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FURTHER ANALYSIS OF IDIOSYNCRATIC ANTECEDENT INFLUENCES DURING THE ASSESSMENT AND TREATMENT OF PROBLEM BEHAVIOR

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Recent research findings suggest that idiosyncratic variables can influence the outcomes of functional analyses (E. G. Carr, Yarbrough, & Langdon, 1997). In the present study, we examined idiosyncratic environment–behavior relations more precisely after identifying stimuli (i.e., a particular toy and social interaction) associated with increased levels of problem behavior. Two children, an 8-year-old boy with moderate mental retardation and a 5-year-old boy with no developmental delays, participated. Results of functional analyses for both children indicated that idiosyncratic antecedent stimuli set the occasion for occurrences of problem behavior (hand biting or hand flapping) and that problem behavior persisted in the absence of social contingencies. Further analyses were conducted to identify specific components of the stimuli that occasioned problem behavior. Treatments based on results of the analyses successfully reduced self-injury and hand flapping.

DESCRIPTORS: antecedents, complementary reinforcers, developmental disabilities, establishing operations, functional analysis, problem behavior

Functional analysis methodologies are designed to identify conditions that are responsible for the occurrence and nonoccurrence of problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). In the typical functional analysis model, putative antecedents and consequences of problem behavior are manipulated during one or more test conditions. These test conditions are designed to determine whether problem behavior is maintained by a particular source of social-positive reinforcement, social-negative reinforcement, or automatic reinforcement.

In tests for social-positive reinforcement, stimuli such as attention and toys are only made available contingent on occurrences of problem behavior. Withholding access to positive reinforcers (the antecedent) and delivering the stimuli for problem behavior (the consequence) should establish and maintain behavior that is sensitive to this contingency. In tests for social-negative reinforcement, stimuli such as instructions or academic tasks are presented, and a brief escape from these events is provided contingent on problem behavior. If problem behavior is sensitive to this contingency, the antecedent presence of aversive stimuli and reinforcing consequences of escape should establish and maintain behavior.

The antecedents and consequences of behavior maintained by automatic reinforcement are more difficult to identify and control than those of behavior maintained by social reinforcement. Tests for automatic reinforcement (typically called "alone" or "no interaction") are usually conducted by removing most potential sources of reinforcement from the immediate environment and by providing no programmed consequences for problem behavior. The rationale for this condition is that low levels of stimulation may increase the likelihood of, or establish, problem behavior maintained by automatic reinforcement (i.e., sensory stimulation).

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Furthermore, automatically reinforced behavior should persist in the absence of social consequences. Nevertheless, this commonly used antecedent condition (i.e., absence of stimulation) may not be a relevant establishing condition for some cases of automatically reinforced behavior. For example, problem behavior could be maintained by the *reduction* of stimulation, such as pain attenuation (i.e., automatic negative reinforcement). In this case, the presence of aversive stimulation rather than the absence of ambient stimulation would occasion problem behavior. The presence or absence of alternative stimuli also may not alter the probability of responding maintained by automatic positive reinforcement if these alternative sources of stimulation are functionally different than the sensory consequences produced by the behavior. For these reasons, behavior is presumed to have an automatic reinforcement function if either (a) the highest levels of problem behavior occur in the alone (or no interaction) test condition, or (b) levels of responding are high and undifferentiated across all test conditions (Iwata et al., 1994).

Most functional analyses also include a control condition, usually called "play" or "leisure," which is characterized by (a) continuous availability of leisure materials, (b) frequent delivery of attention on a noncontingent basis, (c) absence of potentially aversive stimuli such as demands, and (d) absence of programmed consequences for problem behavior. This condition is expected to minimize the likelihood of occasioning or reinforcing problem behavior (regardless of function), because the antecedents and consequences examined in the various test conditions are removed.

The voluminous literature on functional analysis indicates that, in most cases, one or more of the variables manipulated in the test conditions described above are functionally related to problem behavior and that the play condition serves as an adequate control. Nevertheless, some idiosyncratic variables have been associated with problem behavior (e.g., Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998; Iwata et al., 1994; Wacker et al., 1996). For example, Iwata et al. found that the presence of certain ambient noises (e.g., music, the phone ringing) or social interaction served as an establishing operation for self-injury maintained by escape from these events. Results of a study by Piazza, Fisher, Hanley, Hilker, and Derby (1996) suggested that access to certain stimuli (e.g., toys) occasioned self-injury that was maintained by automatic reinforcement.

