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AN INDIVIDUALIZED AND COMPREHENSIVE APPROACH TO TREATING SLEEP PROBLEMS IN YOUNG CHILDREN

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We evaluated the effects of assessment-based interventions on the treatment of sleep problems in 3 young children, 2 of whom had been diagnosed with autism. We used sleep diaries and infrared nighttime video in the child's bedroom to obtain measures of sleep onset, sleep-interfering behaviors, night waking, total sleep, parental presence, and medication administration each night. We then identified environmental factors that contributed to sleep problems using an open-ended interview called the Sleep Assessment and Treatment Tool. Individualized treatment packages were designed with the children's parents based on the idiosyncratic results of the assessment. Treatment packages included adjustment of the sleep schedule based on developmental norms and current sleep phases, design of a sleep-conducive environment, elimination of inappropriate sleep dependencies, and function-based interventions to decrease sleep-interfering behaviors by disrupting the contingency between the interfering behavior and its likely reinforcement. A nonconcurrent multiple baseline design across subjects revealed that treatment was effective for all 3 children. In addition, social acceptability measures showed that the parents were satisfied with the assessment process, the treatment, and the amount of behavior change.

Key words: assessment, autism, children, functional assessment, sleep problems, sleep treatment

Families and practitioners regularly experience difficulty managing sleep problems of young children. Problems with falling or staying asleep, noncompliance with nighttime routines, and problem behaviors that occur after the bid goodnight and interfere with sleep onset (e.g., crying, leaving the bedroom, and playing in bed) are common child-rearing difficulties for parents, frequently complained about to pediatricians, and a common reason for prescribing psychotropic medication to young children (Minde, 1998; Mindell, Moline, Zendell, Brown, & Fry, 1994).

A growing body of evidence suggests that sleep problems can negatively affect children and their families. Child irritability and difficult temperament (Richman, 1981; Wiggs & Stores, 1996), daytime sleepiness (Liu, Liu, Owens, & Kaplan, 2005), unintentional injuries (Koulouglioti, Cole, & Kitzman, 2008), poor performance on IQ measures (Gruber et al., 2010), risk of obesity (Bell & Zimmerman, 2010), and anxiety in adulthood (Gregory et al., 2005) are all positively correlated with sleep problems. Sleep problems are also positively correlated with other behavior problems that are commonly addressed by behavior analysts, such as self-injury, noncompliance, aggression, tantrums, and impulsivity (Wiggs & Stores, 1996; Zuckerman, Stevenson, & Bailey, 1987). Equally troublesome are the concomitant secondary effects on other family members, including poor parental sleep quality and daytime functioning (Meltzer & Mindell, 2007), family stress and tension (Kataria, Swanson, & Trevathan, 1987; Richman, 1981), maternal malaise (Richman, 1981), and marital discord (Chavin & Tinson, 1980).

By approximately 3 to 6 months of age, most infants do not require routine parental care to be able to sleep through the night (T. Moore & Ucko, 1957), yet sleep problems remain prevalent, affecting 35% to 50% of typically developing children and as many as 67% to 73% of children with an autism spectrum disorder (ASD; Johnson, 1991; Polimeni, Richdale, & Francis,

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2005; Souders et al., 2009). Although there is a notion that children eventually grow out of the developmental phase characterized by sleep disturbance, the persistence of these problems suggests that they do not subside with age (Kataria et al., 1987; Zuckerman et al., 1987).

Parents are likely to consult with pediatricians for assistance with sleep problems, but a national survey of pediatric residency programs found that pediatricians receive only about 5 hr of training on addressing sleep problems. A significant number of pediatricians suggest to parents that children will outgrow these problems (Mindell et al., 1994) and therefore do not prescribe treatment. When treatments are recommended, they are often pharmacological, and the prevalence of pharmacological intervention is especially high for children with disabilities who experience sleep problems. Owens, Rosen, and Mindell (2003) surveyed a sample of 671 community-based primary care pediatricians and found that more than 50% of them have prescribed medications and that more than 75% of them have recommended nonprescription drugs for pediatric insomnia (insomnia refers to difficulties falling or staying asleep). Stojanovski, Rasu, Balkrishnan, and Nahata (2007) reported that as many as 81% of children's visits to pediatricians, psychiatrists, and family physicians for sleep problems result in medication prescriptions. These practices persist despite the lack of clear clinical guidelines for prescribing practices and limited research on the long-term efficacy, tolerability, and social acceptability of pharmacological intervention (Rosen, Owens, Scher, & Glaze, 2002).

The need for efficacious treatments to both address and prevent sleep problems in young children is obvious. Recent reviews of empirically supported treatments for pediatric sleep problems encourage the application of strategies derived from a behavior-analytic approach (Kuhn & Elliott, 2003; Mindell, 1999; Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006). Although the behavioral assessment and treatment literature focused on pediatric sleep problems is scarce in comparison to that available for other problem behavior (e.g., self-injury or classroom disruption; Kahng, Iwata, & Lewin, 2002), several notable studies have described effective intervention. For instance, France and Hudson (1990) demonstrated the success of a stimulus control procedure (e.g., routine bedtime stories prior to placing the child in bed) and extinction (i.e., not attending to the child after the bid good night unless absolutely necessary) for decreasing night waking and improving overall sleep quality in seven infants with sleep problems. Piazza and Fisher (1991b) described an effective faded bedtime with response cost procedure that increased the amount of appropriate sleep in four individuals with intellectual disabilities. Three children were being served in an inpatient hospital unit, and one child's evaluation occurred while he was an outpatient. Treatment components involved (a) bidding the child goodnight 30 min past the average sleep-onset time from baseline and fading the bedtime earlier by 30 min on the next night if the child was able to fall asleep within 15 min of bedtime, (b) not allowing the child to go to bed prior to the scheduled bedtime or sleep past the scheduled wake time, and (c) a response cost procedure that involved keeping the child awake and away from bed for 1 hr if sleep-onset delay was more than 15 min. Ashbaugh and Peck (1998) systematically replicated these effects in a home setting with a 2-year-old typically developing child. Considered together, Friman et al. (1999) and Freeman (2006) demonstrated the positive effects of extinction and a bedtime pass on the sleep-interfering behaviors (i.e., crying at night and leaving the bedroom) of six children of typical development. Using the pass resulted in a brief trip outside the bedroom and access to the parent's attention. In sum, these studies demonstrate the efficacy of behavioral tactics for specific sleep problems.

The behavioral literature is not without some limitations. First, the extent to which caregivers are able to implement typical behavioral

interventions in home environments remains largely unknown. More home-based studies, such as that modeled in the single application by Ashbaugh and Peck (1998), are needed with parents as the primary interventionists under the conditions in which children's sleep problems typically occur. Second, the majority of existing behavioral studies rely exclusively on parental reports of sleeping and waking (e.g., Ashbaugh & Peck; Freeman, 2006; Friman et al., 1999). Therefore, more behavioral interventions should be evaluated with additional objective measurement systems in place. Third, most studies do not report social validity measures or describe parental involvement in the development of the intervention; therefore, the social acceptability of behavioral interventions for sleep problems should be more routinely evaluated. Fourth, efficacious tactics such as faded bedtime with response cost (Ashbaugh & Peck; Piazza & Fisher, 1991b), bedtime pass (Freeman, 2006; Friman et al., 1999; B. A. Moore, Friman, Fruzzetti, & MacAleese, 2007), scheduled awakenings (Adams & Rickert, 1989; Johnson & Lerner, 1985), positive routines (Adams & Rickert, 1989; Christodulu & Durand, 2004; Milan, Mitchell, Berger, & Pierson, 1981), and variations of extinction (France & Blampied, 2005; France & Hudson, 1990; Lawton, France, & Blampied, 1991) are available; however, the prescription of these tactics is not necessarily assessment based or predicated on idiosyncratic variables that maintain sleep problems. We believe that effective and socially valid intervention is more likely when treatments are designed based on an understanding of the individual factors that influence the problem behavior, and therefore should be individualized from assessment information.

