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A Four-Year Follow-Up Study of the Effects of Methylphenidate on the Behavior and Academic Achievement of Hyperactive Children

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Sixty-two children were evaluated 4 years after their initial referral for symptoms of hyperactivity. Behavioral measures included parent and teacher judgments of behavior and social adjustment. Academic achievement was assessed by teachers' reports, number of failed grades, special education services, and two individually administered achievement tests. Data were analyzed for the total group to determine both the extent to which presenting problems diminished over time and the major problems still present. The effects of stimulant drug therapy on outcome were assessed by dividing the children into groups according to the duration of time they had taken stimulants. Total duration of time on stimulants ranged from less than 6 months (group 1) to 4 years (group 5). Results indicated that the symptoms of hyperactivity significantly lessened, but remained higher in these children than in normal peers. Behavioral and social problems were less pervasive than academic underachievement. There were no group differences, indicating that the duration of stimulant intervention did not have a significant effect on outcome. The clinical implication of this study is that the beneficial effects of stimulant drug intervention occur within the first months after initiation of therapy. Long-term treatment does not appear to be of value in producing better outcome.

Follow-up studies of adolescents and young adults who had been diagnosed hyperactive as children have resulted in new attitudes regarding the prognosis of this syndrome. Early investigators regarded hyperactivity as a childhood behavioral problem with symptoms that diminish and disappear over time (Bradley, 1957; Laufer & Denhoff, 1957). This viewpoint was

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challenged by reports that hyperactive children were at risk for antisocial and delinquent behavior in adolescence (Huessey & Cohen, 1976; Mendelson, Johnson, & Stewart, 1971; Weiss, Minde, Werry, Douglas, & Nemeth, 1971), psychopathology as adults (Menkes, Rowe, & Menkes, 1967), poor peer relationships and low self-esteem as adolescents and adults (Borland & Heckman, 1976; Minde, Weiss, & Mendelson, 1972; Stewart, Mendelson, & Johnson, 1973; Weiss et al., 1971), and underachievement in school and at work (Borland & Heckman, 1976, Minde et al., 1972; Weiss et al., 1971). Studies using control groups for comparisons have yielded somewhat more positive reports. In a 10-year follow-up, Weiss, Hechtman, and Perlman (1978) reported that, as young adults, hyperactives felt less positive about their personality strengths than nonhyperactive controls but did not report more psychopathological problems. In a related report, Weiss, Hechtman, Perlman, Hopkins, and Wener (1979) described hyperactives as more impulsive and restless than normal controls but observed that these characteristics did not keep them from functioning socially, attending schools, or holding jobs, and that only a small minority of the hyperactives demonstrated serious psychopathology or antisocial behavior at follow-up. Hoy, Weiss, Minde, and Cohen (1978) reported no differences between hyperactives and controls in number of friends, although hyperactives spent more time alone or with younger children.

Although underachievement appears to persist for hyperactive children (Barkley, 1978; Hoy et al., 1978; Milich & Loney, 1979), there is evidence that this is characteristic of learning-disabled children in general and is not related to activity levels (Akerman, Dykman, & Peters, 1977; Blounin, Bornstein, & Trites, 1978). Further, it appears that hyperactives as young adults are viewed as positively as nonhyperactives by their employers (Weiss et al., 1978).

In spite of these reports, it is clear that symptoms of hyperactivity may persist and affect adolescent and adult life, and that secondary personality or socialization problems may arise (Barkley, 1978; Milich & Loney, 1979). A major goal of current research is to identify childhood factors that predict good adolescent and adult outcomes. One factor under investigation is the consequence of successful treatment of childhood hyperactivity with stimulant medications.

There is considerable evidence of the short-term efficacy of stimulants on the symptoms of hyperactivity. There is also a strong clinical belief that successful intervention will prevent failure experiences and therefore predict better futures for treated versus untreated children. To date, however, follow-up studies have not revealed evidence of long-term benefits of treatment with stimulant medication (Akerman et al., 1977; Blounin et al., 1978; Loney, Langhorne, Paternite, Whaley-Klahn, Blair-Broeker, & Hacker, 1980; Minde et al., 1972; Riddle & Rapoport, 1976; Weiss, Kruger,

Danielson, & Elman, 1975). Further, long-term studies have failed to demonstrate that stimulant effects maintain for a long period of active intervention (Charles, Schain, & Guthrie, 1979, 1980; Safer & Allen, 1975).

