experiment 2, baseline and the two DRO schedules were each presented in random order each day to one student in an alternating treatments design. The momentary DRO schedule reduced responding, but the whole-interval schedule was more effective.

DESCRIPTORS: differential reinforcement of other behavior, disruptive behavior

The differential reinforcement of other behavior (DRO) is a schedule in which reinforcement is delivered if a particular response has not been emitted for a specified interval of time (Kelleher, 1961; Lane, 1961; Reynolds, 1961). Within a laboratory setting, it has been shown to be an effective means of reducing behavior, and several factors have been investigated. Some findings are that (a) DRO is more effective when a response incurs the penalty of reinforcement postponement equal to or greater than that occurring in the absence of the response (Uhl & Garcia, 1969); (b) DRO schedules are more effective when the interval is initially small and then gradually increased than when the interval is initially large (Cross, Dickson, & Sizemore, 1978; Repp & Slack, 1977; Topping, Larmi, & Johnson, 1972); (c) DRO is generally more effective than extinction in reducing responding (Johnson, McGlynn, & Topping, 1973; Topping & Crowe, 1977; Topping & Larmi, 1973, Topping, Pickering, & Jackson, 1972); and (d) a fixed DRO schedule is more effective than a variable DRO schedule (Reuter & LeBlanc, Note 1).

In applied work, DRO has sometimes been shown to be effective when used alone or in concert with other procedures (e.g., DeCatanzaro & Baldwin, 1978; Deitz, Repp, & Deitz, 1976; Dwinell & Connis, 1979; Lutzker, 1974; Myers, 1975; Repp & Deitz, 1974; Repp, Deitz, & Deitz, 1976; Repp, Deitz, & Speir, 1975; Tarpley & Schroeder, 1979; Dandy, Oliver, & Kaprowy, Note 2); although at other times, it has been shown to be quite ineffective (e.g., Corte, Wolf, & Locke, 1971; Foxx & Azrin, 1973; Harris & Wolchik, 1979).

The reason for this disparity in results could be quite complex or quite simple. The simplest explanation is that there are individual subject-reinforcer interactions that account for these differences. That is, in the studies showing an effect, the stimulus described as a reinforcer functioned powerfully enough to overcome whatever was maintaining the response that was just reduced; conversely, in the studies not showing an effect, the stimulus scheduled as a reinforcer

Reprints may be obtained from Alan C. Repp, Department of Learning and Development, Northern Illinois University, DeKalb, Illinois 60115.

either was not a reinforcer or was not a powerful enough one to overcome that which was maintaining the response. Although this type of explanation is attractive and probably true in many cases, it suggests only what is well-known: We should be careful in selecting stimuli that are powerful reinforcers. It does not, however, offer us any information about the parameters of the schedule itself that would be useful in programming DRO. The purpose of this study was to examine one factor that might influence the effectiveness of DRO schedules, that factor being the definition of the DRO schedule itself. Recently, Sulzer-Azaroff and Mayer (1977) described two types of DRO schedules, one that we label *whole-interval DRO* and one that we label *momentary DRO*. In whole-interval DRO, reinforcement is delivered if responding has not occurred for an entire prescribed interval (the definition offered by Reynolds, 1961). In momentary DRO, reinforcement is delivered if responding is not occurring at a particular moment of observation (analogous to the momentary time-sampling procedure described by Powell, Martindale, Kulp, Martindale, & Bauman, 1977).

Recently, Harris and Wolchik (1979) used the momentary DRO procedure and compared its effectiveness as a reductive procedure with time-out and overcorrection in reducing the self-stimulatory behaviors of four autistic, severely retarded boys. Momentary DRO was found to be moderately effective in decreasing the behavior of one boy, to have no effects with two others, and actually to increase the behavior of the fourth. However, their results may have been idiosyncratic, so the purpose of the present study was twofold. In one sense, it was to determine whether the lack of effectiveness reported by Harris and Wolchik (1979) would be replicated. If it was not replicated, the results would show that the much easier DRO schedule to program (i.e., the momentary DRO) could be effective. In a broader sense, however, it was to determine whether the most basic parameter of a DRO procedure, i.e., its very definition, would have an effect on its success. The present study, then, compared the effectiveness of these two DRO procedures in two experiments, one using a multiple-baseline design and one using a multiple schedule.