Behavioral, as opposed to pharmacological, treatment of pediatric sleep problems begins with a look at the target behavior through the lens of a contingency. We are interested in the behavior of lying quietly in bed and falling asleep. Procedurally, we focus on developing a period of behavioral quietude (lying quietly in bed; Blampied & France, 1993) because it is a measurable dimension that always precedes the target behavior of falling asleep. We begin with the assumption that lying quietly and falling asleep are operant behaviors maintained by the reinforcing event of sleep[1] (Bootzin, 1977). Just as is the case for any other operant, stimuli in the environment acquire discriminative properties that serve to signal the availability of the reinforcer, in this case, sleep. Discriminative stimuli that often occasion falling asleep include dimly lit rooms, cool temperatures, particular pillows, blankets, stuffed animals, rocking, patting, or the mere presence of a parent. Certain environmental operations may also establish the value of sleep as a reinforcer and evoke behavior that has historically resulted in that reinforcer, similar to the manner in which establishing operations enter into contingencies that control other important behavior (Michael, 1982). Deprivation of sleep, which may occur from insufficient amounts of sleep, extended time since last sleep, or poor-quality sleep, establishes the value of sleep and momentarily increases the probability of behavioral quietude. Certain supplements or drugs like melatonin or clonidine also can temporarily establish the value of sleep. The main point is that a coherent contingency analysis of sleep problems is possible when behavioral quietude and falling asleep are selected as the target responses.

Effective intervention is probably more likely when the controlling variables are also understood for operants that occur after a child is bid good night and that appear to interfere with behavioral quietude and thus preclude falling asleep.

[1] It is important to note that a thorough account of sleep cannot be divorced from an understanding of the selection history on a phylogenetic level (e.g., Heath, Kendler, Eaves, & Martin, 1990; M. Moore, Slane, Mindell, Burt, & Klump, 2011) and cultural level (e.g., cosleeping or sleeping alone; Jenni & O'Connor, 2005; Owens, 2004) in addition to that which is selected on an ontogenetic level (reinforcement history).

Common interfering behaviors include calling out or leaving the bed, crying for parents to return to the bedroom, eating, watching television, playing with toys in bed, or talking to oneself in bed. Another assumption is that the reinforcers for the interfering behavior may vary and may be either automatic (i.e., they do not require mediation by another person; e.g., reading books or repetitively manipulating toys or other objects) or socially mediated, and may be either positive or negative. For example, crying out may be positively reinforced with a glass of milk or extended parental presence in the child's bed. By contrast, crying out may be negatively reinforced by a parent who regularly removes the child from his or her bedroom when he or she cries. A thoroughgoing assessment of sleep problems would involve some attempt to identify the reinforcers for these behaviors as well as their associated establishing operations and discriminative stimuli.

The purpose of the present study was to address the aforementioned limitations of the behavioral literature on pediatric sleep problems. We evaluated an assessment and treatment model to be used by behavior analysts who work in homes with parents in an attempt to resolve one or more of their child's sleep problems. The goal of this model was to develop individualized, comprehensive, and socially acceptable interventions to address sleep problems based on the idiosyncratic results of assessment. Data on the efficacy and acceptability of the model are presented for three families.

METHOD

Participants and Settings

Three children, 7 to 9 years old, and their parents participated in our evaluation. They were recruited via flyers posted at local child-care centers and pediatricians' offices. They were the second, third, and fourth children to participate in the Western New England University's sleep program (the first participant's sleep data were used to refine our measurement systems). The parents of all three children indicated that the sleep problems had persisted for many years and were highly stressful and disruptive to their family life.

Walter was a 7-year-old typically developing boy who reportedly experienced delayed sleep onset. Walter's parents often discovered that he was still awake 1 or more hours after bidding him goodnight. Parents said that he took items such as toys, stuffed animals, or books to his bed when it was time for sleep. They also reported that he talked to himself or got out of bed to ask questions or communicate his inability to fall asleep. Walter had been taken to an outpatient clinic for evaluation of obsessive and compulsive behavior, but neither assessment nor treatment affected his sleep patterns. Although he was reported to usually sleep through the night, his parents found him to appear tired when he woke up in the morning. Parents had attempted to remove books and toys from the bedroom, instructed Walter to count sheep, talked to him about the questions he asked, or instructed him to think about events that occurred during the day to help him fall asleep. Parental goals for Walter's sleep included reduction of sleep-onset delay to 30 min or less, elimination of sleep-interfering behavior, and achievement of an age-appropriate amount of sleep (about 10.5 hr).

Andy was a 9-year-old boy who had been diagnosed with an ASD and who reportedly experienced delayed sleep onset and night awakenings of extended duration. Parents reported that they had a difficult time settling him to bed because he engaged in stereotypy in the form of body rocking, head shaking, and repetitive manipulation of items such as papers, socks, clothes, or pillowcases during bedtime. He also screamed and threw tantrums on some occasions. Parents often found Andy awake when they checked on him in the middle of the night or early in the morning with socks or other clothing items out of the drawers. They had previously attempted to put Andy in a tight wrap prior to bedtime, to hide in the bedroom and instruct him to go to bed, to hold him in bed when he did not

stay in bed, and to give him cold baths as part of the bedtime routine to help settle him to sleep. Clonidine had also been prescribed for his sleep problems and had been administered for about 12 months prior to our study. His parents expressed concern about potential side effects associated with its prolonged use. Parental goals for Andy's sleep were to reduce sleep-onset delay to 15 min or less, to eliminate sleep-interfering behaviors, to reduce night wakings, and to eliminate medication.

Lou was also a 9-year-old boy with an ASD who reportedly experienced difficulty falling asleep and frequently woke up in the middle of the night or early in the morning. His parents reported that he frequently got out of bed to request that a parent sleep with him. If a parent did not lie down with Lou, he was reported to sing songs, walk around the house to turn on all the lights, or try to sleep in the parents' bedroom. Lou's father had been staying or sleeping on the floor in Lou's bedroom almost every night until Lou fell asleep to prevent him from leaving the bedroom. Lou's mother had also tried to lie with him in bed until he fell asleep or when he woke up in the middle of the night. Both parents reported poor sleep quality of their own due to constant nighttime interactions with Lou. Melatonin and Benadryl had also been used to address the sleep problems in the past but with reported limited success. Parental sleep goals for Lou were reduction of sleep-onset delay to 15 min or less, elimination of interfering behaviors, reduction of night and early wakings, achievement of an age-appropriate amount of sleep (about 10.25 hr), and elimination of parental presence at night, medication, and supplements.

The study took place in the children's homes, and their parents implemented all treatment components. All three children slept in their own bedrooms (i.e., without siblings). Walter slept in a regular bed without rails, Andy slept on a bottom bunk bed, and Lou slept in a bed with rails. All three children went to bed in dark or dimly lit bedrooms (with night-lights).

Measurement Systems

Sleep diaries. We asked the parents to observe and record information each day about their child's sleep. Parents documented the time (a) they bid the child goodnight, (b) when the child fell asleep, (c) of night awakenings and resumption of sleep (if any), (d) of morning awakening, and (e) of any naps during each 24-hr cycle. The sleep diary also included open-ended questions regarding bedtime routine noncompliance, sleep-interfering behaviors, and parental presence or cosleeping (if any).

