

THE EFFECTS OF VARIABLE-MOMENTARY DIFFERENTIAL  
REINFORCEMENT ON TODDLER LOCATION PRIOR TO MEALS

BY

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Submitted to the Department of Applied Behavioral Science  
and the Faculty of the Graduate School of the University of Kansas  
in partial fulfillment of the requirements for the degree of  
Master's of Arts

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### Abstract

Adoptability of classroom interventions should be considered when developing techniques for classroom management (Fantuzzo & Atkins, 1992). In the present study, we incorporated several components designed to enhance the practicality of a classroom intervention and evaluated their effect on toddler response allocation prior to meals. In the intervention condition, teachers transitioned each child to meals only when he was seated on a play mat (a requisite for engagement in teacher-led play activities). In the reversal condition, teachers selected each child to transition when he was by the barrier to the meal area (a practice commonly observed under natural conditions). When the data for all children were aggregated, the intervention increased the mean percentage of intervals children were on the play mat and decreased the percentage of intervals children were by the barrier. An examination of individual child data showed positive outcomes for 5 of the 6 children.

## The Effects of Variable-Momentary Differential Reinforcement on Toddler Location Prior to Meals

Teachers are challenged with cultivating the academic and social development of their students by using effective teaching strategies and creating and maintaining an environment that promotes and supports learning. Effective classroom management involves arranging contingencies that promote desirable classroom behavior (e.g., on-task behavior, academic performance) and discourage behavior that interferes with learning (e.g., noncompliance, disruptive behavior). A large body of behavior-analytic research has been devoted to the development and analysis of effective methods for changing classroom behavior (e.g., see Neef et al., 2004). Despite these achievements, behavioral technology has not been widely adopted within classrooms (Axelrod, Moyer, & Berry, 1990; Witt & Martens, 1983).

Educators' failure to adopt behavioral technology may be due, in part, to the behavior analyst's tendency to focus on demonstrating the *efficacy* of techniques without being equally sensitive to factors that may influence their *adoptability* (Fantuzzo & Atkins, 1992). Adoptability may be a function of factors such as the general acceptability of the procedures, practical constraints on classroom resources (e.g., cost of reinforcers, teacher to student ratio), the complexity of the intervention, and the degree of teacher time and effort required to implement the intervention (Fantuzzo & Atkins; Witt & Martens, 1983).

The acceptability and ease of implementation of reinforcement-based interventions may be enhanced by arranging contingencies between desirable

behavior and preferred events that already exist in the classroom. Skinner (1969) noted that many potentially reinforcing events occur regularly within the typical classroom routine and are under teacher control. Examples include privileges such as access to free-time (e.g., Osbourne, 1969), special events (e.g., Bushell, Wrobel, & Michaels, 1968), or early dismissal (e.g., Harris & Sherman, 1973).

As Skinner (1969) noted, reinforcing and aversive events occur throughout the day, “. . . but the fact to be emphasized is what [individuals] are doing at the moment they achieve these results” (p. 94). In other words, contingencies already exist within the classroom regardless of whether they are explicitly programmed. A close examination of the relation between classroom behavior and putative reinforcers may reveal inadvertent reinforcement contingencies for undesirable behavior, as when a child is redirected to a more preferred activity following undesirable behavior. A slight adjustment of the contingency, whereby the general structure of the classroom is maintained (e.g., recess is scheduled to occur following math), but the time at which these reinforcing events occur is manipulated (e.g., recess is delayed until math worksheets are completed or children are sitting quietly at their desks), may preclude the need to use more contrived contingencies. Although teacher preferences for the use of different types of programmed consequences vary, the use of existing classroom events as putative reinforcers may be beneficial because the delivery of these events is likely to be socially acceptable and cost-effective (i.e., requiring minimal time, money, and effort).

