The present study investigated applications of the disequilibrium model of reinforcement in typical classroom contexts with students perceived by their teachers as being difficult to motivate. The disequilibrium model states that reinforcing effects are produced when access to any response (task) is constrained so that an individual cannot meet an (unconstrained) baseline level for that response (task). The implication of the model is that low-probability (low-preference) responses can be constrained and used as reinforcers, a seeming contradiction to the common practice of using a high-probability response to reinforce increases in a low-probability response.

The present study investigated the effects of disequilibrium schedules of reinforcement with six students with several disabilities in classroom contexts. The specific research questions were (i) whether disequilibrium schedules would produce reinforcing effects if both the instrumental and contingent tasks were of moderate to low preference for the student; (ii) how effects of disequilibrium schedules would compare with those of a teacher-generated contingency; and (iii) what effects disequilibrium schedules would have with students who engage in non-task responding during the baseline period.

Results suggest that disequilibrium schedules are effective when used with moderate to low-preference tasks. Results of the comparison with teacher-generated contingencies were mixed. Results do suggest that the presence of higher levels of non-task responding during the baseline period may affect subsequent effectiveness of disequilibrium schedules calculated from the baseline. Copyright © 2003 John Wiley & Sons, Ltd.

INTRODUCTION

Predicting and describing how to arrange reinforcement are key features of a reinforcement theory, as well as central tasks in the development of behavior change interventions. Considerable research and discussion have occurred around the area of reinforcer identification, and progress has been noteworthy. Models for reinforcer selection typically involve measurement of time spent engaging a stimulus or in an
activity during a free-choice baseline (Hopkins, Schutte, & Garton, 1971; Premack, 1963), or by approach to a particular stimulus when pairs of stimuli are presented with a prompt to choose (cf. Mason, McGee, Farmer-Dougan, & Risley, 1989). In the former model, the time spent in each available activity is used to determine high-probability and low-probability activities, which are then arranged in a contingency in which access to the high-probability activity is made contingent on some level of responding on the lower-probability activity. This method, based on Premack’s probability differential model, has been widely adopted for establishing reinforcers, and is particularly attractive in an educational setting because activities that are part of the classroom environment, rather than imported stimuli (e.g. candy, stickers), can be programmed within the daily schedule. However, the Premack model indicates how to identify and sequence activities, but does not provide guidelines for establishing a ratio of time spent on the lower-probability activity to earn access to the higher-probability activity. Furthermore, the Premack model presumes that the higher-probability, contingent activity, can and will be controlled so as to create deprivation. While these may seem minor limitations of an otherwise parsimonious method for arranging reinforcement, they may prevent optimal use of reinforcers in classrooms. The disequilibrium model of reinforcement, the topic of this study, represents an alternative model that may present advantages when arranging reinforcement contingencies in classrooms.

The disequilibrium model of reinforcement (Timberlake, 1984; Timberlake & Farmer-Dougan, 1991) represents an alternative that does provide guidelines for arranging the contingency between activities so as to create reinforcement. According to the disequilibrium model, reinforcement effects are produced when the ratio of instrumental to contingent activity, as exists during a baseline period, is transformed into a state of disequilibrium by pushing the ratio of the instrumental to contingent activity above the ratio established during the baseline period. To regain equilibrium (the ratio of instrumental to contingent tasks established in baseline), an individual will increase the instrumental response above baseline levels. Thus, reinforcement effects can be produced by constraining access to the contingent activity until a greater amount of the instrumental activity has occurred. For example, a student may engage in coloring during 9 minutes of a 15 minute free period in his classroom, with the remainder of his time (6 minutes) spent manipulating building blocks. According to the disequilibrium model, the student will engage in even more coloring if access to the building blocks is constrained so that he must color more to meet his baseline level of 6 minutes of manipulating blocks. Conversely, the student will engage the blocks more than the previously observed 6 minutes if access to coloring is constrained below the normal 9 minutes. The disequilibrium model predicts that to produce reinforcement effects, one must do more than identify a higher-probability activity and manipulate it as a consequence for a lower-probability
activity. Rather, the ratio of those two activities must represent a greater ratio than that found in baseline.

Because, according to the disequilibrium model, reinforcement effects are the product of schedule constraints rather than relative time spent in an activity, implications exist for manipulation of the lower-probability activity as the contingent response. That is, individuals may engage in more of the higher-probability response to gain access to the lower-probability activity; this represents a departure from the Premack model of reinforcement. Implications of this effect are especially intriguing because it may mean that (i) practitioners can arrange reinforcing effects even when students spend minimal time in any activity and no clear ‘preferred’ activity is evidenced, and (ii) reinforcement effects can be arranged even when a limited number of activity options are available. A more thorough discussion of the features and implications of the disequilibrium model can be found in the work of Timberlake and Allison (1974), Allison (1983), and Timberlake and Farmer-Dougan (1991), and will not be discussed here for the sake of brevity.