## EXPERIMENT 1

### *Students and Setting*

Three 7-year-old male students who were classified as mildly retarded participated in the experiment. They exhibited most age-appropriate self-help skills (e.g., dressing, feeding, and toileting), and had well-developed expressive and receptive language skills. For one hour each morning, they were in the same class together with nine other retarded children. Although the classroom activities varied, they were generally of a preacademic nature such as counting, identifying colors and shapes, tracing, and following commands. The three target students all exhibited mildly disruptive behaviors, but no seseverely maladaptive behaviors (e.g., self-abuse).

### *Response Definitions*

The definitions of the disruptive behaviors were modified from those presented by Kendall and Wilcox (1979) and were:

1. *Off-task verbal behavior:* The child says something not related to the task at hand.
2. *Off-task physical behavior:* The child plays with materials in such a way as to draw his attention away from the problem at hand (e.g., throwing objects, kicking at another student, tapping a crayon).
3. *Off-task attention:* In the absence of off-task verbal or off-task physical behavior, the child looks away from the work materials.
4. *Out of seat:* The child's seat and the chair seat are not in contact.
5. *Interruptions:* The child speaks on a non-task-related topic while the teacher or another student is talking (task-related interruptions were not scored).

*Recording Procedure*

Three observers (each enrolled in a research class with the senior author) simultaneously recorded data in the classroom about 45 minutes a day. One acted as the primary observer, another as the secondary observer to assess reliability, and the third signaled the teacher when to reinforce the students. During training, the observers were given the response definitions, were asked to memorize them, and were then taken in pairs to a classroom (not used in this experiment) for training purposes in which they recorded occurrences of the five dependent variables according to a 10-second partial interval schedule. In this procedure, each person observed a student for 10 seconds and recorded any of the five responses that had just occurred. If more than one type of response occurred during the interval, each of those that occurred was marked; if none of the five occurred, a sixth column (for "no response") was marked. Thus, marking the form did not serve as a cue to the other observers that a disruptive response had occurred. The observing and recording periods were coordinated through a tape recorder with a y-plug adapter that allowed each pair of observers to have an earplug. After about half an hour, the observers began to record the behavior of three students at a time. Then, after several more hours of training, each possible pair was tested for interobserver agreement for at least one 45-minute period. After each observer produced an agreement score with each of the other two of at least 80% for each of the six categories, baseline recording began.

During the experiment itself, the observers sat in the front corner of the room and observed all students simultaneously within each interval. At the end of each interval, the observers quickly marked their recording forms and began their observations again.

*Interobserver Agreement*

Interobserver agreement was calculated by dividing the number of intervals of agreement for a category by the total number of intervals in which either observer of the pair recorded a response as having occurred. Because responding occurred in less than 50% of the observations, the occurrence method of calculating agreement was used and unscored intervals were dropped (Hartmann, 1977).

Because we were interested in the effects of the DRO procedures on a class of behavior, disruption, rather than on its subcomponents, the data for this study are presented as the percentage of observations in which disruptive behavior occurred. However, interobserver agreement was calculated for each of the subcategories to determine whether there were weaknesses with any of the definitions. The results showed the following means and ranges for each of the subcomponents used: (a) off-task verbal behavior: mean = 91%, range = 83 to 94%; (b) off-task physical behavior: mean = 94%, range = 87 to 96%; (c) off-task attention: mean = 84%, range = 79 to 91%; (d) out of seat: mean = 100%; and (e) interruptions: mean = 97%, range = 88 to 98%.

*Definition of Reinforcer*

Before baseline data were collected, each student was given a series of 1-minute trials to determine whether a consequating event would increase the rate of a response. In this procedure, each student was given several sheets of paper that contained geometric figures, some of which were green and some of which were white. For the first 10 trials, the students were told that they should circle the green objects, and that the teacher would collect the papers shortly. For the next 10 trials, the students were given the same instructions, but in addition, were told that they would earn small treats after the session for each green figure they had circled. When an event (two different candies and one cereal) was found that produced at least 25% more responding in the B phase than in the A phase, then that event was prescribed as the reinforcer for that child for the DRO schedules. Because the students and their preferences were known to the teacher, only one A-B treat per student was required to define a reinforcer.

