Effects of Methylphenidate on Preschool Children With ADHD: Cognitive and Behavioral Functions

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ABSTRACT

Objective: To report on implications for methylphenidate treatment of this very young age group and the need to examine factors related to achieving compliance. **Method:** Thirty-one children with attention-deficit hyperactivity disorder (ADHD), aged 4 to 6 years, participated in a double-blind, placebo-controlled study using placebo, 0.3 mg/kg, and 0.5 mg/kg of methylphenidate twice per day. **Results:** Improvements related to medication were obtained on cognitive tests of attention and impulsivity as well as behaviors assessed by parent rating scales. In an interactive setting with their mothers, attentional abilities and the children's ability to work more productively also showed improvement. However, no changes were obtained with respect to the children's tendency to comply with parental requests. Side effects increased slightly with the high dosage of medication but remained mild. **Conclusion:** The results suggest that methylphenidate can be used to improve the functioning of preschool-age children with ADHD, in a manner similar to their school-age counterparts. *J. Am. Acad. Child Adolesc. Psychiatry,* 1997, 36(10):1407–1415. **Key Words:** attention-deficit hyperactivity disorder, methylphenidate, preschool children.

Current research indicates that problematic behaviors suggestive of ADHD are identifiable in the preschool age group (see Campbell, 1995, for a review; Campbell, 1985, 1990). Furthermore, the social and academic outcomes for very young children with these symptoms are reported to be poor (McGee et al., 1991; Pisterman et al., unpublished). Although treatment with medication is available as for older children with ADHD, the evidence of its overall efficacy with very young children remains to be established.

Investigations into the use of methylphenidate (MPH) for the treatment of ADHD have been extensively documented with older children (Rapoport and Castellanos, 1996). However, there are fewer studies examining its use with very young children and these have been methodologically and conceptually problematic. Specifically, some studies have subsumed the younger group in a wider age range. This may disregard developmental differences in presenting symptoms and possibly confound treatment responses. A few studies have used the 4- to 6-year-old age range exclusively (Barkley, 1988a; Cohen et al., 1981; Conners, 1975; Cunningham and Barkley, 1978; Cunningham et al., 1985; Mayes et al., 1994; Schliefer et al., 1975). However, clinical issues and methodological differences make it difficult to determine whether or not there are overall patterns of treatment effectiveness. Particular constraints to developing firm conclusions include differences in diagnostic methods, absence of baseline or placebo conditions, and wide age ranges among subjects (Barkley, 1988b; Barkley et al., 1984; Pelham et al., 1989).

This study examines the effectiveness of MPH in ameliorating the symptoms of ADHD in the cognitive, behavioral, and interpersonal domains of a group of 4- to 6-year-old children. Its evaluation is based on the principles of a multimethod, multiassessor framework recommended by Barkley et al. (1988).

Accepted December 20, 1996.

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This research was supported by Health Canada grant 6606-4979-63.

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METHOD

Subjects

One hundred nine children between the ages of 4 and 6 years were recruited over a 2-year period from the Children's Hospital of Eastern Ontario and local area physicians. At initial contact, 43 families did not wish to take part in a research study. Of the 66 families who agreed to participate and completed the screening assessment, 54 children met the following diagnostic and research criteria:

1. The children met *DSM-III-R* (American Psychiatric Association, 1987) criteria for the diagnosis of ADHD as reported by the parent in the Diagnostic Interview for Children and Adults-Parents (DICA-P) (Herjanic and Reich, 1982; Reich et al., 1982) and the Swanson, Nolan and Pelham Checklist (SNAP) (Johnston et al., 1985; Pelham and Bender, 1982). Items are included on the SNAP that reflect the *DSM-III-R* criteria. Criterion for inclusion was a score greater than 1, on 8 of 14 *DSM-III-R* items.
2. The children had a standard score ≥80 on the Peabody Picture Vocabulary Test (Dunn and Dunn, 1981) if unilingual English, ≥72 if bilingual.
3. The children had a mean score equal to 1.5 SD above the age and sex mean on the Hyperactivity Index of the Conners Parent Rating Scale-Revised (CPRS-R) (Conners, 1989) completed by the parent. Reports from day-care providers or preschools were also required to indicate problem behavior.
4. The children had an attention score of less than 88 seconds on the parent-supervised attention task. This criterion is 1.5 SD above the mean for attention on the task performed by normal preschool children (Pisterman et al., 1989, 1992).
5. The children were not attending or entering grade 1 at the time of assessment or for the duration of the study.
6. Parents and children were fluent in English.
7. The children did not have sensory or physical handicaps, developmental disorders (e.g., autism), neurological disease, or obvious CNS dysfunction as assessed by a pediatrician.
8. Children who had received MPH were considered if they had been treated for less than 6 months and if the daily dose was less than that specified for the research protocol ($n = 2$). Medication was withdrawn for 48 hours prior to the screening assessment.

A final total of 41 children participated in the medication phase after parents received feedback and gave informed consent for medication. Of these, 31 children completed the treatment regimen, 4 children withdrew from treatment, and 6 children did not have completed assessment protocols (questionnaires) after one or all of the treatment phases. Table 1 summarizes the comparison of the inclusion criteria for the children who participated with the children whose parents declined medication treatment despite meeting inclusion criteria. The ages of the children with ADHD who participated in treatment ranged from 48 months to 70 months, and they were generally more symptomatic than children whose parents refused treatment participation.

Screening

All sessions were conducted in an observation room equipped with comfortable furniture and age-appropriate toys. Intake information was collected in the first session, and the children were assessed in two consecutive sessions. Feedback was provided and treatment consent was received in a fourth session.

Treatment

Medication. Two doses (0.3 mg/kg and 0.5 mg/kg) of MPH and a lactose placebo were prepared by the pharmacy at the Children's Hospital of Eastern Ontario to the nearest 2.5 mg and placed in orange gelatin capsules (size 16, Ely Lilly Company) to disguise the taste differences between placebo and the two doses. Each dose of MPH was administered twice daily (b.i.d.).

All participants received a minimum of 7 days and a maximum of 10 days of treatment on each of placebo, low dose (0.3 mg/kg), and higher dose (0.5 mg/kg) of MPH. Dosage was determined by the weight of the child. Treatment was presented in a fully randomized order prepared by the hospital's pharmacy department; all subjects, research personnel, and medical personnel were unaware of the order.

At the end of each treatment period, the child and parent attended two sessions on consecutive days. The rating scales and cognitive tasks were administered in one session, and the parent–child interactive tasks were administered in the other. The order of administration of sessions was randomized across children and treatment conditions. Parents were instructed to administer the medication at least one-half hour before the assessment. Treatment compliance was determined by counting the number of pills returned to the researcher at the end of each assessment week. Alternative approaches to monitoring medication compliance, such as urinalysis, were considered too intrusive for this population.

Parent–Child Interaction Tasks. Each child and parent accepting treatment was observed and videotaped trough a one-way mirror

TABLE 1
Means and Standard Deviations of Inclusion Criteria for Treatment Completers and Treatment Refusers

	Treatment Completed ($n = 31$)		Treatment Refused ($n = 13$)		
Inclusion Criteria	Mean	SD	Mean	SD	$F(1,42)$
Age	58.07	6.51	55.62	5.91	1.36
PPVT (Standard Score)	99.26	14.41	102.31	16.24	0.38
DICA symptoms (number)	12.03	1.49	10.85	1.99	4.72*
SNAP symptoms (number)	11.48	1.91	9.62	2.82	6.56*
Conners Hyperactivity Index (T score)	84.61	9.95	67.77	20.26	13.82***
Attention Task-Supervised (sec)	30.43	10.36	36.15	32.51	0.79

Note: PPVT = Peabody Picture Vocabulary Test; DICA = Diagnostic Interview for Children and Adolescents; SNAP = Swanson, Nolan and Pelham Checklist.
*$p < .05$; ***$p < .001$.

while participating in three separate tasks. The first task (Compliance Task) was designed to evaluate the child's level of compliance. The second task (Dot-to-Dot Task) was designed to evaluate the child's attention span under parental supervision. The third task (Cancellation Task) was designed to evaluate the child's attention span in the absence of parental supervision.

