

*EFFECTS OF STIMULANT MEDICATION UNDER VARIED
MOTIVATIONAL OPERATIONS*

F. CHARLES MACE AND KEVIN L. PRAGER

UNIVERSITY OF SOUTHERN MAINE AND
PROVIDENCE OF MAINE

KAREN THOMAS, JANE KOCHY, AND TIM J. DYER

ARAN HALL SCHOOL

LORA PERRY

PROVIDENCE OF MAINE

AND

DUNCAN PRITCHARD

ARAN HALL SCHOOL

We evaluated the evocative effects of four conditions (high- and low-preference activities, low and divided attention) and stimulant medication on the behavior of a 16-year-old boy with attention deficit hyperactivity disorder and moderate mental retardation. All behavior (activity engagement, activity changes, inappropriate touching, rude behaviors, and physical aggression) improved with stimulant medication in most conditions, but undesirable behaviors were not reduced to acceptable levels in all conditions. This finding suggests that stimulant medication may be a valuable adjunct to function-based interventions.

DESCRIPTORS: motivating operations, stimulant medication, attention deficit hyperactivity disorder

A substantial body of evidence exists that children diagnosed with attention deficit hyperactivity disorder (ADHD) and other disorders benefit from various forms and dosages of stimulant medication (e.g., Blum, Mauk, McComas, & Mace, 1996; Gulley & Northup, 1997; Northup et al., 1999; Rapport, Stoner, DuPaul, Birmingham, & Tucker, 1985). Clinical improvements have been reported for behaviors directly related to enhanced attention, such as task engagement and work completion. Collateral benefits have also been observed, such as reduced disruptive behavior, physical aggression, and noncompliance that may, in part, be due to increased academic activity and compliance (e.g., Kelley, Fisher, Lomas, & Sanders, 2006).

In addition to demonstrating favorable clinical outcomes, several studies have demonstrated that stimulant medication can alter an individual's response to specific environmental conditions. For example, Blum et al. (1996), Kayser et al. (1997), Kelley et al. (2006), Northup, Fusilier, Swanson, Roane, and Borrero (1997), and Northup et al. (1999) demonstrated improved response to common behavioral interventions such as token systems, differential reinforcement of alternative behavior, time-out, and reprimands with stimulant medication compared to placebo, and Northup, Jones, et al. (1997) and Dicesare, McAdam, Toner, and Varrell (2005) found that participants were more sensitive to some functional analysis conditions without stimulant medication than with it. These findings support consideration of the use of stimulant medication in conjunction with established behavioral interventions, especially be-

Address correspondence to F. Charles Mace, 407 Bailey Hall, University of Southern Maine, Gorham, Maine 04038 (e-mail: fcmace@usm.maine.edu).

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cause assessment of a clinical response to the medication can be readily established in many cases (Kayser *et al.*; Kelley *et al.*).

The purpose of the present study was to extend the literature showing that individuals with ADHD have differential responsiveness to environmental conditions with and without stimulant medication. We systematically exposed an adolescent boy with ADHD to four different motivational conditions during stimulant medication and placebo conditions. We hypothesized that the evocative effects of the different motivational conditions on a range of undesirable behaviors would be more pronounced without medication, and that activity engagement would improve with medication.

METHOD

Participant and Setting

Guto was a 16-year-old boy who had been diagnosed with ADHD (impulsive type) and moderate learning disabilities (mental retardation). Guto began taking various doses of Ritalin at the age of 12 years. Approximately 2 years ago, Ritalin was discontinued and replaced with 36 mg of Concerta XL to manage his impulsive behavior. Guto's mother raised concerns about possible medication side effects and whether or not he actually benefited from the medication. She requested a formal evaluation of Guto's response to Concerta XL, which precipitated the current study. Guto's mother provided informed consent for Guto to participate in the study.

All sessions were conducted in a large living area (8 m by 4 m) that contained tables and chairs, a couch, and a cabinet with a television. One or two therapists and one or two data collectors were present, depending on the experimental condition.

