JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1980, 13, 221-236 NUMBER 2 (SUMMER 1980)

BEHAVIORAL AND STIMULANT TREATMENT OF HYPERACTIVE CHILDREN: A THERAPY STUDY WITH METHYLPHENIDATE PROBES IN A WITHIN-SUBJECT DESIGN

WILLIAM E. PELHAM, ROBERT W. SCHNEDLER, NANCY C. BOLOGNA, AND J. ANTHONY CONTRERAS

WASHINGTON STATE UNIVERSITY

Eight hyperactive children were treated with a behavioral intervention focusing on teacher and parent training over a period of 5 months. Three times, before therapy and after 3 weeks and 13 weeks of intervention, children received methylphenidate during 3-week probe periods. Each week in a probe they received either a placebo, .25 mg/kg, or .75 mg/kg methylphenidate. Classroom observations of on-task behavior suggested that effectiveness of the behavioral intervention was between that of the two dosages of medication before therapy. Both dosages resulted in higher levels of on-task behavior when administered after 13 weeks of behavioral intervention than when administered before therapy. Teacher rating data showed equivalent effects of therapy and the low dosage of methylphenidate alone but a stronger effect of the high dose alone; only the high dose resulted in improved behavior after 13 weeks of behavioral intervention. *As a group,* only when they received the high dose of methylphenidate after 13 weeks of behavioral intervention did children reach the level of appropriate behavior shown by nonhyperactive controls. However, this level was also reached by two children with the low dose and by one child without medication, and it was not reached by one child. The results suggest that the combination of psychostimulant medication and behavior therapy may be more effective in the short-term than either treatment alone for hyperactive children in school settings. In addition, parent ratings and clinic observation of parent-child interactions suggested that children had improved in the home setting, highlighting the importance of behavioral parent training in the treatment of hyperactivity.

DESCRIPTORS: hyperactivity, modification, medication, behavior therapy, children

The most common mode of treatment for hyperactivity is pharmacological intervention with a psychostimulant, dextroamphetamine, methylphenidate, or pemoline. Although psychostimulants are effective in the short-term management of some hyperactive children (see Sroufe, 1975), important questions have been raised regarding the overall utility of the medication. For example, stimulant therapy alone does not appear to be associated with improvement in academic performance (Rie, Rie, Stewart, & Ambuel, 1976) or long-term improvement in social behavior (Weiss, Kruger, Danielson, & Elman, 1975). Concerns about adverse and dosage-related side effects such as a reduction in the rate of weight gain (Safer & Allen, 1973) have led clinicians to use dosages smaller than those used in early studies. Although there is some evidence that smaller dosages are clinically useful (Werry & Sprague, 1974), it is not conclusive (e.g., Wolraich,

The authors express thanks to the Moscow, Idaho, and Pullman, Washington, School Districts for making referrals to the study. We thank the following individuals without whose assistance at various stages this study could not have been conducted: administrators Loyd Waite and Rich Davidson; principals Ernie Bartleson, Jacqueline Larson, James Hoyt, James Heidenreich, and Fritz Hughes; psychologists Jim Miller and Beth Seale; teachers Nancy Pederson, Jane Abendroth, Peggy Hoobler, Ron Dixon, Charlein Wright, Beth Freese, Jack McGrath, Betty Coon, and Donna Henderson; observers and trainers Betty O'Bryan, Karl Hoover, Luci Weldon, Laurie Harrison, Shiela Keesecker, and Connie Masterman; pediatric consultant Alvin Frostad; and pharmacist Sid Pierson. In addition, we thank Tom Brigham for helpful comments on the manuscript and Jim Swanson for statistical advice. Requests for reprints should be sent to the first author who is now at the Department of Psychology, Florida State University, Tallahassee, Florida 32306.

Drummond, Salomon, O'Brien, & Sivage, 1978). The same concerns over side effects have led to a reduction in the use of medication in the home setting. When medication is the sole method of intervention, then improvement in the home situation generally does not occur. Finally, only two out of three hyperactive children show a positive response to psychostimulants (Sroufe, 1975).

There is thus increasing interest in the use of behavior therapy to treat hyperactive children, and there are indications that behavior therapy is a viable treatment for some hyperactive children (Ayllon, Laymen, & Kandel, 1975; Gittelman-Klein, Klein, Abikoff, Katz, Gloisten, & Kates, 1976; K. D. O'Leary, Pelham, Rosenbaum, & Price, 1976; S. G. O'Leary & Pelham, 1978; Pelham, 1977; Shafto & Sulzbacher, 1977). Most of these studies, however, did not consist of comprehensive clinical interventions and are, therefore, indications of behavior therapy's potential with hyperactives rather than conclusive demonstrations of its effectiveness. The case study reported by Pelham (1977) and the study reported by S. G. O'Leary and Pelham (1978) did involve comprehensive clinical interventions. With a total of eight children they showed that children treated with behavior therapy over a 4-month period reached a level of school functioning essentially equivalent to that reached on medication before therapy had begun. In contrast to these results, Gittelman-Klein et al. (1976) used a between-group design to compare behavior therapy and stimulant medication over an 8-week period and found that medication was more effective than behavior therapy.

Of clinical interest, however, is that the final level of functioning reached either with medication or with behavior therapy in these studies (as well as others) was improved but not "normal." For example, final teacher rating scores were almost a standard deviation above the norm under both conditions. This observation and the *relative* lack of effectiveness of behavior therapy in the Gittelman-Klein et al. study suggest that some adjunct to behavioral treatment might be sought in an attempt to increase its effectiveness. Several adjunctive treatments have been suggested (see Pelham, 1978), the most common being concurrent use of psychostimulants (Brundage-Aguar, Forehand, & Ciminero, 1977; Eisenberg, 1978). Only a few studies have examined the interactive effects of behavior therapy and psychostimulant medication. Some children (e.g., Pelham, 1977; S. G. O'Leary & Pelham, 1978) have shown such disruptive behavior off medication that they have been continued on relatively low dosages of medication for several months while behavior therapy has been implemented. For such children, behavior therapy alone is apparently an insufficient treatment, but in combination with low dosages of medication it appears to be effective.