Compliance Task. For the Compliance Task the parent was given a list of 20 instructions for the child to perform during a 20-minute period.

Dot-to-Dot Task. The Dot-to-Dot Task involved a 10-minute paper-and-pencil activity in which the child was required to connect patterns of dots to match adjacent patterns of increasing difficulty, while under parental supervision.

Cancellation Task. The Cancellation Task was a 10-minute paper-and-pencil activity requiring the child to cross out predetermined figures (either pictures of circles or elephants) interspersed with a collection of other figures. The parent was present but not involved in the task.

Coding of Parent–Child Interactions. The parent–child interactions during the behavioral assessment were coded from videotape by a rater who remained uninformed about treatment conditions for the duration of the study. All identified behaviors were coded continuously in 30-second blocks of parental antecedent, child response, and parental consequence sequences. Interrater reliability was established by a second rater who was also uninformed about the treatment condition. A random selection of one eighth of the tapes with equal representation of the three assessments and behavioral tasks were coded. For child on-task behaviors and child sustained activities, reliability checks were based on identification of the beginning and end of each period of sustained attention with 2-second margins of error. The κ statistics for each coded behavior range from .75 for percent of compliance to .97 for end of on-task behavior in the Cancellation Task.

Design

All children participated in all treatment conditions in a double-blind, drug-placebo crossover design using a placebo and two doses of MPH. In cases of prior administration of MPH (two subjects), medication treatment was discontinued for 48 hours before initial assessment.

Measures

Cognitive Measures. The Gordon Diagnostic System Delay and Vigilance Tasks were used to assess impulsivity (Delay Task, number of correct responses and efficiency ratio; Vigilance Task, number of correct responses and number of errors of commission). Raw scores were used in all cases except for the efficiency ratio, which was calculated as the ratio of the number of correct responses to the total responses on the Delay Task.

Behavioral Ratings. The CPRS-R was used as a measure of parent-observed pre-post behavioral changes. Scores on the Conduct, Learning, and Hyperactivity Index scales were converted to *T* scores for the 3- to 4-year-old normative group. Lower scores were associated with changes in the positive direction.

The Side Effects Rating Scale (Barkley, 1990) was used as a measure of changes in medication-related symptoms. It is composed of 17 symptoms usually associated with the use of MPH and is assessed on a 9-point scale. The total number of symptoms reported and the total rating of the symptoms were analyzed. Higher scores were associated with more symptoms and greater intensity of the symptoms.

Observed Behaviors. The percent of child compliance on each of the Compliance, Dot-to-Dot, and Cancellation Tasks was calculated as the frequency of child compliance relative to parental commands. Higher scores reflect a higher frequency of cooperation by the child with the parent's requests.

Time on-Task. The child's ability to sustain attention was assessed using the mean amount of time the child was coded as being on-task over the 10 minutes of each of the Dot-to-Dot and Cancellation Tasks. Higher scores reflect changes in the positive direction for ability to remain focused while supervised or unsupervised.

Productivity. The total number of patterns completed during the Dot-to-Dot Task and the total number of rows correctly canceled were used as measures of the child's ability to complete tasks accurately.

RESULTS

Twenty-six boys and five girls completed treatment. The mothers were 31 years of age (SD ±4.27) and had completed 13 years of education (SD ±2.42). The combined parental incomes for the families was $42,000 (SD ±$24,352). Seventy-four percent of children who completed treatment were in two-parent homes, 26% were in single-parent homes, and all of the single parents were receiving social assistance at the time of the assessment. Family income and parents' ages were not correlated significantly with inclusion variables.

All participants met clinical criteria for a diagnosis of ADHD on the basis of the DICA-P semistructured interview. None of the children met criteria for diagnoses of mood disorder, obsessive-compulsive disorder, overanxious disorder, somatization disorder, or psychotic symptoms. Oppositional defiant disorder and conduct disorder were diagnosed in 84% and 19%, respectively, of the children with ADHD.

