

*FURTHER ANALYSIS OF THE SEPARATE AND  
INTERACTIVE EFFECTS OF METHYLPHENIDATE AND  
COMMON CLASSROOM CONTINGENCIES*

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We evaluated separate and interactive effects between common classroom contingencies and methylphenidate (MPH) on disruptive and off-task behaviors for 4 children with a diagnosis of attention deficit hyperactivity disorder. Analogue conditions consisting of contingent teacher reprimands, brief time-out, no interaction, and alone were conducted in a multielement design. Medication status (MPH or placebo) was alternated across days in a superordinate multielement design. Results indicate that (a) the behavioral effects of MPH were influenced by one or more of the analogue conditions for each participant, and (b) time-out was associated with zero or near-zero levels of both disruptive and off-task behavior for 3 of the 4 participants during MPH and placebo conditions. Implications for the clinical effectiveness of MPH and possible behavioral mechanisms of action of MPH in applied settings are discussed.

DESCRIPTORS: methylphenidate, attention deficit hyperactivity disorder, disruptive behavior, drug-behavior interactions, behavioral pharmacology, functional analysis

The behavioral effects of some medications may be dependent on a person's environment. Environmental influences on medication effects can include a prior history with the medication (e.g., Siegel, Hinson, Krank, & McCully, 1982) as well as immediate antecedent and consequent stimuli. Basic research in behavioral pharmacology has long demonstrated that some medications may affect specific behaviors by increasing sensitivity to particular kinds of stimuli, by altering the effects of controlling environmental variables, or both. Such drug-behavior interactions are typically referred to as the behavioral mechanisms of drug action, and may include all the same processes through which any other environ-

mental stimuli affect behavior (Blackman & Pellon, 1993; Branch, 1984; Poling, 1986). However, such effects have rarely been considered in applied medication studies.

Methylphenidate (MPH) is a stimulant medication commonly and increasingly prescribed for behavior management purposes (Safer, Zito, & Fine, 1996). MPH has been repeatedly demonstrated to increase on-task behavior and work completion and to reduce disruptive classroom behaviors, aggression, and negative social interactions for some children (e.g., Pelham, 1993; Rapport, Denny, DuPaul, & Gardner, 1994; Stoner, Carey, Ikeda, & Shinn, 1994). However, there are large individual differences in response to MPH across children, dosage, and behaviors. There are few plausible explanations for the frequent individual differences, and it is not currently possible to predict an individual's response to MPH (Cooper et al., 1993; Rapport, Stoner, DuPaul, Birmingham, & Tucker, 1985; Pelham, Bender, Caddell, Booth, & Moorer, 1985).

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A number of studies have applied the general principles of behavior analysis and single-case designs to evaluate the relative and combined clinical effectiveness of medication and well-defined behavioral treatments (e.g., Blum, Mauk, McComas, & Mace, 1996; Shell *et al.*, 1986; Stoner *et al.* 1994). A few studies have also included behavioral treatments based on a functional analysis; that is, target behaviors were first shown to be sensitive to or maintained by specific environmental variables (Cooper *et al.*, 1993; Fisher, Piazza, & Page, 1989; Kayser *et al.*, 1997). These studies suggest that similar procedures might be useful to further evaluate possible drug-behavior interactions between MPH and environmental contingencies that commonly occur in applied settings.

A few studies have been designed specifically to evaluate interactive effects between MPH and environmental variables. Whalen, Henker, Collins, Finck, and Dotemoto (1979) demonstrated a possible interactive effect between MPH and classroom antecedent conditions that varied by noise level and task pacing. Wilkison, Kircher, McMahan, and Sloane (1995) demonstrated that boys with a diagnosis of attention deficit hyperactivity disorder (ADHD) earned significantly more money for button pressing when they received MPH as compared to placebo. Northup, Jones, *et al.* (1997) demonstrated that contingent peer attention was associated with high levels of disruptive behavior by an 8-year-old boy when he received placebo but not when he received MPH. Northup, Fusilier, Swanson, Roane, and Borreo (1997) also showed clear differences between the results of reinforcer assessments conducted when children received MPH compared to placebo; that is, MPH appeared to alter the relative reinforcing effectiveness of token coupons exchangeable for various edible items and activities.

Each of the above studies suggests inter-

active effects between MPH and immediate environmental conditions; however, several qualifications should be noted. Both Whalen *et al.* (1979) and Wilkison *et al.* (1995) used between group designs, although individual differences were reported. Whalen *et al.* evaluated only antecedent conditions, and Wilkison *et al.* evaluated only the generalized reinforcer of money. Northup, Jones, *et al.* (1997) demonstrated an effect only with peer attention, and the procedures may be subject to several methodological limitations. Northup *et al.* did not include an MPH-only condition or a control condition. Thus, it was not possible to evaluate the contribution of MPH alone to the observed behavioral effects.

The purpose of this study was to evaluate separate and interactive effects between common classroom contingencies and MPH on disruptive and off-task behaviors. Control and MPH-only conditions were included to address some limitations of previous studies. Contingent teacher reprimands, brief timeout, no interaction, and alone analogue conditions were conducted in a multielement design. Conditions were alternated each morning within a school day, and medication status (MPH or placebo) was alternated across days in a separate multielement design. It was anticipated that the results might contribute to a further understanding of both the clinical effectiveness of MPH and possible behavioral mechanisms of action of MPH in applied settings.

## METHOD

### *Participants and Setting*

Participants were 4 children who attended a summer program for children with ADHD. Enrollment in the program required a prior diagnosis of ADHD based on the criteria of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*, American Psychiatric Association, (1994). In ad-

dition, a consulting child psychiatrist provided confirmation that the child met criteria for a *DSM-IV* diagnosis of ADHD based on parent interviews and scores at least 2 standard deviations above the mean on the ADHD Rating Scale (DuPaul, 1991) and on the attention problem domains on the Child Behavior Checklist (Achenbach & Edelbrock, 1991).