The one direct test of whether low dosages of medication enhance the effects of behavioral intervention failed to find that the combination treatment was more effective than behavioral intervention (Wolraich et al., 1978). This failure, however, may have resulted from ineffectiveness of the behavioral intervention (teacher ratings did not change with behavioral intervention), the relatively low dosage of medication employed (.3 mg/kg methylphenidate), or the brief time period of the program's implementation (2 weeks). For example, total daily dosages of medication approximately five times greater than those used by Wolraich et al. have been shown to facilitate a behavioral intervention (Gittelman-Klein et al., 1976).

Important variables to manipulate in investigations of the interactive effects of medication and behavior therapy might be the length of the behavioral intervention and the dosage of medication administered. In the present investigation, a comprehensive behavioral intervention was carried out over a 16-week period. Adjunctive benefit of stimulant medication was studied by including three medication probes—the first before behavior therapy had begun, the second 3 weeks after the therapy began, and the third 13 weeks after. Two dosages of methylphenidate

and a placebo were administered during each 3-week probe period. The high dose was .75 mg/kg, qAM, a dose roughly equivalent to the mean morning dose administered by Gittelman-Klein et al. The low dosage was .25 mg/kg, very close to the .3 mg/kg dosage used by Wolraich et al. These two dosages approximate those reported by Sprague and Sleator (1977) as maximizing change in classroom behavior (1.0 mg/kg) and cognitive skills (.3 mg/kg). Teacher rating data and classroom observations made during the medication periods allowed us to address the following questions: (1) Would behavior improve as a result of medication alone? (2) Would medication improve behavior even when administered after behavioral intervention? (3) Would the degree of improvement be a function of dosage? (4) Would dosage effects before therapy and after 3 weeks of therapy differ from those after 13 weeks of behavioral intervention? and (5) Would treatment effects be consistent across dependent measures? Because it had a similar time frame and treatment approach, this study also represents a replication of the S. G. O'Leary and Pelham (1978) report.

METHOD

Subjects

Eight hyperactive children, seven boys and a girl, referred by local physicians and schools, were involved in the therapy study. One additional child also began the project but dropped out when his parents' marital problems and separation interfered with participation in therapy. In order to be included a child had to meet the following criteria: (a) DSM-II (American Psychiatric Association, 1968) diagnosis of hyperkinetic reaction of childhood; (b) teacher ratings on the Abbreviated Conners Teacher Rating Scale (ACTRS) above 15,[1] the accepted cutoff score for hyperactivity (Werry, Sprague, & Cohen, 1975); (c) parent (mother) ratings on the Werry-Weiss-Peters Activity Scale (WWPAS) at least 1 standard deviation above the age norm (Routh, Schroeder, & O'Tuama, 1974); and (d) absence of psychosis, mental retardation, and evidence of gross brain damage. The mean age of the group was 8.3 (range: 6.5 to 11.5). Three of the children were in the first grade; three were in the second grade, which one was repeating; one was repeating the fourth grade, and one was in the fifth grade.

Two children had previously received methylphenidate but neither was taking it during the school year when they were referred for the project. The parents of two other children had had limited previous involvement with a behavioral parent training program. One child was in a transitional adjustment classroom, and all other children were in regular classrooms.

The mean referral score on the ACTRS for the group was 19. Five children's scores were higher, ranging from 20 to 25. Carol's score, 7, was lower. She was included in the project in spite of this score because of her clear problems in the area of attention.[2] She was consistently off task 30% more than her controls and had a score more than 2 standard deviations, above the mean on the inattention factor of the full Conners TRS (Conners, 1969).

The presenting problems for all children were very similar, usually including disobeying teachers and parents, not following directions, not completing seatwork and chores, and fighting or teasing peers and siblings.

Dependent Measures

Classroom observations. Trained observers made observations on a 10-sec observe, 5-sec record basis in each child's classroom. Each observation lasted 30 min in which, in alternating

[1]The ACTRS score for one subject was lower than the cutoff. She was accepted for the study nonetheless because she exhibited attentional problems characteristic of hyperactivity (see below and Footnote 2).

[2]According to the Draft (1/79) of the American Psychological Association's revision of its Manual, this child would have received a diagnosis of attentional deficit disorder *without* hyperactivity. The remaining children in the project would have been diagnosed attentional deficit disorder *with* hyperactivity.

2.5-min blocks, the behavior of the target child and one of three comparison children was coded as on or off task. Off task was defined by each teacher individually but generally consisted either of behavior disruptive to the teacher or other children, or of daydreaming. Three observations were made per week—all during individual seatwork periods and always during the first 2½ hours of the school day. The comparison children were selected by each teacher at the beginning of the study as same-sexed children who had no difficulty completing their work and who were not disruptive. Reliability was checked a total of 19 times, distributed over all classrooms and observers, and averaged 87% for the study (number of agreements divided by number of intervals observed).

Teacher ratings. Teachers made daily ratings of individualized problem behaviors on a 5-point scale (1 = not a problem through 5 = very frequent or very intense problem). Problem behaviors were pinpointed by each child's teacher in conjunction with his or her therapist. These problem behavior ratings (PBRs) were averaged over problems and days to yield a weekly rating. In addition, on Fridays teachers completed the ACTRS which was to reflect the child's behavior for that week. Both the PBR and the ACTRS have been shown to be sensitive to the effects of behavior therapy, and the latter to medication (K. D. O'Leary et al., 1976; S. G. O'Leary & Pelham, 1978; Sleator & von Neumann, 1974). Such ratings correlate with observations of classroom behavior and constitute valid behavioral measures (Bolstad & Johnson, 1977).

Clinic observations. Observations of each child and his or her parents were made in our clinic before and after the program. Parents and child were observed for 25 min from behind a one-way mirror while they were working on individual papers. The parents, but not the child, were aware of the observations. The parents were completing MMPIs and the child was working on a long series of math problems. The parents were instructed to behave as they would at home if both they and their child had something important on which they were working individually. Child behavior was coded as on or off task using the procedure described above. Off task was defined as any behavior other than working on the assignment. The child's paper was saved and the number of problems completed correctly was counted. The number of observation intervals during which parents made command or praise statements was also recorded. A command was defined as any instruction to initiate or terminate a behavior (e.g., "Get back to work" or "Stop playing with your pencil").

