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SEPARATE AND COMBINED EFFECTS OF METHYLPHENIDATE AND A BEHAVIORAL INTERVENTION ON DISRUPTIVE BEHAVIOR IN CHILDREN WITH MENTAL RETARDATION

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We investigated the separate and combined effects of a behavioral intervention and methylphenidate (Ritalin®) on disruptive behavior and task engagement in 3 children with severe to profound mental retardation. The behavioral intervention involved differential reinforcement of appropriate behavior and guided compliance. All 3 children demonstrated decreased disruptive behavior and improved task engagement in response to the behavioral intervention. Two of the 3 children demonstrated similar improvement in response to methylphenidate. Although both interventions were highly effective for these 2 participants, the relative efficacy of the interventions varied between the 2 children. There was no evidence of an additive or synergistic effect of the two interventions, but the high efficacy of each intervention alone limited our ability to detect such effects.

DESCRIPTORS: disruptive behavior, children with mental retardation, drug effects, methylphenidate, differential reinforcement, guided compliance

Disruptive behavior in individuals with mental retardation is a common clinical problem that is treated by a variety of professionals including behavior analysts and physicians. Physicians frequently prescribe medications to decrease disruptive behavior (Gadow, 1985), whereas behavior analysts use a variety of behavioral procedures (Harris & Ersner-Hershfield, 1978; Matson & Gorman-Smith, 1986). Despite the widespread use of both pharmacologic and behavioral approaches to treatment, with the exception of a few studies (Fisher, Piazza, & Page, 1989; Johnson, Handen, Lubetsky, & Sacco, 1994; Schell et al., 1986), it is uncommon for physicians and behavior analysts to collaborate in evaluating the efficacy of these interventions. Potential benefits of collaboration would include (a) more rigorous measures of behavioral effects and side effects than are usually found in pharmacologic studies, (b) use of experimental designs that are capable of investigating treatment effects on individual subjects, and (c) increased investigation of the relative efficacy of behavioral and pharmacologic treatments when used alone and in combination (Schroeder, 1985).

Widespread use of neuroleptic medications for individuals with mental retardation has been criticized because of studies in which participants have shown behavioral improvement when medication was discontinued (Heistad, Zimmermann, & Doebler, 1982) and because of the potential of such medications to cause irreversible movement disorders or other severe side effects (Whitaker & Rao, 1992). Despite these concerns, neuroleptic medications continue to be the psychotropic medication used most frequently in persons with mental retardation (Baumeister, Todd, & Sevin, 1993; Gadow, 1985). Given that overactive behavior is one of the primary reasons for treatment with neuroleptics (Gadow, 1985), stimulant medications such as methylphenidate may be an effective alternative (Aman, Marks, Turbott, Wilsher, & Merry, 1991).

Stimulant medications are used to treat

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attention deficit hyperactivity disorder (ADHD) in 1% to 2% of school-age children in the United States (Safer & Krager, 1988). Early studies of the use of stimulants to treat persons with mental retardation suggested that they were ineffective (Aman, 1982). However, more recent placebo-controlled studies suggested that children with mild to moderate mental retardation and hyperactive behaviors respond to stimulants in a manner similar to children with normal intelligence and ADHD (Aman et al., 1991; Handen, Breaux, Gosling, Ploof, & Feldman, 1990; Handen et al., 1992). Children with mental retardation may have an increased risk of side effects such as tics and social withdrawal (Handen, Feldman, Gosling, Breaux, & McAuliffe, 1991; Helsel, Hersen, & Lubetsky, 1989). However, in contrast to the side effects of neuroleptics, the side effects of stimulants are usually reversible when the medication is withdrawn.

Research on the effects of methylphenidate on persons with severe to profound mental retardation is limited. Aman et al. (1991) found that only 1 of 13 children and adolescents with an IQ of less than 45 and ADHD or conduct disorder had a beneficial response to methylphenidate. However, only a 0.4 mg/kg dose of methylphenidate was assessed in this study. In a placebo controlled study of 29 adolescents and adults with severe to profound mental retardation, Aman and Singh (1982) found no beneficial response to 0.3 mg/kg and 0.6 mg/kg doses of methylphenidate on a variety of rating scales and observations of ward behavior. However, the participants enrolled in this study displayed a variety of disruptive behaviors, including stereotypic behaviors, which one would not expect to respond to methylphenidate. Moreover, the group experimental design did not allow determination of whether individual subjects may have benefited from the medication. There are reports of beneficial effects of stimulants for some individuals with severe to profound mental retardation, but these reports have not used experimental designs (Spencer, 1970; Triantafillou, 1972).

