JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1982, 15, 205-216 NUMBER 2 (SUMMER 1982)

# *RITALIN VS. RESPONSE COST IN THE CONTROL OF HYPERACTIVE CHILDREN: A WITHIN-SUBJECT COMPARISON*

MARK D. RAPPORT, H. ALLEN MURPHY, AND JON S. BAILEY

FLORIDA STATE UNIVERSITY

A within-subject comparison was made of the effects of methylphenidate (Ritalin) and response cost in reducing the off-task behavior of two boys, 7 and 8 years of age, who had been diagnosed as having an attentional deficit disorder with hyperactivity. Several dosages of Ritalin (5 to 20 mg/day) were evaluated with the results indicating varying effects of the drug for both children. Response cost (with free-time as the reinforcer) was superior to Ritalin in raising levels of on-task behavior and in improving academic performance.

DESCRIPTORS: hyperactivity, response cost, medication, Ritalin

Attentional deficit disorder with hyperactivity is a well-publicized and controversial childhood problem. Recent estimates have placed the incidence rate at 1.19% of the elementary school population with relatively constant rates observed across grade levels (Lambert, Sandoval, & Sassone, 1978). These children are particularly noted for their impulsivity, attentional problems, and poor classroom performance.

By far, the most common treatment of hyperactivity is the prescription of medication, usually methylphenidate (Ritalin). However, for a variety of reasons (cf. O'Leary, 1980) there has been an increased interest in providing psychological alternatives to drug therapy (Pelham, Schnedler, Bologna, & Contreras, 1980).

The authors acknowledge the valuable assistance of Mrs. Susan Holiday, master teacher at Sabal Palm Elementary School, Tallahassee, Florida. Technical assistance and advice regarding the apparatus used in the experiment was provided by Ross Henderson, electronical engineer in the Psychology Department at Florida State University. Mark Shamis provided valuable assistance to this study by prescribing and monitoring the children's drug dosages. Sincere appreciation is extended to Alan E. Kazdin, Steve Breuning, and Rolf Jacob, for providing valuable assistance in preparing this manuscript. Reprints may be obtained from the senior author who is now at The University of Rhode Island, Department of Psychology, Kingston, Rhode Island 02881.

Several previous studies have compared the effectiveness of behavioral and medication tactics. The behavioral interventions which have been used fall into two broad categories. First, "behavior therapy" (Gittelman, Abikoff, Pollack, Klein, Katz, & Mattes, 1980; Gittelman-Klein, Klein, Abikoff, Katz, Gloisten, & Kates, 1976; Loney, Weissenburger, Woolson, & Lichty, 1979; O'Leary, Pelham, Rosenbaum, & Price, 1976; Pelham et al., 1980) which consists of an initial training of teachers in behavior management techniques followed by (often weekly) consultation sessions. Second, "direct contingency management" which relies on immediate point reinforcement for appropriate behavior (Ayllon, Layman, & Kandel, 1975; Christensen, 1975; Wulbert & Dries, 1977), point reduction for inappropriate behavior (Rapport, Murphy, & Bailey, 1980), or continuous teacher attention (Shafto & Sulzbacher, 1977).

With the exception of O'Leary et al. (1976) the behavior therapy approach has been less effective than medication. On the other hand, each of the direct contingency management tactics has equaled or surpassed the effects of drug therapy. The disparity of these results can be accounted for in at least three ways. First, it could be that the types of dependent variables measured by researchers using different strategies are differ-

entially affected by behavioral tactics and medication. Traditionally, studies using behavior therapy have relied heavily on teacher ratings with less emphasis on direct observation compared to the contingency management procedures. Second, none of the contingency management programs has been compared to titrated dosages of medication. Conversely, titration has been used by Gittelman-Klein, Klein, Abikoff, Gloisten, & Kates (1976), Loney et al. (1979), and Gittelman et al. (1980), all of whom found greater effects from drugs than behavior therapy. Third, it may be that direct contingency management is a more powerful treatment than traditional behavior therapy, as others have found that reinforcers must provide sufficient cues to direct the child's attention toward specific task demands (Cohen, 1970; Parry, 1973). The partial reinforcement schedules typically used in behavior therapy protocols are usually not sufficient to control hyperactive children's behaviors (Parry, 1973).

The obvious shortcomings of contingency management interventions have been often unrealistic time requirements, high adult-child ratios, and extensive teacher training. While newer psychostimulants have been developed (e.g., pemoline), virtually no applications of alternatives to standard reinforcement programs have been forthcoming with hyperactive children.

Response cost may be a viable alternative to standard reinforcement procedures for several reasons. First, its effectiveness in treating disruptive children in classroom settings is well established (e.g., Hundert, 1976). Second, response cost has been found to be more effective than either neuroleptic medication (Breuning, O'Neill, & Ferguson, 1980) or positive reinforcement (Worland, 1976). Third, undesirable side effects frequently associated with aversive procedures are not typically reported with response cost (Kaufman & O'Leary, 1972). Although response cost appears to hold promise for treating hyperactive children, a direct comparison of response cost and psychostimulant medication with hyperactive children in classroom settings has not been made thus far.

There were several purposes of the present study: (a) to develop a practical, easily used, alternative behavioral intervention to standard reinforcement regimens for classroom use with hyperactive children; (b) to systematically evaluate and compare response cost intervention and titrated methylphenidate medication with baseline performance levels using a variety of dependent measures; and (c) to assess whether a functional relationship may be obtained for different target behaviors using titrated mg/day doses of stimulant medication in a classroom setting.