Identifying atypical events or conditions that either set the occasion for or maintain problem behavior can be critical for determining the function of the behavior. When relevant variables are not manipulated in the functional analysis, little or no problem behavior may be observed, or the behavior may be extinguished rapidly over the course of the assessment. In Iwata et al. (1994), for example, self-injury probably would not have occurred during any condition of the functional analysis if ambient noise had not been identified as potentially relevant to the behavior. In Fisher et al. (1998), few occurrences of problem behavior were observed during initial functional analyses for 2 participants. When the type of instructions presented in the demand condition was changed (from "do" to "don't" requests), problem behavior occurred at high rates and appeared to be maintained by positive reinforcement (i.e., access to preferred activities).

Results of E. G. Carr, Yarbrough, and Langdon (1997) further showed how identifying and manipulating idiosyncratic events can influence functional analysis outcomes. One participant engaged in problem behavior during the test for social-negative reinforcement (escape from table tasks) only when puzzles were present in the room. A 2nd participant engaged in problem behavior during the test condition for social-pos-

itive reinforcement (contingent attention) when the therapist was reading a magazine, but not when the therapist was reading a book. Few occurrences of problem behavior were observed when a 3rd participant had access to wrist bands or small objects in the test conditions.

Although the results of E. G. Carr et al. (1997) showed that the presence of certain idiosyncratic stimuli altered the outcome of functional analyses, neither the function of the participants' problem behavior nor the precise nature of the stimulus–behavior relations was determined. These items (i.e., puzzles, magazines, small balls) could have set the occasion for problem behavior by signaling the availability of some type of social reinforcement (i.e., by functioning as discriminative stimuli), or by altering the potency of the reinforcer that maintained the behavior (i.e., by functioning as an establishing operation). Access to these items also could have functioned as the maintaining consequence for problem behavior. Further analyses are needed to better understand these idiosyncratic environment–behavior relations and to develop effective treatments for problem behavior.

In this study, we identified idiosyncratic stimuli that appeared to set the occasion for, or establish, problem behavior. Putative functional relationships between these stimuli and problem behavior were evaluated. Following these functional analyses, the components of the stimuli that were most associated with occurrences of problem behavior were identified and effective treatments were developed.

GENERAL METHOD

Participants and Settings

Participants were 2 boys who had been referred by teachers at a local elementary school and at a developmental center for children. Timon, an 8-year-old boy who had been diagnosed with moderate mental retardation and hydrocephalus, had been referred for the assessment and treatment of hand biting. He had no expressive language skills and took carbamazepine (Tegretol®) to control seizures throughout the study. Dorian, a 5-year-old boy with no diagnosed developmental delays, had been referred for the assessment and treatment of hand flapping. Both participants were ambulatory, and neither had sensory deficits. Sessions were conducted in an empty classroom at a public school (Timon) or in an empty office at a developmental center (Dorian). The rooms contained several chairs, a desk, bookshelves, and a variety of items necessary to conduct the sessions (described below).

Response Measurement and Reliability

Hand biting (Timon) was defined as closure of the upper and lower teeth on any part of the hand. Hand flapping (Dorian) was defined as opening and closing a hand within 1 s. Toy play for both participants was defined as any contact between the hand and a toy. Data on hand biting were collected using frequency recording, and the data were expressed as responses per minute. Data on hand flapping and toy play were collected via 10-s partial-interval recording and were expressed as percentage of intervals scored. Data were collected on laptop computers by observers seated in the room. Observers did not interact with the participants during the sessions. A second observer simultaneously and independently collected data on target behaviors for 60% of all sessions. Interobserver agreement for each target behavior was calculated by dividing each session into consecutive 10-s intervals. Agreement for hand biting was computed by dividing the number of exact agreements by the number of agreements plus disagreements, and multiplying by 100%. Interval-by-interval agreement for hand flapping and toy play was computed by dividing the in-

tervals in which both observers agreed on the occurrence or nonoccurrence of the target behavior by the total number of intervals, and multiplying by 100%. Mean percentage of agreement was 98% (range, 88% to 100%) for hand biting, 95% (range, 70% to 100%) for hand flapping, and 99% (range, 93% to 100%) for toy play.

Phase 1: Functional Analysis

Procedure

Two functional analyses were conducted with each participant. The outcome of the first functional analysis revealed a correlation between the presence of a stimulus (or stimuli) and the occurrence of problem behavior. Thus, in the second functional analysis, possible functional relationships between these stimuli and problem behavior were explored further. Two to five sessions were conducted daily, 1 to 5 days per week. All sessions lasted 10 min.