Failure to find differences in long-term outcome associated with stimulant intervention does not necessarily mean they do not exist. Measures employed may have been insensitive to subtle but important group differences in outcome, or groups compared may have failed to reflect critical differences in drug intervention.

The purposes of the present study were to evaluate the influence of duration of stimulant intervention on the school achievement, social functioning, and behavior of hyperactive children, and to determine if the benefits of stimulants maintain over years of continuous use. Multiple indices of each variable under study were used. All children were evaluated 4 years after initiation of stimulant medication.

METHOD

Procedure

A 4-year follow-up visit was scheduled for children who had been referred to the UCLA Department of Pediatrics for symptoms of hyperactivity, including short attention span, restlessness, distractibility, and impulsivity. The original sample consisted of 98 children who had participated in a 16-week study of the effects of methylphenidate and had been treated either with active drug or placebo during that time (Schain & Reynard, 1975). Of the 70 children we were able to locate from this sample, 57 came in for an office visit, and partial information was collected by mail for 5. The parents of the remaining 8 children either declined follow-up testing or were unable to participate. Comparisons of children who came in for the follow-up visit and those who did not indicated no significant differences in age, IQ, parents' education, or severity of referral symptoms.

Subjects

At the follow-up visit, the sample of 62 children were from 10 to 16 years old. Mean age was 12 years 3 months, with a standard deviation of 1 year 7 months. Forty-nine boys and 13 girls participated in the study; 55 were Anglo, 6 were black, and 1 was Hispanic. All were from middle-income families, and all resided in urban or suburban areas surrounding Los Angeles. Full-scale IQ scores on the Wechsler Intelligence Scale for Children (WISC) at the time of initial testing ranged from 78 to 138, with a

mean of 104.2 (SD = 13.8). In the original study, 84% of these children (N = 52) had been clinically judged to have a positive response to stimulant medication (methylphenidate), 13% (N = 8) had been classified as drug failures, and 3% (N = 2) had been rated improved on placebo. All of the children were in good physical health, although a substantial number (N = 15) suffered from mild to severe allergy. Eighty-one percent (N = 50) were off all behavior medications at the follow-up visit, while 12 (19%) were still taking methylphenidate (N = 11) or pemoline (N = 1).

There were several reasons the 50 children off stimulants at the follow-up visit had discontinued methylphenidate. Seventeen children (34%) discontinued because the drug no longer seemed necessary or had been successfully withheld for a period of time; medications were judged no longer effective for 11 (22%); 8 (16%) had adverse physiological effects to methylphenidate; and 5 (10%) had had inadequate therapeutic response. The remaining 9 children (18%) discontinued because their parents, teachers, or the children themselves worried about possible negative effects of long-term stimulant use.

Decisions to discontinued medications were made in accordance with medical recommendations in 22 cases. In an additional 22 cases, parents made the decision on their own, and at least 4 of these decisions were contrary to medical advice. Three children refused to continue stimulants, and 1 discontinued without his parents' knowledge. Medications were discontinued for 2 children in response to recommendations by teachers.

Twelve children were still on stimulants at the follow-up visit. Seven had prior recommendations from this office to decrease and/or discontinue medications, and 1 was continuing stimulants with our concurrence. The other 4 children were being monitored by private physicians. Only 1 of these 12 children exhibited signs of restlessness or distractibility during testing, while 4 were noted to be quiet, anxious, or withdrawn.

Taken together, these figures suggest that severity of hyperactivity and therapeutic response to methylphenidate were less influential factors in decisions to continue or discontinue medications than attitudes of parents, children, and teachers regarding the positive and negative effects of stimulants.