Infrared nighttime video. A Sony high-definition camcorder with infrared illumination was placed in an inconspicuous location in each child's bedroom. The camcorder continuously recorded the child's nighttime behavior. Parents were instructed to turn on the camcorder and its night-shot mode before bidding the child goodnight and to turn off the camcorder in the morning shortly after beginning the morning routine. Video recordings served to complement the information obtained from the sleep diary and allowed us to more precisely measure the child's sleep-interfering behaviors during the settling period. Observation, however, was limited to behavior that occurred in and around each child's bed. Video data were collected on a minimum of 30% of the nights with each family, but we obtained as much video data as possible. The amount of obtained video data depended on the availability of the camcorder and the number of errors in setting up the equipment (e.g., night-shot mode not turned on or the camcorder not plugged in at night).

Dependent Variables

Sleep-onset delay was defined as the amount of time (in minutes) elapsed from when the parents bid the child goodnight to when the child fell asleep. We observed the child from bidding goodnight to falling asleep continuously via video to record the duration of sleep-onset delay using data-collection software. Data collectors turned on an assigned key when bidding goodnight to

the child and turned it off when 10 min had elapsed without any signs of being awake (see awake definition below).

Sleep-interfering behaviors were characterized as any behavior that occurred after bidding goodnight that may interfere with behavioral quietude and falling asleep. We defined *interfering behavior* as time (in minutes) spent (a) vocalizing (any audible vocalization coming from the child such as singing, humming, giggling, crying, calling out, making requests, talking, or screaming with the exclusion of sneezing, coughing, or yawning), (b) getting out and staying out of bed (child left the the bed or was not in bed), (c) sitting up (no contact between back and head to any part of the bed) or standing in bed, and (d) engaging in stereotypy (head shaking, body rocking, or the child's hands actively manipulating or repeatedly flapping any items such as books, video games, toys, papers, socks, clothing pieces, pillowcases, and curtains). Sleep-interfering behavior was recorded from the video, and real-time data were collected using the same computer data-collection program.

We used paper and pencil to record entire sleep duration using a time-sampling procedure with 30-min intervals. The observation period during each sampling interval was 1 min to allow sufficient time to examine whether the child was asleep or awake (i.e., we observed for 1 min every 30 min to detect whether the child was awake or asleep in bed). *Asleep* was defined as the child in bed lying on his back, stomach, or side without any signs of being awake, or covers covered his entire body with minimal physical movement. *Awake* was defined as any occurrence of sleep-interfering behavior (see definition above) with the addition of eyes open (if eyes were visible), whispering, looking up with head leaving pillow, quiet babbling, quiet humming, or excessive physical movement in bed or under the blanket. After we scored the entire night of video using the time-sampling procedure, we calculated total sleep by summing the number of asleep intervals and multiplying it by 30 min. We then calculated percentage of sleep during goal hours by dividing the amount of sleep within the ideal sleep zone by the goal amount of sleep and converting the result to a percentage. Ideal sleep zone was determined with sensitivity to the parents' goal and the developmentally appropriate amount of sleep (Ferber, 2006; Weissbluth et al., 1981). We calculated duration of night waking by summing the number of awake intervals from when the child fell asleep to 1 hr prior to the child's appropriate wake time (determined from each child's developmental norms) and multiplying the sum by 30 min.

In sum, direct measures from the video were available for sleep-onset delay, individual topographies of sleep-interfering behavior, night waking, and amount of sleep. The same measures (with the exception of interfering behavior) were also available from the diaries. Calculation for all diary-based measures followed the same criteria as the video-based measures. Finally, we recorded other events, such as bedtime music, parental presence, and the use of clonidine, melatonin, or Benadryl from the sleep diaries.

Interobserver Agreement

Interobserver agreement was assessed by having a second observer independently score at least 20% of baseline and treatment video sessions for all three children. Agreement data for sleep-onset delay, overall sleep-interfering behavior, and specific sleep-interfering behaviors (vocalizations, out of bed, sitting up or standing, and stereotypy) were collected for 43%, 36%, and 25% of baseline sessions and 24%, 28%, and 22% of treatment sessions for Walter, Andy, and Lou, respectively, and 20% of follow-up sessions for Walter. Agreement was calculated by partitioning the observation duration (i.e., from bidding goodnight until the child fell asleep) into 10-s intervals and dividing the smaller duration of scored responses by the larger duration within each interval; results were then converted to a percentage and averaged across all intervals. For all three children, mean agreement was 95% for sleep-onset delay (range, 81% to

100%), 97% for vocalizations (range, 86% to 100%), 99% for out of bed (range, 93% to 100%), 97% for sitting up and standing (range, 85% to 100%), and 99% for stereotypy (range, 90% to 100%).

Agreement data for asleep and awake were collected for 29%, 21%, and 25% of baseline sessions and 24%, 20%, and 22% of treatment sessions for Walter, Andy, and Lou, respectively, and 20% of follow-up sessions for Walter. Observers' data were compared on an interval-by-interval basis. An agreement was scored in any interval in which both observers scored either awake or asleep, and a disagreement was scored in any interval in which one observer scored awake and the other scored asleep. Agreement statistics were calculated by dividing the number of agreement intervals by the number of agreement plus disagreement intervals and converting the result to a percentage. For all three children, mean agreement was 100%.

Procedure

Baseline. Prior to baseline, we obtained basic information on each child's sleep problems and ensured that there were no severe medical or health-related concerns (all children had been evaluated by their physicians to rule out insomnia secondary to a medical condition). We informed the parents about the study's purpose, procedures, and measurement commitments (i.e., diary and in-home video recordings) and obtained consent for participation. At the beginning of baseline, we instructed the parents not to change anything they had been doing to promote good sleep. Parents worked with their pediatricians to alter and ultimately eliminate medications for sleep during baseline.

Assessment. After collecting an amount of baseline data that was sufficient to detect treatment effects, we arranged an open-ended interview with each family, which was guided by the Sleep Assessment and Treatment Tool (SATT; see Supporting Information for relevant sections of the SATT). The SATT is an open-ended functional assessment interview designed to identify specific sleep problems and the idiosyncratic environmental variables that contribute to each child's sleep problems in order to inform an individualized intervention that each family finds acceptable. Specific features of the interview include (a) history of the child's sleep problems; (b) a joint determination of sleep goals; (c) identification of specific sleep problems (e.g., bedtime routine noncompliance, delayed sleep onset, night awakenings, early awakenings), a description of the antecedent conditions under which the specific sleep problems occurred, and the types of interactions (if any) that occur following the specific sleep problems; (d) identification of the child's current sleep schedule and likely sleep dependencies (those items, events, or interactions that appeared to occasion sleep), (e) identification of the topographies of possible interfering behaviors and their likely reinforcers, and (f) descriptions of treatment options from which parents can choose. The results obtained from the interview (and observations from the video) informed the design of individualized and comprehensive treatments.

Treatments. Comprehensive treatments for each child included procedures to enhance the establishing operations and discriminative stimuli for behavioral quietude and to weaken the contingencies for sleep-interfering behaviors. To reduce sleep-onset delay, we attempted to establish the value of sleep by adjusting the child's sleep schedule based on developmental norms and their current sleep phases (Piazza & Fisher, 1991b). To reduce sleep-interfering behavior, we disrupted the contingency between the interfering behavior and its putative reinforcement and provided access to the putative reinforcer only before bedtime or independent of the interfering behavior. Night waking was indirectly addressed with treatments for interfering behavior, but we also attempted to eliminate inappropriate sleep dependencies (e.g., events that were present only during the settling period, e.g., music) and to establish gradually new sleep

dependencies on salient events that were available at bedtime and throughout the night. Total sleep was indirectly addressed by these components.