Adoptability may also be enhanced by arranging contingencies that are easy for classroom teachers to implement. Programming consequences for a single student's behavior may be performed quite readily and reliably, but implementation becomes challenging when applying reinforcement to groups of individuals (i.e., the entire class). This difficulty is exacerbated when, for example, the criteria for reinforcement vary across individuals. One way of facilitating classroom management is to apply group-oriented contingencies wherein uniform consequences are delivered contingent upon uniform criteria (Litow & Pumroy, 1975). Reinforcement can be provided to (a) all individuals within a group, contingent upon the behavior of one or more target individuals (i.e., dependent group-oriented contingencies), (b) all individuals within a group, contingent upon the behavior of all members of the group (i.e., interdependent group-oriented contingencies), or (c) those individuals who meet criteria, independent of other individual's behavior (i.e., independent group-oriented contingencies; Litow & Pumroy).

Published examples of dependent and interdependent group contingencies appear to rely heavily on detailed instructions describing the contingencies to groups of students (e.g., The Good Behavior Game; Barrish, Saunders, & Wolf, 1969; Harris & Sherman, 1973). Thus, these approaches may be less appropriate for very young children, who lack the verbal skills necessary to benefit from complex instructions. For populations with less-developed verbal repertoires, independent group contingencies may be more appropriate. In an example of independent group-oriented contingencies, Salzberg, Wheeler, Devar, and Hopkins (1971) demonstrated that

providing access to a play area contingent upon each child's accurate completion of a printing assignment was effective in increasing the quality of printing in kindergarteners. In the baseline condition, children were provided access to a play area contingent upon completing a printing assignment, regardless of accuracy. During a feedback plus contingency condition, 50% of students were randomly selected (after completing the assignment) to be provided with feedback on the targeted printing letters, and each child was allowed to progress to the play area only after that child's score met a minimum criterion. The other 50% of students were allowed to immediately progress to the play area. This intervention increased the mean percentage accuracy of printing for the class. Furthermore, intermittently applying observations and contingencies to a randomly selected subset of children required less teacher time and effort, while maintaining the mean printing quality of the class.

Accurate implementation of contingencies also requires accurate monitoring or measurement of the target behavior. When an academic performance produces a permanent product (e.g., completion of a work sheet), contingencies may be applied based on examination of that product. However, class-wide contingencies may become increasingly difficult to implement when the behavior of interest requires the constant monitoring of ongoing behavior. One solution is to apply contingencies based on momentary samples of behavior. For example, Lindberg, Iwata, Kahng, and DeLeon (1999) demonstrated the effectiveness of a variable-momentary differential-reinforcement-of-other-behavior (VM DRO) schedule, which required that self-

injurious behavior was absent only at the time of observation. These authors suggested that a VM DRO schedule may serve as a practical alternative to a whole-interval DRO (see Repp, Barton, & Brulle, 1983) because it requires observation only at the end of an interval rather than throughout the whole interval. Lindberg et al. also speculated that variability of the interval lengths may be an important feature of the contingency because it obscures potential discrimination of the point in time at which the individual is being observed.

The practical advantages associated with applying contingencies based on brief observation samples make this approach appealing for application with a group of students. Skinner (1969) described a procedure whereby a child's behavior is randomly, and discreetly, sampled for a short period of time (e.g., 20-30 s), after which the child is told that he has been observed and whether or not he merits a reward (e.g., a token). Bushell et al. (1968) used a similar technique to increase on-task behavior among 12 preschool children. In the intervention phase, teachers moved around the classroom delivering tokens exchangeable for access to special events or snacks to those children who were actively attending to instructions and tasks. Although each child was only required to be on-task at the time of observation, intermittent delivery of tokens contingent upon brief samples of behavior was sufficient to increase the mean percentage of intervals of on-task behavior.

In the current study, we evaluated an intervention for a group of toddlers served in a group setting. We attempted to develop an intervention that was both efficacious and likely to be adopted by caregivers in early childhood settings. We



attempted to maximize adoptability by (a) programming a naturally occurring classroom event as a putative reinforcer, (b) using an independent group-oriented contingency, and (c) scheduling consequences based on a momentary sample of child behavior.