All parents of children in the program were informed of the purpose and procedures of the study. The 4 participants were chosen because (a) each had been previously prescribed MPH, (b) behavior problems continued to be reported as a concern, and (c) parents expressed an interest in having their child participate. Max, Doug, and Charlie were all 7-year-old boys entering second grade, and Matt was an 8-year-old boy entering third grade. Max, Doug, and Matt were within an average range of intellectual functioning and performed at approximately the level of grade placement based on academic assessments of math and reading. A previous evaluation indicated that Charlie was functioning in the high mild range of mental retardation and was 1 to 2 years below grade placement in reading and math performance. The summer program was held in a university laboratory school classroom each weekday between 8:30 a.m. and 11:30 a.m. for two 3-week sessions. Only Max participated in both sessions (thus his greater number of experimental sessions). All procedures were conducted in the classroom. All staff members were graduate and undergraduate students in psychology and education.

#### *Response Definitions and Measurement*

*Response definitions.* Inappropriate vocalizations, out of seat, playing with objects, and off-task behaviors were recorded for all students. *Inappropriate vocalizations* were defined as any vocal noise or verbalization that was not preceded by the child's raised hand

and acknowledgment by an adult. *Out of seat* was defined as the child's full body weight not being supported by a chair for at least 3 s. *Playing with objects* was defined as touching any object that was not associated with an assigned task (e.g., watches, clothing). *Off-task behavior* was defined as breaking eye contact with task materials for greater than 3 s. The number of math problems completed during each session was also recorded.

*Data collection.* Observers recorded target behaviors using a 10-s partial-interval recording procedure with a tape recorder signaling each interval. Interobserver agreement was obtained for at least 25% of sessions for each participant and each condition. Graduate and undergraduate students were required to meet an 85% agreement criterion prior to the beginning of the study; most data collectors had extensive prior experience with this coding system. Agreement was scored on an interval-by-interval basis and calculated for each participant and response definition by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100%. Across participants, interobserver agreement averaged 90% (range, 89% to 93%) for off-task behavior and 90% (range, 87% to 94%) for out-of-seat behavior, inappropriate vocalizations, and playing with objects (subsequently referred to as disruptive behaviors).

Procedural integrity was calculated as a percentage of target behaviors that were followed by a reprimand or time-out as specified for each condition, and the nonoccurrence of any other consequence, during the same or subsequent 10-s interval. Procedural integrity averaged 98% (range, 70% to 100%) for the time-out conditions, 96% (range, 71% to 100%) for the teacher reprimand conditions, and 99% for the no-interaction and alone conditions (range, 97% to 100% and 88% to 100%, respectively).

An experimenter also counted and record-

ed the number of math problems completed during each session. A problem was considered completed if the correct number of digits was written in the answer space on the worksheet. The number of problems correct was also recorded, but are not reported here, because these typically exceeded 80% if completed. A second experimenter also scored 25% of all math worksheets. Interscorer agreement averaged 99% and was calculated by dividing agreements by agreements plus disagreements and multiplying by 100%.

### *Design*

Three to six analogue conditions were conducted each day in a random order within a multielement design. Medication status was simultaneously alternated across days in a superordinate multielement design (Hains & Baer, 1989).

### *Procedure*

*Academic assessment.* A curriculum-based assessment of math skills was conducted to determine an instructional level for each participant. An *instructional level* was defined as math problems previously completed with between 70% and 90% accuracy. Instructional level math problems were subsequently used during all analogue conditions.

*Medication status.* A consulting child psychiatrist prescribed a course of medication that alternated between placebo and the child's previously prescribed dosage of MPH (i.e., the consulting psychiatrist did not change the dosage prescribed by the child's primary physician). Placebos were prepared according to standard pharmacy procedures, and all medications were color coded by the pharmacist for subsequent identification. Matt and Max were prescribed 10 mg, approximately 0.3 mg/kg for each. Doug was prescribed 15 mg (0.7 mg/kg), and Charlie was prescribed 20 mg (0.7 mg/kg).

We provided parents with written instruc-

tions for medication administration each day. Each morning, the program director confirmed with the parent that the child had received medication as prescribed and also confirmed the time of administration. Only the director (or designee) of the program was aware of the child's medication status.

*Analogue conditions.* Analogue conditions included contingent teacher reprimands, brief nonexclusionary time-out, no interaction, and alone. Teacher reprimands and time-out were provided in the respective conditions following each occurrence of an inappropriate vocalization, out-of-seat behavior, or playing with an object, and following a continuous 10-s interval of off-task behavior. Participants were given instructional level math worksheets during all conditions. Students were always seated at desks arranged in traditional rows in the classroom (except during alone conditions). Immediately prior to all sessions, participants were given instructions to stay in their seats and to work quietly until told to stop. Three to six 10-min sessions were conducted each morning. All analogue conditions were conducted between 1 and 3 hr following oral administration of MPH.

Different staff members were assigned to conduct each analogue condition, but the same person always conducted the same condition for each participant. Different staff members were assigned to each condition to further increase the discriminability of the conditions. In addition, the assignment of different staff members to each condition was thought to best represent naturalistic conditions in which different teachers may respond very differently to student behavior, but each responds in a generally consistent manner. Participants' informal comments indicated that they did readily discriminate each condition (e.g., "I know, you're going to have to remind me").

During the teacher reprimand conditions, the teacher maintained a proximity of ap-

proximately 3 m or more, but ignored the participant except to provide a reprimand contingent upon the occurrence of a target behavior. Reprimands consisted of brief disapproving statements delivered in a neutral tone of voice and generally related to the target behavior (e.g., "You need to stay in your seat"). Prior to the session, participants were told that if they did not stay in their seats and work quietly, "I will have to remind you." This condition was intended to test behavioral responsiveness to teacher reprimands as either positive reinforcement (attention) or punishment.