*Design*

A multiple-baseline-across-subjects design was used for this experiment. In this particular adaptation, each student experienced three conditions: baseline (A), momentary DRO (B), and whole-interval DRO (C). The order in which the students experienced each condition was not, however, constant. For two students, the order was A-B-C, whereas for a third it was A-C-B.

*Phase one: baseline.* During baseline, the teacher conducted her class and consequated appropriate and inappropriate responding in her customary style. Baseline ended in a staggered fashion for the three according to the preset criterion for Student 1 which was that (a) baseline was at least 5 days long, and either (b) behavior for 3 consecutive days was within 20% of the mean of those 3 days, or (c) a trend line drawn through 3 consecutive days of data was increasing. The termination of baseline for Student 2 and Student 3 is explained in the next section.

*Phases two and three: DRO.* In these phases, the teacher consequated a child with a reinforcer whenever he met the DRO criterion. This condition began for Student 1 when he met his baseline criterion, and it ended for him when he met the same baseline criterion applied to this second phase. The DRO phase began for Student 2 when (a) Student 1 was in Phase 2 for at least 5 days, and (b) Student 2's data met either the stability or the counter-therapeutic trend criterion. This phase ended for Student 2 when the previously stated criterion was met for this phase. Momentary DRO was experienced by Student 3 in his third rather than in his second phase. As with the other students, the phase began for him when his responding met criterion for the numbered phase into which he was progressing. Phase 3 (and the experiment for all students) ended when the length of Phase 3 for Student 3 equalled the length of Phase 2 for Student 3.

*Momentary DRO.* In the momentary procedure, the student was reinforced if he was not engaging in the behavior at the precise moment the DRO interval ended. At this moment, the third observer signaled the teacher that the interval had ended by raising her hand above her head. She then signaled, by making eye contact and turning her head, which student(s) was to be reinforced. To make the procedure manageable with three students in the same class, the same DRO value (5 minutes) was used with each of them so each hand raise applied to all students. At the termination of the interval, the teacher or an aide looked at each of the students and quickly but without interrupting the activity reinforced those who should be. If the student was being disruptive at this moment, the staff ignored him. At the beginning of each day, the teacher explained to each student the contingency for this phase: "If you are not being disruptive when Ms. Smith raises her hand, you will earn a treat. If you are being disruptive, you will not earn a treat."

Although it is customary to increase DRO schedule values as the subject comes under schedule control, following such a plan would have unnecessarily confounded the study, not allowing us to compare so easily two types of DRO schedules. For example, if one of the schedules reduced behavior more quickly, then the value of that schedule would be increased (e.g., from 5 minutes to 7.5 minutes). In this case, the smallest possible interval in which responding would have to be omitted in order for reinforcement to be delivered would actually be greater for the more effective DRO schedule (e.g., a DRO 5 minutes for one condition and a DRO 7.5 minutes for the other condition). In a time-series design, such changes could be continuing, and differences between the effectiveness of the schedules themselves would be confounded by the two schedules having different minimal requirements for reinforcement delivery. Thus, the 5-minute value at which this condition began was maintained throughout the study. Similarly, although the DRO timer is customarily reset after the emission of an inappropriate response, it was not reset in this study. By not doing so, we equated the number of opportunities responding could come into contact with the contingencies of each of the two schedules (in this study there were eight opportunities; from 40 minutes per session ÷ 5 minutes per interval).

*Whole-interval DRO.* In this condition, the teacher reinforced a child at the end of the interval if the child did not emit a disruptive response *during* the entire interval. Otherwise, the procedure was like that used for momentary DRO. Each student was instructed at the beginning of each session that he had to be nondisruptive for an entire 5 minutes to earn a reward, and treats were distributed when the schedule was met. The third observer again signaled the teacher or aide which of the students should be reinforced at the end of each 5-minute interval, and the same 5-minute value was used throughout.