Measures

Follow-up information from the parents included a structured clinical interview, a Conners Abbreviated Rating Scale, and Global Functioning Ratings of the severity of the child's problem and the degree of change since the original visit. The child's teacher completed and returned by mail a

questionnaire reflecting current academic and social functioning, a Conners Abbreviated Rating Scale, and a 4-point Global Functioning Scale. Psychometric testing included the Wide Range Achievement Test (WRAT) reading, mathematics, and spelling subtests, and the Peabody Individual Achievement Test (PIAT). Comparison data were available from the initial visit for the parent and teacher Conners scales and the Global Functioning ratings.

The Conners scale consists of 10 statements of behavioral characteristics associated with hyperactivity, which are rated from 0 = "not at all" to 3 = "very much." Scores of 15 or more have been judged to indicate clinical hyperactivity (Charles, Schain, Zelniker, & Guthrie, 1979). Teacher ratings of normal children have been reported to yield a mean of 4.3 with a *SD* of 5.2 (Werry, Sprague, & Cohen, 1975). The Global Functioning Scale is an overall assessment of the child's functioning at home or school. Scores range from 4 = excellent to 1 = poor.

Data Analysis

Changes in behavior for the total sample were analyzed using *t*-test comparisons of initial and follow-up scores with two-tailed significance levels. Follow-up data were also evaluated in terms of length of time on medications. The purpose of these analyses was to determine whether longer treatment with stimulants was associated with better outcome or higher academic achievement. The children were grouped into five categories.

1. Children who had not been on stimulants or who had received them for less than 6 months. These children were primarily the drug failures and placebo successes from the original study.
2. Children whose drug intervention had lasted more than 6 months but less than 2 years.
3. Children who had been on stimulants for 2 to 3 years.
4. Children who had received medications for 3 to 4 years, but who had discontinued medications at least 1 month prior to the follow-up.
5. Children still taking stimulants at the time of the follow-up.

Separate one-way analyses of variance were computed for each variable in Table I to determine group equivalene at the time of referral. There were no group differences for sex, age, IQ, or initial severity of the problem as rated by teachers on the Conners scale or by parents and teachers on the Global Functioning scales. Groups differed in parents' initial Conners ratings, $F = 3.71$, df 4, 57, $p < .01$. Newman-Keuls post hoc comparisons of group mean scores indicated that parents rated children in

Table I. Demographic Variables for Time-on-Drug Groups (Standard Deviations in Parentheses)

	Group 1	Group 2	Group 3	Group 4	Group 5	Total
Number	13	10	14	13	12	62
Males	8	7	11	11	12	49
Mean age (years)	12.3	12.3	12.9	12.4	10.9	12.2
	(1.8)	(1.2)	(1.8)	(1.5)	(.7)	(1.6)
Mean IQ	103.5	103.5	103.2	108.1	103.2	104.2
	(17.1)	(9.8)	(15.6)	(11.0)	(14.0)	(13.8)
Initial Conners-parent	17.0	20.2	20.9	23.5	16.5	19.8[a]
	(5.4)	(4.8)	(5.9)	(4.2)	(6.2)	(5.8)
Initial Conners-teacher	17.2	17.8	16.4	16.1	18.5	17.1
	(3.7)	(5.8)	(7.1)	(7.2)	(6.0)	(6.2)
Global Functioning-parent	1.9	2.5	1.9	1.9	2.3	2.1
	(.3)	(.5)	(.7)	(.5)	(.6)	(.6)
Global Functioning-teacher	1.7	1.4	1.8	1.6	1.5	1.6
	(.7)	(.7)	(.9)	(.8)	(.5)	(.8)

[a] $p < .01$, one-way analysis of variance, two-tailed test of significance, df 4,57.

groups 1 and 5 least hyperactive, children in groups 2 and 3 next, and children in group 4 most hyperactive.

RESULTS

Parent Reports

Information from the parent inverviews was generally optimistic. Eighty-seven percent of the parents felt their children had improved in the 4-year period, 6% ($N = 4$) saw no change, and 6% ($N = 4$) felt their children were worse. Forty-one percent judged their child's problem as minor compared to 21% at the initial visit, and 7% felt their child no longer had a problem.