Parent ratings. Parents completed daily PBRs similar to those described above but tailored to the home setting before and after therapy. In addition, parents completed the WWPAS and the Conners Parent Symptom Questionnaire, PSQ (Conners, 1970), before and after the program. The aggressive-conduct factor on the PSQ was scored.

Procedure

General design. Measures began with a 2-week baseline period during which pretreatment assessment data were gathered. During baseline, a total of six classroom observations were made, and teachers made the ratings noted above. In addition, parents made their pretreatment ratings, and the clinic observation was made. Following baseline, but before behavioral intervention, was a 3-week medication probe. For each of the 3 weeks under triple-blind conditions, a child received qAM capsules containing either a placebo, .25 mg/kg methylphenidate (low dose), or .75 mg/kg methylphenidate (high dose). Order of dosage administration was randomly assigned with the restriction that an equal number of children received each of the three dosages in a given week.[3] Following the first medication probe, therapy began. Three weeks after therapy began, a second medication

[3]The loss of one subject made unequal the number of children receiving each random order of medication administration.

probe similar to the first was carried out while therapy continued. Thirteen weeks after the beginning of therapy a final 3-week medication probe began. Therapy was being faded during this probe and most parents and teachers were seen only once. During each medication probe, three classroom observations were made per week and teachers made the ratings discussed above. Observations and ratings were made under triple-blind conditions. Immediately following the final medication probe was a 2-week posttreatment assessment: six classroom observations were made, teachers completed their ratings, the posttreatment clinic observation was made, and the parents completed posttreatment ratings.

Therapy. Therapy focused on parent and teacher training and has been extensively described previously (Kent & K. D. O'Leary, 1976; K. D. O'Leary et al., 1976; S. G. O'Leary & Pelham, 1978; Pelham, 1977, 1978). Three cases were seen by the first author, two by the second author and three by the third author. Each set of parents and each teacher were seen weekly in individual sessions held at the clinic for parents and in the schools for teachers.

Parent training began with assigned readings, *Families* (Patterson, 1976), and discussion of the principles of social learning. Together the parents and therapist devised contingency management programs to modify the child's specific problem behaviors. Procedures used included praising appropriate behavior, ignoring minor inappropriate behavior, punishing with time out or loss of privileges more serious instances of inappropriate behavior, and the implementation of Premack contingencies and incentive systems. Incentive systems were used in all cases to provide rewards for good daily reports from school, and in some cases to reward changes in home behaviors. Individualized rewards included special family activities, extra time before bed, allowances, and more long-range goals such as a new bed or watch. When structured incentive systems were not used, natural contingencies were employed following the Premack Principle. One therapy session with each family consisted of a videotaped parent-child interaction which was shown and discussed with the parents. Therapy was carried out over 5 months and averaged 12 sessions (range 10 to 14). Two or three of the last few sessions were group sessions involving more than one set of parents. One set of parents never met in a group.

Teacher training had a format, time course, and session frequency similar to parent training. Training began with a discussion of the principles of social learning (all of the teachers were familiar with behavioral approaches to working with children). Teacher and therapist then devised programs to deal with each child's specific problem behaviors. In all cases a daily report system was instituted (K. D. O'Leary et al., 1976). Three to five target behaviors were evaluated by the teacher and the child took the report home daily. As noted above, rewards for good reports were given at home. In all cases completion of assigned academic work was a target, and not disrupting the class or disturbing the teacher was frequently a target. Daily reports were changed over the course of therapy as was necessary. In addition to daily reports, teachers used a variety of procedures in the classroom, including praising and ignoring, time out, and Premack contingencies (e.g., work completed before recess or free time upon task completion). In all cases approximations to the final target behavior were carefully shaped.

In addition to parent and teacher training, each child was tutored by a trained undergraduate. Tutoring sessions were held two or three times per week in the child's classroom and occasionally at the clinic. Each session lasted 20 to 30 min and was directed toward teaching self-instructional techniques (Meichenbaum & Goodman, 1971) that others have shown to be useful with hyperactive children (Bornstein & Quevillon, 1976; Douglas, Parry, & Marton, 1976; Palkes, Stewart, & Kahana, 1968). Materials for the training were obtained from each child's teacher and other grade-appropriate sources. Because some children were below

Table 1

Preassessment and Postassessment Classroom Measures

	Teacher Ratings			
	Abbreviated Conners TRS		*Problem Behavior Ratings*	
Child	*Pre*	*Post*	*Pre*	*Post*
Bill	—	—	—	—
Bob	14	3	2.0	1.2
Alan	14	13	3.5	2.5
Dan	15	17	3.1	2.7
Jim	12	5	2.9	1.6
John	22	10	4.7	3.4
Carol	13	4	4.6	2.1
Ron	14	4	2.8	2.2
Mean	15 (3)	8, $t(6) = 3.4$**	3.4	2.2, $t(6) = 4.71$***

	Observations On-task	
Child	*Pre*	*Post*
Bill	70	77
Bob	64	57
Alan	55	87
Dan	50	63
Jim	81	88
John	31	62
Carol	54	63
Ron	52	68
Mean	57 (80)	71 (85), $t(7) = 2.94$*

Note: Observations are reported as percentage of 10-sec intervals in which targeted behavior occurred. Because of illness and other problems, teacher ratings were not available for Bill. On ratings, high scores equal worsened behavior. Numbers in parentheses are mean scores for comparison children.

*$p < .05$.

**$p < .01$.

***$p < .0025$.

grade level in arithmetic skills, several tutors directed some of their efforts toward this area. Flash cards for addition and subtraction facts were the most frequently used materials. The general procedure within each session followed those used by the authors cited above and is described in Pelham (1978). Dan was not tutored as he showed no symptoms that tutoring was designed to modify. The average number of tutoring sessions for tutored children was 22 (range 15 to 28).

RESULTS

Pre-post changes on teacher and parent ratings, and classroom and clinic observations are shown in Tables 1 and 2. Paired t-tests (see Tables for t and p values) revealed that all of the mean changes in children's behavior were statistically significant. Perhaps more important, for most children the changes were large and clinically significant. With a few exceptions on individual measures, changes were shown by all children on all measures.