Following several demonstrations of disequilibrium (also called response deprivation) schedules in laboratory settings (see Allison, 1993, for a review), Konarski and colleagues (Konarski, Johnson, Crowell, & Whitman, 1980; Konarski, Crowell, & Duggan, 1985) conducted a series of studies using academic or classroom activities, also the focus of the present study. Konarski et al. (1980) conducted two experiments with typical first graders using coloring and math problems, and reading and coloring tasks, as the pairs of tasks/responses for which disequilibrium schedules were calculated and implemented. Results indicated that the low-probability responses, when constrained below baseline levels, did function as reinforcers for the higher probability responses. A second finding was that the high-probability response (coloring) functioned as a reinforcer for the low-probability response (reading) only when disequilibrium schedules were implemented. The latter finding suggests that simply making a high-probability response/task contingent on performance of a low-probability response/task may not produce reinforcing effects unless the contingency involves constraint of the contingent task below baseline levels.

In a second study involving academic tasks, Konarski et al. (1985) assessed the effects of disequilibrium (or response deprivation) schedules with six students with mild mental retardation. Responses/tasks used in the study were writing words and completing math problems on a worksheet. The authors compared the effects of disequilibrium schedules with effects of feedback and the effects of reinforcement not based on disequilibrium schedules. Results indicated that disequilibrium schedules produced higher levels of responding/task completion than did the other conditions. Furthermore, the authors demonstrated reversibility, a unique feature to the disequilibrium model, by producing reinforcing effects after switching the contingent and instrumental tasks, and thereby isolating the effects on the
disequilibrium schedule and eliminating the transituationality of the reinforcing responses/tasks as explanation for the results.

Farmer-Dougan (1998) investigated the implications of the disequilibrium model as an explanation for the effects of incidental teaching procedures on responses of four pre-school children. The purpose of the study was to demonstrate that incidental teaching, in which the children were interrupted during toy play and prompted to make several academic responses, was effective because it created a state of disequilibrium in the ratio of the academic response (instrumental response) to toy play (contingent response). During the intervention (incidental teaching) phase, the trainer interrupted student initiations of toy play to prompt an academic response according to four different schedules: 25% of initiations the student made toward the contingent task, 50% of initiations, 75% of initiations, and 100% of initiations. Citing research on bliss-point models (cf. Allison, 1983), the author hypothesized that disequilibrium schedules representing high rates of disruption to the baseline ratio of responding may produce reduced reinforcement effect. Conversely, schedules producing moderate or mild levels of disruption should produce greater reinforcement effect. Results of the study indicated that the average time spent in on-task behaviors during the incidental teaching moments was significantly higher during the intervention conditions than during baseline. In addition, on-task behavior of three of the four subjects was highest during the moderate constraint (50 or 75%), and lower in the 100% constraint condition. The author concluded that the toy disruption at moderate rates was more effective than disruption at very low or very high conditions. In addition, the author noted that inappropriate behaviors were highest in the 100% interruption condition, suggesting that the subjects were frustrated with lack of access to the toys.

A required procedure for implementing disequilibrium schedules is conducting baseline conditions in which the student is able to allocate time to two or more responses/tasks. The requirement of the baseline may, at first glance, seem to require more time and effort than less systematic methods that teachers may use to identify reinforcers for their students. Research has addressed variables that may influence the accuracy of the baseline period for predicting reinforcement under subsequent disequilibrium schedules. The presence of a third response option (including no responding or non-task responding) during the baseline has been shown to disrupt the effectiveness of disequilibrium schedules (Aeschleman & Williams, 1989; Glover & Hanley, 1993). Thus, the extent to which disequilibrium schedules are effective with students who engage in high levels of disruptive or non-task-related behaviors during classroom instruction warrants investigation. A second issue related to the practicality of the baseline procedure is the extent to which students’ ‘preferences’ change over time; to what extent will students allocate their time differently to response/task options after they have been exposed to contingencies involving those
tasks? Fuqua (1989) has suggested that baseline procedures may need to be repeated periodically to assure that disequilibrium schedules are calculated to provide optimal effects.

In summary, parameters for application of the disequilibrium model with academic or classroom responses/tasks have been described in the literature. Several parameters not previously investigated might determine its ultimate utility in classroom settings. The effects of the presence of student behavior that is not directed toward either of two available tasks in a two-choice baseline is of interest because students often engage in non-task responding when the teacher is not providing continuous prompting. Research has not investigated whether disequilibrium schedules that are based on the ratio of time spent on two tasks are affected when a third option—non-task responding—constitutes up to 75% of the baseline period. Implications for any effects of non-task responding in baseline may inform teachers of when and for whom disequilibrium schedules of reinforcement are indicated.

Previous research with disequilibrium schedules has involved contingencies with tasks or activities familiar to the subjects. Thus, results can be generalized only to contexts in which students are exposed to familiar tasks. For maximum impact, contingencies based on the disequilibrium model should also be effective when students are acquiring a new skill. Teacher-mediated tasks have been used in past studies; however, results for an acquisition task have not been specified.

A final concern regarding the disequilibrium model is whether or not classroom teachers would perceive the steps required to determine baseline ratios and contingencies worth the purported benefits. One method for establishing the social validity of the disequilibrium model may be to compare the effects of contingencies determined with the model with those determined by the classroom teacher. Konarski et al. (1980) suggested that one approach for assessing the utility of disequilibrium (response deprivation) schedules would be to compare their effects with those for commonly used methods for arranging reinforcement.