## METHOD

### *Participants and Setting*

Two hyperactive boys between the ages of 7 and 8 years participated in the study. They were given pseudonyms, Brian and Mitch, to protect their identities. They were independently diagnosed as "hyperactive" by a physician and psychologist using DSM III (American Psychiatric Association, 1980) criteria for Attentional Deficit Disorder with Hyperactivity. Additional criteria were (a) teacher ratings on the Abbreviated Conners Teacher Rating Scale (ACTRS) above 15 (see Werry, Sprague, & Cohen, 1975); (b) no history of taking medication for hyperactivity; and (c) observed school behavior including low rates of academic completion, short attention span, disruptive behavior, impulsivity, and rates of on-task behavior below 60% when engaged in academic seat work. The children were of average intelligence and low to middle socioeconomic status. The study was carried out during two consecutive school years in a normal, second-grade classroom with one primary teacher present.

### *Apparatus*

The apparatus used in the experiment for Brian consisted of two wooden stands with numbered cards attached to each. The cards for both

stands were made from poster board, numbered in a descending order from 20 to 0, and could be flipped down individually by the teacher and student.

The above apparatus was refined for Mitch in an effort to develop an easier to use response cost delivery system. The apparatus consisted of a battery-operated, electronic counter with a small digital display which was preset at zero prior to each experimental session. The digital display automatically increased by one number each minute when operative (FI: 1 min). The teacher used a hand-held apparatus to reduce Mitch's digital display by one number and illuminate a red light on the counter for 15 sec; signaling that Mitch had been off task and consequently lost one point. Thus, points could be both earned and lost, depending on the boy's behavior.

*Assessment*

The boys were observed twice daily for 20-min periods. The first period began at 9:00 a.m. and the second at 9:40 a.m. During each observation period, the class completed in-seat academic work assigned by the teacher. Brian and Mitch were observed by graduate psychology students for 80 intervals during each observation period throughout the study. Each interval was divided into 10 sec of observation followed by 5 sec for recording. Observers were blind to both when medication was administered and specific dosage levels, but not to response cost procedures.

*Teacher ratings.* Each Friday the classroom teacher completed the Abbreviated Conners Teacher Rating Scale (Conners, 1973) on both the experimental children and two control children, which reflected the children's behavior for that week. The ACTRS has been demonstrated to be sensitive to the effects of both behavior therapy and medication (O'Leary et al., 1976; O'Leary & Pelham, 1978; Sleator & von Neumann, 1974) in addition to correlating with classroom behavior observations (Bolstad & Johnson, 1977).

*Child behavior.* The child's behavior was categorized as either on task or off task in a manner similar to that used by Iwata and Bailey (1974) and Rapport et al. (1980). Off-task behavior was defined as visual nonattention to one's materials for more than 2 sec within the 10-sec recording interval, unless the student was talking to the teacher, had his hand raised above his head, or was adjusting/glancing at his response cost apparatus.

*Academic Measures*

*Phonics.* The phonics materials consisted of the *Scott Foresman Basics in Reading: Daisy Days Series* (1978) and accompanying activities. There were typically between 30 and 50 problems in each series depending on the level of difficulty and one series was assigned daily. The child's paper was graded after class by the teacher and correct responses taken from the accompanying teacher's manual. Daily performance was recorded for both the percentage of problems completed and the percent correct.

*Arithmetic.* Arithmetic materials consisted of the *Holt School Mathematics Series* (1974), which was composed of arithmetic work problems dealing with basic addition, subtraction, and word problems. Depending upon the level of difficulty, 60 to 100 problems were assigned daily. The child's paper was scored similarly to the phonics assignment, i.e., daily percent completed and correct.

*Reliability.* Reliability checks of child behavior were taken on 39% and 28% of the days for Brian and Mitch, respectively. Obtained and chance estimates (Hopkins & Hermann, 1977; Johnson & Bolstad, 1973) were computed for occurrence, nonoccurrence, and overall agreement (Bijou, Peterson, & Ault, 1968). (Obtained and chance estimates computed for occurrence, nonoccurrence, and overall agreement may be obtained from the senior author.) Overall reliability was consistently over 88%, with a mean of 96% for both children.

Reliability of academic measures were com-

pleted on 40 (48%) and 48 (42%) of the occasions for Brian and Mitch, respectively. Checks were made by the first observer and consisted of scoring the academic assignments independently of the teacher. Agreement was defined as agreement on the number of problems completed and performance accuracy. Reliability was computed by dividing agreement between observer and teacher by agreement plus disagreement and multiplying by 100 to calculate the percentage. Observer-teacher agreement on problems completed ranged from 91% to 100% (mean = 99.8%) and 98% to 100% (mean = 99.9%) for Brian and Mitch, respectively. Agreement on performance accuracy was consistently 100% for both children across experimental conditions.

*General Procedure*

Each morning, the teacher wrote the two academic assignments on the chalkboard and delivered specific instructions regarding their content and requirements for completion. The class worked on the assignments for a 1-hr period, divided into three 20-min intervals. Each child spent one of these intervals in a small, teacher-held math group, while the remainder of the class worked independently on their academic assignments. No data were recorded when the children were in their respective math groups.

*Experimental Procedures*

An ABACBC within-subjects design was used to compare the effects of methylphenidate and response cost on the children's on-task behavior, academic completion rate, academic accuracy, and social behavior.

*Baseline I.* During this condition the child's on-task behavior, academic performance, and academic assignment accuracy were recorded for a period of several days to reflect preintervention levels of behavior.