During the time-out condition, the child's chair was immediately turned to face away from the desk and all other people and activities, and the staff member moved away from the student contingent upon the occurrence of a target behavior. After 30 s, the child's chair was turned back to the desk, and he was gestured to return to work. If necessary, a three-step prompt procedure (verbal, gestural, physical) was used to direct the student to be seated. Otherwise, the staff member maintained a proximity of approximately 3 m from the participant. Before the initial time-out session, the time-out procedures were described and demonstrated for each student. Before each time-out session, participants were told that they would be placed in time-out if they did not remain seated and work quietly. Time-out intervals were subtracted from the total session time to calculate the percentage of intervals of inappropriate behavior. This condition was intended as a test of behavioral responsiveness to the time-out procedures as either punishment or negative reinforcement (i.e., escape from tasks).

During the no-interaction condition, the staff member always maintained a proximity of approximately 3 m but ignored all student behavior. The only instruction was to "stay in your seat and work quietly." This condition had two purposes. First, it provided a

control condition for the occurrence of teacher reprimands and time-out. Second, this condition was representative of a common naturally occurring classroom situation in which children spend much class time near a teacher, but there is no direct interaction.

During the alone condition, the participant was seated alone at a single desk inside an office cubicle constructed of cloth panels (1.6 m by 1.6 m). The cubicle was constructed so that one panel swung open and closed as a door and was placed in front of an elevated one-way observation window at the far end of the classroom. Participants were initially told that this was our "office" and that sometimes they would be asked to complete "office work" alone. Participants were given the same instructions to "stay in your seat and work quietly." This condition served two purposes. First, it served as a baseline MPH-only condition. That is, this condition included both the absence of teacher reprimands and time-out and the absence of an adult as an antecedent or discriminative stimulus. Second, this condition was representative of some naturally occurring situations when an adult is not present (e.g., when a teacher briefly leaves the classroom or is far removed from the student, or when a child is asked to complete homework alone in his or her room).

## RESULTS

All results were initially evaluated for each response definition. Out-of-seat behavior, inappropriate vocalizations, and playing with objects were subsequently combined in one category referred to as disruptive behavior, because overall results were similar for those behaviors for all participants. However, the results for off-task behavior are presented separately because some differences from the disruptive behaviors were evident (except for Charlie).

Table 1  
Mean Number of Problems Completed (and Range) for Each Participant When Receiving MPH or Placebo During All Analogue Conditions

	Charlie		Matt		Doug		Max	
	Placebo	MPH	Placebo	MPH	Placebo	MPH	Placebo	MPH
Alone	18 (0–8)	56 (3–126)	6 (0–13)	28 (0–62)	10 (0–10)	49 (0–137)	7 (0–34)	21 (0–53)
No interaction	21 (0–55)	126 (107–152)	0.8 (0–3)	34 (2–72)	1 (0–3)	58 (0–104)	9 (0–24)	31 (12–91)
Reprimand	52 (0–89)	147 (89–220)	11 (0–29)	62 (40–100)	12 (0–20)	93 (89–110)	19 (8–38)	50 (37–62)
Time-out	63 (26–107)	148 (83–177)	22 (6–48)	59 (42–70)	3 (0–10)	164 (107–148)	43 (3–81)	50 (26–66)

Table 1 shows the total number of math problems completed during all analogue conditions when participants received either placebo or MPH. All participants always completed more problems when they received MPH compared to placebo. However, 3 of the 4 participants completed substantially more math problems during the reprimand and time-out conditions than during the alone or no-interaction conditions, regardless of medication status. Furthermore, 3 participants completed many more problems during the time-out condition when they received placebo compared to any other condition. The mean number of problems completed may be further interpreted in the context of the trend and stability of off-task behavior. For example, Table 1 shows a mean of eight problems completed by Charlie during the alone condition; however, all problems had to have been completed dur-

ing the first session, because off-task behavior was always 100% in subsequent sessions.

Finally, because subtracting time-out intervals decreased total session time, the frequency of time-out (30 s) for each participant and medication status are shown in Table 2.

Figures 1 through 4 show the effects of MPH relative to placebo for disruptive and off-task behavior for all conditions for each participant.

*Charlie.* As can be seen in Figure 1, disruptive behavior occurred at high levels in the alone condition regardless of whether Charlie received MPH ( $M = 39\%$ ; range, 0% to 92%) or placebo ( $M = 88\%$ ; range, 48% to 100%). Levels of disruptive behavior were also high in the no-interaction condition when Charlie received placebo ( $M = 44\%$ ; range, 0% to 100%); however, disruptive behavior was zero or near zero when he received MPH. Disruptive behavior also did not occur during the time-out and teacher reprimand conditions when he received MPH. When Charlie did not receive MPH, levels of disruptive behavior increased during the last three sessions of the reprimand condition, but remained low during the time-out condition, with the exception of one session. For Charlie, the overall results for off-task behavior were similar to those for disruptive behavior.