## Method

### *Setting*

This experiment was conducted in the toddler classroom of a university-run, full-day early childhood program. The classroom served 12 typically developing toddlers between the ages of 12 and 30 months. Classroom teachers included undergraduate practicum students, undergraduate students holding paid positions in the classroom, and paid employees not currently enrolled in the university. At the time of the study, the teachers' experience in the classroom ranged from 2 months to 6 years.

The toddler classroom was divided into areas designated for different activities (i.e., play, meal, and toileting). Each of these areas was separated by a 0.9-m barrier. During this study, children were observed in the play area just prior to lunch and afternoon snack. The play area contained two play mats (each 1.8 m x 2.5 m) on opposite sides of the room. A teacher was assigned to each of the play mats and two teacher-led play activities were available simultaneously, allowing children to move freely between the activities. The play activities and toys available during transitions were rotated approximately once every 3-5 days according to a predetermined schedule. No systematic relation existed between specific play

activities and phases of the experiment. Examples of play activities included doctor (doctor's kits, stuffed animals, and phones), tea party (dress up clothes and tea sets), gardening (flowers, shovels, buckets, and baskets), shape sorters, farm (farm animals, barns, silos, and people), and houses and people. In addition to these teacher-led activities, children were allowed free access to toys available on low shelves (e.g., cash registers, trucks, and blocks).

Teachers were encouraged to lead play activities that would safely engage a large number of toddlers. The play mats were used to designate space for a particular activity (e.g., gardening). Teachers were encouraged to position themselves and toys on that mat and to lead the activity in such a way that children would be attracted to the activity and would remain engaged in the activity for several minutes at a time.

During all conditions, teachers implemented standard classroom practices for encouraging appropriate behavior and minimizing inappropriate behavior. These included (a) modeling appropriate play, (b) distributing attention equally to all children by interacting with each child in the area of the teacher's play activity at least once every two minutes, including inviting those who were not engaged to participate in the planned activity (e.g., "The phone's for you, Adam"), (c) redirecting children to a different activity contingent upon aggressive behavior, and (d) implementing a brief (1-min) timeout contingent upon bites or attempts to bite (see Porterfield, Herbert-Jackson, & Risley, 1976). Although children were verbally invited to participate in a teacher-led play activity being conducted on the play mats, children were never physically guided to the play mat.

Prior to the study, teachers received written and vocal instruction on classroom procedures during a one-day orientation or one-to-one meeting with a classroom supervisor. In addition, teachers received feedback from the classroom supervisor regarding implementation of classroom strategies throughout the course of their employment and throughout the duration of this study. The experimenter assigned two experienced teachers, who held supervisory positions, to act as lead teachers (one for each mealtime). The role of the lead teacher was to implement the experimental procedures outlined below and to facilitate communication between the experimenter and teachers concerning changes in experimental phases.

The experimental procedures were designed to work seamlessly within the typical classroom procedure for transitioning children to meals. Typically, two teachers remained in the play area, while the lead teacher selected children to transition to the meal area. Children were selected one by one to allow time for the lead teacher to assist each child with handwashing. Thus, the time between selections varied depending on how long it took to complete this process. There was no prescribed order for transitioning children to the meal area. A fourth teacher remained in the meal area to supervise and assist children who were seated at the table.

### *Participants*

Although the experimental procedures were applied to all 12 children in the classroom, only six children, identified during pilot work as having the lowest levels of engagement, were selected for observation. All children had age appropriate skills, responded to simple instructions, and were ambulatory.

### *Dependant Variable*

A primary goal of the toddler classroom was to promote child engagement in developmentally appropriate activities, which were designed to be a primary context for embedded teaching. This is the currently recommended approach to teaching in early education (see, Bredekamp & Copple, 1997; Bricker, Pretti-Frontczak, & McComas, 1998). As described previously, teachers led play activities on each of two play mats; therefore, sitting on a mat was requisite for child engagement in teacher-led play activities. Having children seated on a play mat also allowed teachers leading the play activities to supervise the children more closely and to intervene quickly to remedy unsafe situations. Thus, sitting on a mat was the dependant variable targeted for increase in this study.