*Medication I.* In this condition the parents gave the boy a dosage of methylphenidate each morning, according to the prescribed dosage schedule outlined by White (1977), i.e., 5-mg increments each week until symptomatic improvement was noticeable and responding stable. A placebo condition was not included because it was considered clinically unadvisable due to the severity of the children's behavior. In an effort to control for possible expectation effects, parents told their child that he would be taking vitamin pills periodically to keep from catching a cold. The parents were aware their children were taking stimulant medication but were not aware of the specific dosages. Brian's medication periods included dosages of 5 mg/day (.22 mg/kg), 10 mg/day (.44 mg/kg), and 15 mg/day (.63 mg/kg), lasting for a total of 31 days. Further increments were not administered due to the occurrence of head jerks. Mitch was given 5 mg/day (.23 mg/kg), 10 mg/day (.46 mg/kg), 15 mg/day (.64 mg/kg), and 20 mg/day (.92 mg/kg) during his medication trials, which lasted 50 days. All medication changes (e.g., switching from 5 mg/day to 10 mg/day, or to response cost) took place over weekends to ensure adequate adjustment. The teacher involved in the study was blind to both when medication was administered and specific dosage levels.

*Baseline II.* The second baseline phase began on a Monday morning (medication was terminated on the preceding Friday) to allow wash-out of the medication over the weekend. The wash-out period was consistent with the 3- to 4-hr half-life of methylphenidate following oral ingestion. This phase was otherwise identical to Baseline I and lasted a total of 6 and 8 days for the phonics assignment, and 12 days for the arithmetic assignment for Brian and Mitch, respectively.

*Response cost I.* The response cost program was initiated on days 44 and 73 in the phonics assignment, and lasted for 17 and 13 consecutive days for Brian and Mitch, respectively. On days 50 (Brian) and 77 (Mitch), the response cost procedure was additionally implemented in the arithmetic assignment, and lasted for 11 and 9 days, respectively. During this condition, the child completed assignments at his desk while

the teacher conducted her small groups. Both the teacher and the child had their cost apparatus adjacent to them. The child was told that he could earn up to 20 min of free time for working hard during each academic period in which the cost apparatus was used. If the child was not working on his assignments, the teacher would flip a card down (Brian) or activate her apparatus (Mitch) and 1 min of the child's free time would be lost. Brian was instructed to look at the teacher's apparatus and the number showing occasionally, then to match his apparatus card accordingly. Mitch's apparatus automatically deducted 1 min of free time when the teacher activated it and illuminated a red light to signal him that he had been off task. The amount of free time earned each day was equal to the number on the apparatus showing at the end of the assignment period and was provided approximately 1 hr later.

*Medication II.* During this condition, the methylphenidate dosage determined most effective in the previous medication trials was administered daily. This decision was made jointly by the attending physician and senior investigator and was based upon the dependent measures obtained. The 15 mg qAM dosage was judged optimal for both children due to the observed rates of on-task behavior, high academic completion percentages, and teacher ratings. This phase was otherwise identical to the Medication I condition.

*Response cost II.* Following a medication-free weekend for wash-out purposes, the response cost intervention was simultaneously implemented in the phonics and arithmetic assignments on days 71 and 96, and lasted 12 and 19 days for Brian and Mitch, respectively.

## RESULTS

The effects of each intervention were evaluated on the percentage of intervals of on-task behavior, problems completed, and problems completed correctly.

### *Child Behavior*

As depicted in Figures 1 and 2, prior to any intervention both children were generally attentive for less than half the scored intervals with high variability observed across days. Upon introduction of the 5 mg/day dose of Ritalin, the percentage of intervals scored as on-task increased appreciably for both children, but remained highly variable. Increasing the dosage to 10 mg/day resulted in no significant improvement of on-task performance for Brian and a slight increase for Mitch. A daily Ritalin dosage of 15 mg/day was administered on days 21 and 44 for Brian and Mitch, respectively. Brian's on-task behavior during the phonics assignment increased slightly with no appreciable change noted in mathematics. Mitch's mean on-task behavior during this condition was essentially unchanged from the previous medication condition; however, daily variability was restricted to a moderate degree. Medication was increased to 20 mg/day Ritalin on days 55 through 64 with reduced variability and no change in mean on-task behavior noted. The datum indicated as "probe" in this condition represents a day in which Brian's parents forgot to administer the morning medication. It is interesting to note that his on-task behavior dropped abruptly on this day. During the no-treatment reversal phase, both children's on-task behavior decreased to near original baseline levels.

Introduction of the response cost program on days 44 and 73 in phonics and days 50 and 77 in math, for Brian and Mitch, respectively, resulted in a high percentage of attentiveness for both children across academic assignments areas. The multiple baseline lag on days 44 through 49, and 73 through 76 in Figures 1 and 2 respectively, demonstrates a strong causal relationship between the implementation of the response cost system and the students' increase in attending behavior. Additionally, it allows two direct comparisons to be made between baseline and response cost conditions.