The purpose of the present study is to extend our knowledge of the effects of disequilibrium schedules with moderate constraint on task responding of subjects with severe disabilities in a two-task context. The design of the study was intended to address applications of the disequilibrium model with typical classroom problems and contexts. Specific research questions were the following:

(i) Will disequilibrium schedules produce reinforcement when the two response (task) options are of moderate to low preference for the student?
(ii) How will the effects of disequilibrium schedules compare to those of teacher-generated contingencies and reinforcers?
(iii) What effects will disequilibrium schedules have on subjects who spend some to most of the baseline period in non-task-related responding?
METHOD

Participants and Settings

Six students with moderate to severe mental retardation served as participants. Students were nominated by their teachers according to the following criteria defined by the investigators: (i) student is in the third or fourth quartile of students in being difficult to motivate, and (ii) student is in the top quartile of students for whom reinforcer identification is difficult.

Jack was an eight-year-old boy with moderate to severe retardation (IQ score of 32 on Stanford–Binet) associated with Down syndrome. He exhibited limited vocal speech and wore glasses to correct his vision. The second participant, Felicia, was an 11-year-old girl with mild to moderate mental retardation. Testing yielded the following scores: Vineland Adaptive Behavior Scales—M.A. of 7.2 years; Vineland Adaptive Behavior Scales—M.A. of 5.6 years. She possessed no sensory or physical limitations.

Participant 3, Mitchell, was an 11-year-old boy with moderate mental retardation (full scale IQ score of 45 on the Stanford–Binet) associated with Down syndrome. Mitchell received Ritalin, 5 mg BID, throughout the study. He demonstrated language deficits, and communicated with manual signs. Juan, the fourth participant, was an 11-year-old boy with moderate mental retardation (test scores indicated a mental age of 2–3 years; however, the testing report indicated that interfering behavior during testing produced low, unrepresentative scores). Juan had a seizure disorder for which he received Tegretol, 700 mg daily, throughout the study.

Hilda, an 11-year-old girl with moderate mental retardation, served as the fifth participant. Her records indicated a recently obtained IQ score of 48 on the Stanford–Binet (form LM). The sixth subject, Edgar, was a 10-year-old boy with moderate mental retardation, evidenced by an IQ score of 50 on the Stanford–Binet (fourth edition).

Jack participated in the study in his primary classroom for students with moderate to severe developmental disabilities. He was seated at a small table used by all students for free time activities and for some instructional activities. Felicia, Mitchell, Edgar, and Hilda participated in a room used for pre-vocational activities. Each participant was seated at a table or desk.

Selection of Tasks

Teachers for the participants were instructed to identify all tasks and materials cited in each student’s individualized educational plan (IEP). From this list, the teachers then identified two tasks perceived to be of moderate to low preference for
the student. This judgment was based on the number of times the student had chosen this task during free time periods and how much prompting the teacher had to provide to maintain steady responding during instruction on that task.

Tasks identified for Jack were manipulating a toy mailbox set, and activating an electronic language device that stated the name of objects (e.g. horse) as the student touched the corresponding picture. Tasks identified for Felicia were cutting papers with various pre-drawn lines, and assembling a three-piece electrical part. For Mitchell, selected tasks were a two-piece assembly of an electrical part, and a three-piece packaging task that required counting and sorting pieces into containers. Tasks selected for Juan were sorting groups of cassettes and placing them into special notebooks, and discriminating letters and numbers 1–10. The latter task involved the teacher presenting stimuli and a prompt to touch_____. Inclusion of a teacher-mediated task has been investigated only in Farmer-Dougan’s (1998) study involving incidental teaching. Such a task was included to investigate whether effects of disequilibrium schedules can be used during acquisition tasks mediated by a teacher.

Tasks identified for Hilda were cutting coupons from the newspaper and filing colored index cards. Tasks for Edgar were filing cards by matching letters and tracing letters on work sheets.

Data Collection and Variables

All sessions were videotaped with a camera placed approximately 6 feet lateral to the seated participants. Videotapes were later scored using a laptop computer and observational software system that records data in real time, and that provides a summary table of frequency and duration of each behavior code (Repp, Karsh, VanAcker, Felce, & Harmon, 1989). The following is a description of the codes recorded.

Manipulation of task A or B was defined as purposeful manipulation of stimuli for one of the two tasks arbitrarily designated as task A or task B. Tasks A and B were later designated as the instrumental or contingent tasks when disequilibrium schedules were arranged. Other movement during baseline was defined as any gross or fine motor movement not related to or occurring with manipulation of a task during the free baseline period. No movement during baseline was defined as no visible task or non-task-related movement during the baseline period. Other movement during access to instrumental task was defined as in baseline with the exception that this code was activated only when the instrumental task was available to the subject. No movement during access to instrumental task was defined as in baseline with the exception that it was scored only when the instrumental task was available. The last two codes were recorded only during the intervention phase, when the instrumental and contingent tasks were not simultaneously available.
The dependent variable, *percentage of access to instrumental activity with manipulation*, was calculated by summing durations of codes for manipulation of task A or B and other movement during access to instrumental task, then dividing this sum into the former of the two codes. For example, suppose a student spends 12 minutes of a 15 minute session engaged in manipulation of task A, the instrumental response. She spends the remaining 3 minutes engaged in other movement during access to the instrumental task. Therefore, the percentage of access to instrumental activity with manipulation would be 12/15 minutes, or 80% of the session. This procedure provided not only data on time spent on the instrumental task, but also the extent to which the subject initiated and sustained responding, thereby maximizing instructional time. This latter measure may be used to assess the overall efficacy of disequilibrium schedules as interventions.