In contrast, there is an extensive behavioral literature on the treatment of disruptive behaviors in persons with mental retardation (Harris & Ersner-Hershfield, 1978). In this literature, differential reinforcement procedures (including differential reinforcement of alternative behavior; DRA) are the most frequently described intervention for decreasing problem behaviors (Lennox, Miltenberger, Spengler, & Erfanian, 1988). Differential reinforcement has been shown to be effective in decreasing stereotyped behavior (Mulhern & Baumeister, 1969), inappropriate verbalizations (Deitz & Repp, 1973; Konczak & Johnson, 1983), disruptive classroom behaviors (Deitz, Repp, & Deitz, 1976), and aggressive and self-injurious behaviors (Repp & Deitz, 1974). Although the potential of differential reinforcement procedures to decrease problem behaviors is clear, the success of this intervention depends on the identification of effective reinforcers and maintaining variables that can be altered (Vollmer & Iwata, 1992). Furthermore, behavioral treatments may not always reduce the disruptive behaviors to zero or near-zero levels (Repp & Deitz, 1974; Sewell, McCoy, & Sewell, 1973) and may require very high frequencies of reinforcement (Mulhern & Baumeister, 1969) that may be difficult to implement in the home and school environments.

Given the advantages and disadvantages of pharmacologic and behavioral treatments, it is important to investigate the relative efficacy of these interventions and the possibility that combining behavioral and pharmacologic treatments will result in additive or interactive effects (Pelham & Murphy, 1986). Studies of groups of children with ADHD provide some support for the additive effects of methylphenidate and behavioral treatments (Carlson, Pelham, Milich, & Dixon, 1992; Pelham, Milich, & Walker, 1986), but the extent to which these effects are seen in individual children is less clear (Schell et al., 1986). In this study we investigated the separate and combined effects of methylphenidate and a behavioral treatment involving differential reinforcement and guided compliance in decreasing the disruptive behaviors of 3 children with mental retardation.

METHOD

Subjects and Setting

Three children with severe to profound mental retardation participated in this study. All engaged in severe disruptive and aggressive behaviors and were admitted to an eight-bed inpatient hospital unit dedicated to the treatment of severe behavior disorders in individuals with developmental disabilities. Treatment sessions were conducted by graduate students or trained behavior analysts who worked with the children individually. Sessions were conducted in a dormitory-style room (4.5 m by 6.0 m) that served as the children's living quarters. It was equipped with a full bathroom, a table (180 cm long), two to four beds, and three to five chairs. Participants were enrolled in the study after obtaining written parental informed consent.

Ted. Ted was a 6-year-old boy with severe mental retardation whose aggressive and disruptive behaviors included hitting, kicking, and throwing or knocking over objects and furniture. His mother reported that his disruptive and aggressive behaviors occurred several times every day at both home and school, but were most evident at home. She stated that he had been "hyperactive" since he was an infant. Ted had never taken medications for his behavior. He lived with his mother, stepfather, and two siblings. He communicated using approximately seven signs and a variety of gestures. He could follow one-step commands and eat with utensils, but did not independently use the toilet. On the Revised Gesell Developmental Schedules (Knobloch, Stevens, & Malone, 1987), his adaptive and language skills were estimated to be at 21 months.

Bill. Bill was an 11-year-old boy with profound mental retardation whose aggressive and disruptive behaviors included pulling hair, hitting, and throwing objects at others or off shelves. He was described by his mother as very active, often climbing on people and jumping on furniture. These behaviors occurred several times per day at home. Bill's behavior had been treated with thioridazine in the past without improvement. He was taking no medications at the time of his admission. Bill lived with his parents and five siblings, two of whom also had mental retardation. He communicated primarily by using gestures and pointing. He imitated single-syllable words by using grunts of various intonations and could follow simple one-step commands. Bill required assistance with all personal care skills. He could eat with his fingers, but not with utensils. He could help with dressing by putting his arms through the sleeves of a shirt and by pulling up his pants.

Art. Art was a 7.5-year-old boy with fragile X syndrome, severe mental retardation, and a seizure disorder. His anticonvulsant (valproic acid) dose was not changed during the study. He was admitted for the treatment of aggressive and disruptive behaviors that included hitting, biting, pinching, and spitting at his parents and others. Prior to his admission to this hospital, he had been admitted to an inpatient psychiatric unit for treatment of these behaviors. During the psychiatric hospitalization, his aggressive behaviors had been treated with risperidone, but his parents were concerned that he seemed to be sedated. Art was weaned off the risperidone before this investigation was begun. Art communicated using multiword sentences. On the Revised Gesell Developmental Schedules (Knobloch et al., 1987), his adaptive skills were at 36 months. On the Peabody Picture Vocabulary Test (Dunn & Munn, 1981), his age-equivalent score was 27 months (standard score less than 40).