Timon. The initial functional analysis was conducted using procedures similar to those described by Iwata et al. (1982/1994) with the following exceptions: (a) Timon received 20-s access to the reinforcer contingent on problem behavior in the test conditions for social reinforcement (Fisher, Piazza, & Chiang, 1996); (b) instructions were delivered continuously in the demand condition; and (c) attention was delivered continuously in the play condition. The functional analysis included attention, demand, tangible, play, and no-interaction conditions. Toys used in the attention, tangible, and play conditions were selected via a stimulus choice preference assessment similar to that described by Fisher et al. (1992). A Bumble Ball®, See-N-Say®, and musical turtle were his most preferred toys. However, few occurrences of hand biting were observed across the first 22 sessions of the initial functional analysis. Anecdotally, it was observed that Timon engaged in hand biting when he interacted with a certain toy during the play sessions. To evaluate whether the presence of this toy (a Bumble Ball®) differentially affected levels of hand biting, no-interaction sessions with and without the toy were alternated in a reversal design (ABABA). In both conditions, observers remained in the room but did not interact with Timon. In the no-interaction with toy condition (A), Timon had continuous access to the ball. The no-interaction without toy condition (B) was identical to the no-interaction condition of the functional analysis.

A second functional analysis then was conducted with Timon to further evaluate potential functional relationships between the Bumble Ball® and hand biting. It was hypothesized that hand biting was maintained by a social reinforcer, such as access to or escape from the toy, or by some form of automatic reinforcement. Thus, three conditions designed to test these hypotheses were alternated in a multielement design. In the contingent removal condition, Timon received continuous access to the ball. The therapist removed the ball for 20 s contingent on each occurrence of hand biting. In the contingent access condition, the therapist withheld access to the ball. Contingent on each occurrence of hand biting, Timon received access to the ball for 20 s. The no-interaction sessions were identical to the no-interaction with toy sessions used in the initial functional analysis. An extended series of no-interaction sessions was also conducted to determine whether Timon's hand biting would persist in the absence of social consequences (Vollmer, Marcus, Ringdahl, & Roane, 1995).

Dorian. The initial functional analysis was identical to that conducted for Timon, with the following exceptions: (a) The tangible condition was not implemented, and (b) toys used in the attention and play sessions were selected by asking Dorian to bring his