**Interobserver Agreement**

A second observer scored a sample of videotapes to establish interobserver agreement. The software program calculated second-by-second agreement for the data strands generated by the two observers. Agreement was summarized and printed as percentage agreement, meaning the percentage of seconds both observers recorded an occurrence of a behavior. Agreement for Jack was assessed on nine of 20 sessions (45%). Percentage agreements for each code were as follows: manipulation of task A (language toy) 99%, manipulation of task B (mailbox) 88%, other movement during baseline 99%, and other movement during access to instrumental response 97%. The no movement codes were never recorded.

Agreement for Felicia was assessed on 11 of 18 sessions (61%). Percentage agreements were as follows: manipulating task A (cutting) 99%, manipulating task B (two-piece assembly) 89%, other movement during baseline 99%, and other movement during access to instrumental response 100%. The no movement codes were never recorded.

A second observer scored nine of 21 sessions (43%) for Mitchell. Percentage agreement for each code was as follows: manipulation of task A (three-piece assembly) 86%, manipulation of task B (two-piece assembly) 99%, other movement during baseline 95%, no movement during baseline 98%, and other movement during access to instrumental task 99%. No movement during access to instrumental task did not occur. Interobserver agreement was assessed on nine of 14 (64%) sessions for Juan. Percentage agreements were as follows: manipulation of task A (cassettes) 87%, manipulation of task B (discriminated stimuli) 97%, other movement during baseline 94%, and other movement during access to instrumental task 100%. The no movement code did not occur during baseline or intervention phases.
Agreement for Edgar was assessed on eight out of 24 sessions (33%). Percentage agreements were as follows: manipulation of task A (tracing letters) 96%, manipulating task B (filing cards) 92%, other movement during baseline 95%, and other movement during access to the instrumental response 98%. The no movement code was not recorded in baseline or intervention.

Agreement for Hilda was assessed in nine out of 25 sessions (36%). Percentage agreements were as follows: manipulation of task A (cutting coupons) 98%, manipulation of task B (filing colors) 96%, other movement during baseline 92%, and other movement during access to the instrumental response 95%. The no movement code did not occur.

Experimental Design and Conditions

There were three phases to the experiment: (i) the baseline period, (ii) an alternating treatments (between sessions) design implemented to compare the effects of two interventions, and (iii) a follow-up baseline (for Jack and Felicia only).

Baseline

The purpose of the baseline phase was to establish a ratio of time participants would allocate to the two available tasks. The number of baseline sessions was dependent on stability in the student’s allocation to the two tasks. Baselines were considered stable when three consecutive data points varied by no more than 20%. Identical procedures were followed for Jack, Felicia, and Mitchell. During the 15 min initial and follow-up baseline periods (for Jack and Felicia), the participants were seated at a desk or table with stimuli for both tasks within their reach. No contingencies were implemented, and the stimuli remained available throughout the period. During the free baseline, the experimenter provided a verbal prompt once per minute throughout the session informed the students that they could work on task A or task B, or do nothing. This rule was implemented to reduce the likelihood that the participants would spend the entire session on whichever task they contacted first. Following completion of the third free baseline period, a ratio of time spent on tasks A and B was calculated. Jack spent 100% of his time manipulating the language toy; therefore, calculating a ratio was not required because requiring even 1 second of responding to the instrumental task (mailbox) would produce a disequilibrium schedule. The other codes (other movement or no movement) were not activated during the baseline.

Baseline measures for Felicia also yielded a large probability differential of 88 (assembly task):1 (cutting). She did engage in other movement, with the mean for that code being 11% for the three baseline sessions. Baseline measures for
Mitchell yielded a ratio of 20 (two-piece assembly task):1 (three-piece packaging task). He spent 29% of the baseline engaged in other movement and 7% in no movement.

Procedures were modified for Juan because one task, letter/number identification, required teacher mediation. For Juan, the experimenter placed the stimuli for the cassette sorting task and the discrimination task on the table. Then he sat across the table from Juan on the end containing the materials for the discrimination task. When Juan oriented toward that task and looked at the letters/numbers, the experimenter would present the S+ and one distractor, and say ‘Touch______’. If Juan pointed at the correct stimulus, the experimenter said ‘That’s correct’ in a neutral tone and withdrew the stimuli. New stimuli were presented continuously (pause of 1 second) as long as Juan remained oriented toward the stimuli. To avoid potential confounding effects of attention for one task, but not the other, the experimenter avoided prompting Juan to continue on the discrimination task (B). Also, the feedback ‘That’s correct’ was provided each time Juan placed a folder with cassettes (A), even though he had mastered this task. Results of the three free baseline sessions indicated that Juan spent 70% of the baseline engaged in other movement. When he was engaged in one of the tasks, the ratio of engagement was 7 (placing cassettes in folder):1 (discrimination task).

Baseline procedures for Edgar and Hilda varied from those for the other participants. In addition to reminding the participants once per minute that they could engage in either task, or do nothing, the experimenter interrupted prolonged manipulation. When a student manipulated the same task for more than three consecutive minutes, the stimuli were removed and placed in their original positions, and the original instruction was repeated. Free baseline conditions were continued until a minimum 60:40 ratio between tasks was achieved for three consecutive sessions.