Dependent Variables and Data Collection

Ted and Bill. The primary dependent measure for Ted and Bill was the percentage of time engaged in disruptive behavior during 10-min task sessions in which they were asked to place plastic blocks or books into a specific container. Disruptive behaviors were defined as throwing objects, climbing on or under furniture, knocking over furniture, swinging doors open and closed repeatedly, or attempting to destroy objects by ripping, stomping, or kicking them. Data were collected on laptop computers using Portable Computer Systems For Observational Use software. The duration of disruptive behavior was measured from the onset of the disruptive behavior until the child had not engaged in any disruptive behavior for 5 s. Interobserver agreement was obtained on an average of 38% (Ted) and 32% (Bill) of sessions across all phases and conditions of the experiment. Total agreement was calculated as the exact overlap in the length of time (in seconds) that two independent observers agreed on the presence of disruptive behavior plus the exact overlap in the length of time that they agreed on the absence of disruptive behavior divided by the length of the session (600 s) and multiplied by 100%. For Ted, mean agreement (with ranges in parentheses) for disruptive behavior during baseline conditions was 96% (85% to 100%) on placebo and 98% (87% to 100%) on 0.3 mg/kg of methylphenidate. During the DRA and guided compliance intervention, mean agreement for disruptive behavior was 89% (63% to 100%) on placebo and 99% (93% to 100%) on 0.3 mg/kg of methylphenidate. For Bill, mean agreement for disruptive behavior during baseline conditions was 94% (87% to 99%) on placebo, 98% (96% to 99%) on 0.3 mg/kg of methylphenidate, and 98% (97% to 100%) on 0.6 mg/kg of methylphenidate. During the DRA and guided compliance intervention, mean agreement for disruptive behavior was 96% (88% to 100%) on placebo, 98% (97% to 99%) on 0.3 mg/kg of methylphenidate, and 99% (97% to 100%) on 0.6 mg/kg of methylphenidate.

Engagement with the task, defined as the child's picking up or walking with a toy or book in the direction of the container or depositing a toy or book in the container, was also measured. Engagement was coded from the onset of the behavior until these behaviors were discontinued for at least 5 s. Coding of engagement was also stopped if the child exhibited disruptive behaviors, received physical guidance from the therapist, or held a toy or book for longer than 5 s without attempting to deposit it in the container. Interobserver agreement for engagement was calculated in the same manner as described for disruptive behavior. For Ted, mean agreement for engagement during baseline conditions was 99% (97% to 100%) on placebo and 98% (86% to 100%) on 0.3 mg/kg of methylphenidate. During the DRA and guided compliance intervention, mean agreement for engagement was 88% (33% to 100%) on placebo and 98% (89% to 100%) on 0.3 mg/kg of methylphenidate. For Bill, mean agreement for engagement during baseline conditions was 93% (87% to 99%) on placebo, 88% (87% to 88%) on 0.3 mg/kg of methylphenidate, and 94% (91% to 100%) on 0.6 mg/kg of methylphenidate. During the DRA and guided compliance intervention, mean agreement for engagement was 95% (85% to 98%) on placebo, 94% (90% to 97%) on 0.3 mg/kg of methylphenidate, and 97% (95% to 99%) on 0.6 mg/kg of methylphenidate.

Art. The primary dependent measure was the rate of disruptive behaviors during a number or letter identification task. Disruptive behavior was measured as a rate rather than as a percentage of time, because Art's disruptive behaviors tended to be discrete events of short duration. Disruptive behaviors were defined as described above. However, because Art had to sit at a table to engage in this task, getting up from the table was also coded as a disruptive behavior. Engagement was defined as holding or looking at task materials. It was measured from the onset of the behavior until Art did not engage in the behavior for 5 s. If Art held the task material for longer than 5 s without looking at it, he was not considered to be engaged with the task. Data were collected on laptop computers as described above. Interobserver agreement was obtained on an average of 23% of the sessions across all phases of the experiment. For disruptive behavior, interobserver agreement was calculated on a point-by-point basis (House, House, & Campbell, 1981). Counts of disruptive behaviors within 10-s intervals were compared for two independent observers, and the number of agreements was divided by the total number of agreements plus disagreements and multiplied by 100%. During baseline conditions, mean agreement for disruptive behavior was 91% (76% to 100%) on placebo, 96% (93% to 100%) on 0.3 mg/kg of methylphenidate, and 100% on 0.6 mg/kg of methylphenidate. During the DRA and guided compliance intervention, mean agreement for disruptive behavior was 95% (92% to 97%) on placebo, 91% (77% to 100%) on 0.3 mg/kg methylphenidate, and 100% on 0.6 mg/kg methylphenidate. For engagement, interobserver agreement was calculated by the observational software as described above. During baseline conditions, mean agreement for engagement was 92% (88% to 100%) on placebo, 96% (93% to 100%) on 0.3 mg/kg of methylphenidate, and 92% (agreement recorded in only one session) on 0.6 mg/kg of methylphenidate. During the DRA and guided compliance intervention, mean agreement for engagement was 93% (90% to 97%) on placebo, 86% (59% to 100%) on 0.3 mg/kg of methylphenidate, and 97% (agreement recorded in only one session) on 0.6 mg/kg of methylphenidate.

Procedures

Baseline. During each baseline session for Ted and Bill, the therapist pointed to a specific block and the designated box and said, "Put the block in this box." If the child complied with the request, the therapist issued the next request upon completion of the task. If the child did not comply with the request, the therapist repeated the request 30 s later. Disruptive behaviors were ignored during this condition.

During baseline sessions with Art, the therapist presented him with two letters or three numbers and said, "Point to the . . ." (a letter or number). If he did not respond within 5 s, the therapist repeated the direction. If he did not respond to this second instruction within 5 s, he was shown the correct answer. When Art pointed to a card or after he was shown the correct answer, another trial with a different set of letters and numbers began. No reinforcement for task completion was provided. The therapist did not respond to disruptive behaviors. However, if Art got up from the table, the therapist brought him back.

