

A Dose-Ranging Study of Behavioral and Pharmacological Treatment for Children with ADHD

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ABSTRACT

Behavioral and pharmacological treatments both have an evidence base for the treatment of children with ADHD. However, the combination of the two treatments has been relatively understudied. In particular, multimodal studies with long acting stimulant preparations have not been conducted. In this investigation, placebo and three doses of methylphenidate were crossed with three levels of behavior modification (BMOD) in the context of a summer treatment program (STP). Participants were 27 children aged 6-12 and diagnosed with ADHD. Children received four medication conditions in random order with conditions changing daily. BMOD conditions were implemented for 3-week blocks, with order randomized across groups. Both treatments produced large and significant effects on children's behavior and performance in the STP. Combined treatment was superior to either treatment alone, and a low dose of methylphenidate (average of 5 mg MPH i.d.) combined with BMOD produced equivalent effects as those of a high dose (average of 15 mg MPH i.d.) alone.

INTRODUCTION

Only two interventions for attention-deficit/hyperactivity disorder (ADHD) have an evidence base: medication with a central nervous system (CNS) stimulant and behavior modification. Numerous studies have demonstrated the short-term efficacy of these medications, especially methylphenidate (MPH), in the treatment of ADHD.

A number of studies suggest that the most effective short-term treatment for the majority of ADHD children appears to be combined pharmacologic and behavioral treatment. There is, however, controversy regarding whether combined treatments for ADHD are indeed superior to unimodal treatments. The source of this disagreement likely rests with the fact that most studies have compared nonintensive or faded behavioral treatments with active medication conditions.

We have previously crossed multiple doses of medication with the presence or absence of behavioral treatment and found significant effects of both treatments. Medication effects were enhanced with the presence of behavioral treatment such that very low doses had the same effects as did high doses when used alone; on some measures even high doses did not improve behavior as much as did behavioral treatment.

The current study extends previous studies by using three intensities, or "doses", of behavioral treatment in the STP, so that behavior modification could be fully crossed with medication.

PARTICIPANTS

- 44 boys and 4 girls between the ages of 5 and 12 entered the investigation.
- Enrolled in the 2002 summer treatment program (STP) for children with ADHD conducted at the University at Buffalo.
- Required to meet DSM-IV diagnostic criteria for ADHD, full-scale IQ ≥ 80 , no documented adverse response to methylphenidate.
- Parents and children provided informed consent and the University at Buffalo Health Sciences IRB approved the protocol.
- The sample was 77% Caucasian
- 50% comorbid oppositional/defiant disorder, 21% comorbid conduct disorder
- One child's parents withdrew him from the study after two days because of their concerns about possible side effects of the medication. A second boy's late-afternoon dose was reduced in the 0.6 mg/kg condition because of evening side effects. The remainder of the participants completed the study.

Table 1. Participant Characteristics.

Item	M	SD
Age in Years	9.35	1.97
Full Scale IQ	106.97	14.31
DSM IV Items Endorsed:		
Inattention	7.88	1.67
Hyperactivity/Impulsivity	6.96	2.5
Oppositional/Defiant	4.63	2.3
Conduct Disorder	1.40	1.53
Overall Impairment-Parent	4.89	1.11
Overall Impairment-Teacher	4.37	1.62

DESIGN AND PROCEDURES

Design: Two within-subjects factors: medication (placebo, .15 mg/kg MPH tid, .3 mg/kg MPH tid, .6 mg/kg MPH tid) and behavior modification (no behavior modification (NBM), low-intensity behavior modification (LBM), high-intensity behavior modification (HBM)). Medication was randomly assigned and varied daily on Mondays–Thursdays for 24 days. Behavioral treatment was varied on a triweekly basis; medication was varied daily. Children, parents, and staff members were blind to medication conditions. **Setting:** The investigation took place in the context of the summer treatment program (Pelham, Greiner, & Gnagy, 1997; Pelham & Hoza, 1996; Pelham et al., 1996).

Behavior Modification :

NBM	LBM	NBM
Point System	Feedback	Feedback
Time Out with contingencies	Sitout (fixed length)	–
Social reinforcement	Social reinforcement	–
On-line sports training and attention questions	On-line sports training and attention questions	–
Daily report card with daily & weekly reward	Daily report card with weekly reward	–
Classroom contingency	Classroom contingency	–
Daily Recess contingency	Daily Recess contingency	–
Daily social skills	Weekly social skills	–
Problem-solving training	–	–
Honor Roll	–	–
Individualized programs	–	–

MEASURES

Counselor-recorded behavior from the point system: (1) following activity rules and rule violations; (2) noncompliance; (3) interrupting; (4) complaining; (5) conduct problems (lying, stealing, intentional destruction of property, and intentional aggression); and (6) negative verbalizations (verbal abuse to staff, teasing peers, and swearing).

Behavior ratings: Counselors completed the (1) Inattention/Overactivity subscale from the IOWA Conners Rating Scale (Loney & Milich, 1982), (2) Oppositional/Defiant IOWA Conners subscales, and (3) abbreviated Conners scale.

Effectiveness/stress ratings: Counselors rated pleasantness and stress of interacting with the children, how well the children got along with peers, and their overall effectiveness in the treatment role.