Cognitive Tasks

Impulsivity and Attention. The number of correct responses and the efficiency ratio obtained from the Gordon Delay Task were analyzed using a repeated-measures multivariate analysis of variance with dose as the within-subjects factor (Table 2). Multivariate tests (Pillais') indicated an overall difference between conditions ($F[4,27] = 5.16$, $p < .01$). Univariate analyses indicated a significant difference in the number of correct responses ($F[2,60] = 9.93$, $p < .001$). Post hoc comparisons using the Tukey procedure (Stevens, 1992) indicated the number of correct responses during placebo treatment was less than the number of correct responses with 0.3 mg/kg and 0.5 mg/kg, $p < .05$. There were no differences between the two MPH conditions.

TABLE 2
Means and Standard Deviations of Cognitive Tests, Conners Parent Rating Scale, and Observed Behaviors by Dose

Variables	Condition			$F(2,60)$
	Placebo	0.3 mg/kg	0.5 mg/kg	
Cognitive tasks				
Gordon Delay				
No. correct				
Mean	27.77	37.55	34.10	9.93***
SD	11.31	11.57	13.14	
P < L; P < H				
Efficiency ratio				
Mean	0.57	0.63	0.63	1.02
SD	0.24	0.22	0.27	
Gordon Vigilance				
No. correct				
Mean	17.29	20.32	21.29	5.08**
SD	8.88	7.41	8.17	
P < L; P < H				
Commission errors				
Mean	14.87	18.00	16.65	0.33
SD	13.04	19.87	20.29	
Parent Rating Scales				
Conners				
Learning				
Mean	80.80	72.55	66.26	12.82***
SD	15.19	17.50	17.94	
P > L; P > H; L > H				
Conduct				
Mean	74.20	65.68	61.74	11.40***
SD	17.18	15.61	13.68	
P > L; P > H				
Hyperactivity Index				
Mean	77.23	67.03	63.29	15.82***
SD	14.10	15.39	13.44	
P > L; P > H				
Observed behaviors				
Child compliance				
Compliance Task				
% Compliance				
Mean	33.09	33.08	34.53	0.17
SD	14.92	15.53	16.06	
Dot-to-Dot Task				
% Compliance				
Mean	30.65	36.43	34.10	1.30
SD	20.13	16.93	20.87	
Cancellation Task				
% Compliance				
Mean	20.52	26.68	19.84	0.93
SD	14.51	28.00	21.02	
Time on-Task				
Dot-to-Dot Task				
Mean time (sec)				
Mean	29.22	45.36	80.79	4.98**
SD	33.08	49.88	133.79	
P < H; L < H				
Cancellation Task				
Mean time (sec)				
Mean	18.13	31.32	66.73	7.90**
SD	20.42	27.53	84.10	
P < H; L < H				

— *Continued*

TABLE 2
(Continued)

Variables	Condition			$F(2,60)$
	Placebo	0.3 mg/kg	0.5 mg/kg	
Productivity				
Dot-to-Dot Task				
Patterns correct				
Mean	21.10	21.10	23.30	1.33
SD	11.80	12.09	14.16	
Cancellation Task				
Rows correct				
Mean	54.57	61.87	93.00	5.79**
SD	51.77	41.94	77.29	
P < H; L < H				

Note: P = placebo; L = low dose (0.3 mg/kg); H = higher dose (0.5 mg/kg).
**$p < .01$; ***$p < .001$.

The number of correct responses and the errors of commission obtained from the Gordon Vigilance Task were used to assess medication-related changes in sustained attention and impulsivity under conditions of high arousal and low feedback. Overall multivariate tests indicated a significant difference between treatment groups ($F[4,27] = 4.00$, $p < .05$). Univariate analyses of the number of correct responses indicated differences among treatment conditions ($F[2,60] = 4.84$, $p < .01$). Post hoc Tukey's analyses on the number of correct responses showed the children's accuracy increased after administration of MPH. There were no differences observed between the two doses of MPH.