DRA and guided compliance. During each session for Ted and Bill, the therapist asked the child to complete the task described above. If the child complied with the request, the therapist provided a reinforcer, and the next request was made after the child was given the reinforcer. If the child did not comply with the request, he was physically guided to complete the task and the next request was issued immediately upon completion.

Art was given the instructions described above. If he pointed to either card, he was given verbal praise. If he pointed to the correct card, he also received an edible reinforcer on a variable-ratio (VR) 3 schedule. If he did not respond to the second verbal instruction, hand-over-hand physical guidance was used to assist him in pointing to the designated number or letter.

For Ted, verbal praise and physical attention were initially used as reinforcers, but when they appeared to be ineffective, the reinforcers were changed to verbal praise and edible items. For Bill and Art, a forced-choice preference assessment (Fisher et al.,1992) was used to identify reinforcers. Ten stimuli (a combination of edible items, solitary play items, and interactive play items) were presented two at a time, and the child was allowed 30 s of access to the stimulus he selected. The pairings were presented in a randomized order, and each stimulus was paired with all other stimuli one time. The three stimuli selected most frequently were chosen as reinforcers. For both Bill and Art, the three most highly preferred stimuli were all edible items (small piece of a cookie or cracker, or a piece of cereal).

Methylphenidate. Each child was randomly assigned to receive a placebo (A), a 0.3 mg/kg dose of methylphenidate (B), and a 0.6 mg/kg dose of methylphenidate (C), in one of the following four orders: ABACA(B or C), ACABA(B or C), BACA(B or C), or CABA(B or C). The methylphenidate dose was rounded to the nearest 2.5 mg, and identical capsules containing methylphenidate or a placebo were prepared by the hospital pharmacy. The child received one capsule at 8 a.m. and one at noon. All sessions were conducted 1 to 3 hr after the child received the capsule. All members of the treatment team, participants in the study, and family members were blind to the order of medication administration during the first four phases of the study. At the end of the fourth phase, one physician was unblinded in order to instruct the pharmacy about what medication to prepare for the final phase. This was done to allow within-subject replication of the most effective methylphenidate dose as determined during the first four phases of the investigation. All other members of the treatment team, study group, and family remained blind to the medication that the child received during these phases.

Ted's medication schedule was randomized in the ACABA(B or C) order, but he had side effects to the medication (tics) on the first day that the 0.6 mg/kg dose of methylphenidate was given. When the tics occurred, one physician was unblinded to medication conditions and instructed the pharmacy to continue with the study using an ABAB design. All other members of the treatment team remained blind to medication conditions. Bill's and Art's medication schedules were both randomized in the BACA(B or C) order.

Experimental Design

The baseline sessions and the DRA and guided compliance sessions were conducted each day of the study. They were counterbalanced in a multielement design across all medication phases. The order of the sessions each day was randomized. Methylphenidate and the placebo were alternated in a reversal design for the most effective methylphenidate dose.

RESULTS

Ted

Figure 1 shows the percentage of disruptive behavior during each session. Initially, verbal praise and physical attention were used as reinforcers in the DRA intervention, but when they appeared to be ineffective, the