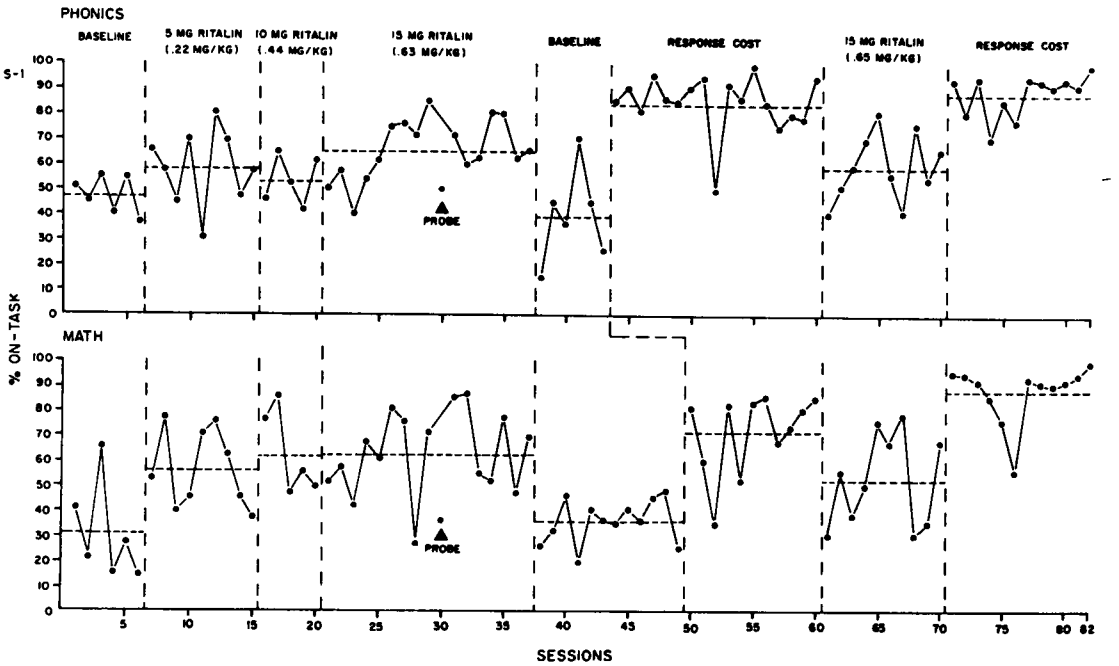


Fig. 1. Mean percentage of intervals of daily on-task behavior for Brian. Individual means for each condition are indicated by dashed lines. The datum indicated as "probe" represents a no-medication day and was not computed in the mean.

A daily Ritalin dosage of 15 mg was reintroduced on days 61 and 86 for Brian and Mitch, respectively, and resulted in a rate of attending behavior similar to the previous 15 mg/day condition. On day 89, Mitch's parents were instructed to forego medication administration (designated "probe" in Figure 2), which resulted in a dramatic decrease in on-task behavior. Neither of the data indicated "probe" was included in arriving at the 15-mg condition means shown as dashed lines.

The response cost program was reinstituted on

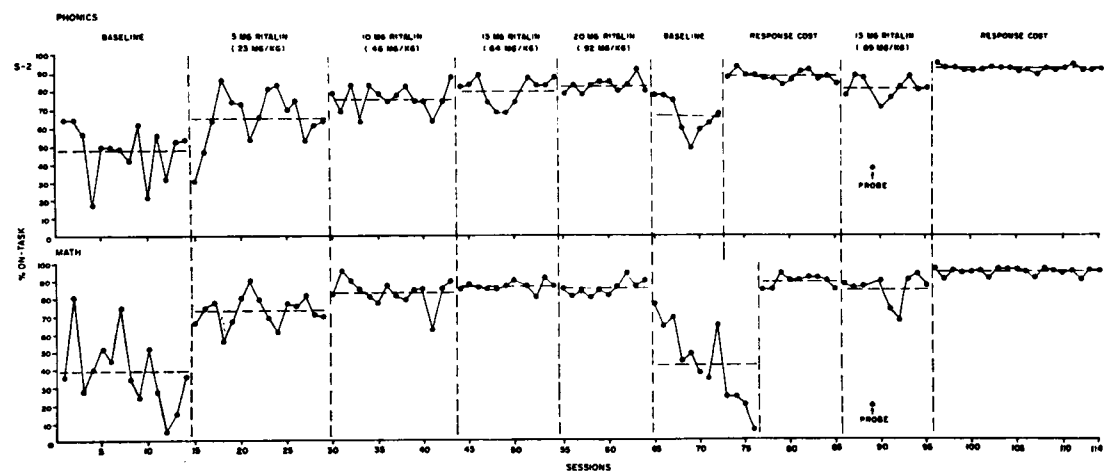


Fig. 2. Mean percentage of intervals of daily on-task behavior for Mitch. Individual means for each condition are indicated by dashed lines. The datum indicated as "probe" represents a no-medication day and was not computed in the mean.

days 71 (Brian) and 96 (Mitch) and resulted in unprecedented levels of on-task behavior observed. Variability in the children's daily responding was also noticeably reduced across academic areas. The BCB portion of the experimental design, comparing response cost to medication (Ritalin), demonstrates that both interventions were effective in increasing the on-task behavior of hyperactive children, with response cost resulting in higher rates in the two children.

### *Academic Assignment Completion and Accuracy*

Figures 3 and 4 show the percentage of problems completed for each of the two morning academic assignments for Brian and Mitch, respectively. These graphs show that both children were completing 60% or less of their daily assignments on the average, with high variability across days observed. Introduction of the 5 mg/day Ritalin condition resulted in marked increases in the numbers of problems completed by both children, most notably in the mathematics assignment. The 10 mg/day Ritalin condition was initiated on days 16 (Brian) and 30 (Mitch), with a resultant increase in Mitch's phonics completion rate. Introduction of the 15 mg/day dosage continued to result in higher rates of responding in Mitch's math assignment but did not appreciably affect his phonics performance. Brian's phonics performance remained unchanged from the previous condition with lower performance levels observed in mathematics. Medication was not administered on the day marked "probe" in Figure 3, with a resultant decrease in math performance observed.

The 20 mg/day Ritalin condition was in effect on days 55 through 64 for Mitch, with a resultant decrease in the percentage of problems completed in both phonics and math. This effect is remarkable, given the high rate of on-task behavior under the 20 mg/day Ritalin condition observed in Figure 2. It appears that being "on task" does not guarantee high academic assignment completion rates.