Target Behaviors and Data Collection

Data were collected on two behaviors that are reported to be directly affected by stimulant medication: *activity engagement*, defined as

facial orientation toward activity materials, appropriate use of activity materials, or comments related to the activity; and *activity changes*, defined as cessation of one activity and onset of a different activity according to this definition of activity engagement. Three other behaviors that may be indirectly affected by stimulant medication were also measured: *rude vocalizations or gestures*, defined as profane statements, name calling, or sexually explicit gestures; *inappropriate touching*, defined as spitting at someone or touching another person's breasts, groin, buttocks or legs; and *physical aggression*, defined as forceful physical contact with another person in the form of hitting, slapping, pinching, or kicking.

These target behaviors were recorded using a continuous 10-s partial-interval recording procedure. Interobserver agreement data were collected by a second trained and independent observer for 25% of the sessions, balanced across experimental conditions. Total agreement was calculated on an interval-by-interval basis, and means were at or above 96% for all behaviors (session range, 77% to 100%).

Procedure

The medication evaluation was conducted over 4 consecutive days. We presented four different conditions to Guto per day in separate 5-min sessions, for a total of 64 sessions for the entire study. Sessions were separated by 2 min of nearly continuous pleasant social interaction with a preferred therapist. Half the sessions were conducted on days in which Guto received 36 mg of Concerta XL; the other half were conducted under a quasiplacebo condition. One therapist conducted all sessions and was joined by a second therapist in the divided attention condition described below. The therapists did not respond to rude vocalizations or gestures, inappropriate touching, and physical aggression. Attempts to touch the breast, groin, and buttocks areas were blocked.

Low attention. At the onset, the therapist terminated the intersession social interaction by

saying, "I need to get some of my work done. I'll talk to you a little later." The therapist then sat at a table, read a book, and did not interact with Guto until the session ended.

Divided attention. A second preferred therapist entered the room, and the first therapist said, "I need to talk with Jane right now." Both therapists sat at a table and engaged in nearly continuous conversation about various topics, and neither interacted with Guto.

High-preference activity. Staff familiar with Guto identified making paper chains as a highly preferred activity; he was skilled at making paper chains and required no assistance. A therapist sat next to Guto at a table, presented the necessary materials, and interacted pleasantly with him by providing frequent encouragement and compliments.

Low-preference activity. Guto's teacher provided a spelling worksheet that he had been working on in school. The work was at his skill level but not yet mastered. The therapist sat next to Guto at a table, presented the worksheet, and said enthusiastically, "Let's do some spelling." The therapist pointed at the first picture, asked him to identify the picture, and then to spell the word in the blocks provided. Within 5 s of disengagement from the activity, the therapist pointed to the worksheet and provided a vocal prompt to continue the task. Engagement was praised on a variable-interval (VI) 30-s schedule (intervals ranged from 10 s to 50 s). Work completion was praised on a fixed-ratio (FR) 1 schedule. If Guto left the table, the therapist immediately followed him and provided prompts to return to the table on a variable-time (VT) 20-s schedule (intervals ranged from 10 s to 30 s). Praise availability (secondary to the VI schedule) and prompt occurrences (secondary to the VT schedule) were signaled by the primary data collector.

Medication and quasiplacebo. Guto's psychiatrist was informed of the details of the evaluation and supervised the medication portion of the study. At 8:30 a.m. each day, a

member of the school staff provided Guto with a cup containing one 36-mg Concerta XL tablet and two vitamin tablets. All three tablets were oblong shaped. The staff member said, "Guto, it's time for your medication." Guto placed all three pills in his mouth and drank a small cup of water. On 2 days of the study, the Concerta XL tablet was replaced with a third vitamin tablet that was similar in shape and size. Guto was not likely aware of the change in medication; he took all tablets without comment. The therapists and data collectors were aware of the medication status, making this a single-blind placebo controlled study.