The results of the medication probes, presented in Table 3 and Figure 1, were assessed with a series of orthogonal planned comparisons (Hays, 1963) on each dependent measure. Within each time period, the mean of the active dosages was tested against placebo, and the high dosage was tested against the low.

Table 2

Preassessment and Postassessment Home Measures

	Parent Ratings					
	Werry-Weiss-Peters		*Parent Symptom Questionnaire Aggressive-Conduct Factor*		*Problem Behavior Ratings*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*
Bill	21	15	1.7	1.8	2.5	2.3
Bob	18	13	1.8	1.7	2.8	1.6
Alan	14	3	1.7	1.4	2.7	2.2
Dan	18	11	2.2	1.7	3.3	2.2
Jim	25	18	1.8	1.4	1.4	1.2
John	34	19	2.8	1.9	1.6	1.3
Carol	18	6	2.0	1.5	1.4	1.9
Ron	32	16	2.0	1.5	3.0	1.6
Mean	23	13, $t(7) = 6.6^{***}$	2.0	1.6, $t(7) = 3.99^{***}$	2.3	1.8, $t(7) = 2.26^{*}$

	Clinic Observations							
	Percentage On task		*Number Correct Problems Completed*		*Parents Praises*		*Parent Commands*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Bill	0	20	19	29	9	13	12	6
Bob	36	80	32	55	4	3	9	0
Alan	33	30	59	78	4	0	6	0
Dan	77	81	92	74	0	0	2	0
Jim	23	61	25	42	0	0	24	0
John	44	73	31	60	0	0	20	5
Carol	72	73	41	54	1	6	16	4
Ron	58	73	20	30	1	0	6	1
Mean	43	63	40	53	2	3	12	2
	$(t(7) = 3.0^{**})$		$(t(7) = 2.59^{*})$		$(t(7) = .4)$		$(t(7) = 3.97^{***})$	

Note: On task reported as percentage of 10-sec intervals scored as on task. Parent praises and commands are the total number which occurred in the session. Problem Behavior Ratings are from placebo week of the first and last medication probes, as they were not made during assessment periods. All parent ratings are mother's ratings, and high scores on ratings equal worsened behavior.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .0025$.

Table 3

Individual Data on Classroom Dependent Measures during 3-Week Medication Probes

	Classroom observations of on-task behavior								
	Medication probes								
	Before intervention			*After 3 weeks of intervention*			*After 13 weeks of intervention*		
Child	*pl*	*lo*	*hi*	*pl*	*lo*	*hi*	*pl*	*lo*	*hi*
Bill	72	69	89	78	57	73	63	85	80
Bob	60	82	81	52	65	77	75	78	85
Alan	71	71	92	63	73	83	90	95	98
Dan	50	72	71	54	60	82	60	84	78
Jim	68	82	94	73	66	88	83	90	94
John	26	41	46	75	71	79	82	74	85
Carol	38	45	71	62	76	62	42	82	83
Ron	54	72	75	71	87	98	61	91	93
	Abbreviated Conners Teacher Rating Scale								
Bill	–	–	–	–	–	–	–	–	–
Bob	7	7	2	5	3	4	2	2	1
Alan	17	15	18	18	18	15	16	19	11
Dan	16	9	8	17	6	3	10	12	8
Jim	7	8	8	9	7	3	6	5	1
John	28	14	4	17	13	2	16	13	1
Carol	13	8	2	7	7	3	8	6	5
Ron	20	6	1	11	1	1	10	7	4
	Problem Behavior Ratings								
Bill	–	–	–	–	–	–	–	–	–
Bob	1.4	1.2	1.0	1.7	1.2	1.2	1.1	1.0	1.1
Alan	3.2	2.9	3.1	3.3	2.3	1.8	2.7	2.8	2.0
Dan	3.3	2.1	2.4	2.5	1.5	1.7	2.2	2.1	1.8
Jim	2.4	2.4	2.1	1.9	2.0	1.9	1.5	1.6	1.3
John	4.5	4.2	1.6	3.2	2.5	1.9	3.9	3.4	1.1
Carol	4.6	3.9	1.7	3.4	3.0	3.0	3.3	2.2	2.5
Ron	2.7	1.5	1.5	1.9	1.3	1.1	2.2	1.9	1.2

Note. Observations reported as percentage of 10-sec intervals child was on task. PBRs scored on scale from 1 (not a problem) to 5 (very frequent or very intense problem). High ACTRS scores represent more hyperactive behavior. Three-week probes consisted of one week each of placebo, low (.25 mg/kg), and high (.75 mg/kg) dosages of methylphenidate. Because of illness and other problems, systematic teacher ratings were not available for Bill.

Medication Probes

Before behavioral intervention. On the observational measures, on-task behavior was significantly increased by the mean of the medication doses, $t(28) = 4.60$, $p < .001$, and the high dose increased it more than the low, $t(28) = 9.38$, $p < .001$. In both teacher rating measures the same pattern was shown. ACTRS scores were significantly lowered by medication, $t(24) = 5.98$, $p < .001$, and the high dose was more effective than the low, $t(24) = 2.34$, $p < .025$). The corresponding results for the PBRs were, respectively, $t(24) = 4.28$, $p < .001$ and $t(24) = 1.99$, $p < .05$.