A return to baseline conditions on days 38 (Brian) and 65 (Mitch) resulted in assignment completion rates similar to those obtained in

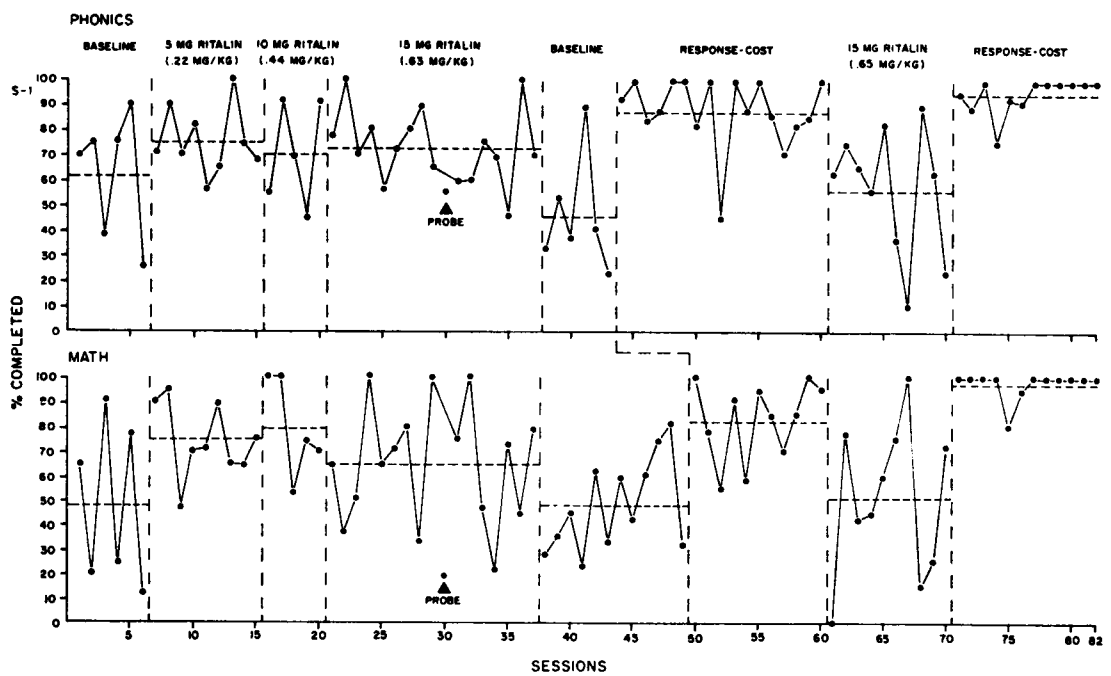


Fig. 3. Mean percentage of Brian's daily problems completed for each of the two morning assignments. Individual means for each condition are indicated by dashed lines.

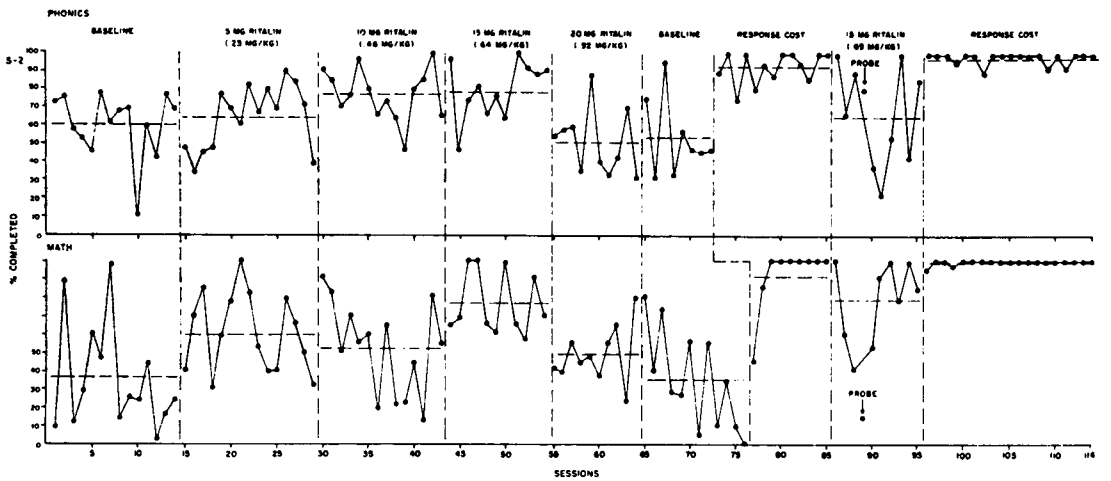


Fig. 4. Mean percentage of Mitch's daily problems completed for each of the two morning assignments. Individual means for each condition are indicated by dashed lines.

Baseline I. Overall, the ABA portion of the experimental design, contrasting medication with baseline performance levels, demonstrates that Ritalin may positively affect the assignment completion rates of hyperactive children. Further, there appears to be a U-shaped dose-response curve with higher dosages (i.e., 20 mg/day) resulting in deteriorated responding.

The response cost program was implemented on days 44 and 50 in Brian's phonics and math assignments, respectively, and resulted in unprecedented levels of academic performance. A similar result was observed in Mitch's academic performance, with the percentage of assignments completed increasing appreciably in both academic areas. Reintroduction of the 15 mg/day Ritalin condition resulted in decreased rates of responding for both children across academic areas. As reported earlier, the "probe" indicated in Figure 4 represents a no-medication day and was not used in computing the mean in this condition. It is interesting to note that Mitch's performance was inconsistent on this day across variables, remaining relatively stable in phonics, yet dramatically decreasing in mathematics. Response cost was reimplemented on days 71 (Brian) and 96 (Mitch) and resulted in high academic completion rates and reduced variability across days. The CBC portion of the experimental design, comparing response cost to medication (methylphenidate), demonstrates that both interventions produce positive changes in academic completion rates, with the response cost program resulting in higher and more stable responding.

Academic accuracy was also assessed for both children across experimental conditions with no appreciable changes observed. (Individual graphs illustrating each boy's academic accuracy across experimental conditions may be obtain from the senior author.) Given the increased assignment completion rates observed in both children, it is noteworthy that both maintained rates of accuracy averaging well above 80%.