Experimental Design

The study employed multielement and BABA designs, with the random and counterbalanced implementation of the four motivational conditions comprising the former, and the daily alternation of Concerta XL comprising the latter.

RESULTS

Medication effects during high- and low-preference activities on activity engagement and activity changes are presented in Figure 1. Guto typically engaged in the preferred activity (making paper chains) at higher levels than he did with the less preferred spelling activity, and levels of engagement with both activities generally improved on the days he took Concerta XL compared to placebo. The magnitude of the medication effect was similar during both high- and low-preference activities, indicating no apparent interaction of medication and activity engagement.

Guto changed activities more often during the low-preference activity than during the high-preference activity, and activity changes were typically lower with stimulant medication than placebo during the high-preference activity.

The three panels of Figure 2 show the effects of medication and placebo by motivational condition for Guto's three undesirable behaviors. Under placebo conditions, all three behaviors appeared to be sensitive to depriva-

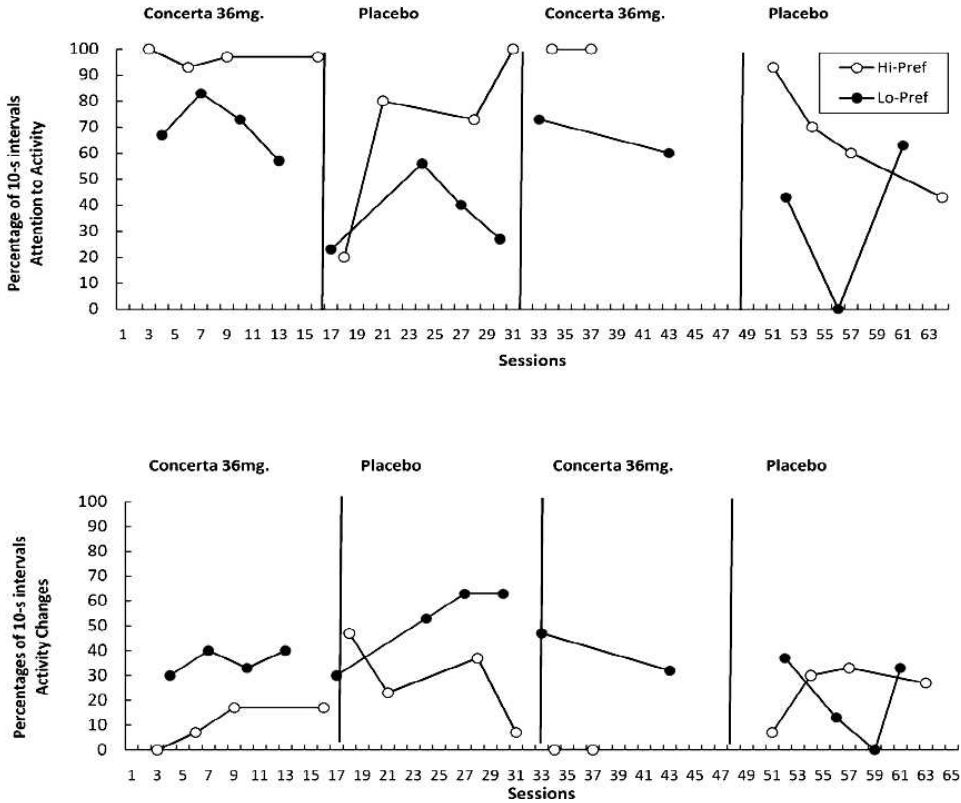


Figure 1. Percentage of 10-s intervals Guto was engaged in the assigned activity (top) or changed activities (bottom) during the high- and low-preference activities. Guto refused to participate in two high-preference and three low-preference sessions, resulting in some missing data points.

tion of therapist attention in the low-attention and divided-attention conditions; however, all three behaviors occurred at much higher levels during the divided-attention condition. Concerta XL was correlated with reductions in all three behaviors. Inappropriate touching and rude vocalizations and gestures were reduced to less than 10% of the intervals, and physical aggression was reduced to zero during the low-attention condition with the medication. Although the benefits of stimulant medication during divided attention were substantial, the behaviors continued to occur at unacceptably high levels. The three undesirable behaviors typically did not occur at high levels when Guto had the undivided attention of the therapist and the opportunity to engage in either activity.