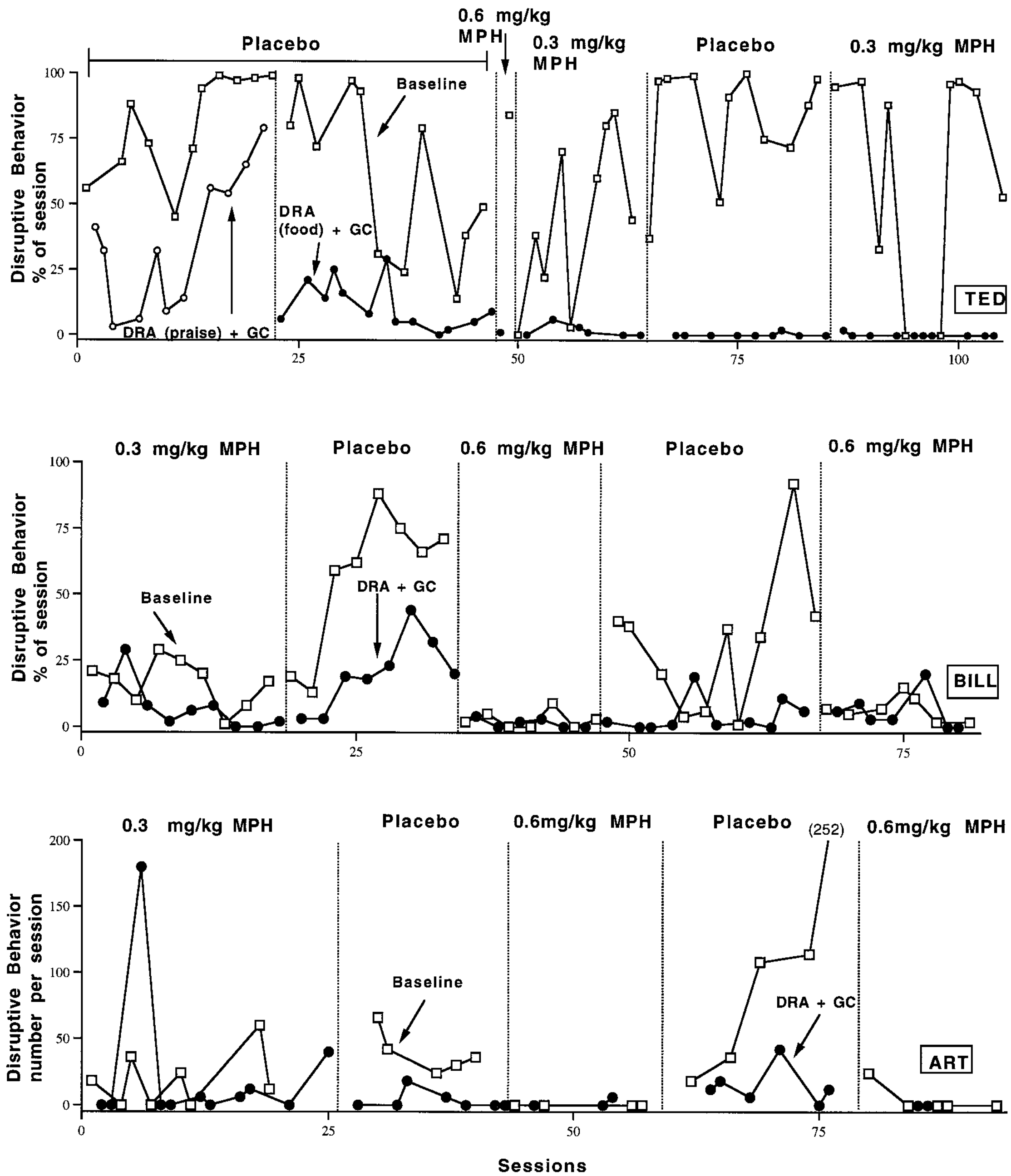

Figure 1. Percentage of each task session engaged in disruptive behaviors (Ted, Bill) or number of disruptive behaviors per hour during each session (Art). Baseline conditions (open squares) were counterbalanced with a differential-reinforcement-of-alternative-behavior and guided compliance (DRA + GC) intervention across all methylphenidate (MPH) and placebo phases. The open circles indicate that praise and attention were the reinforcers, and the filled circles indicate that verbal praise and an edible item were the reinforcers.

reinforcers were changed to verbal praise and food for the remainder of the study. During Phase 2 on placebo with the DRA and guided compliance intervention, disruptive behavior occurred during an average of 11.3% of each session. In baseline sessions during this phase, disruptive behavior occurred during 61.4% of each session.

On the 0.6 mg/kg dose of methylphenidate (Phase 3), only two data points were obtained because Ted developed tics, and he was tearful or crying much of the day. These side effects were resolved on the 0.3 mg/kg dose of methylphenidate, and thus only the efficacy of the 0.3 mg/kg dose of methylphenidate was further assessed.

During Phase 4 on the 0.3 mg/kg dose of methylphenidate, disruptive behavior occurred during an average of 1.7% of each session with the DRA and guided compliance intervention and during an average of 44.6% of each session in baseline. During the return-to-placebo conditions, disruptive behavior increased to an average of 82.3% of each session in baseline, but there was no reversal of disruptive behavior in the sessions with the behavioral intervention. During Phase 6, on methylphenidate at the 0.3 mg/kg dose, disruptive behavior occurred during 65.2% of each session under baseline conditions and remained at near-zero levels with the DRA and guided compliance intervention. Although the behavioral intervention was clearly effective, the 0.3 mg/kg dose of methylphenidate did not have a clinically significant effect.

Engagement data are shown in Figure 2. Although engagement initially seemed to improve on methylphenidate, this effect was not replicated during the reversal phase. During Phase 2, the DRA and guided compliance intervention resulted in engagement during an average of 31.2% of each session. In both phases that combined the DRA intervention with methylphenidate, mean engagement improved to over 90% of each session. However, even when methylphenidate was withdrawn, the DRA and guided compliance intervention continued to result in similarly high levels of engagement.

Bill

The results in Figure 1 show that the 0.6 mg/kg dose of methylphenidate (Phase 3) was more effective in decreasing disruptive behaviors than the 0.3 mg/kg dose (Phase 1). During Phase 2 on placebo, Bill was disruptive an average of 56.6% of the time during baseline sessions, compared to an average of 20.2% of the time during sessions with the DRA and guided compliance intervention. During Phase 3, treatment with the 0.6 mg/kg dose of methylphenidate suppressed disruptive behavior to an average of 2.7% of each session under baseline conditions and an average of 1.5% of each session with the behavioral intervention. During return to the placebo, disruptive behavior increased to an average of 31.4% of each session during baseline conditions, but remained at a low level during sessions with the behavioral intervention. Reintroduction of methylphenidate at the 0.6 mg/kg dose replicated the decrease in disruptive behavior during baseline sessions. Medication and the DRA and guided compliance intervention were not more effective than the medication alone. During the first placebo phase, the DRA and guided compliance intervention alone was not as effective as it was during the second placebo phase. However, during the second placebo phase, the DRA and guided compliance intervention alone was approximately as effective as the 0.6 mg/kg dose of methylphenidate alone. Although both treatments were effective when used alone, there was no evidence of an additive effect when the treatments were used together.