In the absence of an intervention, many children spent a large proportion of time just prior to meals standing at the barrier and looking into the meal area. Children in this position did not appear to be benefiting from the programmed play activities; thus, we sought to decrease standing by the barrier, while simultaneously increasing the time that children spent on the play mats.

### *Data Collection and Interobserver Agreement*

Momentary time sampling (MTS), which involves the intermittent observation and recording of a momentary samples of behavior, was used to measure the behavior of 6 children. A 30-s MTS interval length was selected because it allowed for a large number of observations for each child, which was likely to introduce less error into the measurement system (Powel, Martindale, & Kulp, 1975), while still allowing

sufficient time between observations (i.e., 5 s) for data collectors to scan the room for the next child.

Trained graduate and undergraduate research assistants collected data from an adjacent observation booth equipped with a one-way mirror. Observations occurred during transitions to lunch (between approximately 11:30 a.m. and 12:00 p.m.) and afternoon snack (between approximately 3:00 p.m. and 3:30 p.m.). Because the intervention was designed to alter child behavior during the time period during which they were gradually transitioned to meals, the observation sample for all children began three intervals prior to the start of the first child's transition, and the observation sample for each individual child ended when that child was selected to transition to the meal area. Thus, the length of the observation sample for each child varied (ranging from 2 to 34 time samples). In addition, children were sometimes unavailable for a scheduled momentary time sample because they were participating in toileting routines.

Data collectors recorded child location (i.e., mat, barrier, or other) during each momentary time sample. "Mat" was scored when most of the child's body was sitting/ kneeling on a play mat; "barrier" was scored when most of the child's body was within 0.5 m of the barrier (marked by masking tape on the floor). "Other" was used to indicate when the child was in the play area, but not meeting criteria for the two previous categories. Throughout sessions, data were collected according to a prerecorded audio tape that signaled the name and moment of observation for each child. More specifically, approximately 4 s prior to each MTS, the audio tape

indicated the name of the next child to be observed, allowing data collectors time to scan the classroom prior to signaling the moment of observation (indicated by the auditory stimulus, “now”).

A second observer simultaneously, but independently, collected data for a minimum of 40% of sessions, with equal distribution across conditions. An agreement was defined as both observers scoring the same location (i.e., mat, barrier, other) for an MTS interval. Interobserver agreement (IOA) was calculated by dividing the number of agreements by the number of agreements plus disagreements multiplied by 100. IOA averaged 96.6% (range, 87.5% to 100%).

Procedural integrity data were collected for a minimum of 40% of sessions, with equal distribution across conditions. Data were collected on each child’s location at the time of selection. A selection was scored as correct when the lead teacher transitioned a child who was sitting on the mat during the DR mat condition or by the barrier during the DR barrier condition. Lead teachers implemented the selection procedures with 100% accuracy throughout the study. IOA for procedural integrity was collected for 39% of sessions and was 100%.

### *Experimental Design and Conditions*

The effect of the intervention was evaluated using an A-B-A reversal design, beginning with the intervention condition.

*DR mat.* During the intervention condition, classroom teachers transitioned a child to meals and snacks only when that child was seated on the mat where a teacher led a play activity. Prior to transitioning each child, the lead teacher entered the play

area, approached the child, and said “(Child’s name), you’re doing a good job sitting on the mat! It’s time to eat.” This procedure was repeated until 15 min had elapsed from the selection of the first child, after which the observation period ended and any remaining children were physically prompted to sit on the mat for 3-5 s prior to transitioning to the meal area. There was no prescribed order for transitioning children to the meal area.

*DR barrier.* During the reversal condition, classroom teachers transitioned a child to meals and snacks only when that child was positioned by the barrier to the meal area. This condition was designed to replicate the procedures that teachers typically follow in the absence of the intervention described above. That is, in the absence of specific training on mealtime transitions, teachers typically transition children who are closest to the meal area. The lead teacher entered the play area, approached the child, and said, “(Child’s name), you look hungry! It’s time to eat.” This procedure was repeated until 15 min had elapsed from the selection of the first child, after which the observation period ended and any remaining children were physically guided to the barrier for 3-5 s prior to transitioning.