Walter. Assessment results indicated that Walter had delayed sleep onset and was usually bid goodnight at least 1 hr before he fell asleep. We first established the value of sleep by bidding Walter goodnight closer to his natural sleep phase (when he typically fell asleep). We did this by pushing Walter's bedtime forward by 1 hr and gradually moving it back by 30 min if he fell asleep within 30 min (his goal range of sleep-onset delay had been determined jointly with his parents) until a desirable bedtime was reached. We also asked the parents to keep his sleep schedule consistent so that the amount of sleep he received each night was developmentally appropriate.

Walter also engaged in sleep-interfering behavior in the forms of (a) manipulating items such as books, magazines, or paper that were in his bed at bedtime; (b) periodically interacting with siblings; and (c) getting out of bed to ask "big questions" pertaining to mathematics or religion or to communicate his inability to fall asleep. Based on assessment results, the putative reinforcers for Walter's sleep-interfering behavior were access to books, magazines, papers, and parental or sibling attention. For treatment, we instructed parents to provide access to these putative reinforcers before bedtime by allowing access to books, magazines, and paper for at least 20 min before getting ready for bed, and by arranging a period of qualitatively rich social interaction and a period of question asking and answering with the parents. Access to these same putative reinforcers was then restricted after bedtime by making items such as books and magazines unavailable, not addressing any questions after bidding goodnight, and gently guiding Walter back to bed when he got out of bed. Parents were asked to keep a neutral facial expression, to make minimal eye contact, and to minimize conversation with Walter when he was out of bed. Parents then again bid Walter goodnight.

Andy. Assessment results for Andy indicated delayed sleep onset that usually lasted for more than 1 hr. To reduce sleep-onset delay, the value of sleep was established by moving his bedtime forward by 1.5 hr at the start of the treatment and moving the bedtime back by 30 min only if he was able to fall asleep within 15 min (Piazza & Fisher, 1991b). Parents continued the faded bedtime procedure until the desirable bedtime was reached. We also informed the parents about the developmentally appropriate amount of sleep (just over 10 hr) and cautioned them against allowing him to sleep past the desirable wake time.

Andy engaged in sleep-interfering behaviors that primarily involved repetitively manipulating items such as papers, socks, clothing pieces, pillowcases, and curtains, rocking his body back and forth, and shaking his head (on some occasions, he jumped back and forth, ran around in the bedroom, and made indecipherable sounds). Parents typically left immediately after bidding goodnight, and the interfering behaviors occurred in the bedroom while he was alone; interfering behaviors were likely maintained by consequences produced directly by his own behavior (i.e., automatic reinforcement). Based on this interpretation, treatment involved first instructing parents to allow Andy to engage in stereotypy for 30 min before his bedtime routine. This was arranged to decrease the value of the automatic reinforcers for stereotypy while in bed (see Lang et al., 2010, for the abolishing effects of access to stereotypy). During this period, he had access to items such as paper, socks, and clothing pieces, and he was allowed to engage in stereotypy. The second component involved restricting access to these likely reinforcers after bedtime by instructing the parents to gently interrupt instances of stereotypy and guide Andy back to bed. A video-based baby monitor was used by the parents to determine when to go into the bedroom and interrupt stereotypy.

SATT results indicated that Andy had lengthy night wakings during which he engaged in interfering behaviors. His inappropriate sleep dependency appeared to be music. Andy's parents turned on a CD player that played music for

about 45 min every night when they bid him goodnight; this stimulation was not present for the entire night, thus increasing the likelihood that brief night-waking episodes sometimes resulted in full awakenings. Based on this interpretation, parents were asked to eliminate music at bedtime and throughout the night. We wanted Andy's sleep environment to stay consistent throughout the entire night so that when he woke up in the middle of the night, the same conditions under which he fell asleep would be present and thus be more likely to reoccasion falling sleep. Night wakings were also indirectly addressed with the treatments for interfering behavior. However, we instructed the parents to gently and quietly guide Andy back to bed, tuck him in, and bid him goodnight to reinitiate the sleep sequence any time he left his bedroom in the middle of the night (this rarely occurred).

Lou. Lou experienced delayed sleep onset of 30 min to 1 hr. Based on SATT results, he had an overly stimulating bedtime routine that began 30 to 40 min before he was bid goodnight (40 min of watching TV, browsing the web, playing with toys, or listening to dance music with headphones after he had changed into pajamas and brushed his teeth). To address the sleep-onset delay, we rearranged the order of the bedtime activities so that the period of highly stimulating games and activities occurred before he changed into pajamas and brushed his teeth. The stimulating activities were thus further removed from the time in which behavioral quietude was expected. Lou was given a choice board to access different activities; choices included activities that decreased in intensity as bedtime approached. To promote behavioral quietude, we introduced a more relaxed transition activity by having the parents read a story and offer quiet social interaction just before they bid him goodnight.

Lou's interfering behavior included getting out of bed, singing songs, playing with toys or video games, and reciting stories when parents were not present. On many nights, his father slept in the bed or on the bedroom floor to attend to Lou. Based on SATT results, the likely reinforcers for Lou's sleep-interfering behaviors were access to parent attention and access to tangible items in the form of toys, books, and music. Parents provided access to attention (during story time as mentioned above) and toys, books, and music (during free play as mentioned above) before they bid goodnight. To restrict access to toys and books after bedtime, parents implemented a bedroom clean-up routine with Lou before story time to signal that these items were inaccessible. Parents then disrupted the contingency for interfering behavior by visiting Lou on a time-based schedule. Parental visits were made independent of Lou's behavior. Visits were frequent for the first few nights, with more time between each visit (5 s, 10 s, 30 s, 1 min, 5 min, 10 min, 30 min), and were progressively thinned by eliminating the first visit every second night. This strategy was similar to noncontingent reinforcement with progressively increasing fixed-time intervals (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Parents maintained a neutral facial expression with minimal language and eye contact, gently tucked Lou in if he was out of bed, and bid him goodnight.

Treatments for Lou's night waking first involved elimination of inappropriate sleep dependencies. Lou relied on both the presence of his parents and music (through headphones). Time-based visiting was implemented, and headphone use was prevented. We then attempted to develop a new dependency by adding a sound machine that provided constant white noise throughout the night. Parents were instructed to turn it on right after saying goodnight and to turn it off when Lou woke up in the morning. Night waking was also indirectly addressed by treatments for interfering behavior; however, we also instructed the parents to simply guide Lou back to bed if he got up (this rarely occurred).

Parent training. A 2-hr parent training session was conducted with each family to review the rationale and specifics of each treatment strategy. Behavioral skills training, which included instructions, modeling, role-play, and feedback, was

used to ensure that parents could implement each of the treatment components correctly. Parents role-played the procedure with the therapist acting as the child. They were invited to contact the first author at any time to ask questions or discuss any challenges they encountered. The first author visited families at least twice per week to download the video data and to provide feedback on treatment implementation. They were also given a checklist composed of the individual treatment components to indicate whether a particular strategy was implemented. If a particular strategy was not carried out when applicable, parents commented on any challenges they experienced or other factors that hindered treatment implementation. We calculated the percentage of treatment implementation by dividing the number of implemented components by the number of applicable components for a particular night and converting the result to a percentage. Parents' self-reported average percentages were 86% (range, 67% to 100%), 91% (range, 71% to 100%), and 100% for Lou, Andy, and Walter, respectively.