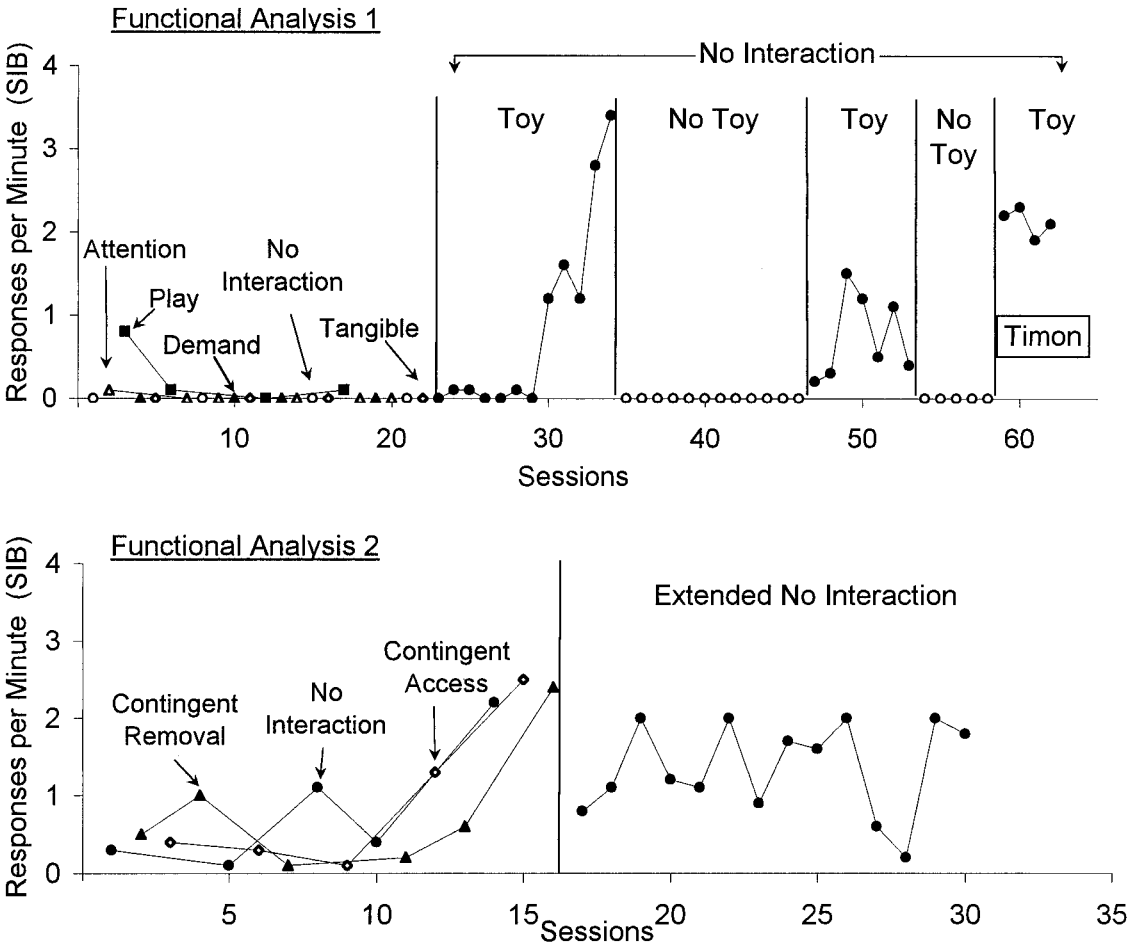

Figure 1. Responses per minute of hand biting across sessions during Timon's first functional analysis (top panel) and second functional analysis (bottom panel).

favorite toys from home, which consistently included action figures, toy cars, and plastic animals. Results of Dorian's initial functional analysis showed that the highest levels of hand flapping occurred during the play condition (i.e., when he received continuous therapist attention and access to toys, and no social consequences were provided for hand flapping). This finding is somewhat atypical, in that the control condition is expected to produce differentially low levels of problem behavior. We hypothesized that contingent access to attention or toys was not relevant to hand flapping because the behavior was lowest in the attention condition of the functional analysis (i.e., when he received contingent attention for hand flapping) and was highest in the play condition (i.e., when he had continuous access to attention and all his toys). Thus, it was hypothesized that his behavior was either maintained by escape from these stimuli (see E. J. Carr, Hatfield, Austin, & Bailey, 1998; Kahng & Iwata, 1998) or by some form of automatic reinforcement. To test these hypotheses, escape and no-escape conditions were alternated within a reversal design (ABAB) in a second functional analysis. In both conditions, the therapist interacted with Dorian continuously and toys were available. The no-escape condition (A) was identical to the play condition of the first