#### *Social Acceptability Measures*

Following completion of the study, the two lead teachers who were in charge of selecting children to transition to the meal area were each provided two opportunities to choose which condition they would implement for the upcoming meal. Prior to meal preparation, the experimenter placed two sheets of paper describing the transition procedures (i.e., DR mat, DR barrier) in front of the lead

teachers, briefly reviewed the procedures, and asked them to choose one to implement for the upcoming meal or snack. Data were collected on the lead teacher's selections.

### Results

Figure 1 depicts aggregated data for the six participants. Overall, children were on the play mats designated for teacher-led activities during a higher percentage of intervals in the intervention condition (DR mat;  $M = 53.7%$ ,  $48.1%$ ) compared to the reversal condition (DR barrier;  $M = 36.9%$ ). Conversely, children were at the barrier to the meal area on a smaller percentage of intervals in the DR mat condition ( $M = 11.6%$ ,  $13.1%$ ) relative to the DR barrier ( $M = 20.5%$ ) condition.

Figure 1. Mean percentage of intervals on the mat and by the barrier for the six participants.

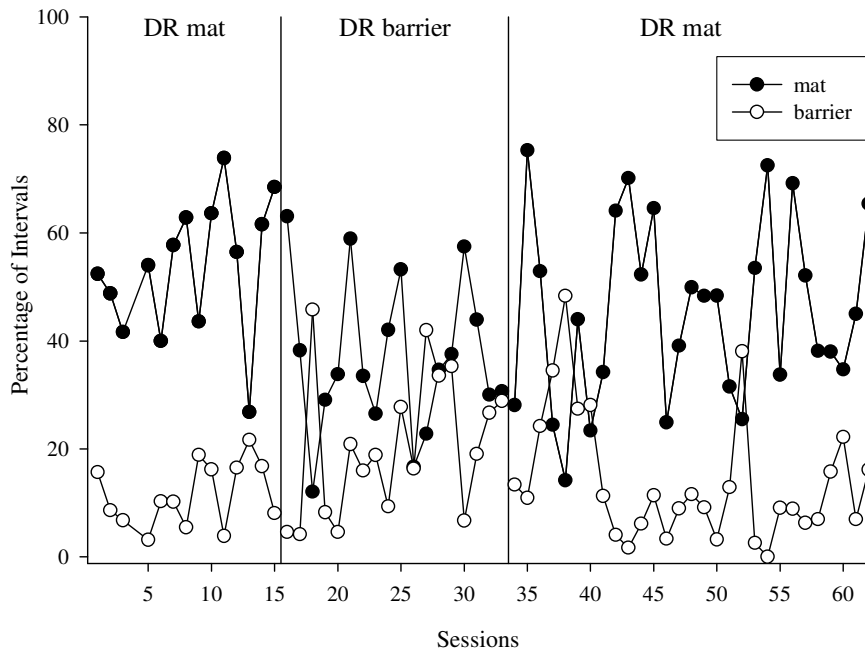




Figure 2. Percentage change for each of the six children.