Treatment integrity. We measured treatment integrity by observing parent behavior from video recordings for at least 20% of the treatment nights. Data were collected only on the treatment components that could be measured from the video. For Walter, we observed whether (a) toys or books were absent from the bed after bidding goodnight, (b) the times of bidding the child goodnight and waking the child were consistent with the prescribed sleep schedule, and (c) parents withheld visiting the child after bidding goodnight or visited only to interrupt instances of sibling interaction or playing with toys. For Andy, we observed whether (a) toys, socks, or stimulating items were absent after bidding goodnight; (b) music was turned off after bidding goodnight; (c) the times of bidding goodnight and waking the child were consistent with the prescribed sleep schedule; and (d) parents withheld visits after bidding goodnight or visited only to interrupt instances of stereotypy. For Lou, we observed whether (a) toys and books were absent after bidding goodnight, (b) the sound machine was turned on after bidding goodnight, (c) the times of bidding goodnight and waking the child were consistent with the prescribed sleep schedule, and (d) parents withheld visits after bidding goodnight or visited based on the recommended schedule (a correct response was scored if parents visited within 2 min of the scheduled interval). Treatment integrity was calculated by dividing the number of correctly implemented components by the number of applicable components and converting the result to a percentage. Treatment implementation was calculated by dividing the number of implemented components by the number of applicable components for a particular night and converting the result to a percentage. Mean percentages of treatment integrity were 100%, 90% (range, 75% to 100%), and 82% (range, 75% to 100%) for Walter, Andy, and Lou, respectively.

Social validity. To assess whether our treatment package resulted in socially meaningful changes for the families, parents completed a social validity questionnaire at the end of the treatment. The questionnaire asked the parents about the extent to which they found the (a) assessment procedures acceptable, (b) treatment package acceptable, (c) improvement in their child's sleep satisfactory, and (d) sleep consultation helpful. We also invited parents to provide any additional comments regarding these four areas.

Design

We assessed treatment efficacy using a nonconcurrent multiple baseline design across subjects.

RESULTS

Agreement between Video-Based and Diary Measures

Both video and diary data are displayed in Figures 1, 3, and 4 to allow visual inspection of the consistency of the two measures. It is

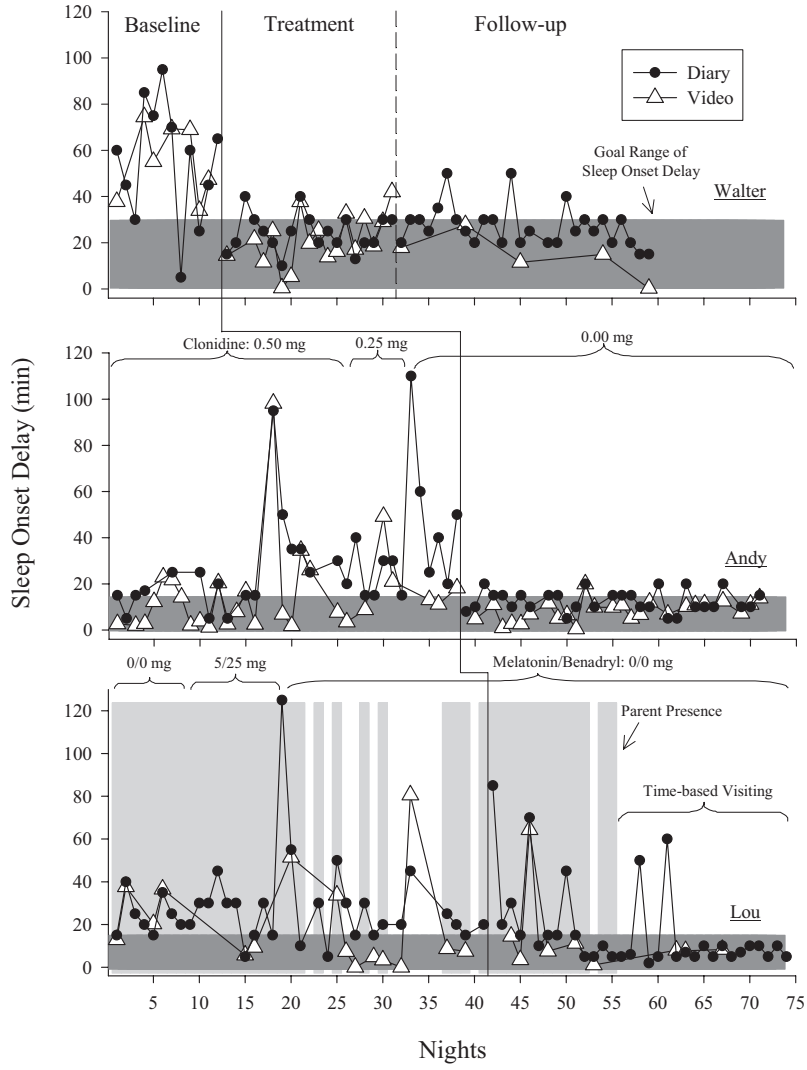

Figure 1. The duration of sleep-onset delay (in minutes) for all three children. The horizontal gray bar for each panel represents the target range of sleep-onset delay jointly determined with the parents. For Andy, clonidine was titrated from 0.50 mg to 0.25 mg and 0 mg before treatment. For Lou, melatonin and Benadryl were eliminated at the beginning of baseline, reinstated for a brief period at parents' request, and eliminated again before treatment. The vertical bar represents the nights in which the parents did not leave the bedroom after bidding goodnight (they stayed in the bedroom until the child fell asleep or slept in the bedroom).

important to note that both measures were sensitive to and capable of detecting the implementation of the independent variable.

Effect on Sleep-Onset Delay

Figure 1 shows the effect of the treatment package on sleep-onset delay. In baseline, sleep-onset delay was highly variable (Walter: diary $M = 55$ min, video $M = 55$ min; Andy: diary $M = 30$ min, video $M = 16$ min; Lou: diary $M = 28$ min, video $M = 20$ min). After implementation of the individualized intervention, there was an immediate decrease in the level and variability of sleep-onset delay for Walter (diary

$M = 24$ min, video $M = 21$ min) and Andy (diary $M = 13$ min, video $M = 8$ min) with more nights falling within the target range. Short sleep onsets were maintained for Walter at the 3-month follow-up (diary $M = 27$ min, video $M = 14$ min).

There was a delayed treatment effect for Lou. Mean sleep-onset delay during treatment was 17 min from the diary measure and 14 min from the video measure; however, the delays were shorter at the end of treatment (M for last 7 nights = 7 min). Based on parents' preference, they remained in the bedroom while all the other treatment components were in place during the first 2 weeks. Parents then implemented the time-based visiting component.

Effect on Interfering Behavior

Figure 2 depicts the effect of the treatments on the duration of individual topographies of sleep-interfering behavior. For Walter, all four topographies decreased to near-zero levels in the treatment and follow-up conditions, with larger and more evident decreases in the level and variability of sitting up or standing and stereotypy (in the form of object manipulation). Decreases in the level and variability of all four sleep-interfering behaviors were also observed for Andy. For Lou, a reduction was observed only for vocalization following treatment due to the low baseline occurrence of the other forms of interfering behavior.