Mean scores for the Conners scale dropped from 19.8 ($SD = 5.8$) at the initial visit to 10.3 ($SD = 5.7$), $t = 11.4$, df 61, $p < .001$, at the follow-up. Mean scores on the Global Functioning Scale improved from 2.1 to 2.4, $t = 3.0$, df 61, $p < .005$. The mean differences between initial and follow-up scores on the Conners and Global Functioning evaluations and significance levels are reported in Table II. A one-way analysis of variance indicated no group differences in improvement.

Forty-eight parents (77%) reported that their children had friends both at home and at school and had no special problem making or keeping friends. For most of those who were reported to have social problems, the difficulty was attributed to shy, withdrawn behavior and/or low

competence in sports. Several parents mentioned that their children preferred younger friends, and immature, overeager and loud behavior was reported as interfering with adequate social adjustment. Only 3 of the 14 parents reporting poor peer relationships said that their child's unpopularity was due to aggressiveness, teasing, or bullying.

Teachers' Reports

School reports were available for 57 of the 62 children. Teachers' overall evaluations of the severity of the child's problem showed some improvement over the 4-year period, although not to the degree predicted by the parents' reports. Conners ratings from teachers improved from a mean of 17.2 (SD = 6.2) at the initial visit to a mean of 12.7 (SD = 6.9) at the follow-up, t = 4.1, df 57, $p < .001$. However, the mean scores remained considerably above the norms reported for nonhyperactive children (Werry et al., 1975). The Global Functioning ratings from teachers were also significantly improved, t = 3.7, df 57, $p < .001$. Group differences in improvement were not significant (see Table II).

Teachers reported greater social difficulties for the children than had parents. Thirty-eight (66%) were judged adequate in their ability to get along with other children. Of the 19 who did not get along well, 14 were rated loud, immature, or aggressive, with only 5 judged shy or withdrawn. Further, 29% (N = 17) were evaluated as unable to accept responsibility and classroom limits, with an additional 8 (14%) judged inconsistent in that ability.

However, the major problem for these children appeared to be in school achievement. Seventy-four percent (N = 43) were judged as achieving below grade level expectancy in reading, 69% (N = 40) in mathematics, and 66% (N = 38) as unable to sustain attention. In addition, 21 of the 62 children (34%) had repeated one or more grades, 26 (42%) were

Table II. Mean Behavioral Improvement for Time-on-Drug Groups[c]

	Group 1	Group 2	Group 3	Group 4	Group 5	Total
Difference-Conners-parent	−8.1	−11.0	−8.3	−11.7	−8.8	−9.5[b]
Difference-Conners-teacher	−4.7	− 6.5	−1.9	− 4.1	−7.0	−4.5[b]
Difference-Global-parent	.38	.10	.29	.54	.36	.34[a]
Difference-Global-teacher	.75	.88	.07	.82	.89	.63[b]

[a] $p < .005$ (t-test comparisons of initial versus follow-up scores for total sample, two-tailed significance levels).
[b] $p < .001$.
[c] One-way analysis of variance for group differences, n.s.

in special class placements, and 15 (24%) were being tutored. Only 35% (N = 22) of our sample were receiving regular classroom instruction in their expected grades without support services. Chi-square tests indicated no group differences in teachers' reports of children functioning below grade level, number of repeated grades, number in special education placements, or number currently tutored (see Table III).

Achievement Test Scores

Confirmation of these children's academic difficulties was provided by the achievement tests administered at the follow-up visit (N = 57). The discrepancy between each child's age and achievement on the PIAT and between each child's expected grade and his achievement on the WRAT were calculated and compared by group (see Table IV). Seventy-seven percent were 2 or more years below grade level on one or more of the PIAT or WRAT subtests. On the PIAT total score, 37% were at or above expected grade level, while 48% were 2 or more years below grade level. One-way analysis of variance for each variable indicated no statistically significant differences between groups, although there was a nonsignificant tendency for those groups on drug longest (groups 4 and 5) to be performing closer to grade level than those with the shortest drug interventions (groups 1 and 2). This trend was not, however, linear. The children still receiving stimulants (group 5) were farther below expected achievement levels than group 4, and the children with the shortest drug interventions (group 1) were less disabled than group 2 (see Table IV).