Table 2  
Total Number of Time-Outs and Sessions for Each Participant When Receiving MPH and Placebo

	Placebo		MPH	
	Time-outs	Sessions	Time-outs	Sessions
Charlie	8	18	0	4
Matt	29	5	2	4
Doug	40	4	1	4
Max	13	7	6	7

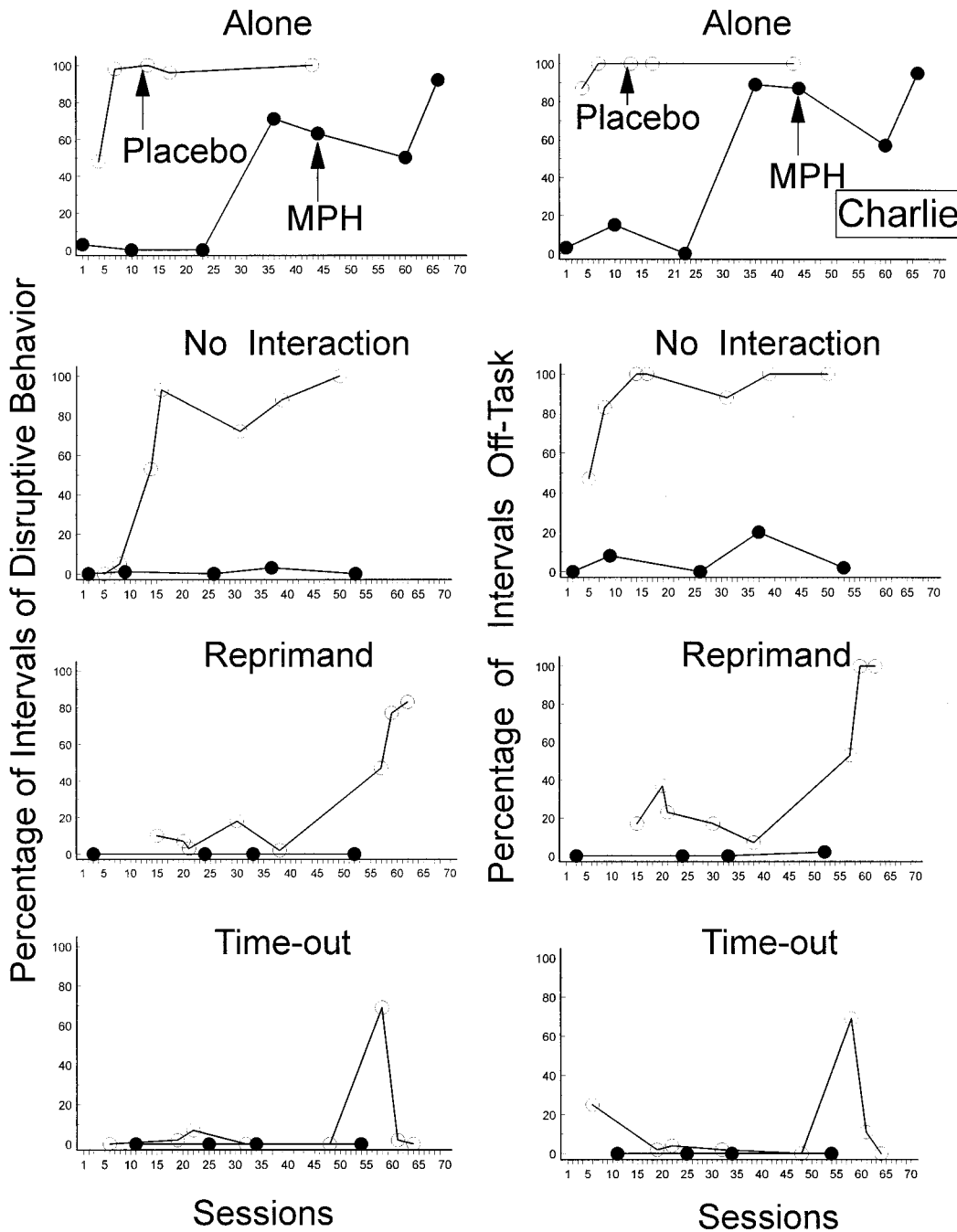


Figure 1. Percentage of intervals of disruptive (left panel) and off-task (right panel) behavior when receiving MPH or placebo during all analogue conditions for Charlie.

Charlie completed the fewest math problems during the alone condition regardless of whether he received placebo or MPH ( $M = 8$  and  $56$ ). However, he completed more

problems during the no-interaction condition (placebo,  $M = 21$ ; MPH,  $M = 126$ ) than during the alone condition, and more problems during the reprimand condition

(placebo,  $M = 52$ ; MPH,  $M = 147$ ) compared to the no-interaction condition. Charlie completed the most problems during the time-out condition, regardless of medication status (placebo,  $M = 63$ ; MPH,  $M = 148$ ).

*Matt.* Figure 2 shows that disruptive behavior was high in the alone condition, regardless of whether Matt received MPH or placebo ( $M = 49\%$ ; range, 0% to 100% and  $M = 84\%$ ; range, 47% to 100%, respectively). Similarly high and stable levels of disruptive behavior were observed in the no-interaction condition when Matt received placebo ( $M = 98\%$ ; range, 93% to 100%); however, levels of disruptive behavior were very low when he received MPH ( $M = 6\%$ ; range, 0% to 20%). No disruptive behavior occurred during the time-out condition, and levels were very low during the teacher reprimand condition ( $M = 7\%$ ; range, 0% to 10%) when Matt received MPH. When Matt did not receive MPH, levels of disruptive behavior remained high during the reprimand condition ( $M = 74\%$ ; range, 48% to 100%) but declined to low levels during the time-out condition ( $M = 16\%$ ; range, 3% to 40%).

Similar results occurred for off-task behavior, except that levels of off-task behavior were higher and more variable during the no-interaction condition, compared to disruptive behavior, when Matt received MPH. However, off-task behavior occurred at low levels during the teacher reprimand condition when Matt received MPH but remained high when he did not. Thus, a possible interaction effect between MPH and the teacher reprimand condition is also suggested. Time-out resulted in low levels of off-task behavior, regardless of whether Matt received MPH.