**Disequilibrium Schedule (DS)**

During this condition, the lower-probability response during baseline was designated the instrumental response and the higher-probability response became the contingent response. Disequilibrium schedules (DS) were created by constraining access to the contingent response below its baseline level. Constraint was operationalized as a contingency that reduced access to the instrumental response to approximately 25–50% of the level observed in baseline. The precise contingencies were based on the authors’ experiences with increasing task engagement by students with severe disabilities, and not on a formula. The amount of time a student was required to engage the contingent response was based on the amount of engagement for that task during baseline and the size of the ratio between the instrumental and contingent tasks. For example, when a student engaged
minimally or not at all with one task during baseline, the contingency for that same task during the disequilibrium would require a relatively brief period of engagement before the contingent task was made accessible, as would be expected in a behavior shaping program. Another factor that influenced the contingencies was our desire to have the students contact the contingencies more than once during the 15 minute sessions. This meant that time allowed on the contingent responses had to be limited so they did not take up most of the session.

Identical procedures were used for Jack, Felicia, Mitchell, and Juan. For Jack, the ratio of mailbox play to language toy was set at 8:1. Values for each task were set at levels intended to facilitate success by the participants. Because Jack had not manipulated the instrumental task during the baseline period, a small value of 30 s was set. The contingency then became 30 s of manipulation of the mailbox set to earn 4 min access to the language toy.

Baseline sessions for Felicia had yielded an 88 (assembly):1 (cutting) ratio. For the DS schedule, the ratio was quartered to 22 (assembly):1 (cutting). Values were set as follows: 15 s of cutting earned 5.5 min access to the assembly task. The small value of 15 s was selected for the cutting task because of the relatively significant response effort required for Felicia to manipulate the scissors, and because the value could always be increased if Felicia did engage in high levels of manipulation.

Mitchell had manipulated the two tasks at a 20 (packaging):1 (assembly) ratio during the baseline. For the deprivation schedule, the ratio was halved to 10:1. Values were set at 30 s (assembly):5 min (packaging). Values were intended to provide multiple exposures to the contingency, while allowing enough time to completely assemble three to five pieces.

The baseline ratio for the two tasks for Juan was 7 (cassette):1 (discrimination). For the deprivation schedule, the ratio was halved to 3.5:1. Values were set as follows: 15 s of continuous participation in the discrimination task earned 50 s access to the cassettes. As with the other participants, the values were intended to provide repeated exposure to the contingency.

For Edgar and Hilda, two deprivation schedule conditions were implemented for each participant. In the DS: High condition, the high-probability task became the contingent task, while the lower-probability task served as the instrumental task, as was done with the previous subjects. In the second deprivation schedule, the DS: Low condition, reversibility was assessed by using the lower-probability task as the contingent task for the high-probability, instrumental task. In other words, the student had to engage in the high-probability task in order to earn access to the low-probability task.

For Edgar, the DS: High condition involved halving the free baseline ratio of 9 (filing):5 (tracing) to 4.5 (filing):5 (tracing). For this experiment, we increased values to reflect better actual instructional conditions in which participants are required to
work for longer durations. Higher values were possible because the probability differentials observed in baseline were not as large (e.g. 0% time in task 2 for Jack) as those for other participants. Values and contingency for Edgar in the DS: High condition were 2 min 25 s of filing coupons earned 2 min 40 s of access to tracing, thereby maintaining the 5:4.5 ratio. In the DS: Low condition, the baseline ratio of 9 (filing):5 (tracing) was doubled to 18:5, with a resulting contingency of 3 min 36 s of filing earning 1 min access to tracing.

Identical procedures were used to determine the two sets of disequilibrium schedules (high and low) for Hilda. The baseline ratio for cutting coupons and filing colors was 3:2. For the DS: High condition, the ratio was halved to 1.5 (cutting):2 (filing), with the contingency requiring 2 min 48 s filing colors to earn 2 min 6 s access to cutting coupons. For the DS: Low condition, the ratio was doubled to 6:2 to make filing colors the contingent task. Values for the two tasks were 3 min 45 s of cutting coupons to earn 1 min 15 s of filing colored cards.

Sessions with disequilibrium schedules were approximately 15 minutes in length. Because, however, contingencies specified how long participants had to engage in the instrumental response to gain a specified duration of access to the contingent response, the sessions sometimes lasted slightly longer than 15 minutes to complete the contingency.

**Teacher Contingency (TC)**

Teacher contingencies were generated according to a structured protocol. First, the experimenters reviewed the baseline data and ratios with each teacher. Next, the experimenter indicated that the goal of the intervention phase would be to increase time spent on the low-probability (instrumental) task. Teachers were asked to identify a reinforcer and schedule of reinforcement that they believed would increase instrumental responding. The investigators determined the schedules of reinforcement for Edgar and Hilda for purposes described later. Teachers were instructed that they could choose reinforcers from any stimuli or activities available in the school, and that the experimenters would implement the intervention. After the teachers generated reinforcers and schedules, the experimenters role-played its implementation until meeting the teacher’s criterion.