Engagement data are shown in Figure 2. During Phase 2 while on placebo, engagement occurred during an average of 16.5% of each session under baseline conditions

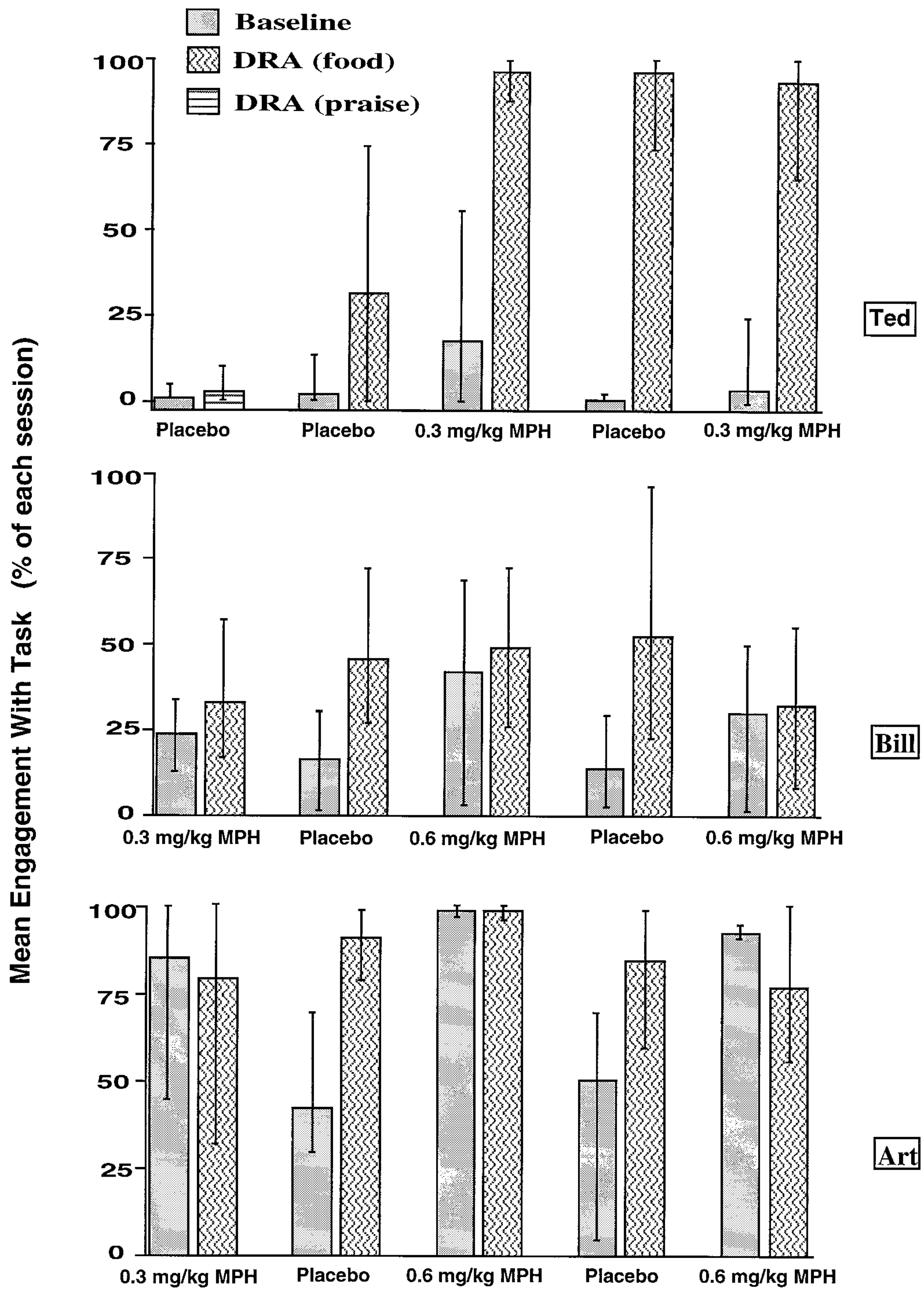

Figure 2. Mean percentage of each session engaged in the task for the baseline condition and the differential reinforcement and guided compliance (DRA + GC) conditions across all methylphenidate (MPH) and placebo conditions. Bars indicate ranges.

and 45.9% of each session with the DRA and guided compliance intervention. Treatment with the 0.6 mg/kg dose of methylphenidate did not further improve engagement during sessions combined with the behavioral intervention, but did improve engagement in baseline sessions.