Matt completed the fewest number of math problems during the alone (placebo,  $M = 6$ ; MPH,  $M = 28$ ) and no-interaction (placebo,  $M = 0.8$ ; MPH,  $M = 34$ ) conditions, regardless of whether he received

placebo or MPH. When Matt received placebo, he completed more math problems during the reprimand condition ( $M = 11$ ) than during either the alone or the no-interaction conditions, but he completed the most problems during the time-out condition ( $M = 22$ ). When Matt received MPH, he also completed more problems during the reprimand condition than either the alone or no-interaction conditions, but the number of problems completed during the time-out condition was very similar to the reprimand condition ( $M = 59$  and  $62$ , respectively).

*Doug.* Figure 3 shows the effects of MPH relative to placebo for disruptive behavior for Doug. Levels of disruptive behavior were high and stable across all conditions when Doug received placebo. Disruptive behavior was initially low during the alone condition when he received MPH but increased substantially after the fifth session. In contrast, disruptive behavior remained at low levels during the no-interaction condition ( $M = 7\%$ ; range, 0% to 22%), the teacher reprimand condition ( $M = 3\%$ ; range, 0% to 12%), and time-out condition ( $M = 0\%$ ) when he received MPH.

Overall results for off-task behavior were very similar to those for disruptive behavior. However, off-task behavior was higher and more variable during the no-interaction condition, compared to disruptive behavior, when Doug received MPH. Off-task behavior was substantially lower during both the time-out and teacher reprimand conditions when he received MPH than when he received placebo. These results more clearly suggest an interaction effect between MPH and reprimands that was not apparent for disruptive behavior.

When Doug received placebo, the number of math problems completed did not appear to vary meaningfully across analogue conditions; he completed a mean of 10 problems during the alone condition, 1



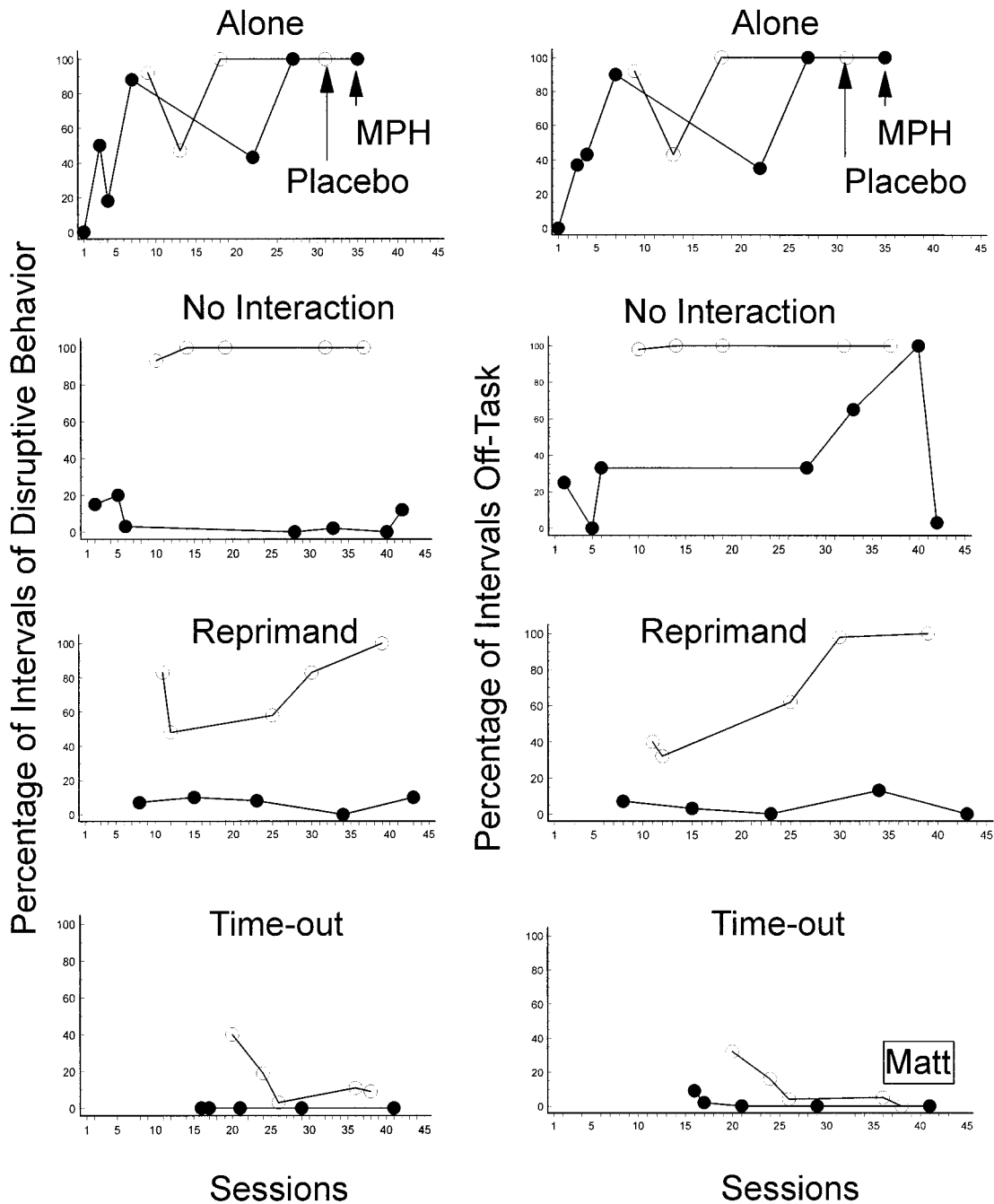


Figure 2. Percentage of intervals of disruptive (left panel) and off-task (right panel) behavior when receiving MPH or placebo during all analogue conditions for Matt.

problem during the no-interaction condition, 12 problems during the reprimand condition, and 3 problems during the time-out condition. In contrast, when he received