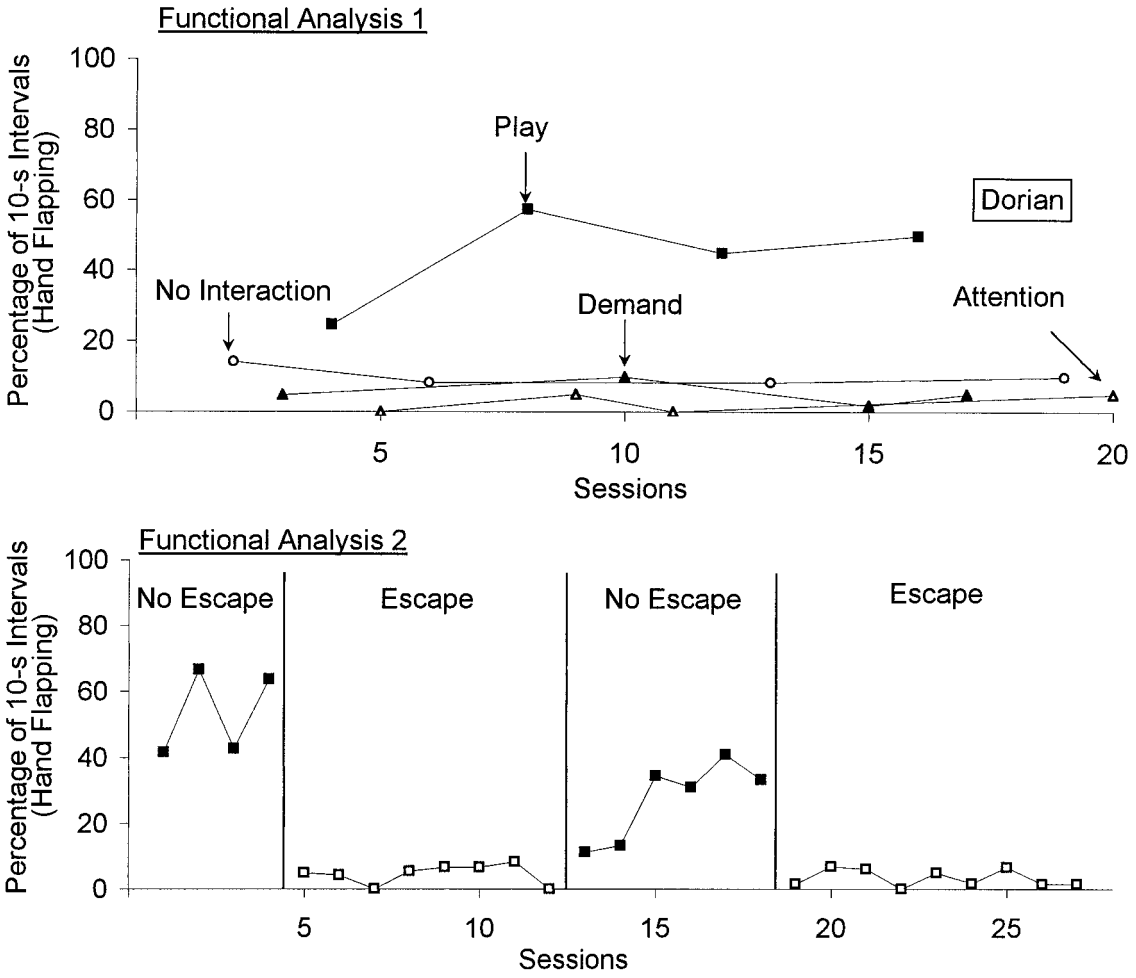

Figure 2. Percentage of 10-s intervals with hand flapping across sessions during Dorian's first functional analysis (top panel) and second functional analysis (bottom panel).

functional analysis. In the escape condition (B), the therapist told Dorian at the start of each session that attention and toys would be removed briefly if he hand flapped. The therapist then removed the toys and turned away from Dorian for 20 s contingent on each occurrence of hand flapping. Each session continued until Dorian was exposed to 10 min of attention and toys, and escape time was subtracted from total session time prior to data calculation.

Results and Discussion

Timon. Results of Timon's functional analyses are depicted in Figure 1. In the initial functional analysis, hand biting rarely occurred during any condition with the exception of play (M = 0.3 responses per minute). During the extended series of no-interaction sessions, high levels of hand biting were observed when the Bumble Ball® was present (M = 1 response per minute), whereas no hand biting was observed when the ball was absent. During the second multielement functional analysis, undifferentiated levels of hand biting were observed across the contingent removal (M = 0.8 responses per minute), contingent access (M = 0.9 responses per minute), and no-interaction conditions (M = 0.8 responses per

minute). In addition, hand biting persisted across the extended series of no-interaction sessions (M = 1.4 responses per minute). These results suggested that hand biting was occasioned by the presence of the ball, but that the behavior would be maintained independent of social consequences.

Dorian. Results of Dorian's functional analyses are depicted in Figure 2. In the initial functional analysis, moderate levels of hand flapping were observed in the play condition (M = 44%), whereas low levels were observed in the no-interaction (M = 8%), demand (M = 10%), and attention (M = 5%) conditions. These results suggested that Dorian's hand flapping was not sensitive to contingent attention or escape from demands and that the behavior was unlikely to occur independent of social consequences in the absence of attention or toys. In the second functional analysis, moderate levels of hand flapping occurred during the no-escape condition (M = 38%), whereas low levels of hand flapping occurred during the escape condition (M = 4%). These findings were inconsistent with the negative reinforcement hypothesis and suggested that hand flapping would persist in the absence of social consequences. In fact, the escape contingency had a suppressive effect on behavior. Anecdotally, Dorian reacted to the escape period as though it was an aversive event, crying and yelling at the therapist (e.g., "I hate you") when the contingency was implemented during the first few sessions of the escape condition.

Functional analysis results for both Timon and Dorian indicated that their aberrant behavior was occasioned by the presence of a certain toy (Timon) or by the continuous presentation of attention and access to toys (Dorian). However, these stimuli did not appear to increase the likelihood of problem behavior by signaling the availability of contingent social reinforcement (i.e., by functioning as discriminative stimuli). When the stimuli were presented continuously, levels of problem behavior persisted in the absence of social consequences for both participants.