Art

The results in Figure 1 indicate that the 0.6 mg/kg dose of methylphenidate (Phase 3) was more effective than the 0.3 mg/kg dose (Phase 1) in suppressing disruptive behavior. In the first placebo condition, disruptive behaviors occurred an average of 39.6 times per hour during baseline sessions and 3.4 times per hour in sessions with the DRA and guided compliance intervention. During the next phase of the study on the 0.6 mg/kg dose of methylphenidate, disruptive behavior did not occur in any baseline session and occurred at an average rate of 1.5 per hour during sessions with the behavioral intervention. When the medication was withdrawn, disruptive behaviors occurred at an average rate of 105.6 per hour during baseline sessions and 15.0 per hour during sessions with the behavioral intervention. Reintroduction of the medication suppressed disruptive behaviors to near-zero levels under both conditions. Methylphenidate alone and the behavioral treatment alone were very effective at decreasing disruptive behaviors. During the second placebo phase, the behavioral treatment was not as effective as it was during the first placebo phase. Thus, in general, it appears that the medication alone may have been somewhat more effective than the DRA and guided compliance intervention alone.

Engagement data are shown in Figure 2. During the first placebo phase, Art was engaged with the task during an average of 91.4% of each session with the DRA and guided compliance intervention and 42.2% under baseline conditions. Treatment with the 0.6 mg/kg dose of methylphenidate increased engagement to over 90% under baseline conditions. There was no additional effect of the behavioral intervention.

DISCUSSION

This study demonstrates the use of single-subject experimental methodology to investigate the separate and combined effects of a behavioral and pharmacologic intervention concurrently. The multielement design allows comparison of baseline and behavioral treatment alone conditions during placebo phases and comparison of methylphenidate alone and combined treatment during methylphenidate phases. Methylphenidate and placebo phases were compared using a within-subject reversal design. Methylphenidate has a rapid onset of action (within 30 min) and short duration of action (3 to 4 hr) that allow for rapid within-subject reversals (Greenhill, 1995).

This is one of only a few studies (Johnson et al., 1994; Schell et al., 1986) that have used single-subject experimental designs that allow a controlled comparison of baseline conditions, a behavioral intervention alone, methylphenidate alone, and the combination of methylphenidate and a behavioral intervention for the treatment of disruptive behavior in individual subjects. It is the only study to provide a relatively large number of data points within each medication condition, thus allowing for a more complete evaluation of within-subject effects and an assessment of the stabilization of data within medication conditions. Furthermore, it is the only study to use a single-case experimental design to investigate these effects in children with severe to profound mental retardation.

For all 3 participants in this study, the DRA and guided compliance intervention reduced disruptive behaviors and improved engagement with the task. For Ted, the low dose of methylphenidate (0.3 mg/kg) had no clinically significant effect on disruptive behavior or engagement, and the high dose of methylphenidate (0.6 mg/kg) was discontinued due to side effects. For Bill and Art, the high dose of methylphenidate decreased disruptive behavior and improved engagement with the task. In both cases, the high dose was much more effective than the low dose.

For Bill, high-dose methylphenidate alone initially seemed to be more effective than DRA and guided compliance alone, but during the second placebo and high-dose methylphenidate phases, the two interventions appeared to be equally effective in decreasing disruptive behavior. Both interventions were also effective in improving engagement with the task. However, despite the effectiveness of each intervention alone, there was no evidence that the two interventions had an additive or synergistic effect in decreasing disruptive behaviors or improving engagement with the task. The effectiveness of each intervention alone may have limited the possibility of detecting an additive or synergistic effect in decreasing disruptive behavior, but this would not explain the failure to demonstrate such an effect on engagement with the task. In Art's case, high-dose methylphenidate alone was slightly more effective than the DRA intervention alone in decreasing disruptive behavior and improving engagement with the task. Methylphenidate was so effective that the potential for a synergistic effect cannot be evaluated because of a floor effect for disruptive behavior and a ceiling effect for engagement.

The data demonstrate intersubject variability in the relative efficacy of the behavioral and pharmacologic interventions. Ted responded well to the DRA and guided compliance intervention and had intolerable side effects on the high dose of methylphenidate. Bill responded similarly to both interventions, and Art responded better to methylphenidate than to the behavioral intervention. These findings support other studies of individual children with mental retardation, some of which report that behavioral interventions are more effective than methylphenidate (Shafto & Sulzbacher, 1977), and others of which report that methylphenidate is more effective than a behavioral intervention in decreasing defiant, hyperactive, or disruptive behaviors (Johnson et al., 1994; Schell et al., 1986). The use of reinforcer assessments to identify effective reinforcers for Bill and Art may help to explain the effectiveness of the behavioral interventions in this study. However, it is noteworthy that despite the use of a reinforcer assessment in developing the behavioral intervention for Art, the 0.6 mg/kg dose of methylphenidate was more effective than the behavioral treatment. The use of functional analysis and reinforcer assessment to develop behavioral interventions to study in combination with pharmacologic treatments is a potential area for greater collaboration between physicians and behavior analysts.