DISCUSSION

Both attention-related and collateral undesirable behaviors of an adolescent with ADHD and moderate mental retardation improved with stimulant medication. Activity engagement was higher and activity changes occurred less often with 36 mg of Concerta XL. This finding replicates other studies showing that stimulant medication can improve academic performance and engagement (Gulley & Northup, 1997; Rapport, Stoner, DuPaul, & Gardner, 1994; Stoner, Carey, Ikeda, & Shinn, 1994). Rude vocalizations and gestures, inappropriate touching, and physical aggression all were reduced with medication. This finding is consistent with the results of Blum et al. (1996) and Northup et al. (1999), who

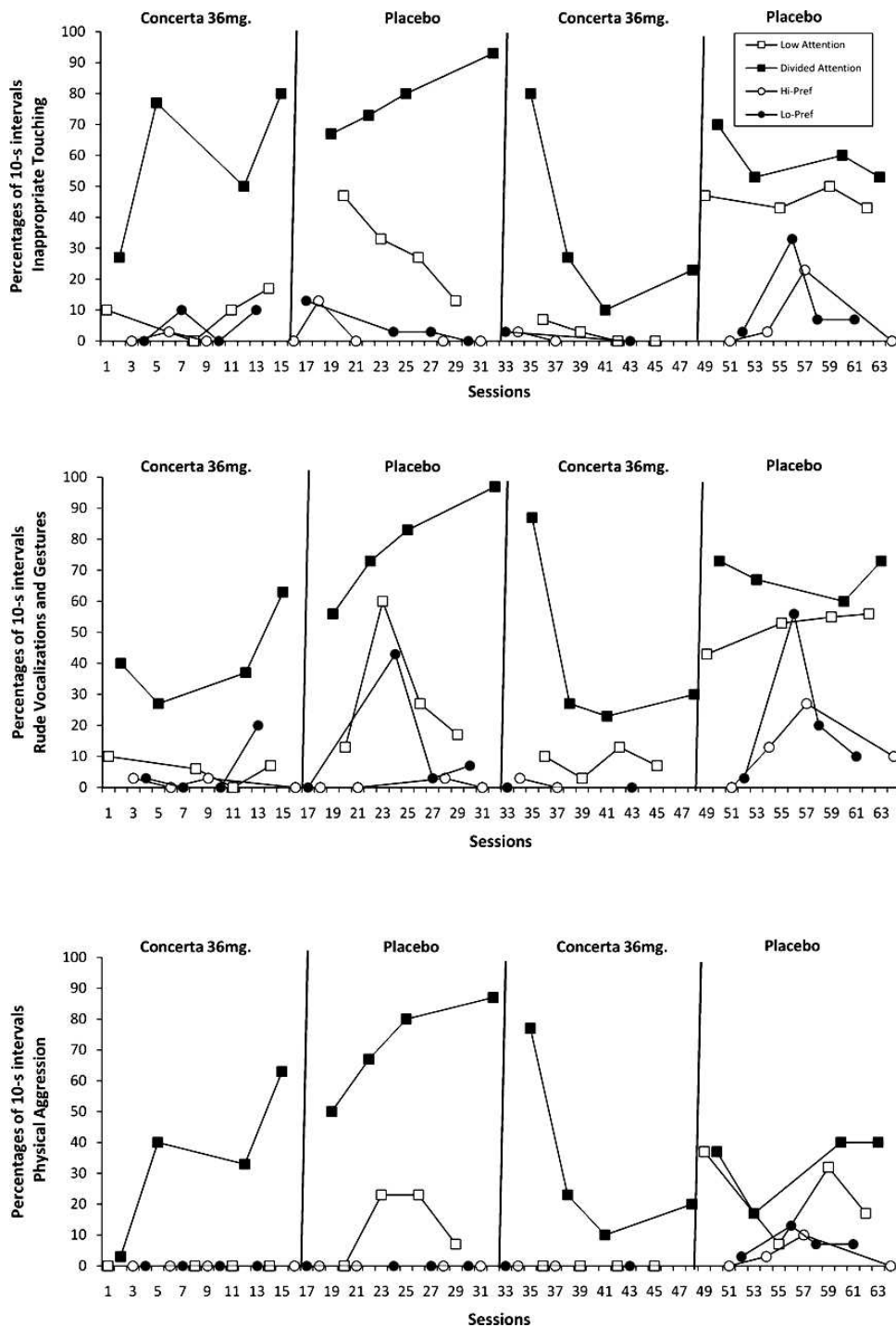


Figure 2. Percentage of 10-s intervals Guto engaged in inappropriate touching (top), rude gestures and vocalizations (middle), and physical aggression (bottom) by motivational condition.

demonstrated collateral improvements in a range of undesirable behaviors related to the use of stimulant medication.

The novel feature of the present study was the assessment of the influence of different types of motivational conditions that are commonly experienced by youth (e.g., high- and low-preference activities, high and low levels of attention), with and without stimulant medication. Independent of medication condition, the high-preference leisure activity evoked more activity engagement and fewer activity changes than the low-preference academic assignment. However, the magnitude of evocation varied systematically across medication conditions. Two of the three undesirable behaviors measured (rude vocalizations and gestures and inappropriate touching) appeared to be sensitive to deprivation of attention independent of the form of deprivation or medication condition.

These results may be best interpreted within the motivational operations conceptual framework developed by Michael and colleagues (Laraway, Snyderski, Michael, & Poling, 2003; Michael, 1982, 1993). The effects of low and divided attention appear to have established the value of the reinforcers for undesirable behavior. Nevertheless, therapist presentation of the high-preference activity (making paper chains) may have had both discriminative and motivating functions on Guto's behavior. The presentation of the activity may have signaled the increased availability of reinforcement for manipulation of the activity materials and pleasant social interaction with the therapist. Hence, activity presentation likely had a discriminative function. However, the availability of the preferred activity and pleasant social interaction may have abolished the effectiveness of other forms of attention and less preferred activities as effective reinforcers.