The teacher contingency (TC) for Jack required that he manipulate the mailbox set for two continuous minutes to earn 3 min access to the language toy. As indicated, Jack’s teacher chose the same tasks for the teacher contingency as she had chosen for the disequilibrium schedules. Felicia’s teacher determined that she should engage in cutting, with pauses of no more than 5 s, for the entire 15 min period. If she achieved this, she would earn a packet of school forms that she enjoyed writing on and taking home to show her mother.
For Mitchell, the contingency required 3 min of continuous (no pauses more than 5 s) engagement to earn 1 min access to a bag of personal items brought from home. Items typically included jewelry, clothes, pictures, and toys. Items were often age inappropriate and were not appropriate for use in school. Juan’s teacher recommended a contingency in which Juan would earn 1 min access to a toy drum if he worked on the discrimination task continuously for 5 minutes.

The investigators determined the schedules of reinforcement for Edgar and Hilda. To control for schedule effects, the experimenters solicited reinforcers from the student’s teachers, but delivered those reinforcers at the same schedule being used in the two DS conditions. This procedure allowed the experimenters to attribute potential differences in responding under the disequilibrium or teacher-contingency conditions to the reinforcer, and not to the schedule with which it was made accessible.

For Edgar, the teacher chose building blocks as the reinforcer. Thus, the blocks were used as the contingent response and presented according to the same contingency and for the same values as were used in the disequilibrium condition with which it was being compared. Hilda’s teacher selected books as the reinforcer. As with Edgar’s blocks, Hilda’s books were presented on the same schedule as that used in each of the disequilibrium schedules.

Sessions involving teacher contingencies were approximately 15 minutes in length with some lasting longer to accommodate access to the contingent response based on the established schedule.

Procedures
Baselines

Procedures for the initial and follow-up baseline conditions were identical for all participants except Juan. The procedure for presenting the discrimination task to Juan was described earlier in the description of the baseline session and involved teacher mediation.

For each session, the participants were asked to sit at the desk or table. The experimenters then placed stimuli for both tasks on the table, alternating sides for each session. Once stimuli were placed within the participant’s reach, the experimenter demonstrated each task. During the first three sessions, they were required to perform each task for approximately 3 s to indicate that they could manipulate the stimuli correctly. Following the modeling, the experimenter gave the following instruction: ‘You can do______, or______, or both, or you can do nothing. You do have to stay in your seat’. This statement was repeated approximately every minute. Immediately following the instruction, the experimenter turned on the video
camera and moved to another part of the room. When 15 min had elapsed, the experimenter thanked the participant for following instructions and prepared the student to join the next classroom activity.

**Disequilibrium Schedule**

Similar procedures were used for all participants. A timer was used to signal when criteria for the instrumental response had been met or access to the contingent response had expired. Initial steps were the same as those in baseline, until the contingency was presented. At this time, the experimenter removed materials for the contingent task and stated the contingency. For Jack, the instruction was as follows: ‘Jack, if you work on putting together the mailbox set for 30 seconds, you can have the language toy for 4 minutes’. The experimenter then set a timer so that a buzzer would sound at the end of the required engagement. The experimenter demonstrated putting letters into the mailbox as the instruction was given. The contingency was repeated (i) each time access to the contingent response expired and the mailbox was re-presented, or (ii) once per minute when Jack was engaged in other movement. When Jack met the criterion and earned the language toy, the experimenter moved the materials for the instrumental task (mailbox) to the side of the table. When the access to the language toy had elapsed, the experimenter removed the toy, slid the mailbox materials in front of Jack, and re-stated the contingency.

The same general procedures were followed for Felicia. The contingency statement was as follows: ‘Felicia, if you cut for 15 straight seconds, you can work on the parts for five and one half minutes’. The experimenter pointed to the task materials as they were described. The changeover periods when the experimenter was switching the instrumental and contingent tasks was limited to 3–4 s, which were added to the duration of the task being removed, and hence, balanced out over the course of the session.

For Mitchell, the experimenter placed the materials on the table, demonstrated how they were to be manipulated, and then withdrew the instrumental task as he said ‘If you work on these parts for 30 s, you can have these parts for 5 minutes’. Again the experimenter pointed at each set of task stimuli as they were mentioned.

During sessions for Juan, the contingency statement was ‘If you work on letters and numbers for 15 s, you can have the cassettes and notebooks for 50 seconds’. The experimenter pointed at each task as it was mentioned.

The same general procedures were followed for Edgar and Hilda. Experimenters modeled each task, then presented the contingency statement and used timers to provide auditory feedback for completion of the instrumental criterion. The contingency statements for the DS: High and DS: Low conditions were described earlier in this paper.
Teacher Contingency

During the sessions for Jack, the experimenter placed the reinforcer (language toy) on a desk near Jack. The experimenter stated ‘If you work with the mailbox for two minutes, you can play with the (language) toy for three minutes’. For Felicia’s sessions, the reinforcer (packet of school forms) was placed on a desk near her, and the experimenter stated ‘If you keep cutting for the next 15 minutes, you will get the packet of papers to take home with you today’.

During the sessions for Mitchell, the experimenter placed the reinforcer (bag of items) on a table near Mitchell. The experimenter stated ‘If you work on these parts for 3 minutes, you can have your bag of toys for 1 minute’. A similar procedure was followed for Juan. The toy drum was placed nearby, and the experimenter said ‘If you work on the letters and numbers for 5 minutes, you can play with the drum for 1 minute’.