### *Accuracy of Reinforcer Delivery*

Because the task of the third observer was to signal the staff when to reinforce students for nondisruptive behavior, her accuracy in both conditions was of paramount importance. Fortunately, her task was quite easy, and some of her behavior could be checked. For the momentary DRO, results showed more than 99% agreement between the primary and secondary observer on the accuracy of the third observer, and more than 99% agreement between the primary and the third observer. For the whole-interval DRO, results again showed more than 99% agreement between the primary and the secondary observer on the accuracy of the third observer, and more than 99% agreement between the primary and the third observer.

## RESULTS

Figure 1 shows the percentage of observations in which disruptive responding occurred. For Student 1, the study consisted of 11 days of baseline, 13 days of momentary DRO, and 34 days of whole-interval DRO. The baseline data varied between 8% and 20% and averaged 15%. In the second phase, the data varied between 5% and 30% and averaged 14%. In the final, whole-interval, phase, disruptions decreased to zero within 6 days and remained low for the following 27 days.

For Student 2, the three phases were presented in the same order. In the 17 days of baseline, disruptions varied between 0% and 19% and averaged 9%. In the momentary DRO phase, disruptions varied between 2% and 11% around a mean of 6%. In the whole-interval phase, disruptions decreased from an initial high of 9% to average 2% for the 23 days of this condition.

For Student 3, the study consisted of 22 days of baseline, then 18 days of whole-interval DRO, followed by 28 days of momentary DRO. Baseline disruptions varied between 1% and 18% and averaged 9%. During the whole-interval phase, disruptions dropped to an average of 2%, with a range of 0% to 8%. Disruptions during the momentary DRO phase varied between 0% and 5%, averaging 2%, and remained at the low level of the prior phase.

## DISCUSSION

The results for Students 1 and 2 show that the whole-interval DRO schedule was more effective than the momentary DRO schedule (with the possibility of an order effect controlled for by Student 3). For this student, disruptions decreased considerably when whole-interval DRO was instituted and remained reduced during momentary DRO. Thus, whole-interval DRO was just as effective after baseline as after momentary DRO. Whether the maintenance seen with Student 3 during momentary DRO is due to the procedure or is just a carry-over from the whole-interval DRO phase is not clear. It is possible that momentary DRO is too weak to produce significant reductions in disruptions, but can maintain them.