MPH, he completed a mean of 49 and 58 problems during the alone and no-interaction conditions, and he completed a mean number of 93 problems during the reprimand

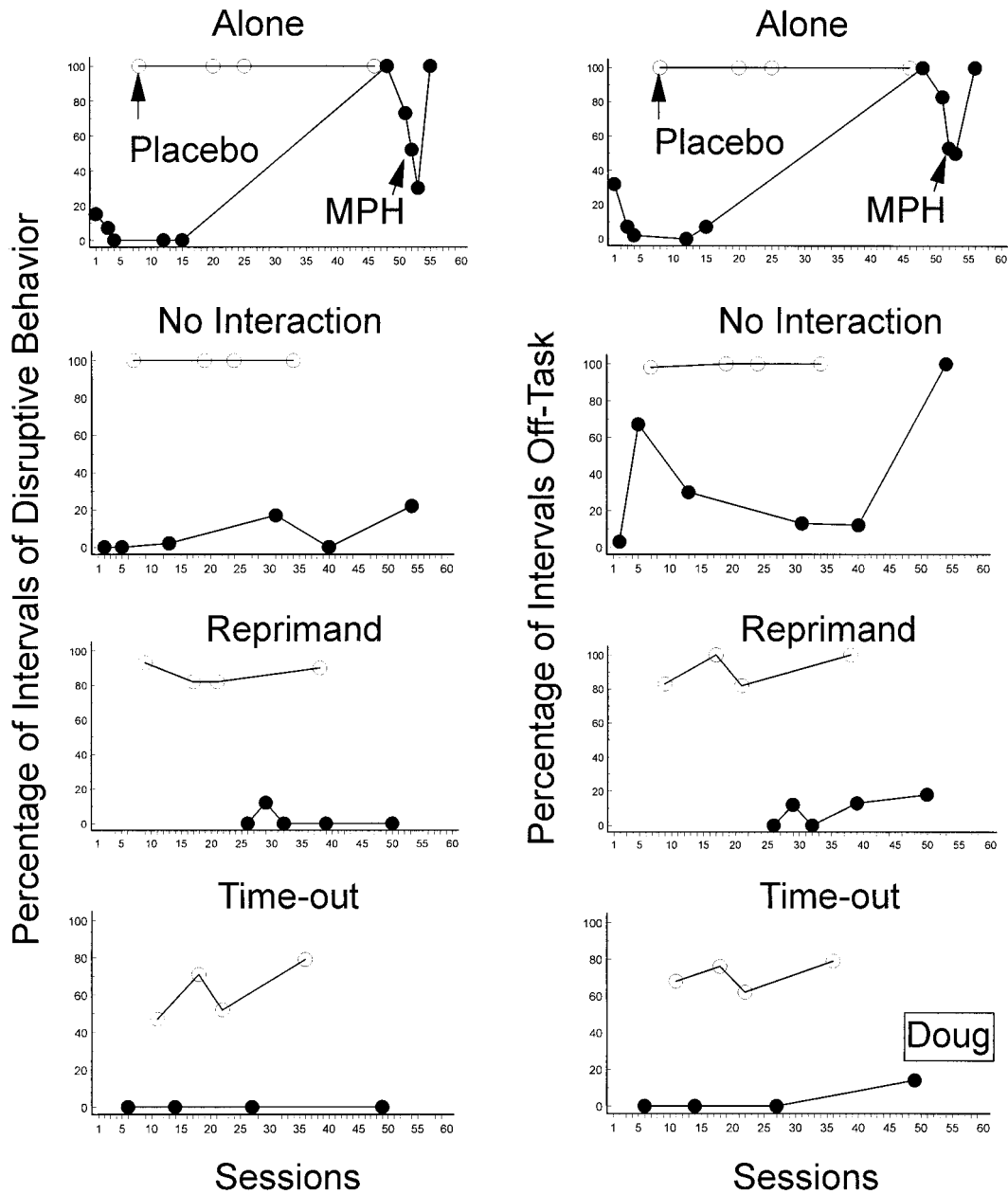


Figure 3. Percentage of intervals of disruptive (left panel) and off-task (right panel) behavior when receiving MPH or placebo during all analogue conditions for Doug.

mand condition and 164 during the time-out condition.

*Max.* Figure 4 shows the results for Max. Overall, levels of disruptive behavior were lower in the alone condition when Max received MPH ( $M = 30\%$ ; range, 0% to

65%) compared to placebo ( $M = 74\%$ ; range, 32% to 100%). Disruptive behavior occurred at lower levels during the no-interaction condition than during the alone condition when Max received placebo ( $M = 55\%$ ; range, 15% to 95%) but occurred at still