After 3 weeks of behavioral intervention. On-task behavior was significantly increased by medication, $t(28) = 2.45$, $p < .025$, and the high dose was more effective than the low, $t(28) = 2.62$, $p < .01$. Corresponding tests for the ACTRS scores also revealed a significant medication effect, $t(24) = 4.62$, $p < .001$, and an incremental effect of the high dosage, $t(24) = 2.34$, $p < .025$. On the PBRs, however, only the ef-

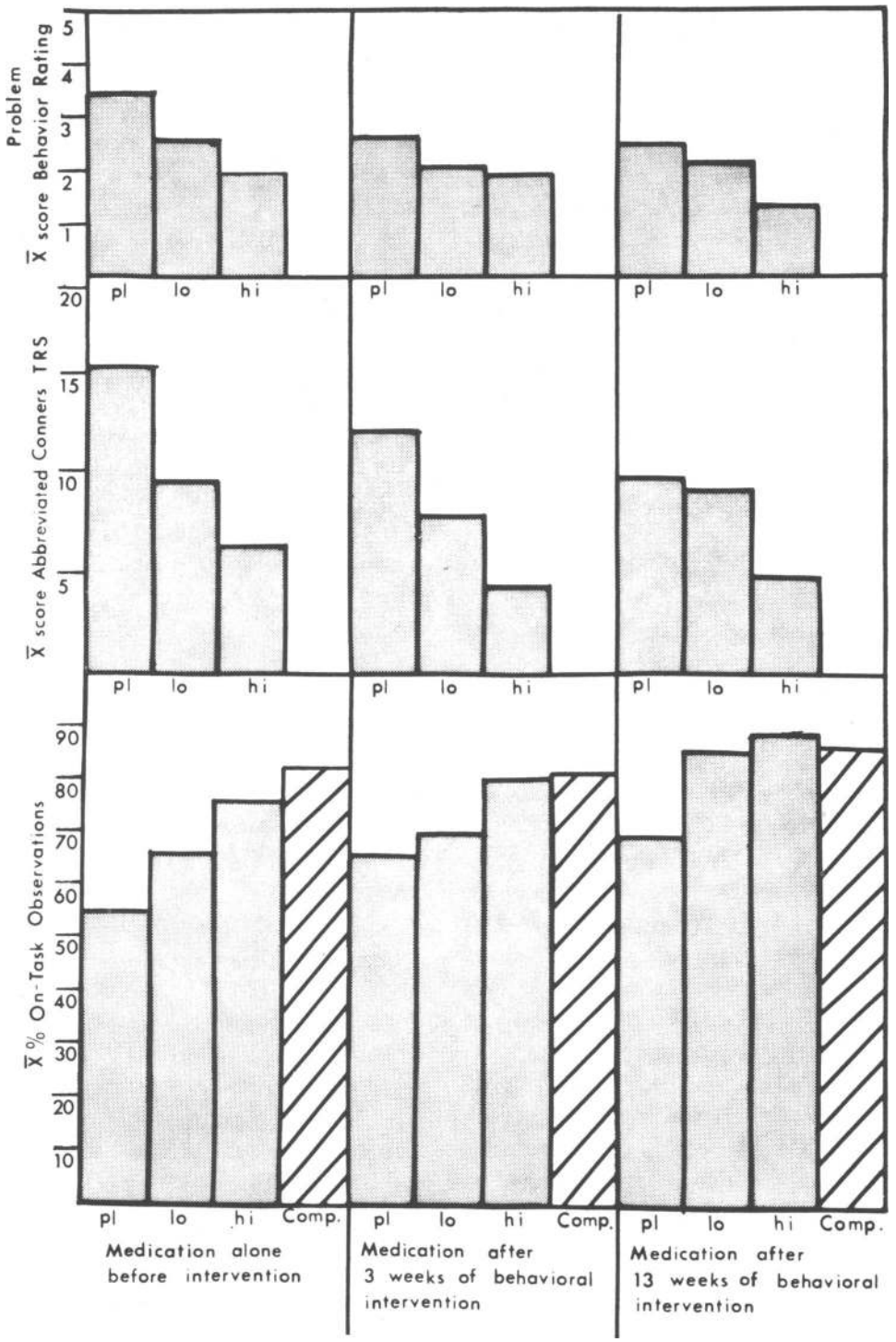

Fig. 1. Mean scores for dependent measures during medication probes. Higher observations and lower Problem Behavior and Abbreviated Conners ratings represent improved behavior. Placebo (pl), .25 mg/kg methylphenidate (lo), and .75 mg/kg methylphenidate (hi) weeks are shaded. Comparison children's on-task behavior in striped columns.

fect of medication was significant, $t(24) = 2.50$, $p < .01$.

After 13 weeks of behavioral intervention. On-task behavior was increased by medication, $t(28) = 4.66$, $p < .001$, but the high dose was not more effective than the low, $t < 1$. In contrast, on ACTRS scores significant effects were obtained for both medication, $t(24) = 2.20$, $p < .025$, and for the incremental effect of the high dose, $t(24) = 3.03$, $p < .005$. The same pattern was apparent on the PBRs with medication, $t(24) = 2.55$, $p < 0.1$, and high dose, $t(24) = 2.68$, $p < .01$, revealing significant effects.

DISCUSSION

These results suggest that low to moderate dosages of methylphenidate may be of incremental benefit to some and perhaps most hyperactive children being treated with a behavioral intervention. A corollary of this conclusion is that the behavioral intervention was apparently an effective but not *maximally* effective treatment for most of the children. Because acceptance of medication's incremental benefit is contingent on acceptance of the effectiveness of the behavioral intervention, we shall begin discussion by offering several arguments for the validity of those results.

Results of Behavioral Intervention

The pre-post results replicate those of S. G. O'Leary and Pelham (1978) and thus support the conclusion that behavior therapy is a viable treatment for some hyperactive children. Interpretation of pre-post improvement is limited because neither this study nor the O'Leary and Pelham study had a no-treatment control group. Several other studies, however, have used placebo treatment or no-treatment groups of hyperactive children over time periods similar to and longer than the one for which these children were followed (e.g., Conners, Goyette, Southwick, Lees, & Andrulonis, 1976; K. D. O'Leary et al., 1976; Quinn & Rapoport, 1975). These studies suggested that hyperactive children as a group did not show substantial improvement in school relative to a variety of treatment groups. Similarly, over a 16-week period, untreated conduct-disorder children with behaviors similar to hyperactivity did not improve relative to children treated with behavioral intervention (Kent & K. D. O'Leary, 1976). In addition, improvement in this study was evident in both the school and clinic observations—measures less subject to bias than rating scales. Although maturation and other factors may have contributed to the pre-post improvement observed herein, it is unlikely that such factors rather than the behavioral intervention accounted for much of that improvement.