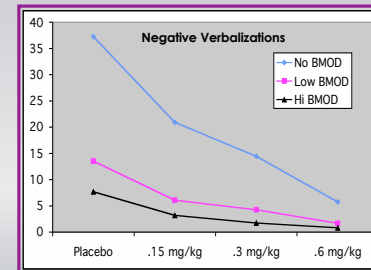
RESULTS

Overview

For all dependent measures, a 4 (drug: placebo, .15, .3, .6) X 3 (BMOD: NBM, LBM, H BM) multivariate analysis of variance was conducted. Table 1 shows means and standard deviations for each condition. Significant effects of drug were followed up by examining pairwise tests among doses. Significant 2-way interactions were followed up by examining the simple effects of each treatment component.

- On all behavioral measures, both medication and BMOD produced large and significant main effects.
- The two treatments interacted such that the dose-response curve was flattened in the presence of behavioral treatment compared to medication alone (see Figure 1 for example)
- The majority of the medication effect occurred at the lowest dose in the LBM and HBM conditions. A more linear dose-response relationship was found for the NBM condition.
- Further analyses will include normalization rates and examination of ratings of treatment effectiveness and acceptability.

	Placebo		.15 mg/kg MPH			.3 mg/kg MPH			.6 mg/kg MPH			
	NBM	LBM	HBM	NBM	LBM	HBM	NBM	LBM	HBM	NBM	LBM	HBM
Rule Violations	48.7 (41.2)	35.8 (44.8)	28.4 (36.2)	29.4 (31.5)	18.6 (23.6)	12.2 (12.2)	20.1 (15.8)	14.2 (29.5)	11.0 (14.6)	14.4 (13.0)	7.5 (6.3)	7.0 (6.3)
Interruption	18.4 (25.5)	12.9 (16.3)	8.1 (9.4)	11.9 (15.8)	6.3 (7.9)	3.9 (4.3)	6.0 (10.6)	4.0 (6.1)	2.9 (3.7)	4.0 (5.8)	2.4 (3.7)	1.1 (1.3)
Noncompliance	18.3 (30.4)	6.3 (8.8)	3.5 (5.0)	9.9 (18.3)	3.0 (6.4)	1.5 (2.1)	5.7 (12.8)	1.9 (3.7)	0.9 (1.3)	2.7 (4.2)	0.8 (1.3)	0.6 (1.1)
Complaining	21.0 (31.5)	13.4 (25.7)	6.9 (13.5)	11.8 (18.4)	5.3 (8.7)	3.5 (4.6)	6.5 (9.7)	2.7 (5.3)	2.5 (4.1)	3.8 (5.5)	1.7 (2.8)	0.9 (1.3)
Negative	37.3 (68.8)	13.5 (22.6)	7.7 (13.5)	20.9 (51.8)	6.1 (13.5)	3.2 (6.3)	14.4 (39.5)	4.3 (12.3)	1.7 (5.8)	5.8 (13.5)	1.7 (4.6)	0.8 (1.7)
Verbalizations	7.4 (25.2)	1.8 (5.0)	1.0 (2.5)	4.4 (17.0)	0.7 (2.5)	0.3 (0.9)	1.8 (4.3)	0.6 (2.8)	0.3 (1.0)	1.2 (3.7)	0.1 (0.2)	0.1 (0.2)
Conduct												
Problems												



DISCUSSION

- Both medication and behavioral treatment produced large and significant effects on nearly all behavioral measures. These findings expand on our previous studies carried out in the classroom setting (Carlson et al., 1992; Pelham et al., 1993) by extending the period of evaluation to the entire day (i.e. recreational activities, lunchtime, transitions).
- On most measures, the effects of high intensity behavior modification was equivalent to high dose medication, and low intensity behavior modification was equivalent to a moderate dose of medication (see Figure above).
- As Carlson et al. (1992) found, the low dose of medication produced as much change in the BM conditions as the higher doses of medication produced in the NBM condition—on some variables, the effect of even the highest dose of medication in the NBM condition did not surpass the effect of the lowest dose in the BM conditions. We have long argued that one of the benefits of combining treatment modalities is that one can produce equivalent behavioral improvement using lower doses of medication. It should be noted that the lowest dose used in this study was equivalent to 5 mg IR MPH i.d.—a very low dose that is half of that used in Carlson et al.
- Notably, at the high dose levels of either condition, there were little if any incremental benefits of adding the other intervention. These results can be compared to those of the MTA, in which little effect of medication was seen in the combined treatment group compared to behavioral treatment only during the STP (Pelham et al., 2000) and little incremental effect of less intensive behavioral treatment compared to higher doses of medication was seen by the end of the study (MTA Cooperative Group, 1999).
- Although the group results of this study are clear, we witnessed several individual patterns of behavior that warrant further investigation. First, some children were maintained for a period of several days when the behavioral treatment was first withdrawn before their behavior deteriorated. A related behavioral pattern is that some children did not return to their previous rates of behavior, and even deteriorated, the first few days that the behavioral interventions were reinstated. For many children, the second and third NBM weeks resulted in more negative behavior than the first week. Finally, some children were maintained in the NBM condition with little behavioral deterioration. Further analyses with a larger N will investigate whether there are individual difference factors that predict different patterns of response to the behavioral treatment.
- Another factor to be examined in future analyses is the effect of order of treatment exposure.