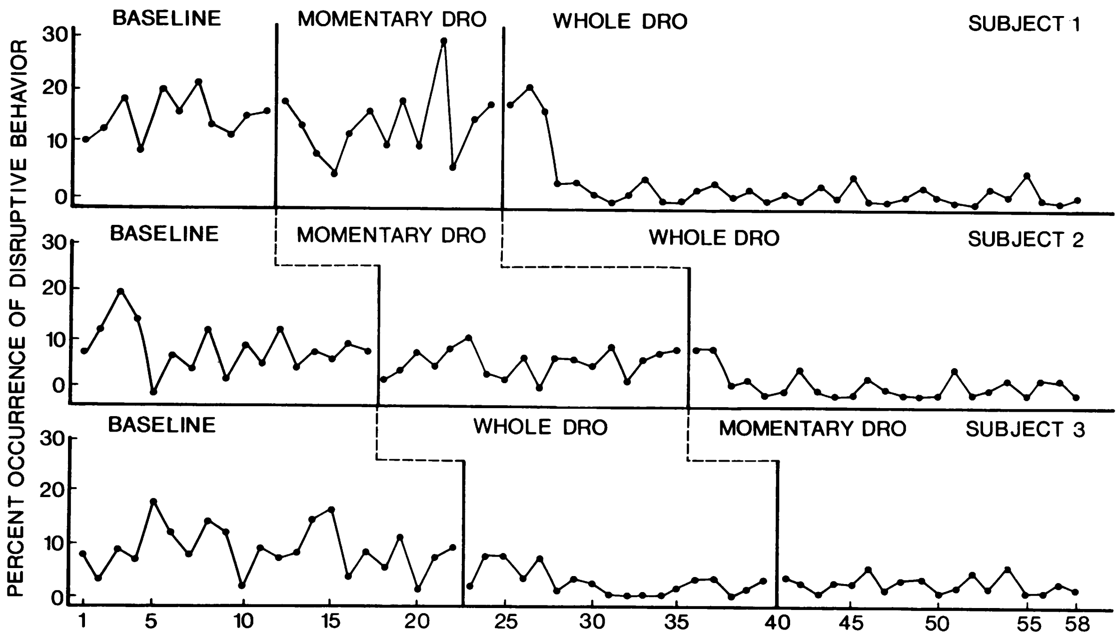


Fig. 1. The percentage of observations in which disruptive responding occurred. Data were recorded using a 10-second partial interval method, and the data represent behaviors that were either off-task verbal, off-task physical, off-task attention, out of seat, or interruption.

## EXPERIMENT 2

Experiment 1 showed that whole-interval DRO was more effective than momentary DRO, but the design used is a relatively weak one for comparing two treatments (e.g., Barlow & Hayes, 1979). It relies, for example, on consistent between-subject comparisons rather than maximizing the importance of within-subject comparisons. Experiment 2 used a multiple schedule design to test the replicability of the results within a subject. Experiment 2 also examined the maintenance of the effects of momentary DRO following whole-interval DRO.

### METHOD

*Student and Setting*

An 8-year-old male student, who was moderately retarded (Stanford-Binet score of 49) participated in this experiment. He exhibited most age-appropriate self-help skills, and had good but developmentally delayed expressive and receptive language. For most of the day, he was enrolled in a class with five other students, an aide, and a teacher. The study was conducted each day for one hour beginning at 9:00 a.m.

*Data Collection*

Like the children in the first study, this child was somewhat disruptive, so the same response definitions were used. In addition, the same method of recording and method of assessing interobserver agreement were used. The number of sessions of data collection for this study, however, was predetermined and was 30 days.

*Design*

A multiple schedule design was used in this experiment to provide another way to compare the effects of the independent variables.

Before the experiment began, the test for reinforcer effects used in Experiment 1 was repeated. In baseline, a (0.5 m $\times$ 0.5 m) piece of red paper was attached to the child's desk top; in momentary DRO, the paper was green; in whole-interval DRO, it was white. Each color was correlated with only one schedule. At the beginning of each session, one of the colors was attached to the desk according to a predetermined random schedule; after 20 minutes it was changed to another color; after another 20 minutes, it was changed to the third color.

## RESULTS

Figure 2 presents the rate of disruptive responses for the child under each of the conditions. Disruptions during the baseline condition varied between 0.2 rpm and 3.2 rpm, averag-