Although our results suggest that behavior therapy helps hyperactive children, they raise several points that warrant discussion. First, the behavior therapy was apparently a beneficial but not maximally effective intervention.[4] For example, neither the final level of on-task behavior reached after behavioral intervention, 71%, nor the level reached under high medication alone, 76%, reached the level exhibited by the comparison children—80% to 86%, depending on the observed period. That level was reached only with the *combination* of methylphenidate and the behavioral intervention—not by either treatment alone. Similarly, the final ACTRS mean rating was 8, above both the mean rating of 5 for elementary-aged children (Werry, Cohen, & Sprague, 1975) and the aver-

[4]In this discussion, the terms *behavior therapy* and *behavioral intervention* refer to the procedures described and referenced above—a standard approach to parent and teacher training in contingency management. Our conviction that such a program is usually not a sufficient intervention for hyperactivity should not yet be interpreted as a belief that nothing short of a pharmacological intervention would constitute a sufficient treatment. For example, we have argued elsewhere (see Note 1) that a child-based program in social skills training is a valuable adjunct to a contingency management program. There is a need to develop and study more comprehensive and innovative behavioral interventions before it can be concluded that *nothing* short of medication is a sufficient treatment for hyperactivity.

age rating of 3 which teachers in the present study assigned to the comparison children they had selected. These ratings are consistent with the teachers' judgments that only one child, Bob, showed a relatively normal pattern of behavior with behavioral intervention alone (see discussion below, however). For the other seven children, only with the combination of medication and behavior therapy was the level of behavior in or approaching the range that is considered normal. These results suggest that behavior therapy often effects clinically important *improvement* in hyperactive children's behavior, but that there is room for additional improvement even after behavioral intervention—a fact that is often overlooked in discussions of whether behavior therapy is an effective treatment for hyperactivity. It appears to be a distinctly beneficial but not a maximally effective treatment. This point is supported by other recent data that suggest that despite the large improvement shown with a standard behavioral intervention, hyperactive children are not "normal" in the important area of peer interactions, and additional intervention directed at social skills appears to be necessary (Pelham, Paluchowski, Ronnei, O'Bryan, & Wilson, Note 1).

A second point raised by the pre-post data concerns the parent-child observations. Although again the lack of a control group limits the conclusions that can be drawn, it is worth noting that the changes we observed were similar to those reported in studies involving either behavioral intervention or psychostimulants. Thus, in contrast to the pretreatment observations, at posttreatment children were on task more and parents were less aversive and controlling but no more rewarding. Similar results have been found both with behavioral interventions (e.g., Taplin & Reid, 1977) and in medication studies (Barkley & Cunningham, 1979; Humphries, Kinsbourne, & Swanson, 1978). One difference, however, between this study and medication studies is that the children showed a large increase in the number of math problems completed correctly at posttreatment. Although both medication and behavioral interventions have been shown to increase on-task behavior, increases in amount of work completed correctly have been reported only with the latter (Ayllon et al., 1975; Wolraich et al., 1978). We should note that five months of school had elapsed between the pre and post observations. Part of the increase in problems completed correctly may have been a result of learning how to do them. The task consisted of a large number of relatively simple problems, however, and the children's motivation rather than their ability to do the problems appeared to be the variable tapped by the observations.

Another noteworthy point regarding the pre-post data is that the post scores on the dependent measures in this study were virtually identical to those reported by S. G. O'Leary and Pelham (1978). With one exception the therapy procedures were very similar for the two studies: in the present study children received a number of training sessions in verbal self-instruction. The fact that the treatment gains were identical suggests that the verbal self-instruction was not incrementally effective. Although such a conclusion should not be drawn with compelling conviction from these data, at least one controlled study appears to have reached the same conclusion (Friedling & S. C. O'Leary, 1979).

A final point regarding the pre-post results can be made by comparing them with the results of the first medication probe, thus providing information about the relative effects of medication and behavior therapy. Because medication has acute effects that are not expected to change over time (Swanson & Kinsbourne, 1979), results from an acute drug trial can be compared with the results of behavioral intervention carried out over a longer period. As a comparison of Table 1 and the first medication probe in Figure 1 reveals, the effects of behavioral intervention approximated those of the low dosage of medication but did not reach those of the high dosage. Wolraich et al. (1978) also reported essentially equivalent effects of behavioral and drug treatments with a low

(.3 mg/kg) dosage of methylphenidate, whereas Gittelman-Klein et al., used substantially higher dosages and reported that medication was superior to behavior therapy. The present results suggest that the question of which is the more effective short-term treatment can only be answered with consideration of the medication dosage (among other variables, of course). Our behavioral intervention seemed to work as well as the low but not the higher dosage.

Results of the Medication Probes

These results show across dependent measures that there were significant medication effects both *before* and *after* behavior therapy had been initiated. The fact that there were medication effects even *after* behavior therapy had been implemented for 13 weeks is a clear indicator that medication has incremental value for hyperactive children receiving behavior therapy. Further, the planned comparisons testing the effects of dose showed that on the *observational* measures there were no differences between the effects of low and high medication during the final medication probe. Because this pattern was not apparent during either of the first two probes, the result indicates a true *interaction* between behavior therapy and medication on this measure. That is, on-task behavior under both dosages was higher after intensive behavioral intervention than before, but the increase was greater for the low dosage than the high. Although there was no evidence of a similar interaction on the two teacher rating measures during the final probe, the opposite effect was found on the PBRs made during the second probe. There, with the introduction of behavior therapy the high dosage failed to decrease PBR ratings and was no different from the low dose in its effects. In contrast, after 13 weeks of behavior intervention, the high dose reduced scores significantly more than the low dose. With the exception of these two apparent interactions, the planned comparisons showed that the high dose of methylphenidate improved behavior more than the low both before and after behavioral intervention.

These results provide answers for the first four questions posed in the introduction. Medication affected the children's behavior before and after intervention. There were dosage effects with the higher dose resulting in greater improvement than the low on most measures both before and after intervention. Finally, there was some indication that the behavioral intervention affected the dosage effects. Behavior therapy and psychostimulant medication appear to have additive and in certain conditions interactive effects.