Effect on Night Waking

Figure 3 depicts the effects of the treatment package on the duration of night waking (quiet wakefulness and early awakenings were included with this measure). Night waking was generally low for Walter throughout the analysis; nevertheless, it decreased during treatment (baseline diary $M = 8$ min, video $M = 12$ min; treatment diary $M = 2$ min, video $M = 4$ min). Near-zero night wakings were observed for Walter at follow-up. Andy's mean night

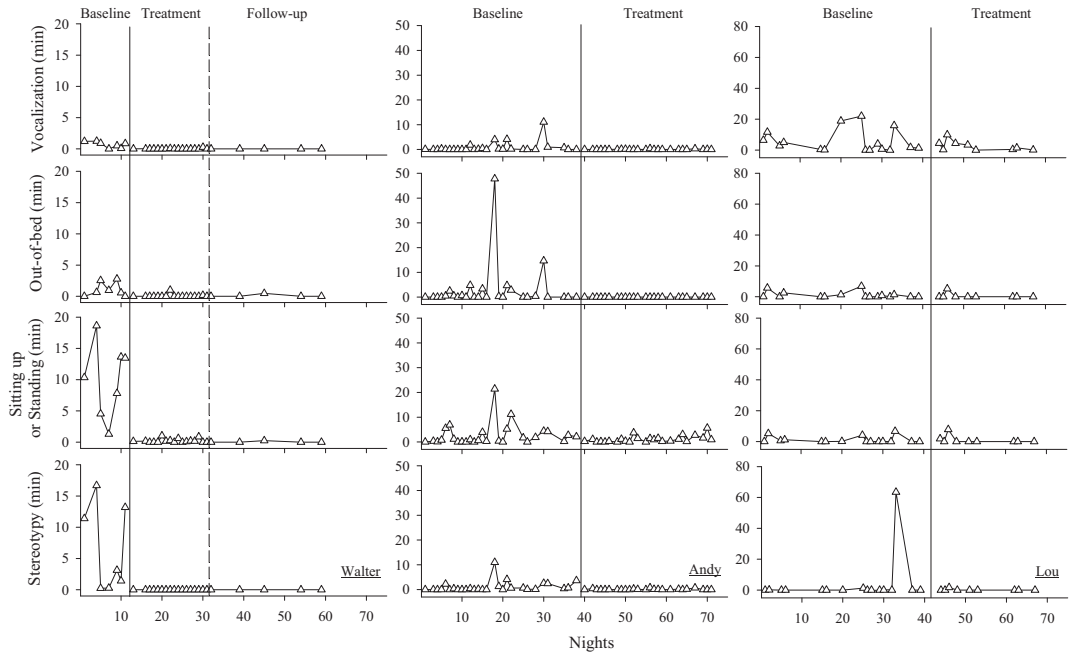

Figure 2. The duration of individual topographies of sleep-interfering behavior (in minutes) for Walter, Andy, and Lou.

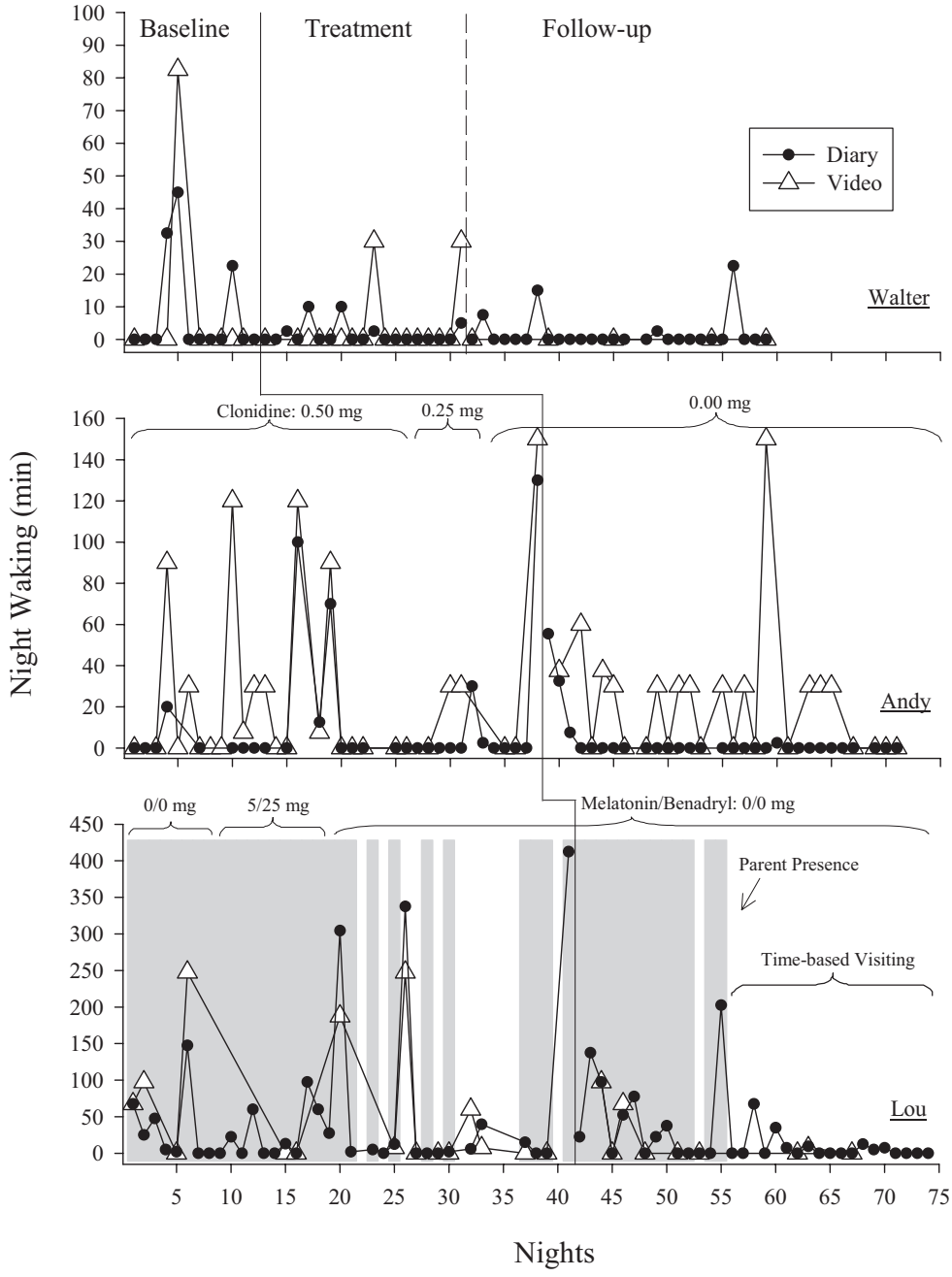

Figure 3. The duration of night waking (in minutes) for Walter, Andy, and Lou. Developmental norms were used to calculate the duration of night waking. Quiet wakings (e.g., eyes open) and early wakings are also included with this measure.

waking was 12 min (diary data) and 26 min (video data) in baseline. Night waking decreased to a mean of 3 min (diary data) and 22 min (video data) following treatment. Video detected more episodes of night waking for Andy. This was likely a function of more quiet wakefulness (eyes open in bed), to which the parent diary was not as sensitive (typically not considered