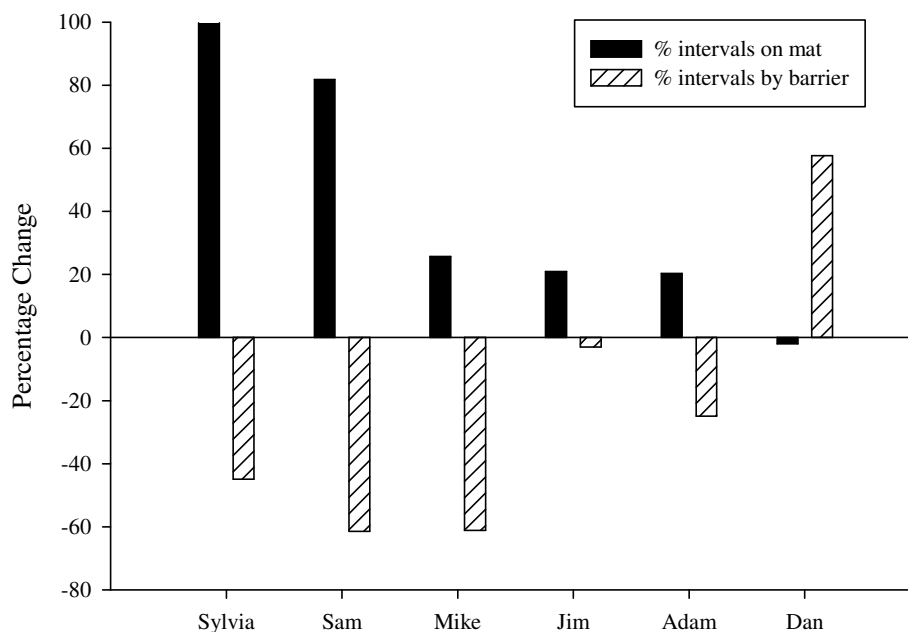


Figure 2 depicts the percentage change for both dependent variables for each of the 6 participants. To calculate the percentage change for the percentage of intervals sitting on the mat, the average percentage of intervals on the mat for the DR barrier condition was subtracted from the average percentage of intervals on the mat in both phases of the DR mat condition. The resulting number was then divided by the average percentage of intervals on the mat in the DR barrier condition and multiplied by 100. This formula (i.e.,  $[(DR\ mat - DR\ barrier) / DR\ barrier] \times 100$ ) was also used to calculate the percentage change for the barrier measure. Bars above 0% signify an increase in the DR mat condition relative to the barrier condition; bars below 0% signify a decrease in the DR mat condition relative to the barrier condition. For 5 of 6 participants, percentage change scores indicated improved performance consistent with the aggregated data. Interestingly, for Dan, there was no effect on the

average percentage of intervals on the mat, and the percentage of intervals by the barrier changed in the undesired direction.

When lead teachers were provided with an opportunity to choose which strategy to implement, they exclusively chose DR mat. In addition, procedural integrity data for the meals following the social acceptability measures were 100%, demonstrating that the supervisors did, in fact, correctly implement the strategy they chose. IOA for procedural integrity was collected for 50% of these sessions and was 100%.

### Discussion

In the current study, a variable-momentary differential-reinforcement (VM DR) schedule increased desirable classroom behavior in young, typically developing children. When access to the meal area was provided contingent upon children sitting on the play mat, the average percentage of intervals children sat on the play mat increased. Alternatively, when access to the meal area was provided contingent upon children being by the barrier, the average percentage of intervals children were by the barrier increased. These effects were consistent across the majority of children evaluated. Furthermore, teachers implemented the intervention with 100% integrity and chose to implement the intervention when presented with a choice of procedures.

The intervention involved a simple rearrangement of events already occurring in the classroom and was implemented by the typical classroom teachers with minimal effort. Similar interventions could be used to promote a wide range of desirable classroom behavior such as engagement, standing in line appropriately, or

participating in tasks such as clean-up. Of course, requiring appropriate behavior just prior to allowing a child to transition to the next activity will only increase appropriate behavior if the transition involves initiation of a relatively more preferred activity. In the current study, it is possible that the intervention was not effective for Dan, because the transition to meals did not serve as a reinforcer. Dan's results highlight a limitation of group-oriented contingencies. That is, the effectiveness of group-oriented contingencies is directly related to the degree to which the consequences are effective for individual children. In other words, the application of uniform consequences is only beneficial for the group if the consequences are effective for the majority of children.