Comparison with previous findings. Two previous studies had failed to find that the combination of stimulants and behavior therapy was the most effective treatment for hyperactivity (Gittelman-Klein et al., 1976; Wolraich et al., 1978). Possible explanations for Wolraich et al.'s results were noted above. In contrast to their results, the effect we obtained was much clearer with the higher of the two dosages of medication used and when the behavioral intervention had been in effect for a considerably longer time. The length of the intervention may also account in part for the differences between our results and those of Gittelman-Klein. Our intervention lasted twice as long, and our data showed a clearer combined treatment superiority during the medication probe after 13 weeks than during the one after 3 weeks of therapy. In addition, the maximum daily dosage of methylphenidate used in this study was half that administered in the Gittelman-Klein study. It is not surprising that they reached a ceiling in improvement with medication, preventing additional improvement from behavioral intervention. There are many reasons to avoid sole reliance on high dosages of medication as a treatment for hyperactivity (K. D. O'Leary, 1980; Sprague & Sleator, 1977). After the behavioral intervention had been well established in the present study, maximum improvement in on-task behavior was reached with a dosage of medication one-sixth the size Gittelman-Klein employed, and maxi-

mum improvement on teacher ratings was reached with a dosage one-half the size they administered. It is important to note that the maximum improvement obtained on these measures could not have been much closer to "normal" behavior than it was (see Note 1, however).

Response across dependent measures. The final question posed in the introduction concerns the consistency of findings across dependent measures. As Figure 1 and the interactions noted above suggest, there were differences in medication effects across measures. The planned comparisons revealed linear effects of dosage on all dependent measures before behavior therapy. During the final probe, however, the higher dose was more effective than the lower on the teacher rating but not the observational measures. Although orthogonal comparisons to test the effect could not be made, Figure 1 shows that the low dose had very little effect during the final medication probe except on the observational measure. This interaction between dosage effects and dependent measures could result from several sources. First, the teacher ratings and observations were made at different times. The observations were made in the morning while the medication was active, but teachers made PBRs after school, several hours after medication had worn off, and they made ACTRS ratings at the end of the week. Unmedicated behavior occurring in the afternoon and forgetting over days may have washed out real effects of the low dosage which may thus be more accurately reflected in the observational data. A second possibility is that the dependent measures reflect different behavioral domains, and the relatively greater effects of the low dosage on the observational measures may reflect the differential dose-response curves others have discussed (e.g., Sprague & Sleator, 1977). The low dosage may have exerted its effects primarily on cognitive abilities reflected in on-task behavior during seatwork, whereas the high dosage may have had a greater effect on teacher-rated behaviors—most often interpersonal behavior and compliance.

Additional research is necessary before these questions can be answered. These findings do, however, highlight the importance of using multiple dependent measures in evaluating response to medication and behavior therapy. Studies that have used only a single dependent measure may have drawn inaccurate conclusions based on an incomplete evaluation of treatment effects. One recent study, for example, used only observation of on-task behavior and concluded that behavioral and pharmacological interventions had equivalent effects (Loney, Weissenburger, Woolson, & Lichty, 1979). The current data suggest that teacher ratings might have yielded different results. The importance of a variety of types and sources of information is often emphasized in clinical assessment (Evans & Nelson, 1977; K. D. O'Leary & Johnson, 1979) and in therapy outcome studies (Hartmann, Roper, & Gelfand, 1977). Such an emphasis has not been as apparent in child psychopharmacological research although its importance is easily demonstrated.

Consider, for example, John's responses on the different measures during the medication probes (see Table 3). Initially he showed large medication effects on on-task observations, but these effects disappeared when the behavioral program was introduced. In isolation these data could have argued that behavior therapy was both effective and sufficient for John. On teacher ratings, however, a substantially different picture emerged. On the ratings the high dosage was much more beneficial than the low, and both dosages added substantially to the behavioral program. Thus, out of 4 possible "yes's" on his daily report card, John averaged .4, 2.7, and 3.8 during placebo, low, and high dosage weeks, respectively, of the final medication probe. Opposite treatment recommendations for John would have been made had only *either* teacher ratings *or* observations been made. A variety of dependent measures are necessary to give a complete picture of treatment effects.

Although much has been written about *group* effects of stimulant drugs on hyperactive children, very little attention has been paid to assessment

of medication responses in *individual* children in clinical settings. As John's case illustrates, the probe design employed in this study offers a useful clinical assessment device for professionals concerned with treatment decisions for individual children. The need for such a clinical tool is great, as the large number of children currently medicated with stimulants are generally placed on and maintained on medication with only crude measures of medication effects or no measures at all.

Individual differences in responses to medication. As Table 3 shows there was considerable individual variability in response to medication. In brief, after behavior therapy the incremental improvement shown with medication by two children, Bob and Dan, was not sufficient to justify continued use of medication. Two other children, Carol and Ron, improved so much with the low dosage of medication that in combination with behavior therapy it appeared to be the treatment of choice. The remaining four children showed maximal improvement only when the higher dose was administered after 13 weeks of behavioral intervention.

Conclusion

First, the optimum average dosage of methylphenidate for these children may have been between .25 and .75 mg/kg. Alternatively, the optimum medication effect might have been reached not by increasing the dosage but by repeating the administration at midday (e.g., Pelham, Schnedler, Miller, Ronnei, Paluchowski, Budrow, Nilsson, Bender, & Marks, Note 2). Second, dextroamphetamine or pemoline might have shown similar results when combined with a behavioral intervention. Because both these stimulants are available in forms that have longer effective spans of action, their use might have shown even better results than those reported herein. Finally, although our conclusions are limited by the use of the probe technique and by the lack of a no-treatment control group, these data suggest that for six of the children we treated, a combination of behavioral intervention and psychostimulant medication was the treatment of maximum short-term effectiveness. Although the children's behavior definitely improved with behavioral intervention, it continued to improve when medication was added. Psychostimulant medication thus appears to be a valuable adjunctive treatment for hyperactive children receiving behavior therapy, and its more frequent use by behavior therapists in consultation with knowledgeable physicians appears to be warranted. Whether this conclusion will hold for prolonged treatment and long-term results is a question of extreme importance that remains to be an answered.