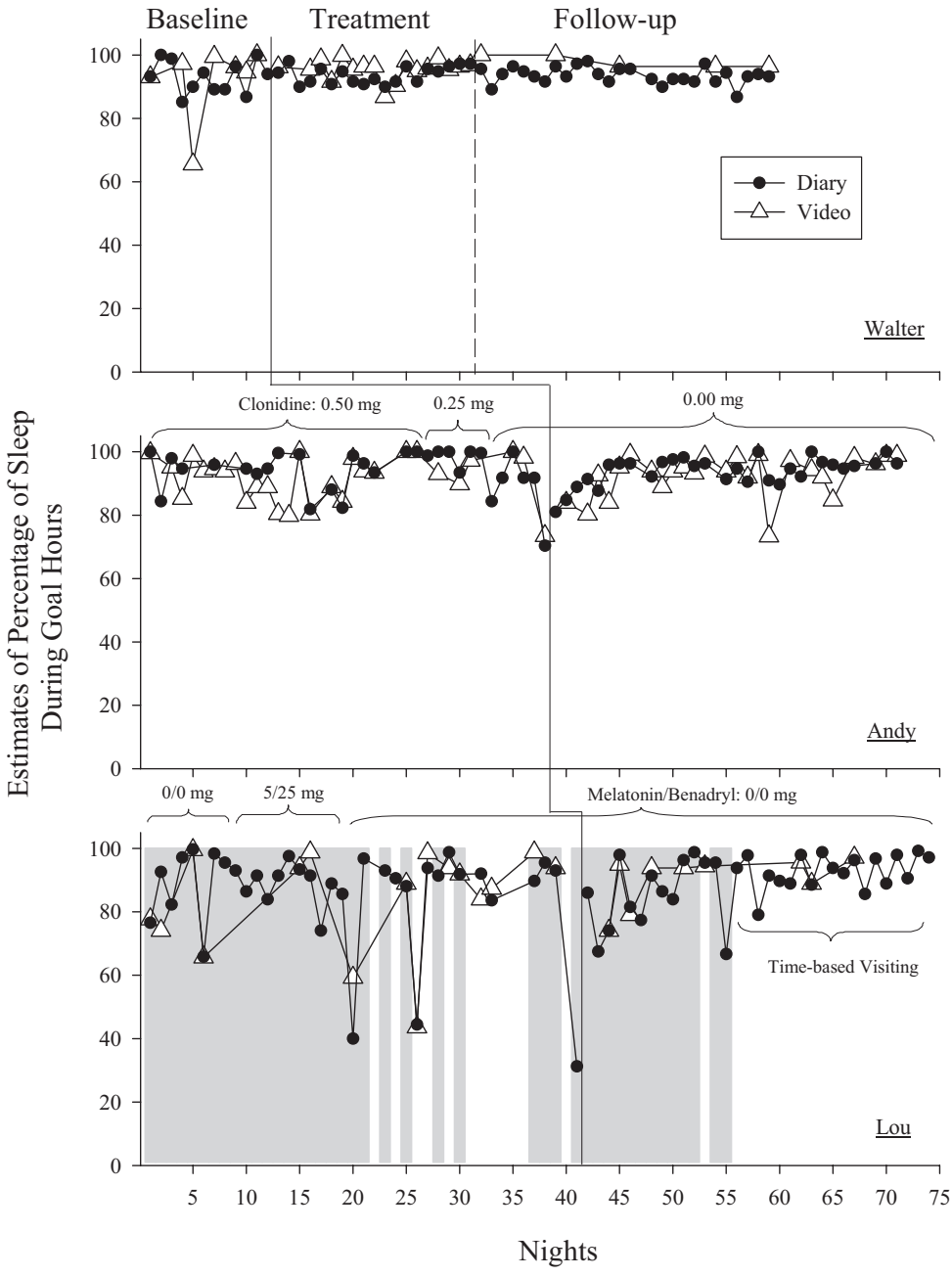

Figure 4. Estimates of percentage of sleep during goal hours.

to be a problem by many families). There was also a decrease in night waking for Lou from baseline (diary $M = 49$ min, video $M = 58$ min) to treatment (diary $M = 24$ min, video $M = 19$ min).

Effect on Total Amount of Sleep

Figure 4 depicts the effect of the intervention on the percentage of sleep during goal hours. For example, if the ideal sleep zone was from 9:00 p.m. to 7:00 a.m. and the child slept from

12:00 a.m. to 9:00 a.m., the percentage of sleep during goal hours would be 70%. For both Walter and Andy, there was a slight decrease in variability in the percentage of sleep and more stability following treatment. Lou's percentage of sleep, by contrast, was highly variable in baseline. On some nights, the percentage of sleep during goal hours was as low as 40%. After treatment, variability appeared to decrease, especially during the final 2 weeks of treatment.

Effect on Sleep Goals for All Measures

Figure 5 depicts whether the sleep goals were met across multiple sleep-related measures for each child. This goal chart provides a convenient sleep profile and conveys the extent to which sleep goals were achieved and whether the child was a better and more independent sleeper following treatment. Diary data (with the exception of interfering behavior) are depicted in these profiles because it was consistent with the video data and we had diary data for more nights for all children. Depicted measures for each child include sleep-onset delay, interfering behavior, night waking, and percentage of goal sleep. Additional measures for Andy are the use of music and clonidine; additional measures represented for Lou are parental presence and the use of melatonin and Benadryl. The criteria for meeting the sleep goals were fairly strict and were as follows: less than 30 min of sleep-onset delay for Walter and 15 min for Andy and Lou, less than 2 min of interfering behavior, 0 min of night waking, greater than 90% of goal sleep, the absence of disruptive music (Andy), 0 mg of clonidine (Andy), the absence of parental presence (Lou), and 0 mg of melatonin or Benadryl (Lou). For all three children, there were more nights during which sleep goals were met during treatment than in baseline (mean

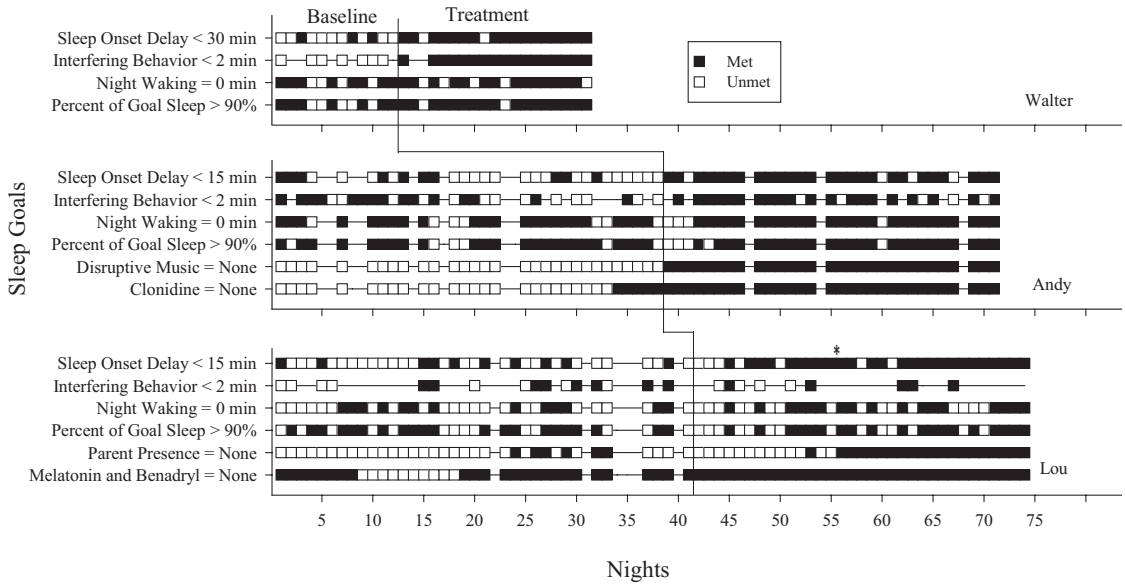

Figure 5. This figure depicts whether the sleep goals were met across different dependent measures for each child. Filled squares represent nights during which a particular sleep goal was met, and open squares represent nights during which a particular sleep goal was not met. Measures for all three children include sleep-onset delay, interfering behavior, night waking, and total sleep. Additional measures are disruptive music and the use of clonidine for Andy and parent presence and the use of melatonin and Benadryl for Lou. The asterisk above Lou's graph indicates the start of time-based visiting.

percentages of sleep goals met for first 10 baseline nights were 43%, 59%, and 35% for Walter, Andy, and Lou, respectively; mean percentages of sleep goals met for the last 10 treatment nights were 93%, 93%, and 88% for Walter, Andy, and Lou, respectively) demonstrating a positive effect on multiple measures as a function of the personalized treatments.