### *Teacher-Rated Improvement*

The ACTRS scores for Brian, Mitch, and two control children are illustrated in Figure 5. This graph allows comparisons to be made regarding the differential effectiveness of medication and response cost interventions as viewed by the classroom teacher. Control children were selected by the teacher prior to the experiment and represented "normal" children without inherent learning or behavior problems. The 15 mg/day Ritalin and response cost conditions appear to be the most effective in reducing teacher-viewed hyperactivity and concomitantly approaching normality in these children.

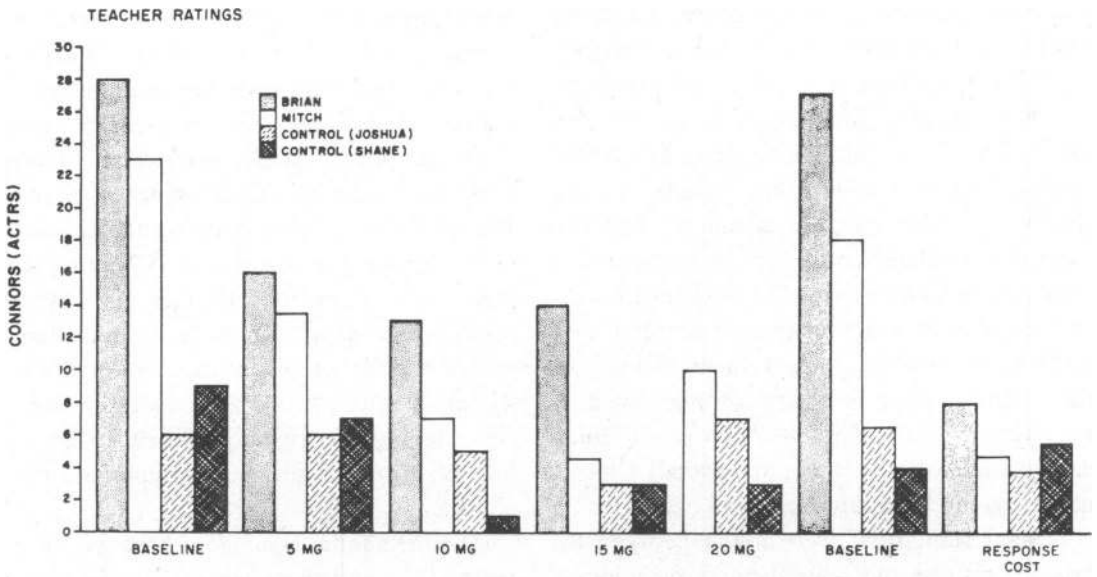


Fig. 5. The Abbreviated Conners Teacher Rating Scale (ACTRS) scores for Brian, Mitch, and two classroom control children across experimental conditions. Lower scores represent improvement in the child's behavior.

## DISCUSSION

The results indicated that both the response cost and psychostimulant medication (methylphenidate) interventions were effective in increasing on-task behavior and academic performance in children diagnosed as having attentional deficit disorder with hyperactivity. The effect of individually titrated dosages of Ritalin was contrasted with response cost to determine the relative efficacy of each. The greatest improvement in on-task behavior and academic performance for both children occurred during response cost.

The greater success of the response cost program in the present investigation may be attributed to several factors. First, a necessary condition of successful contingency management programs has been to direct the child's attention toward specific tasks using immediate positive or negative consequences. Although positive reinforcement is more desirable, its continuous application may actually distract a child from ongoing task demands by pushing him above optimal arousal levels (Firestone & Douglas, 1975). Mild, negative feedback coupled with reinforcement (i.e., response cost) may be a reasonable alternative and has been shown to help hyperactive children modulate their responding in laboratory tasks (Firestone & Douglas, 1975). Second, there was relatively little delay between a child's off-task behavior and teacher-produced consequences; an important consideration given the impulsivity of these children. Previous studies have generally required the teacher to walk across the room to provide reinforcement for on-task behavior, necessitating an undue time lag between behavior and consequences. Finally, behavior therapy programs may be viewed as less effective and burdensome by teachers due to their excessive time demands and impracticality (Loney et al., 1979). The response cost procedure, however, required only brief teacher training (i.e., approximately 15 min plus two feedback sessions) and limited time involvement while operative (i.e., the teacher didn't have to walk across the classroom to check a card or provide verbal praise).

Teacher ratings suggested that response cost was an effective intervention for improving the classroom behavior of hyperactive children and normalized them to an appreciable degree. Ques-

tionnaires administered at the conclusion of the study indicated that both the teacher and students viewed the response cost procedure positively.

The 15 mg/day Ritalin dosage was the optimal dose for both children, resulting in levels of on-task behavior and academic completion rates clearly exceeding baseline measures. This is a surprising result given the findings reported by Barkley and Cunningham (1978) whose review of the literature reported little if any improvement in the academic achievement of hyperactive children while receiving stimulant medication. However, the difference between a child's daily academic performance and overall achievement may not be highly correlated.

Several similarities were found between the present results and past laboratory findings, providing external validity (albeit limited) to the latter. For example, Sprague and Sleator (1977) found that hyperactive children performed better on a short-term memory task under low dosages (.30 mg/kg Ritalin) and experienced deterioration in learning under high dosages (1.0 mg/kg) of stimulant medication, i.e., U-shaped dose-response curve. The present results extend these finding in that academic performance continued to improve with Ritalin dosages up to approximately .65 mg/kg for both children. Walker (1980) reported a similar finding with hyperactive children on repeated acquisition tasks. The children performed maximally at .70 mg/kg vs. .30 mg/kg of methylphenidate. There are two possible reasons for the differences between the present findings and Walker's (1980) findings vs. those reported by Sprague and Sleator (1977). First, Sprague and Sleator's dose-response curves were plotted between placebo, .30 mg/kg, and 1.0 mg/kg Ritalin, with no intermediate dosages administered. Had intermediate dosages been administered (e.g., 70 mg/kg) their performance curves may have been extended. Second, they used laboratory tasks that may have been more sensitive to drug dose changes, i.e., laboratory tasks under highly controlled conditions will presumably be more sensitive to subtle medication changes than will classroom measures. Thus, it may be that some hyperactive children will continue to improve with Ritalin dosages falling between these levels (i.e., .30 and 1.0 mg/kg).