REFERENCE NOTES

1. Pelham, W. E., Paluchowski, C., Ronnei, M., O'Bryan, B., & Wilson, J. Teaching social skills to hyperactive children: The effects of reward and instruction in the laboratory and in the natural environment. Unpublished manuscript, Department of Psychology, Florida State University, Tallahassee, FL 32306. Available from the first author.
2. Pelham, W. E., Schnedler, R. W., Miller, J., Ronnei, M., Paluchowski, C., Budrow, M., Nilsson, D., Bender, M., & Marks, D. The combination of behavior therapy and psychostimulant medication in the treatment of hyperactive children: A therapy outcome study. Paper presented at the annual meeting of the Association for the Advancement of Behavior Therapy, San Francisco, CA, December, 1979.

REFERENCES

American Psychiatric Association's Diagnostic and Statistical Manual. Washington D.C.: American Psychiatric Association, 1968.

Ayllon, T., Laymen, 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., & Cunningham, C. The parent-child interactions of hyperactive children and their modification by stimulant drugs. *Archives of General Psychiatry,* 1979, **36,** 201-211.

Bolstad, D., & Johnson, S. The relationship between teacher's assessment of students and students' actual behavior in the classroom. *Child Development,* 1977, **48,** 570-578.

Bornstein, R., & Quevillon, R. The effects of a self-instructional package on overactive preschool boys. *Journal of Applied Behavior Analysis,* 1976, **9,** 179-188.

Brundage-Aguar, D., Forehand, R., & Ciminero, A. A review of treatment approaches for hyperactive behavior. *Journal of Clinical Child Psychology,* 1977, Spring, 3-10.

Conners, C. K. A teacher rating scale for use in drug studies with children. *American Journal of Psychiatry,* 1969, **126,** 884-894.

Conners, C. K. Symptom patterns in hyperkinetic, neurotic and normal children. *Child Development,* 1970, **41,** 667-682.

Conners, C., Goyette, D., Southwick, D., Lees, J., & Andrulonis, P. Food additives and hyperkinesis: a controlled doubleblind experiment. *Pediatrics,* 1976, **58,** 154-166.

Douglas, V., Parry, P., & Marton, P. Assessment of a cognitive training program for hyperactive children. *Journal of Abnormal Child Psychology,* 1976, **4,** 389-410.

Eisenberg, L. Hyperkinesis revisited. *Pediatrics,* 1978, **61,** 319-320.

Evans, I., & Nelson, R. Assessment of child behavior problems. In A. Ciminero, K. Calhoun & H. Adams, (Eds.), *Handbook of behavioral assessment.* New York: Wiley, 1977.

Friedling, C., & O'Leary, S. G. Effects of self instructional training on second- and third-grade hyperactive children: A failure to replicate. *Journal of Applied Behavior Analysis,* 1979, **12,** 211-219.

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

Hartmann, D., Roper, B., & Gelfand, D. An evaluation of alternative modes of child psychotherapy. In B. Lahey & A. Kazdin (Eds.) *Advances in clinical child psychology* Vol. 1. New York: Plenum, 1977.

Hays, W. *Statistics for psychologists.* New York: Holt, Rinehart & Winston, 1963.

Humphries, T., Kinsbourne, M., & Swanson, J. Stimulant effects on cooperation and social interactions between hyperactive children and their mothers. *Journal of Child Psychology and Psychiatry,* 1978, **19,** 13-22.

Kent, R., & O'Leary, K. D. A controlled evaluation of behavior modification with conduct problem children. *Journal of Consulting and Clinical Psychology,* 1976, **44,** 586-596.

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.

Meichenbaum, D., & Goodman, J. Training impulsive children to talk to themselves. *Journal of Abnormal Psychology,* 1971, **77,** 115-126.

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

O'Leary, K. D., & Johnson, S. B. Psychological assessment. In H. Quay & J. Werry (Eds.), *Psychopathological disorders of childhood* (2nd ed.). New York: Wiley, 1979.

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.

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

Palkes, H., Stewart, M., & Kahana, B. Porteus maze performance of hyperactive boys after training in self-directed verbal commands. *Child Development,* 1968, **39,** 817-826.

Patterson, G. *Families: Application of social learning to family life.* Champaign: Research Press, 1976.

Pelham, W. E. Withdrawal of a stimulant drug and concurrent behavior intervention in the treatment of a hyperactive child. *Behavior Therapy,* 1977, **8,** 473-479.

Pelham, W. E. Hyperactive children. In R. P. Liberman (Ed.), Symposium on Behavior Therapy in Psychiatry. *Psychiatric Clinics of North America,* 1978, **1,** 227-246.

Quinn, P., & Rapaport, J. A one year follow-up of hyperactive boys treated with imipramine or methylphenidate. *American Journal of Psychiatry,* 1975, **132,** 241-245.

Rie, H., Rie, E., Stewart, S., & Ambuel, J. Effects of methylphenidate on underachieving children. *Journal of Consulting and Clinical Psychology,* 1976, **44,** 250-260.

Routh, D. K., Schroeder, C. S., & O'Tuama, L. A. Development of activity level in children. *Developmental Psychology,* 1974, **10,** 163-168.

Safer, D. M., & Allen, R. P. Factors influencing the suppressant effects of stimulant drugs on the growth of hyperactive children. *Pediatrics,* 1973, **51,** 660-667.

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

Sroufe, L. A. Drug treatment of children with behavior problems. In F. Horowitz (Ed.), *Review*

of child development research (Vol. 4). Chicago: University of Chicago Press, 1975.

Swanson, J., & Kinsbourne, M. The effects of stimulant drugs on hyperactive children. In G. Hale and M. Lewis (Eds.) *Attention and the development of cognitive skills.* New York; Plenum, 1979.

Taplin, P., & Reid, J. Changes in parent consequences as a function of family intervention. *Journal of Consulting and Clinical Psychology,* 1977, **45,** 973-981.

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. Methylphenidate in children: effect of dosage. *Australian and New Zealand Journal of Psychiatry,* 1974, **8,** 9-19.

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.

Winer, B. J. *Statistical principles in experimental design.* New York: McGraw-Hill, 1971.

Wolraich, M., Drummond, T., Salomon, M., O'Brien, M., & Sivage, C. Effects of methylphenidate alone and in combination with behavior modification procedures on the behavior and academic performance of hyperactive children. *Journal of Abnormal Child Psychology,* 1978, **6,** 149-161.

Received July 18, 1978
Final acceptance December 12, 1979