Because the schedules for Edgar and Hilda were matched to those in the disequilibrium sessions, the general procedures were the same for teacher contingency sessions. The exception was the reinforcer named in the contingency.

RESULTS

Results of the initial baseline sessions were described earlier, and will not be repeated. Results of the DS and TC conditions, as well as the follow-up baseline for Jack and Felicia, will be described here. For economy of space, only the percentage of access to instrumental task with manipulation will be presented in text and graph forms, as it is the dependent variable most relevant to classroom applications.

Percentage of access to instrumental task with manipulation for Jack is displayed in Figure 1, which indicates gradual increases in manipulation for the DS condition, and a significant increase for the TC condition upon the second session. The DS condition provided slightly higher levels over the last five sessions, ending with over 90% manipulation in the last two sessions. Significant variability is evident in the follow-up baseline, in which the percentages of manipulation for the three sessions were 22, 19, and 76, all higher than the 0% observed in baseline. Mean percentages for manipulation were as follows: initial baseline 0%, DS schedule 83%, teacher contingency 75%, and follow-up baseline 39%.

Figure 2 presents the percentage of access to instrumental response with manipulation for Felicia. The first session of the DS schedule produced 100% manipulation, which was repeated in all but the last session, in which she engaged in cutting 96% of access time. The TC condition produced lower, less stable rates. Variability in manipulation is evident in the follow-up, with session percentages of
18, 0, and 10. Mean percentages of manipulation during access were as follows: initial baseline (1%), DS schedule (99%), teacher contingency (82%), and follow-up baseline (9%).

Percentage of access to the instrumental task with manipulation for Mitchell is presented in Figure 3. Manipulation increased gradually during the first three sessions of the DS condition, reaching and stabilizing at 100% on session 4. In contrast, manipulation under the teacher contingency condition began at 100%, dipped to 80% on the second session, and then rose again before plummeting during the sixth and seventh sessions.

Felicia

Figure 2. Felicia. Percentage of access to instrumental task with manipulation for baseline, disequilibrium schedule, teacher contingency, and follow-up baseline conditions.
The variability in performance under the two conditions is less evident in the mean percentages, which were as follows: baseline 20%, DS schedule 77%, and TC 81%.

Percentage of access to instrumental task with manipulation for Juan is depicted in Figure 4. As is evident, neither condition produced high or stable responding. The teacher-contingency condition produced 100% manipulation on the first session, but declined to 55% on the second. The third and fourth sessions appear more stable at 70 and 76%; however, the percentage dropped to 0, then rose to 98 for the fifth and sixth sessions.

Figure 4. Juan. Percentage of access to instrumental task with manipulation for baseline, disequilibrium schedule, and teacher contingency conditions.
sessions, respectively. The DS condition produced only one (the initial) session over 30% manipulation, with a declining trend evident over the remaining four sessions. The study was stopped after the sixth DS session due to the relative lack of progress. Mean percentages of access with manipulation for baseline and experimental phases were baseline 4%, disequilibrium schedule 18%, and teacher contingency 67%.

Percentage of access to instrumental task with manipulation will be presented for Edgar and Hilda in two figures, one each for the high- and low-probability disequilibrium schedule conditions. Percentage of access with manipulation for Edgar under the DS: High condition is presented in Figure 5. Percentage of manipulation under the DS: Low condition is depicted in Figure 6. Both figures indicate high percentages of manipulation under both disequilibrium schedules (high and low) and slightly lower manipulation under teacher contingency conditions. Figure 6 shows relatively less variability between the DS and TC conditions. Means for percentage of access with manipulation to the higher probability task of filing for Edgar were as follows: baseline 64%, DS: Low 99%, TC: Low 98%. Percentages for the second task, tracing, were as follows: baseline 36%, DS: High 98%, and TC: High 95%. Note that filing could only be used in the DS: Low condition because it was the higher probability task and was therefore the instrumental task when the lower-probability task of tracing was used as the contingent response (the DS: Low condition). Figure 7 presents the percentage of access to instrumental response with manipulation under the DS: High condition for Hilda. Most notable is the decline in manipulation for both conditions in the last three sessions, following relatively high,

Figure 5. Edgar: DS: High. Percentage access to instrumental task with manipulation for baseline, disequilibrium schedule (high-probability task as reinforcer), and teacher contingency: matched schedule.
stable responding under both conditions. Figure 8 depicts percentage of manipulation when the lower-probability task served as the contingent task (DS: Low condition). Most notable in this figure is the decline in manipulation in the fourth session of the DS: Low condition. No steep decline in the final sessions, such as that observed in the prior figure, is present in Figure 8. Means for access with manipulation for the high-probability task of filing were as follows: baseline 57%, DS: Low 96%, and TC: Low

---

**Edgar**

**Figure 6.** Edgar: DS: Low. Percentage access to instrumental task with manipulation for baseline, disequilibrium schedule (low-probability task as reinforcer), and teacher contingency: matched schedule.

**Hilda**

**Figure 7.** Hilda: DS: High. Percentage access to instrumental task with manipulation for baseline, disequilibrium schedule (high-probability task as reinforcer), and teacher contingency: matched schedule.
98%. Means for the lower-probability task of cutting were as follows: baseline 38%, DS: High 93%, and TC: High 95%.