Table III. Academic Achievement for Time-on-Drug Groups[a]

	Group 1	Group 2	Group 3	Group 4	Group 5	Total
Teacher reports of below grade level work						
Reading	77%	75%	64%	73%	83%	74%
Spelling	69%	75%	64%	55%	75%	67%
Mathematics	69%	100%	56%	73%	58%	69%
Written composition	69%	75%	71%	73%	92%	76%
Ability to sustain attention	38%	75%	71%	73%	75%	66%
Unclear oral language	15%	12%	14%	45%	50%	28%
Percentage of repeated grades	46%	50%	36%	31%	8%	34%
Special education class placement	31%	60%	36%	31%	58%	42%
Currently tutored	15%	30%	14%	23%	41%	24%

[a] χ^2 tests of group differences, n.s.

Table IV. Achievement Tests for Time-on-Drug Groups[a]

	Group 1	Group 2	Group 3	Group 4	Group 5	Total
WRAT: Difference (years) between expected grade and achievement						
Math	−2.0	−2.9	−3.0	−2.3	−1.1	−2.2
Reading recognition	−.9	−1.7	−1.2	−.4	−.6	−.9
Spelling	−2.0	−2.4	−2.5	−1.4	−1.5	−1.9
PIAT: Difference (months) between age and achievement						
Math	−16.7	−19.1	3.1	1.8	1.3	*−5.6*
Reading recognition	**−24.9**	**−26.4**	**−19.0**	**−7.9**	−21.4	−19.6
Reading comprehension	−25.7	−22.8	−8.6	5.9	−10.4	−12.0
Spelling	−27.8	−38.2	−28.4	−15.0	−20.6	−25.5
Information	−15.9	−12.1	−12.5	1.4	−7.2	−10.7
Total test	−23.1	−28.2	−14.0	−4.3	−14.3	−16.3

[a]One-way analysis of variance, two-tailed tests of significance, *df* 4,52, n.s.

DISCUSSION

Three major conclusions may be drawn from these data. The first two of these are consistent with prior follow-up studies. First, hyperactive children improve behaviorally over time; they do not, however, entirely outgrow their social problems. Most were still evaluated as having problems by teachers and parents, and the mean behavioral ratings on the Conners scale remained above population norms. Interestingly, parents and teachers did not, in most cases, view peer acceptance as a major problem.

Second, underachievement in school remained a significant problem for these children. Many had repeated grades, were in special educational class placements, and were currently being tutored. Within these placements, teachers reported that the majority were performing below grade level in academic subjects and had difficulty in sustaining attention. Achievement tests confirmed that most of the children were functioning well below the norms for children their age. In sum, only a fairly small percentage were at an academic level commensurate with their age and IQ scores.

Third, differences in duration of stimulant drug intervention failed to produce a statistically significant difference in the groups tested on any outcome variable, nor were there clear directional trends favoring the group still on stimulants (group 5). It was expected that comparisons of groups with different lengths of treatment would reveal differences in outcome that were not demonstrated by simple medicated-nonmedicated comparisons. At the least, it was expected that children still on stimulants would be demonstrably different from children who had discontinued stimulants. These differences were not apparent for either the achievement or behavioral measures. These findings suggest that the benefit derived from stimulants occurs early in the course of treatment. Prolonged administration of medication does not appear to result in outcomes different from early termination of medication.

The clinical implication of this study is that expectations regarding stimulant drug intervention are best based on the immediate behavioral effects that often result in a respite period and allow orderly planning of educational interventions. The belief that long-term drug intervention will continue to be of value or produce better outcome in hyeractive children has not been substantiated by this or other studies.

REFERENCES

Akerman, P. T., Dykman, R. A., & Peters, J. E. Teenage status of hyperactive and non-hyperactive learning disabled boys. *American Journal of Orthopsychiatry,* 1977, *47,* 577-596.

Barkley, R. A. Recent developments in research on hyperactive children. *Journal of Pediatric Psychology,* 1978, *3,* 158-163.