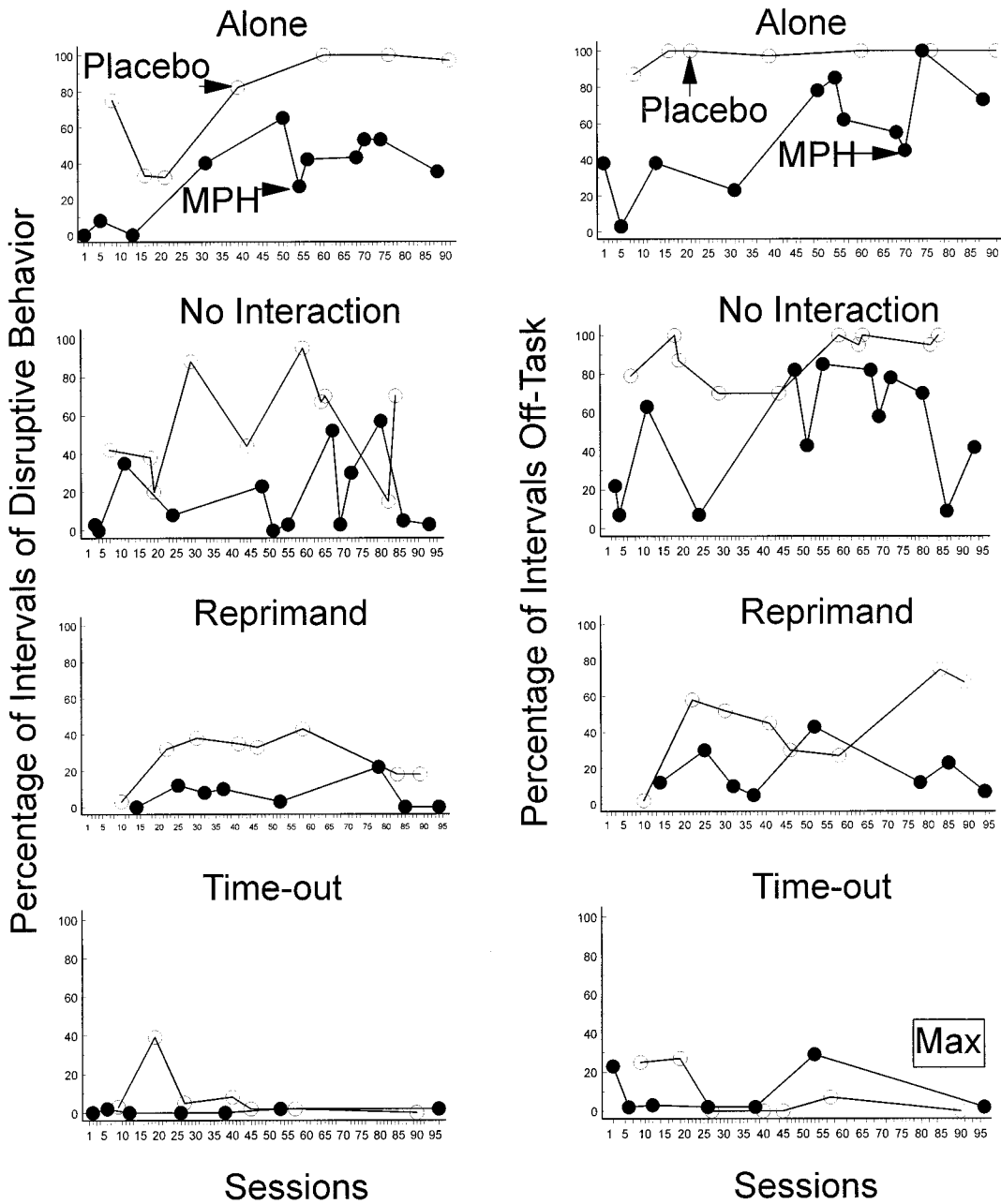


Figure 4. Percentage of intervals of disruptive (left panel) and off-task (right panel) behavior when receiving MPH or placebo during all analogue conditions for Max.

lower levels when he received MPH ( $M = 17\%$ ; range, 0% to 57%). Levels of disruptive behavior were lower during the teacher reprimand condition compared to the no-interaction condition when Max received placebo ( $M = 27\%$ ; range, 3% to 43%) but

more substantially so when he received MPH ( $M = 7\%$ ; range, 0% to 22%). Time-out resulted in very low levels of disruptive behavior, regardless of whether Max received MPH or placebo.

Off-task behavior was high and stable in

the alone condition when Max received placebo and increased to high but more variable levels when he received MPH. Although lower than in the placebo condition, off-task behavior remained relatively high and variable in the no-interaction condition when Max received MPH. As with disruptive behavior, off-task behavior was lower during the teacher reprimand condition under MPH but not in placebo conditions. Time-out resulted in low levels of off-task behavior, regardless of whether Max received MPH or placebo.

Matt completed the fewest number of math problems during the alone (placebo,  $M = 7$ ; MPH,  $M = 21$ ) and no-interaction (placebo,  $M = 9$ ; MPH,  $M = 31$ ) conditions, regardless of whether he received placebo or MPH. When he received placebo, he completed more math problems during the reprimand condition ( $M = 19$ ) than during either the alone or no-interaction conditions, but he completed the most problems during the time-out condition ( $M = 43$ ). When Matt received MPH, he completed more problems during both the reprimand and time-out conditions ( $M = 50$  for both) than either the alone or no-interaction conditions. However, there was only a small difference between the number of problems completed during the time-out conditions when Matt received MPH compared to placebo ( $M = 50$  and  $43$ , respectively).

## DISCUSSION

Overall results indicate two primary outcomes. First, the behavioral effects of MPH were shown to be influenced by immediate environmental conditions for each participant. That is, each participant displayed high levels of disruptive and off-task behavior during the alone condition regardless of medication status (i.e., MPH or placebo). However, substantial reductions in disruptive

and off-task behaviors occurred for each participant during one or more of the other conditions when he received MPH but not when he received placebo. For 3 participants, the lowest levels of disruptive behavior associated with MPH occurred during the no-interaction condition. In addition, disruptive behavior occurred at lower levels for 2 participants during the teacher reprimand condition than during the no-interaction condition when they received MPH but not when they received placebo. Also, the time-out condition was associated with zero or near-zero levels of both disruptive and off-task behavior for 3 of the 4 participants, regardless of whether they received MPH or placebo.

The mean number of math problems completed was always greater when the children received MPH than when they received placebo, regardless of condition. However, 3 participants completed substantially more problems during the reprimand and time-out conditions than during either the alone or the no-interaction condition, regardless of medication status. Two participants completed the most problems during the time-out condition, regardless of medication status. Similar results occurred for a 4th participant only when he received MPH. These results indicate that work completion, as well as disruptive and off-task behaviors, were differentially responsive to one or more of the conditions for 3 participants when they received placebo. Furthermore, these results indicate that the reprimand and time-out conditions may have enhanced MPH effects associated with increased work completion. That is, all participants completed a greater number of math problems during the reprimand and time-out conditions than during the alone or no-interaction conditions when they received MPH.