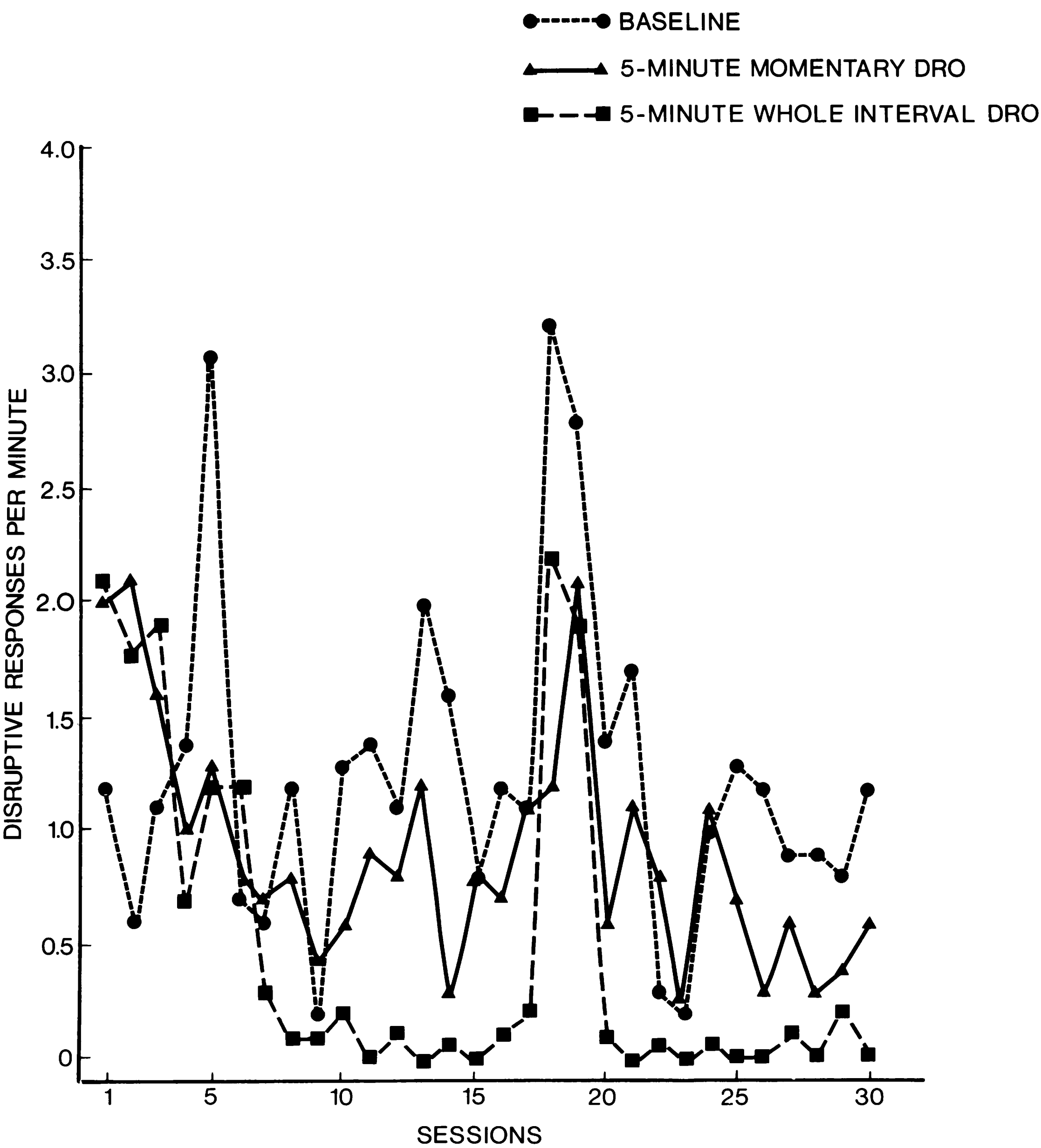


Fig. 2. The rate of disruptive responses for one-student operating under a multiple schedule in which each of three conditions were randomly presented each day for 20-minute periods, those conditions being: baseline, 5-minute momentary DRO, and 5-minute whole-interval DRO.

ing 1.3 rpm, with similar averages for the first (1.25 rpm) and the second (1.3 rpm) 15 sessions. During the momentary DRO procedure, disruptions varied between 0.2 rpm and 2.1 rpm, averaging 0.9 rpm. The average for the first five sessions was 1.6 rpm, but 0.8 rpm for the last 25 sessions. During the whole-interval DRO procedure, disruptive responding varied between 0 rpm and 2.2 rpm, averaging 0.5 rpm. With a mean of 1.3 rpm during the first six sessions and a mean of 0.3 rpm during the last 24 sessions, the rate of disruptions in this component was similar to that in the other two components during the first 6 days of the study (1.2 rpm for baseline and 1.3 rpm for momentary DRO), and substantially less during the last 24 days. Except for the atypical and inexplicably high rates on days 18 and 19, disruptions after the first 6 days in baseline, momentary DRO, and whole-interval DRO average 1.2 rpm, 0.7 rpm, and 0.05 rpm, respectively.

Figure 3 allows easier inspection of the relative effectiveness of the DRO procedures. In each of the three panels, disruptions in one component are divided by the sum of disruptions in that and a second component. Thus, if the quotient is 0.5, disruptions are occurring in equal amounts in both components. The upper panel represents the data produced by dividing disruptions during the whole-interval condition by the sum of disruptions in the whole-interval and the momentary DRO conditions. Each point below 0.5 means that fewer disruptions are occurring in the whole-interval condition than in the momentary DRO condition. This comparison favors the whole-interval component in 23 of the last 24 sessions. The middle panel represents the quotient produced by dividing disruptions in the whole-interval conidtion by the sum of disruptions in the whole-interval and baseline conditions. This comparison favors the whole-interval DRO component in 24 of the last 24 sessions. The lower panel displays disruptions in the momentary DRO condition divided by the sum of disruptions in the momentary and baseline conditions. This comparison favors momentary DRO in 17 of the last 24 sessions; and the advantage is modest in each of those sessions.