Blounin, A. G., Bornstein, R. A., & Trites, R. L. Teenage alcohol use among hyperactive children: A five year follow-up study. *Journal of Pediatric Psychology,* 1978, *3,* 188-194.

Borland, B. L., & Heckman, H. K. Hyperactive boys and their brothers. *Archives of General Psychiatry,* 1976, *33,* 669-675.

Bradley, C. Characteristics and management of children with behavior problems associated with organic brain damage. *Pediatric Clinics of North America,* 1957, *4,* 1049-1060.

Charles, L., Schain, R. & Guthrie, D. Long-term use and discontinuation of methylphenidate with hyperactive children. *Developmental Medicine and Child Neurology,* 1979, *21,* 758-764.

Charles, L., Schain, R., & Guthrie, D. A study of prolonged administration of methylphenidate in childhood hyperactivity. In W. M. Cruickshank (Ed.), *Approaches to learning* (Vol. 1): *The best of ACLD.* Syracuse: Syracuse University Press, 1980.

Charles, L., Schain, R., Zelniker, T., & Guthrie, D. Effects of methylphenidate on hyperactive children's ability to sustain attention. *Pedriatrics,* 1979, *64,* 412-418.

Hoy, E., Weiss, G., Minde, K., & Cohen, N. The hyperactive child at adolescence: Cognitive, emotional, and social functioning. *Journal of Abnormal Child Psychology,* 1978, *6,* 311-324.

Huessey, H. R., & Cohen, A. H. Hyperkinetic behaviors and learning disabilities followed over seven years. *Pediatrics,* 1976, *57,* 4-10.

Laufer, M. W., & Denhoff, E. Hyperkinetic behavior syndrome in children. *Journal of Pediatrics,* 1957, *50,* 463-474.

Loney, J., Langhorne, J. E., Jr., Paternite, C. E. , Whaley-Klahn, M. A., Blair-Broeker, C. T., & Hacker, M. The Iowa habit: Hyperkinetic/aggressive boys in treatment. In S. B. Sells (Ed.), *Human functioning in longitudinal perpectives: Studies of normal and psychopathic populations.* Baltimore: Williams and Wilkins, 1980.

Mendelson, W., Johnson, N., & Stewart, M. A. Hyperactive children as teenagers: A follow-up study. *Journal of Nervous and Mental Disease,* 1971, *153,* 273-279.

Menkes, M. M., Rowe, J. S., & Menkes, J. H. A twenty-five year follow-up study of the hyperkinetic child with minimal brain dysfunction. *Pediatrics,* 1967, *39,* 393-399.

Milich, R., & Loney, J. The role of hyperactive and aggressive symptomatology in predicting adolescent outcome among hyperactive children. *Journal of Pediatric Psychology,* 1979, *4,* 93-112.

Minde, K., Weiss, G., & Mendelson, N. A 5-year follow-up study of 91 hyperactive school children. *Journal of the American Academy of Child Psychiatry,* 1972, *11,* 595-610.

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.

Safer, D. J., & Allen R. P. Stimulant drug treatment of hyperactive adolescents. *Diseases of the Nervous System,* 1975, *36,* 454-457.

Schain, R. J., & Reynard, C. L. Observations on effects of a central stimulant drug (methylphenidate) in children with hyperactive behavior. *Pediatrics,* 1975, *55,* 709-716.

Stewart, M. A., Mendelson, W. B., & Johnson, N. E. Hyperactive children as adolescents: How they describe themselves. *Child Psychiatry and Human Development,* 1973, *4,* 3-11.

Weiss, G., Hechtman, L., & Perlman, T. Hyperactives as young adults: School, employer, and self-rating scales obtained during a ten-year follow-up evaluation. *American Journal of Orthopsychiatry,* 1978, *48,* 438-445.

Weiss, G., Hechtman, L., Perlman, T., Hopkins, J., & Wener, A. Hyperactives as young adults. *Archives of General Psychiatry,* 1979, *36,* 675-682.

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

Weiss, G., Minde, K. Werry, J. S., Douglas, V. I., & Nemeth, E. Studies on the hyperactive child. *Archives of General Psychiatry,* 1971, *24,* 409-414.

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