Summary. MPH treatment appeared to improve ability to sustain attention during the Vigilance Task, while improvements in impulsivity were obtained on only one measure. There was no evidence of a dosage effect.

Parent Rating Scales

Three subscales of the CPRS-R (Learning, Conduct, and Hyperactivity Index) were selected to assess the effectiveness of medication in decreasing parent ratings of negative behaviors (Table 2). Multivariate analyses indicated significant differences in each of the Learning, Conduct, and Hyperactivity Index subscales related to treatment conditions ($F[6,25] = 5.41$, $p < .001$). Univariate analyses also revealed significant differences in each of these subscales ($F[2,60] = 12.82$, 11.40, and 15.82, $p < .001$, respectively). Tukey's post hoc analyses revealed several significant findings. With the Learning factor both medication conditions resulted in improvements in behavior (lower ratings), with the 0.5-mg/kg condition achieving significantly better ratings than the 0.3-mg/kg condition. On the Conduct and Hyperactivity Index factors, both medication conditions resulted in lower ratings, without evidence of a significant dosage effect.

Summary. Parental ratings of the intensity of their child's negative behaviors, inattention, and impulsivity decreased as a function of medication. However, dosage effects were not uniformly evident.

Observed Behavior

Child Compliance. There was no evidence of medication effects on the percentage of child compliance with parental commands on any of the three tasks (Compliance, Dot-to-Dot, Cancellation) (univariate $F[2,60] = 0.17$, 1.30, and 0.93, $p > .05$, respectively).

Time on-Task. The mean time on-task (seconds) was obtained from each of the Dot-to-Dot and Cancellation Tasks (Table 2). Two separate analyses of variance were conducted to assess change related to medication treatment. Univariate tests of the mean time on-task during the Dot-to-Dot Task and on the Cancellation Task indicated significant changes related to medication treatment conditions ($F[2,60] = 4.98$, $p < .05$, and $F[2,60] = 7.90$, $p < .01$, respectively).

Tukey's test revealed that in both of these tasks, mean time on-task was greater while on 0.5 mg/kg than 0.3 mg/kg and placebo. Performance in the lower dosage condition did not differ significantly from placebo; however, dose differences were obtained on both tasks.

Productivity. Differences were obtained in the Cancellation Task as measured by the number of rows

correctly canceled ($F[2,60] = 5.79$, $p < .01$). Tukey's test indicated there were more correct rows completed after treatment with 0.5 mg/kg MPH compared with placebo or 0.3 mg/kg, which did not differ from each other.

Summary. Child compliance with parents' requests did not improve with medication. However, the children demonstrated significantly improved ability to stay on-task after treatment with 0.5 mg/kg MPH, both when working with their parents or on their own. Dose differences were also noted on the behavioral attention tasks. There was also some support for improved productivity on the highest dosage of medication when the children were working on their own.

Side Effects

The Side Effects Rating Scale, which uses a scale of 0 to 9, was used to assess symptoms usually associated with MPH treatment (Barkley, 1990). Symptoms ranged from somatic symptoms such as stomachaches and headaches to psychological symptoms such as anxiety and sadness. Two scores were derived from the 17 items (Table 3). The number of symptoms was used as an indication of changes in symptoms after treatment. The mean of the rating scale was used as an indication of the overall severity of the symptoms endorsed.

Multivariate analyses of the number of symptoms and the overall severity achieved significance ($F[4,27] = 4.96$, $p < .01$). Univariate analyses were also significant ($F[2,60] = 5.35$ and 9.96, $p < .01$ and .001, respectively). Tukey's tests indicated parents reported significantly more symptoms as well as, on average, more severity within symptoms in the 0.5-mg/kg compared with the other conditions. There was no evidence of increased side effects in the lower dosage condition.