Social Acceptability

On a 7-point Likert scale (1 = *not acceptable, not satisfied, not helpful*, and 7 = *highly acceptable, highly satisfied, very helpful*), the average rating from the social acceptability questionnaire for all three families and all four questions was 6.8 (range, 6 to 7).

DISCUSSION

Decreases in sleep-onset delay and sleep-interfering behaviors and improvements in other measures of sleep were evident for all three children following the implementation of comprehensive and individualized behavioral interventions. This effect was immediate for two children (Walter and Andy) and was delayed for the third child (Lou). Medication (clonidine and Benadryl) and supplement use (melatonin) were eliminated for the two children who had been taking them, and parental presence while the child fell asleep was eliminated for the one child who was dependent on adult presence to fall asleep. Finally, the parents who implemented the interventions in their homes reported high levels of satisfaction with the assessment procedures, treatment packages, improvements in their child's sleep, and the consultation process.

Our results demonstrate the efficacy of a comprehensive treatment model for children's sleep problems that is predicated on a thorough assessment of possible factors that influenced sleep problems for each child. Identification of the likely controlling variables for problem behavior from which personally relevant interventions can be derived necessitates a functional assessment of the problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994; Iwata, Wong, Riordan, Dorsey, & Lau, 1982), and functional assessments have become the hallmark of behavioral intervention for severe problem behaviors such as aggression and self-injury (Hanley, Iwata, & McCord, 2003; Kahng et al., 2002). Sleep problems, such as delayed sleep onset, sleep-interfering behaviors, and night waking, have historically been exempt from functional assessment processes. Behavioral sleep intervention has thus far yielded a variety of efficacious tactics, but the conditions under which each should be applied are not apparent, and the extent to which treatments are based on unique features of the sleeper's history or present sleeping conditions is not clear. A review of this literature suggests that specific tactics be applied to specific types of sleep problems (e.g., progressive waiting or bedtime pass for crying and leaving the bedroom, France & Blampied, 2005; Freeman, 2006; Friman et al., 1999; Lawton et al., 1991; B. A. Moore et al., 2007; scheduled awakenings for night waking, Johnson & Lerner, 1985; Rickert & Johnson, 1988; faded bedtime and response cost for delayed sleep onset, Ashbaugh & Peck, 1998; Piazza & Fisher, 1991a, 1991b). Therefore, the conditions beyond the topography of the sleep problem under which a particular tactic should be selected or the conditions under which tactics should be combined into more comprehensive strategies have not been outlined.

The present study demonstrates the utility and acceptability of a synthesis model from which efficacious tactics can be combined into comprehensive treatments. The selection of tactics and the features of each tactic are based on individualized factors that influence various sleep problems, with both the sleep problems and the likely controlling variables identified via an open-ended interview process guided by the SATT. In addition, multiple measures were considered to determine when or if healthy sleep was achieved and was done so via acceptable means.

The primary advantages of using the SATT prior to developing a treatment for sleep problems are that the specific sleep problems, parental goals, and possible controlling variables can be identified and thus inform the particulars of treatment. In essence, researchers and practitioners may be more likely to design contingency-based interventions if they first ask parents, who have the most direct and frequent contact with the sleep problems, informed questions about possible controlling variables. By incorporating parents into the assessment and treatment process, practitioners may be more likely to build effective relationships and develop socially acceptable treatments that parents are willing to implement in their homes with consistency and integrity. It is also possible that a general treatment package without the use of SATT would also yield improvement in sleep. Future researchers should compare the efficacy of a general treatment package against a SATT-based intervention. However, at this point, we believe that effective and socially valid intervention is more likely when treatments are individualized from the assessment information.

The effects of the comprehensive interventions were demonstrated in a multiple baseline design (i.e., large changes in target behaviors were observed when and only when the treatment packages were in place) with somewhat redundant measurement systems. Agreement between diary- and video-based measures was satisfactory for all three families. Both video data and sleep diaries also showed sensitivity to the intervention despite some discrepancies between the two measures on particular nights. These findings suggest that when video recordings may be intrusive for the family or impose too much effort to extract the data, parental diaries may be relied on exclusively. However, we caution against an exclusive adoption of sleep-diary data because it is possible that there was an interaction effect between the video and diary data; that is, the accuracy of parents' data might have been a function of the camcorder in the bedroom. Therefore, we recommend that these measures be used simultaneously or that the video-based measures be used at least initially to calibrate parent-based measurement systems. In addition, clear benefits are associated with each measurement system. For instance, parent diaries are important for detecting problems that occur outside the bedroom (e.g., sleeping at other locations, nighttime routine noncompliance) and throughout the day (e.g., naps at school). Although video recordings may be intrusive for certain families and require monitoring and data extraction, they are essential for precise measurement of the amount of sleep-interfering behaviors and quiet wakefulness. Technical difficulties we encountered included parents forgetting to turn on the night-shot mode or plug in the camcorder.

Our study is sufficiently analytic in that the experimental design allows one to infer that behavior changes were a function of the changes in the sleep environments outlined in the treatments. However, our analysis does not allow identification of the independent effects of the individual treatment components on the observed changes in behavior. In this way, our study might be considered insufficiently analytic (Baer, Wolf, & Risley, 1968). We believe, however, that the sleep-intervention literature contains a sufficient number of examples that show the isolated effects of specific tactics (Adams & Rickert, 1989; Ashbaugh & Peck, 1998; Christodulu & Durand, 2004; France & Blampied, 2005; France & Hudson, 1990; Lawton et al., 1991; Piazza & Fisher, 1991a, 1991b; Rickert & Johnson, 1988) and that a synthesis of this literature serves the important function of demonstrating the utility of a functional and comprehensive behavioral approach for addressing sleep problems in the places they occur, by the people who experience them, and in a way that leaves little ambiguity about the extent to which the problems were solved. This comprehensive approach yielded high levels of social acceptability, indicating that the treatments were not only effective for each child's sleep problems but also were meaningful for the families

involved. We believe that more evaluations of highly synthetic treatments that are based on an understanding of the variables that influence problem behavior should be conducted and published by behavior analysts as a means of moving our field along the continuum from efficacy-oriented to more effectiveness-oriented research (Hoagwood, Hibbs, Brent, & Jensen, 1995). This type of research does not preclude more microanalytic treatment evaluations; it may simply complement such analyses. In that spirit, we believe that future research should evaluate the independent and interactive effects of the treatment components that addressed sleep dependencies and sleep-interfering behaviors. Germane to the latter, we also believe comparative analyses of typical extinction procedures, time-based reinforcement (as was conducted with Lou), and the bedtime pass (in which an alternative behavior is reinforced; Friman et al., 1999) are important areas for further research.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web-site.

Appendix S1. Relevant Sections of the Sleep Assessment and Treatment Tool