It might be noted that no programmed consequences were provided for work completion. Thus, problems completed may

more clearly reflect medication effects. Math performance has been previously shown to be a sensitive measure of MPH effects under some conditions (Gulley & Northup, 1997; Stoner et al., 1994).

Although the overall pattern of results was similar for off-task and disruptive behavior, off-task behavior occurred at higher levels than disruptive behavior for 3 of the 4 participants during the no-interaction condition compared to the alone condition. These results are generally consistent with previous findings that reductions in disruptive behaviors are not necessarily associated with increases in other appropriate behaviors, such as being on task or completing work (e.g., Shell et al., 1986). However, the results for off-task behavior suggest an additional interaction effect between MPH and reprimands. That is, off-task behavior occurred at lower levels for 3 participants during the reprimand condition, compared to the no-interaction condition, when they received MPH but not when they received placebo.

Overall results most clearly demonstrate an interaction effect between MPH alone and the no-interaction condition (and presumably the immediate presence of an adult). It is well established that teacher proximity can reduce disruptive behavior (Travers, Elliott, & Kratochwill, 1993). However, in the present study, lower levels of disruptive behavior often occurred during the no-interaction condition only when the student received MPH. One possible explanation for this result is that MPH acted to establish the presence of an adult as a discriminative stimulus (Michael, 1993). The large differences in the number of time-outs implemented between placebo and MPH strongly suggest that MPH altered antecedent rather than consequent effects. That MPH may alter the effects of antecedent events is consistent with the results of Whalen et al. (1979), Wilkison et al. (1995), and Northup, Jones, et al. (1997). However, the

very low levels of behavior during the no-interaction (MPH) and time-out (MPH or placebo) conditions created floor effects that typically precluded evaluation of differential effects by the type of consequence (i.e., changes in reinforcer value). The high levels of disruptive behavior during the alone condition also might suggest that the target behaviors were not maintained by any type of social reinforcement; thus, any controlling environmental variables were, at best, unknown.

The demonstration of the potential contribution of the immediate behavior of teachers and parents to observed medication effects may have the most applied significance. The present results suggest that active supervision and monitoring of children's behavior may be necessary to achieve the most beneficial medication effects, and that the addition of other behavioral consequences may further enhance MPH effects in some instances. Such immediate environmental influences may contribute, in part, to the frequently observed individual differences in response to MPH.

Nevertheless, several idiosyncratic results were evident. For example, the no-interaction condition was associated with low levels of disruptive behavior for 2 participants but more moderate levels for the other 2 participants. Although time-out was effective regardless of medication status for 3 participants, it was effective for the 4th only when he received MPH. Other idiosyncratic effects were evident for off-task behavior.

Several procedural issues should be noted. Although the alone condition might represent a relatively uncommon naturally occurring condition, its inclusion was considered essential for evaluating the effects of MPH alone. As can be seen in the current results, the absence of the alone condition could have created the appearance that MPH was effective independent of environmental conditions. The no-interaction condition also

provided a similar control for each of the consequences; that is, in several instances time-out or teacher reprimands might have appeared to be effective when in fact only the teacher's presence was necessary.

It should be noted that the teacher reprimand and time-out conditions in this study were not intended to represent optimal behavioral treatments, and it was not the primary purpose of this study to evaluate the relative effectiveness of MPH and behavioral treatments. Rather, possible drug-behavior interactions were of primary interest, and analogue conditions were developed only to represent naturally occurring conditions or programmed consequences that might be expected to commonly occur in a classroom. More complex differential reinforcement programs might be expected to be associated with greater treatment effects, and may be a desirable direction for future drug-behavior interaction studies.

Several limitations must be acknowledged. It is unknown to what extent the current results might generalize to a child's regular classroom. Also, compliance with medication administration was assessed only by parental reports. In future studies we would prefer to use direct observation, if feasible, or add a second measure such as pill counts.

Dosage is a critical variable related to MPH effects (DuPaul & Barkley, 1993; Gulley & Northup, 1997). Although an optimal dosage of MPH was not demonstrated for the current participants, only Max's mother reported any concern about the medication's effectiveness. Previous parent and teacher self-reports endorsed the dosage of MPH as effective and satisfactory for each of the other participants. However, it is a limitation of this study that dosage varied across participants and that effects for only one dosage were evaluated. For example, it is possible that a different dosage would have resulted in a lower occurrence of target behaviors during the alone condition. Future

studies might include evaluations across different dosages of MPH as well as different "strengths" of behavioral treatments (Hoza, Pelham, Sams, & Carlson, 1992; Northup, Fisher, Kurtz, Harrel, & Khang, 1997). It remains possible that interactions between MPH and environmental conditions could result in an optimal combination.

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## STUDY QUESTIONS

1. What type of experimental design was used in the study, and what was its primary advantage?
2. What was the purpose of each of the analogue conditions, and what contingencies were in effect during the conditions?
3. When calculating percentages of intervals containing inappropriate behavior during the time-out condition, why was it important to subtract time-out intervals from total session time?

4. If the results of the analogue conditions can be interpreted as data from a functional analysis, what was the function of each participant's inappropriate behavior? Did it ever appear that MPH masked the function?
5. What results were obtained with respect to math problem completion?
6. Regardless of medication status, the time-out condition was associated with low levels of inappropriate behavior and relatively high levels of math completion. Based on these results, what function did time-out serve?
7. During what conditions did there appear to be an interactive effect between environmental manipulations and MPH?

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