In the present study, deteriorated academic completion rates were observed at the .92 mg/kg Ritalin dosage level, supporting the conclusions drawn by Sprague and Sleator (1977) regarding high (i.e., 1.0 mg/kg) dosages and associated performance deterioration. It appears that the optimum dosage level for these children may be slightly higher that those previously reported (i.e., .30 mg/kg), with performance deterioration occurring as the dosages approximate 1.0 mg/kg.

Another similar conclusion between the present findings and those reported by Sprague and Sleator (1977) and Walker (1980) is the observation that different target behaviors improve at different dosages. In the present investigation, the child's on-task behavior showed the greatest improvement under the .92 mg/kg Ritalin dosage, approximating the 1.0 mg/kg dosage level reported by Sprague and Sleator. However, the classroom teacher rated the children's social behavior as maximally improved under the 15 mg/day Ritalin condition (i.e., approximately .65 mg/kg) as opposed to the even higher 20 mg/day dose. This may have been due to the teacher's sensitivity to the amount of academic work completed each day and her rating the 20 mg condition accordingly, i.e., the teacher was required to score the child's academic work immediately after class and may have been influenced by the child's decreased assignment completion rate despite the scale's loading on social behavior. This was confirmed by the teacher at the study's conclusion.

Individually titrating medication dosages with hyperactive children is a valuable clinical method and should depend on feedback from a variety of dependent measures, especially given the idiosyncratic behavior of these children under similar medication dosages (Sprague and Sleator, 1975). Drug dosage should represent a balance

between improved social behavior and learning. Without such considerations, erroneous conclusions may be drawn regarding treatment efficacy.

A placebo control condition would have been desirable and was planned at the inception of the study. As noted earlier, however, it was not clinically desirable, which may be a frequent problem when working in naturalistic settings. The present study presents a practical alternative to control for possible expectation effects when placebo administration is undesirable or not possible. The results suggest that the "vitamin control" was effective in limiting expectation effects in several ways. First, on task and academic completion rates improved gradually in both children across days, whereas little if any improvement is typically observed on ratings of specific behaviors or global estimates with placebo treatment (Gittelman-Klein, Klein, Katz, Saraf, & Pollak, 1976; Henker, Whalen, & Collins, 1979). Second, both children showed deteriorated responding at higher stimulant doses, a finding consistent with the responder hypothesis. Third, follow-up student questionnaires indicated that both children believed they were taking "vitamin pills" for cold prevention vs. medication to help their behavior.

The inclusion of a response cost plus medication condition was not included in the present investigation due to time constraints. This type of comparison has been lacking in the field thus far and our future research will address such issues.

Caution should be used in generalizing from the present results to hyperactive children in general. Although precise measurement was used, only two children were studied. Further, a specialized response cost apparatus was used with both children. Studies using dissimilar delivery systems may not obtain identical results.

The response cost intervention may be used in conjunction with or instead of psychostimulant medication. Clearly, medication is easier to administer and does not require the extra effort that contingency management interventions do. Equally clear, however, is the fact that medicated children continue to experience academic difficulty (Riddle & Rapoport, 1976; Weiss, Kruger, Danielson, & Elman, 1975) and that many do not respond positively to psychostimulant medication. Thus, effective, easy to use behavioral interventions will continue to be required in the future.

## REFERENCES

American Psychiatric Association. *Diagnostic and Statistical Manual: DSM III* (3rd ed.). Washington, D.C.: American Psychiatric Association, 1980.

Ayllon, T., Layman, D., & Kandel, H. J. A behavioral-educational alternative to drug control of hyperactive children. *Journal of Applied Behavior Analysis,* 1975, **8,** 137-146.

Barkley, R. A., & Cunningham, C. E. Do stimulant drugs improve the academic performance of hyperkinetic children? *Clinical Pediatrics,* 1978, **17,** 85-82.

Bijou, S. W., Peterson, R. F., & Ault, M. H. A method to integrate descriptive and experimental field studies at the level of data and empirical concepts. *Journal of Applied Behavior Analysis,* 1968, **1,** 175-191.

Bolstad, O. D., & Johnson, S. M. The relationship between teachers' assessment of students and the students' actual behavior in the classroom. *Child Development,* 1977, **48,** 570-577.

Breuning, S. E., O'Neill, M. J., & Ferguson, D. G. A comparison of psychotropic drug, response cost, and psychotropic drug plus response cost procedures for controlling institutionalized mentally retarded persons. *Applied Research in Mental Retardation,* 1980, **1,** 253-268.

Christensen, D. E. Effects of combining methylphenidate and a classroom token system in modifying hyperactive behavior. *American Journal of Mental Deficiency,* 1975, **80,** 266-276.

Cohen, N. Psychophysiological concomitants of attention in hyperactive children. (Doctoral dissertation, McGill University, 1970). *Dissertation Abstracts International,* 1970, **32,** 553B.

Conners, C. K. Rating scales for use in drug studies with children. *Psychopharmacology Bulletin,* 1973, 24-84.

Firestone, P., & Douglas, V. I. The effects of reward and punishment on reaction times and autonomic activity in hyperactive and normal children. *Journal of Abnormal Child Psychology,* 1975, **3,** 201-216.