Although both low- and divided-attention conditions involved deprivation of attention, it is possible that deprivation per se was not the operation that produced behavior-altering

effects. For instance, in the low-attention condition, the therapist picked up a book and said to Guto that he needed to do some work and would not be able to talk. These events may have represented a reflexive conditioned establishing operation (CEO; Michael, 1993) that in this case indicated a worsening situation—the unavailability of therapist attention. However, if the book and statement functioned as a reflexive CEO, offset of the operation (i.e., putting the book down and attending to Guto) would be established as an effective negative reinforcer. This would likely lead to a short latency to the onset of undesirable behaviors whose function is to terminate the reflexive CEO. In the present study, the latency to onset of undesirable behaviors ranged from 40 s to 60 s in the low-attention placebo condition. The evocative effects of the divided-attention condition were substantially stronger than the low-attention condition. The condition not only resulted in much higher levels of undesirable behavior but the latency to undesirable behavior was less than 10 s in all but two of the 16 divided-attention sessions. These results suggest that deprivation may have been operating in the low-attention condition, whereas a reflexive CEO was more likely influencing undesirable behavior in the divided-attention condition.

Finally, the results of the medication evaluation by motivating condition suggest strongly that stimulant medication alone will not be sufficient to effectively manage Guto's undesirable behavior. Although the medication effectively reduced undesirable behaviors in several conditions, these behaviors remained at unacceptable levels while attention was divided between adults and not directed towards Guto. Thus, there were environmental conditions that were sufficiently powerful to motivate and maintain behavior while he was under the influence of stimulant medication. For this reason, a combination of stimulant medication and function-based behavioral treatments is indicated by our data.

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