## DISCUSSION

When these results are compared with those of Experiment 1, more can be learned about the effects of the DRO component. That experiment suggested that momentary DRO may not be very efficient at suppressing responding, but that it might maintain previously suppressed levels of responding. If this were so, then Figure 3 should show baseline and momentary DRO moving apart gradually and remaining apart. Such an effect did occur and suggests that momentary DRO may produce this function.

## GENERAL DISCUSSION

Two studies were conducted to compare the relative effectiveness of two methods of programming DRO schedules of reinforcement. In the first experiment, a multiple-baseline-across-subjects design was used to assess the effectiveness of the schedules, whereas in the second, a multiple schedule was used. As noted by Ferster and Skinner (1957), this schedule is less susceptible to extraexperimental changes over time as it alternates stimulus-correlated conditions within the same session rather than between sessions (as in the ABAB or multiple-baseline designs); and as demonstrated by Repp, Klett, Sosebee, and Speir (1975) and by Repp and Slack (1977), it is a design under which moderately and severely retarded persons can exhibit schedule control.

Overall, the results of these two experiments suggest that if we are to use a DRO schedule of reinforcement, we should at least initially use the whole-interval method for programming it. Then, we may move to momentary DRO for continued suppression. In part, the first experiment replicated the study by Harris and Wolchik (1979) by showing the ineffectiveness of the momentary DRO procedure. Results of the second experiment did not replicate the inef-