Gittelman, R., Abikoff, H., Pollack, E., Klein, D. F., Katz, S., & Mattes, J. A controlled trial of behavior modification and methylphenidate in hyperactive children. In C. Whalen & B. Henker (Eds.), *Hyperactive children.* New York: Academic Press, 1980.

Gittelman-Klein, R., Klein, D. F., Abikoff, H., Katz, S., Gloisten, A. C., & Kates, W. Relative efficacy of methylphenidate and behavior modification in hyperactive children: An interim report. *Journal of Abnormal Child Psychology,* 1976, **4,** 361-379.

Gittelman-Klein, R., Klein, D. F., Katz, S., Saraf, K., & Pollack, E. Comparative effects of methylphenidate and thioridazine in hyperkinetic children. I. Clinical results. *Archives of General Psychitary,* 1976, **33,** 1217-1231.

Henker, B., Whalen, C. K., & Collins, B. E. Double-blind and triple-blind assessments of medication and placebo responses in hyperactive children. *Journal of Abnormal Child Psychology,* 1979, **7,** 1-13.

Hopkins, B. L., & Hermann, J. A. Evaluating interobserver reliability of interval data. *Journal of Applied Behavior Analysis,* 1977, **10,** 121-126.

Hundert, J. The effectiveness of reinforcement, response cost, and mixed programs on classroom behaviors. *Journal of Applied Behavior Analysis,* 1976, **9,** 107.

Iwata, B. A., & Bailey, J. S. Reward versus cost token systems: An analysis of the effects on student and teacher. *Journal of Applied Behavior Analysis,* 1974, **1,** 567-576.

Johnson, S. M., & Bolstad, O. D. Methodological issues in naturalistic observation: Some problems and solutions for field research. In L. A. Hanerlynch, L. C. Handy, & E. J. Mash (Eds.), *Behavior change: Methodology, concepts, and practice.* Champaign, Ill.: Research Press, 1973.

Kaufman, K. F., & O'Leary, K. D. Reward, cost, and self-evaluation procedures for disruptive adolescents in a psychiatric hospital school. *Journal of Applied Behavior Analysis,* 1972, **5,** 293-309.

Lambert, N. M., Sandoval, J. H., & Sassone, D. M. Prevalence estimates of hyperactivity in school children. *Pediatric Annals,* 1978, **7,** 330-338.

Loney, J., Weissenburger, F., Woolson, R., & Lichty, E. Comparing psychological and pharmacological treatments for hyperkinetic boys and their classmates. *Journal of Abnormal Child Psychology,* 1979, **7,** 133-143.

O'Leary, K. D. Pills or skills for hyperactive children. *Journal of Applied Behavior Analysis,* 1980, **1,** 191-204.

O'Leary, S. G., & Pelham, W. E. Behavior therapy and withdrawal of stimulant medication with hyperactive children. *Pediatrics,* 1978, **61,** 211-217.

O'Leary, K. D., Pelham, W. E., Rosenbaum, A., & Price, G. Behavioral treatment of hyperkinetic children: An experimental evaluation of its usefulness. *Clinical Pediatrics,* 1976, **15,** 511-515.

Parry, P. *The effect of reward on the performance of hyperactive children.* Unpublished doctoral dissertation, McGill University, Montreal, 1973.

Pelham, W. E., Schnedler, R. W., Bologna, N. C., & Contreras, J. A. Behavioral and stimulant treatment of hyperactive children: A therapy study with methylphenidate probes in a within-subject design. *Journal of Applied Behavior Analysis,* 1980, **13,** 221-236.

Rapport, M. D., Murphy, A., & Bailey, J. S. The effects of a response cost treatment tactic on hyperactive children. *Journal of School Psychology,* 1980, **18,** 98-111.

Riddle, K. D., & Rapoport, J. L. A 2-year follow-up of 72 hyperactive boys. Classroom behavior and peer acceptance. *Journal of Nervous and Mental Disease,* 1976, **162,** 126-134.

Shafto, F., & Sulzbacher, S. Comparing treatment tactics with a hyperactive preschool child: Stimulant medication and programmed teacher intervention. *Journal of Applied Behavior Analysis,* 1977, **10,** 13-20.

Sleator, E., & von Neumann, A. Methylphenidate in the treatment of hyperkinetic children. *Clinical Pediatrics,* 1974, **13,** 19-24.

Sprague, R. L., & Sleator, E. K. What is the proper dose of stimulant drugs in children? *International Journal of Mental Health,* 1975, **4,** 75-104.

Sprague, R. L., & Sleator, E. K. Methylphenidate in hyperkinetic children: Differences in dose effects on learning and social behavior. *Science,* 1977, **198,** 1274-1276.

Walker, M. K. Stimulant drugs. In S. E. Breuning & A. D. Poling (Eds.), *Drugs and Mental Retardation,* Springfield, Ill.: Charles C Thomas, 1980.

Weiss, G., Kruger, E., Danielson, U., & Elman, M. Effect of long-term treatment of hyperactive children with methylphenidate. *Canadian Medical Association Journal,* 1975, **112,** 159-165.

Werry, J., Sprague, R., & Cohen, M. Conners' Teacher Rating Scale for use in drug studies with children—an empirical study. *Journal of Abnormal Child Psychology,* 1975, **3,** 217-229.

White, J. H. The hyperactive child syndrome. *American Family Practice,* 1977, **15,** 100-104.

Worland, J. Effects of positive and negative feedback on behavioral control in hyperactive and normal boys. *Journal of Abnormal Child Psychology,* 1976, **4,** 315-326.

Wulbert, M., & Dries, R. The relative efficacy of methylphenidate (Ritalin) and behavior modification techniques in the treatment of a hyperactive child. *Journal of Applied Behavior Analysis,* 1977, **10,** 21-31.

*Received February 18, 1981*
*Final acceptance November 24, 1981*