DISCUSSION

In general, the results of this investigation confirm the large body of literature demonstrating the effectiveness of stimulant medication with school-age children. This research has shown that stimulant medication has positive effects on cognitive measures of attention as well as resulting in improved home and school behavior in ADHD children as rated by parents (see Rapoport and Castellanos, 1996, for recent review). An informal comparison of effect sizes in the current study compared with published data from similar investigations with school-age children (Barkley et al., 1988; Fischer and Newby, 1991) suggests the effect sizes are similar for the behavior ratings by parents and smaller for the cognitive measures. This may indicate that, for preschool children with ADHD compared with school-age children with ADHD, cognitive processes are more difficult to enhance. Alternatively, it is possible that the variables used to assess cognitive processes are less reliable with younger children.

In this study, attention was assessed in three situations in order to tap various aspects of functioning: cognitive (number of correct responses on Gordon Vigilance Task), parent ratings (Learning subscale of the CPRS-R), and performance while carrying out a paper-and-pencil exercise with a parent and independently (mean time on-task and productivity of the Dot-to-Dot and Cancellation Tasks). On the cognitive measure, the parent rating of the child's behavior, and both tasks measuring ability to stick with a paper-and-pencil

TABLE 3
Means and Standard Deviations of Side Effects by Dose

Variables	Condition			$F(2,60)$
	Placebo	0.3 mg/kg	0.5 mg/kg	
No. of symptoms				
Mean	5.70	6.65	8.40	9.96***
SD	3.28	3.77	3.58	
P < H; L < H				
Severity				
Mean	1.23	1.40	1.92	5.35**
SD	.82	.93	1.10	
P < H; L < H				

Note: P = placebo; L = low dose (0.3 mg/kg); H = higher dose (0.5 mg/kg).
**$p < .01$; ***$p < .001$.

assignment, there were significant improvements in performance while on medication compared with placebo. The parents' ratings appeared most sensitive, as they were able to distinguish each of the placebo and medication conditions. With the other measures the 0.5-mg/kg dose was always most successful in improving performance, while performance on 0.3 mg/kg was mixed. The reason for the mixed outcome in performance on the paper-and-pencil task is unclear. It may indicate that improved ability to sustain attention on a task in one setting may not necessarily translate to improved performance in a different setting because other factors such as problem-solving skills may be involved. Nevertheless, the effectiveness of stimulant medication on the attentional processes of preschool children with ADHD is reflected in the fact that 90% of the subjects showed a positive response on at least one of these measures of attention.

A similar differential pattern of improved performance with stimulant medication was reported first by Sprague and Sleator (1976, 1977). They noted a similar difference in dose response to cognitive tasks and teacher ratings, leading them to suggest optimal doses may differ for various attentional and behavioral changes. Although subsequent research has not always supported this finding (see Barkley, 1990; Rapport et al., 1985), it is possible that different demand characteristics or settings may contribute to these discrepancies.

Impulsivity-hyperactivity, the other cardinal trait of ADHD, was also assessed by using cognitive tasks (number of correct responses and efficiency ratio scores on the Gordon Delay Task; commission errors on the Gordon Vigilance Task) and parent ratings of the child's behavior at home (Conners Conduct and Hyperactivity Index subscales). Classification of the number of correct responses during the Delay Task according to the threshold scores (Gordon, 1987) showed children performed in the normal range compared with their peers. Nevertheless, MPH resulted in improved performance on this measure. In addition, on both the Conduct and Hyperactivity Index subscales, parents rated their children significantly improved while on medication. There was no evidence of dosage effects on the Hyperactivity Index. It is also noteworthy that all *T* scores decreased up to 1.5 SD, with the Conduct and Hyperactivity Index scores during 0.5-mg/kg treatment falling at or below the clinical cutoff. In fact, more than 80% of the children showed some improvement on the parent rating scales. Previous cognitive assessments of medication efficacy on improving impulsivity in preschool-age children with ADHD have been equivocal as well. Cohen et al. (1981) and Schliefer et al. (1975) indicated positive changes associated with medication treatment, while Conners (1975) did not. On the other hand, as in this study, parental ratings of changes in the behavior of this age group have been reported to be sensitive to medication effects (Cohen et al., 1981; Conners, 1975; Schliefer et al., 1975) and parallel the findings with school-age children (Barkley et al., 1988; Nolan and Gadow, 1994).