Other studies of children with mental retardation also have failed to show an additive or synergistic effect of methylphenidate and behavioral treatment on disruptive behavior or engagement with a task. Christensen (1975) found that adding 0.3 mg/kg of methylphenidate to a behavioral treatment involving token and verbal reinforcement plus extinction did not improve the classroom behavior of 16 children with mental retardation. Schell et al. (1986) assessed the separate and combined effects of a behavioral intervention and a 0.3 mg/kg dose of methylphenidate in a child with mild mental retardation. They did not find an additive effect of methylphenidate and the behavioral intervention on defiant behavior, but they did find an additive effect of the two interventions on correct responses to an academic task. Similarly, in 3 children with mild mental retardation, Johnson et al. (1994) found additive effects of methylphenidate and a behavioral intervention on task accuracy, but not on measures of fidgety or defiant behaviors. Thus, although we did not find an additive or synergistic effect of methylphenidate and the DRA and guided compliance intervention, we cannot rule out that such an effect may have been found had we investigated other behaviors or these behaviors in other settings.

In contrast to the predominately single-case studies in children with mental retardation discussed above, group studies of children with ADHD and average intelligence have found that behavioral treatments in combination with low doses of methylphenidate are more effective than either intervention alone (Carlson et al., 1992; Pelham et al., 1986; Pelham & Murphy, 1986). However, some studies suggest that a high dose of methylphenidate alone is as effective as combined treatments (Carlson et al., 1992; Gittelman et al., 1980). The degree to which these group studies characterize the response of individual children to these interventions is not known. This gap in the literature highlights the need for further studies of these effects using single-subject experimental designs.

Interestingly, during the initial phase with the DRA and guided compliance intervention and placebo, Ted and Bill exhibited relatively high rates of disruptive behaviors. In both cases, it was during treatment with methylphenidate that disruptive behaviors decreased to near-zero levels. However, a return to the behavioral intervention alone did not result in a reversal in the frequency of disruptive behavior. In contrast, the frequency of disruptive behavior did reverse in the baseline condition. These results suggests the possibility that for these 2 participants, methylphenidate facilitated learning of the behavioral contingencies. Although a facilitative effect of methylphenidate on learning behavioral contingencies has been suggested by others (Christensen & Sprague, 1973), it has not been clearly demonstrated. This explanation for the results of our study must be regarded as tentative, because this study was not designed to investigate this hypothesis.

This is the first report of the beneficial effects of stimulants in children with severe to profound mental retardation that has used an experimental design to document the effects. It is consistent with previous case reports of stimulant medications resulting in improved behavior in this population (Spencer, 1970; Triantafillou, 1972). However, in two group studies (Aman, Kern, McGhee, & Arnold, 1993; Aman et al., 1991), only 1 out of a total of 18 children with an IQ of less than 45 had a beneficial response to methylphenidate. In both studies, only a 0.4 mg/kg dose of methylphenidate was assessed. Given that the response to the 0.6 mg/kg dose was much greater than the response to the 0.3 mg/kg dose in our study, it is possible that the low response rate in the previous studies was related to the relatively low dose of methylphenidate that was used. Aman and Singh (1982) used both 0.3 mg/kg and 0.6 mg/kg doses of methylphenidate in a group of adolescents and adults with severe to profound mental retardation and reported no benefit for either dose, but the group experimental design may not have allowed detection of individuals who benefited from the medication. Alternatively, the response to medication in adults with severe to profound mental retardation may be different from the response in children.

The findings of this study show the idiosyncratic character of response to methylphenidate and to behavioral treatment in children with severe to profound mental retardation. The findings suggest that individuals who conduct interventions for disruptive behaviors in this population should consider both behavioral and pharmacologic approaches. When considering the use of methylphenidate, one should remember that children with mental retardation have been reported to have a higher incidence of side effects than is found in the general population (Aman et al., 1991; Handen et al., 1991). This may be especially true of social withdrawal, which is a commonly reported side effect in children with mental retardation (Handen et al., 1991; Helsel et al., 1989), but is not frequently found in children of average intelligence (Ahmann et al., 1993; Barkley, McMurray, Edelbrock, & Robbins, 1990). Due to this higher rate of side effects and the difficulty in predicting which children's behavior will improve on stimulants, it is necessary to carefully monitor for efficacy and side effects when children with mental retardation are given methylphenidate. It is likely that this can be best accomplished if physicians and behavior analysts collaborate on the clinical management of these individuals.

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STUDY QUESTIONS

1. What are some disadvantages of operant and pharmacological approaches to the treatment of behavior disorders, and what potential benefits might result from an integrative approach?
2. What were the target behaviors and how were they measured?
3. Describe the contingencies in effect during the baseline and the DRA plus guided compliance conditions.
4. Briefly describe the medication dosages that were evaluated and the general method of administration.
5. What types of experimental designs were used to evaluate the effects of the behavioral and pharmacological interventions?
6. What were the effects of each treatment separately on disruptive behavior and task engagement for Ted, Bill and Art, and which treatment was more effective for each subject?
7. The authors indicated that there was no evidence of an interactive or synergistic effect resulting from combined treatment. What type of outcome would have suggested an interaction effect, and what feature of the results may have obscured such an effect?
8. The authors mention that they used a preference assessment to aid in the identification of reinforcers used during treatment. What additional analysis may have been helpful in developing the behavioral interventions or in interpreting the results if the behavioral intervention had been less effective than it was?

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