**DISCUSSION**

Research questions for the present study were as follows: (i) will disequilibrium schedules (DS) produce reinforcement effects when the two responses (tasks) are moderate to low preference for the student, (ii) how will the effects of disequilibrium schedules (DS) compare with those of a teacher-generated contingency and reinforcers, and (iii) what effects will disequilibrium schedules (DS) have on subjects who spend more than one-third of the baseline period in non-task responding? These questions were pursued because they address typical classroom contexts and problems.

Results for all subjects except Juan suggest that contingencies can be arranged for two tasks of moderate to low preference to produce reinforcing effects. For four subjects, the percentage of access with manipulation was above 80% for the last several sessions. The apparent effectiveness of the DS with tasks that are not generally preferred increases the social validity of DS schedules in classroom settings, where providing tangible reinforcers (e.g. candy, tokens) can be disruptive. Furthermore, DS schedules involving two tasks can involve 100% instructional time, while contingencies, which involve non-instructional materials, cannot claim this
advantage. The DS was only initially effective with Juan, who had spent 70% of his baseline engaged in other movement. Interpreting results for Juan is complicated by use of a teacher-mediated task (discriminating letters/number) as the instrumental task. Perhaps the low levels of manipulation could have been attributed to or maintained by social or task escape.

The relative effectiveness of the teacher contingencies was somewhat surprising, and may defy satisfactory explanation. The teacher contingencies were slightly less effective for Jack and Felicia, while those for Edgar and Hilda produced percentages of access with manipulation similar to those for the disequilibrium schedules. For Mitchell, the mean percentages of manipulation for the TC (81%) and DS (77%) were similar, although an inverse pattern was evidenced as percentages for DS increased in the last four sessions. Results for Juan indicated that the TC was significantly more effective than the DS. Any relationship between the levels of other movement present in baselines, particularly for Juan, and the variability in manipulation under both conditions cannot be determined. We included participants with higher levels of other movement during baseline to further address the issue of substitutability demonstrated by Aeschelman and Williams (1989). Results suggest that the amount of other movement may be critical for successful use of disequilibrium schedules, and future studies might focus on the function of non-task responding (other movement) during baselines. For example, other movement may be maintained by modulations in sensory stimulation, or by escape from specific tasks. Implications for other movement maintained by sensory modulation may be that DS schedules are less effective, or that actual schedules must be calculated differently.

Results for Edgar indicated high percentages of manipulation under both the DS and TC conditions. Interestingly, manipulation was slightly higher and more stable when the lower-probability task was used as the reinforcer, a clear demonstration of reversibility. The role of the matched schedule could only be discerned if the reinforcer (e.g. looking at books) had been presented on different schedules. Future research might investigate whether disequilibrium schedules are more efficacious for moderate- to low-probability responses, while effectiveness of high-probability responses is less dependent on a ratio based on baseline measures.

The declines in manipulation in the last three sessions for Hilda, and the last four sessions for Juan, may suggest a need to repeat baseline procedures and compute new ratios and disequilibrium schedules within the course of an intervention. The follow-up baselines for Jack and Felicia did indicate changes in allocation of responding to the instrumental task. Future research might investigate possible benefits of periodically returning to baseline and recalculating DS schedules within an extended intervention. If we interpret allocation to a task as preference for that task, then the disequilibrium model may have implications for influencing preferences of students during free time.
Several features of the present study limit interpretation of the results. Effects of the teacher contingency could be attributed to either (i) the reinforcer chosen, or (ii) the contingency. The experimenters did not influence these selections, believing that the teachers possessed knowledge to produce a typical classroom intervention. Results suggest that the teachers chose functional reinforcers, and set successful contingencies. Although the teachers were instructed not to use the tasks in the study at other times during the day, we cannot determine the extent of deprivation for the tasks chosen by the teacher. We can say with certainty that the reinforcers chosen for Felicia (school forms) and Mitchell (bag of toys) were not appropriate for use in an educational setting.

The extent to which the present study can be considered an extension of previous research on disequilibrium schedules may be somewhat limited due to procedural differences. In prior studies by Konarski and colleagues, a baseline period in which each task alone was available was used to establish baseline levels for each task. When these levels changed during disequilibrium schedules, the change was attributed to the schedule, and not simply to response restriction caused by the contingency. That is, increases in the instrumental response could be compared with levels for that response during the baseline when only that task was available. Farmer-Dougan (1998) did not employ the single-task baseline in her study, and we elected not to conduct the single-task baseline in the present study. Our rationale was that the disequilibrium schedules, based on the baseline ratios, were evidence of the effects of the disequilibrium model. We cannot be certain that the high levels of manipulation during the disequilibrium schedules were not a product of simple response restriction; when the contingent task was removed, the student allocated more time to the available task. While this is certainly a plausible explanation, it should not be a foregone conclusion because the students could have engaged in another response option—other movement—at any time. We chose the dependent variable of access to the instrumental task with manipulation because we were interested in knowing how much time was spent in other movement when the instrumental task was available. In the present study, subjects were informed of the contingency, and even though the severity of their disabilities no doubt limited their comprehension, they may have been prompted to engage whatever materials were present. This procedure may prevent attribution of the increased manipulation entirely to the disequilibrium schedule; however, it is more representative of typical classroom instruction and resembles the procedures used by Farmer-Dougan (1998).

REFERENCES