A universal observation of the parents of preschool children with ADHD is their noncompliance with everyday requirements. The laboratory tasks used to tap this domain required mothers to instruct their children to carry out certain tasks. The children did not change their level of compliance with parental requests, and this measure proved to be insensitive to detecting medication effects. Although parents reported observing positive changes in their children related to medication treatment at home, similar findings were not evident in the laboratory. Previous research with preschool-age children has demonstrated medication effects on the percent of compliance (Barkley et al., 1984, 1985) and on the duration of compliance (Barkley, 1988a). However, the children in these studies represented a large age range (3 to 10 years old) and there is no clear indication of the medication responses of the very young children who participated. It is interesting that previous work in our laboratory, in which the parents of preschool children with ADHD were provided with 10 sessions of parent training, showed that child compliance did improve with behavioral intervention (Pisterman et al., 1989, 1992). It is possible that medication alone, as used in this study, is not sufficient to address the parent and/or child attributes that contribute to compliance or that such changes in behavior require a longer trial of medication. Thus, further examination of treatment requires a consideration not only of methodological issues but of whether medication alone is sufficient to address the parent and/or child attributes that contribute to such behavior change.

Several issues concerning the manner in which medication was used in the current investigation require comment. In clinical practice, it is generally recommended that medication dosages be titrated on the

basis of a balance of desirable changes in a child's behavior and evidence of side effects. Furthermore, in clinical practice it is not uncommon for minor side effects experienced in the first week to dissipate with continued use. In our study, the children received standard milligram-per-kilogram dosages of medication for a 1-week period, on the basis of previous estimates. This, although experimentally appropriate, deviates from common practice. It is quite probable that titration would have resulted in better performance than that evidenced in this investigation.

Overall, on the basis of the parents' reports, the results reveal that there was an increase in the number of side effects the average child in the study experienced. In addition, there was an increased severity in the experienced side effects with a relatively high dosage of medication. Results similar to the findings in this study have been reported in previous studies of side effects in school-age children treated with MPH (Barkley et al., 1990; Fine and Johnston, 1993; Fischer and Newby, 1991; Pataki et al., 1993). Nevertheless, it is quite clear that the increase in number and severity of side effects were clinically negligible. A glance at Table 3 reveals that from a possible 17 side effects that were monitored, the number of side effects went up by approximately 1 on the low dosage of medication relative to placebo, and 21/2 on the high dosage of medication compared with the other conditions. In terms of severity, measured on a 9-point scale, children while on 0.5 mg/kg were rated approximately one-half increment higher compared with the other conditions. Although we do not have normative data , it appears the ADHD children in this study demonstrated many behaviors assumed to reflect side effects. It is possible, as suggested by Ahmann et al. (1993) and Fine and Johnston (1993), that this high baseline rate may in fact reflect behavioral styles associated with ADHD and are not in fact side effects of medication. These results support the common practice of using 0.5 mg/kg of MPH as the preliminary dosage, even with preschool children.

One interpretation of the results is that these children were getting relatively conservative dosages of medication. This interpretation would be based on the relatively minor increase in the number and severity of side effects reported by the parent. It is interesting to speculate that, although the use of MPH resulted in many positive changes, because of the conservative dosages, the potential beneficial effects of the MPH were not truly attained. Conceivably, establishing the optimal dosage for each subject would have resulted in a wider array of responses, or greater response, to MPH.

In conclusion, MPH was demonstrated to be successful in improving the attentional capacities and the parent-rated behaviors of preschool children with ADHD, and there was no evidence that comorbidity with oppositional defiant disorder was a contraindication. Furthermore, the effectiveness of the medication in these areas, combined with the absence of increased compliance in interactions, argues for future investigations into multimodal treatment plans. Nevertheless, it is noteworthy that the positive effects obtained paralleled those obtained with older children. This extends the usefulness of medication treatment to the younger population and expands the treatment repertoire for very young children with ADHD.

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