A limitation of this study is that the intervention produced only small improvements in desirable behavior. Because the intervention was implemented by classroom teachers within the typical classroom routine, a number of potential influential variables were allowed to vary unsystematically. For example, the children's position in the classroom (i.e., on mat or by barrier) may have been influenced by their preference for the available activities, time since their last meal, the presence of preferred peers, or the quality of the food available in the meal area (e.g., behavior appeared to be disrupted in the intervention condition in session 52 when a parent brought cupcakes for snack). In addition, although teachers were instructed to distribute attention evenly among the children, and were provided feedback with respect to their performance, the amount of teacher attention and prompting may have varied across conditions. However, the fact that a small

adjustment to existing classroom contingencies had an overall effect on classroom behavior is noteworthy given the amount of variability permitted in the classroom environment.

It is likely that the momentary nature of the contingency also contributed to the relatively small effects. In the intervention conditions, children who were on the mat at the moment of observation were allowed to transition to the meal area, even if they spent all of the previous observation intervals by the barrier. Lindberg et al. (1999) suggested that, when momentary schedules are used, variable interval lengths may obscure the potential discriminative function introduced when reinforcement is delivered at regular time intervals. In the current study, variability in the timing of the teachers' momentary observations was not programmed, but an examination of the data reveals a wide range in the length of observation periods (i.e., time between the start of the observation period and a particular child's transition), suggesting that the timing of momentary observations was somewhat unpredictable. Despite this variability in observation periods, unprogrammed discriminative stimuli may have controlled the children's position in the classroom. For example, children in the play area were not selected to transition to the meal area when the lead teacher was assisting another child with handwashing. Bushell et al. (1968) attempted to reduce the potential discriminative function of the teacher's proximity or approach by encouraging teachers to avoid delivering tokens to those children within close proximity and to move through the classroom in unpredictable patterns. It is possible

that the effects of the current intervention would have been enhanced through similar attempts to obscure the timing of momentary observations.

Table 1.

*Summary of the number of time samples for each condition for the six participants*

	Number of time samples DR mat			Number of time samples DR barrier		
	Session range	Average	# of times 30 or above	Session range	Average	# of times 30 or above
Sylvia	2-27	10.6	0	2-33	11.0	1
Sam	3-20	8.0	0	2-12	5.4	0
Mike	3-22	8.7	0	2-32	9.5	1
Jim	3-26	8.7	0	3-7	4.6	0
Adam	2-21	9.9	0	3-31	10.5	1
Dan	2-25	9.6	0	3-34	12.2	2

The strength of the contingency may have been weakened further by the fact that a child could eventually gain access to the meal area without independently engaging in the target behavior. Recall that any children remaining in the play area after 15 min from the selection of the first child were physically guided to the target location for 3-5 s and then transitioned to the meal area. Thus, the contingency did not require manipulating *whether* children transitioned to the meal area, only *when* they transitioned. We did not explicitly record occasions when children were

physically guided to the target location, but an estimate of this variable can be obtained by examining the length of sessions. Session lengths of less than 30 intervals indicated that all children were transitioned within 15 min; therefore, no children were physically guided to the target location during these sessions. The data in Table 1 show that only 5 sessions lasted 30 intervals or more, indicating that it was very rare for children to be transitioned to the meal area without independently performing the target response.

Though the difference in the mean percentage of intervals on the mat and by the barrier across conditions may be considered small, the contingency was powerful enough to effect overall response allocation across the majority of children evaluated. Fantuzzo and Atkins (1992) suggest that techniques that demonstrate positive effects across a number of individuals may be more desirable than those that demonstrate positive effects on few individuals, even if the effect is smaller. However, because it may be desirable to increase the percentage of intervals on the mat beyond those obtained in this study, future research might evaluate the additive effects of other procedures (e.g., prompting children to engage in the appropriate behavior).

The present study represents an example of an effective classroom management technique designed for maximum adoptability. Naturally existing classroom events were programmed as reinforcers to enhance the social acceptability of the procedure, and delivery of these events required no additional classroom resources. Furthermore, applying independent group-oriented contingencies based on momentary samples of observation required minimal teacher time and effort.

Behavioral technology might be more widely adopted in educational settings if additional research focused on the development and evaluation of more socially acceptable and practical interventions.

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