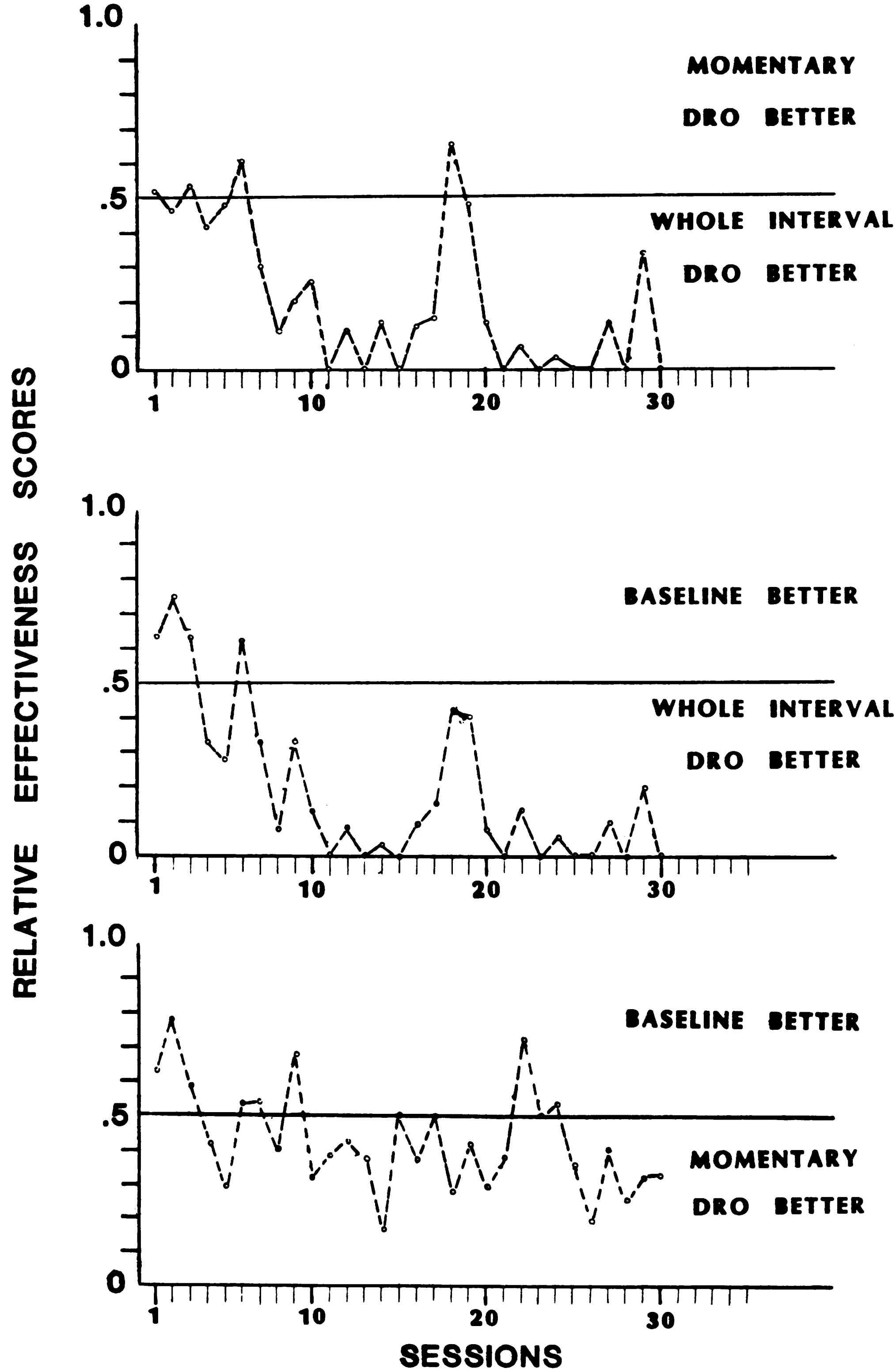


Fig. 3. The relative effectiveness of each of the components of the multiple schedule.

fectiveness of this schedule, showing instead that it may be effective, albeit less so and perhaps only under special conditions (i.e., in a multiple schedule). Although this problem is a difficult one when one is interested solely in research, this latter finding (if generalizable) could be useful for strictly applied purposes. From our experiences, accurate implementation of DRO schedules can be difficult in applied settings when the programming duties of staff do not allow observation of clients during each entire interval as required by whole-interval DRO schedules. However, if whole-interval DRO schedules can be alternated with momentary DRO schedules throughout the day, the effectiveness of the momentary DRO schedule might be enhanced. The pursuit of such a program both in research and in nonresearch settings seems worthwhile, as the momentary DRO schedule is much easier to program.

A second concern both from a research and a programmatic standpoint is that most of the studies showing DRO to be ineffective, and even those showing DRO to be effective, neglect either to have reported or to have demonstrated a functional relationship between the scheduled consequences and a response of the client before the study began. Some of these studies may have been scheduling presumed reinforcers which, in fact, were simply not reinforcers. In effect, many studies on such schedules (e.g., DRL, DRH) may have demonstrated the extent to which some researchers are poor or unlucky at the task of selecting reinforcers, rather than the extent to which some schedules are ineffective.

In terms of future work, these results offer several concerns. One centers about the generalizability of the results. Our studies, of course, were concerned only with mildly disruptive behavior, with one DRO value (5 minutes), and with retarded children. An important question is whether the effects reported here would have been evident if we had used a different DRO value (e.g., 15 or 20 minutes) which would be much easier for a teacher alone in a classroom in terms of programming and data collection. On the other hand, as has been suggested to us, the results of the momentary DRO may have been less evident than reported here had we studied more capable (i.e., nonretarded) youngsters who would more readily discriminate the contingencies of the two DRO schedules. Additionally, our manner of programming the DRO for the three students in Experiment 1 was unlike the more typical method in which a response both resets a timer and incurs the penalty of reinforcement postponenment equal to or greater than that occurring in the absence of the response. The latter makes DRO more effective in reducing the behavior of infrahumans (Uhl & Garcia, 1969), and it might have altered the results of this study had we been able to program such a delay for each of the three students. We do not, however, have any information that would suggest how this result would differentially affect the two DRO schedules used here. For this, and for previously stated reasons, we need more research on the parameters of DRO and other reductive procedures (perhaps in lieu of continued demonstrations that single aspects of particular procedures do or do not work).

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