Assessment outcomes also provided some information about potential treatments. Timon never bit his hand when the ball was removed from the environment. However, the toy produced several forms of stimulation (it vibrated, had plastic protrusions, and made noise), one or more of which might be produced by other objects readily available in Timon's environment. Thus, it seemed necessary to isolate the precise components of the Bumble Ball® that occasioned problem behavior. For Dorian, eliminating all social interaction and toys from the environment did not seem to be an appropriate treatment. Results of his second functional analysis indicated that contingent removal of attention and toys (i.e., time-out) would be an effective treatment for hand flapping. However, it was not yet clear whether attention, toys, or the combined stimuli occasioned his behavior. Furthermore, we wanted to collect additional data on levels of hand flapping in the presence of attention or toys to further verify that his behavior would persist in the absence of social consequences.

Phase 2: Component Analyses

Procedure

Two to five sessions were conducted daily, 1 to 5 days per week. All sessions lasted 10 min.

Timon. The relative influence of three stimulus components of the Bumble Ball® on levels of hand biting and toy play was evaluated in a reversal design. The components of the ball that seemed most salient were the vibration, the sound the ball's motor produced while vibrating, and the ball's plastic protrusions, which Timon sometimes placed in his mouth. In all three conditions, Timon had continuous access to the ball,

and no one interacted with him. No programmed consequences were provided for hand biting. In the intact condition (A), the ball was identical to that used in Phase 1. That is, the toy vibrated, made sounds, and contained plastic protrusions. In the no-vibration condition (B), the batteries were removed from the ball so that it could not vibrate, but an audiotape of a vibrating ball was played throughout the sessions. The tape player was placed near Timon, and the volume of the taped sound was adjusted to match the actual sound produced by the ball when the motor operated. Thus, only the vibration component was eliminated. In the no-protrusions condition (C), the plastic protrusions were removed, but the ball still vibrated and made noise. Thus, only one component (plastic protrusions) was eliminated. These three conditions were presented in the following order: ABACBC.

Dorian. The relative effects of social interaction and toys on levels of hand flapping were evaluated in a reversal design. Across all conditions, no programmed consequences were provided for the behavior. In the interaction plus toys condition (A), the therapist interacted continuously with Dorian, and toys were available. Specifically, the therapist talked to Dorian about his favorite television shows, pretended to be his favorite super hero, and played with him. In the toys condition (B), Dorian had access to toys, but no one interacted with him. In the interaction condition (C), Dorian received continuous adult attention, but no toys were available. These conditions were presented in the following order: ABACBC.

Results and Discussion

Timon. Results of Timon's component analysis for hand biting and toy play are depicted in the first and second panels of Figure 3. The intact and no-protrusions conditions were associated with similarly high levels of hand biting (M = 1.4 and M = 1.5 responses per minute, respectively), whereas the no-vibration condition was associated with very little hand biting (M = 0.04 responses per minute). High levels of toy play were observed during the intact and no-protrusions conditions (M = 99.7% and M = 99.6%, respectively). Lower levels of toy play were observed in the no-vibration condition (M = 69.4%). These results suggested that the toy's vibration, rather than its sound or plastic protrusions, was the stimulus component most associated with the occurrence of Timon's hand biting. Furthermore, hand biting continued to persist in the absence of social consequences as long as the toy vibrated. The presence of vibration also was positively related to levels of toy play, suggesting that exposure to vibration set the occasion for both behaviors. These results were consistent with teacher reports that Timon would often bite his hand when he played with certain toys in the classroom.

Dorian. Results of Dorian's component analysis are depicted in the third and fourth panels of Figure 3. The interaction plus toys condition and interaction condition were associated with similarly high levels of hand flapping (M = 66% and M = 68%, respectively), whereas the toys-only condition was associated with low levels of hand flapping (M = 5%). High levels of toy play were observed in the interaction plus toys condition (M = 99.8%). With the exception of a single session, similarly high levels of toy play were observed in the toys-only condition (M = 88.1%). These results suggested that social interaction, rather than access to toys, was the component most associated with the occurrence of hand flapping. Furthermore, the behavior continued to persist in the absence of social consequences as long as Dorian received continuous social interaction. These results were consistent with parent reports that Dorian would flap his hands at home when playing with someone or while

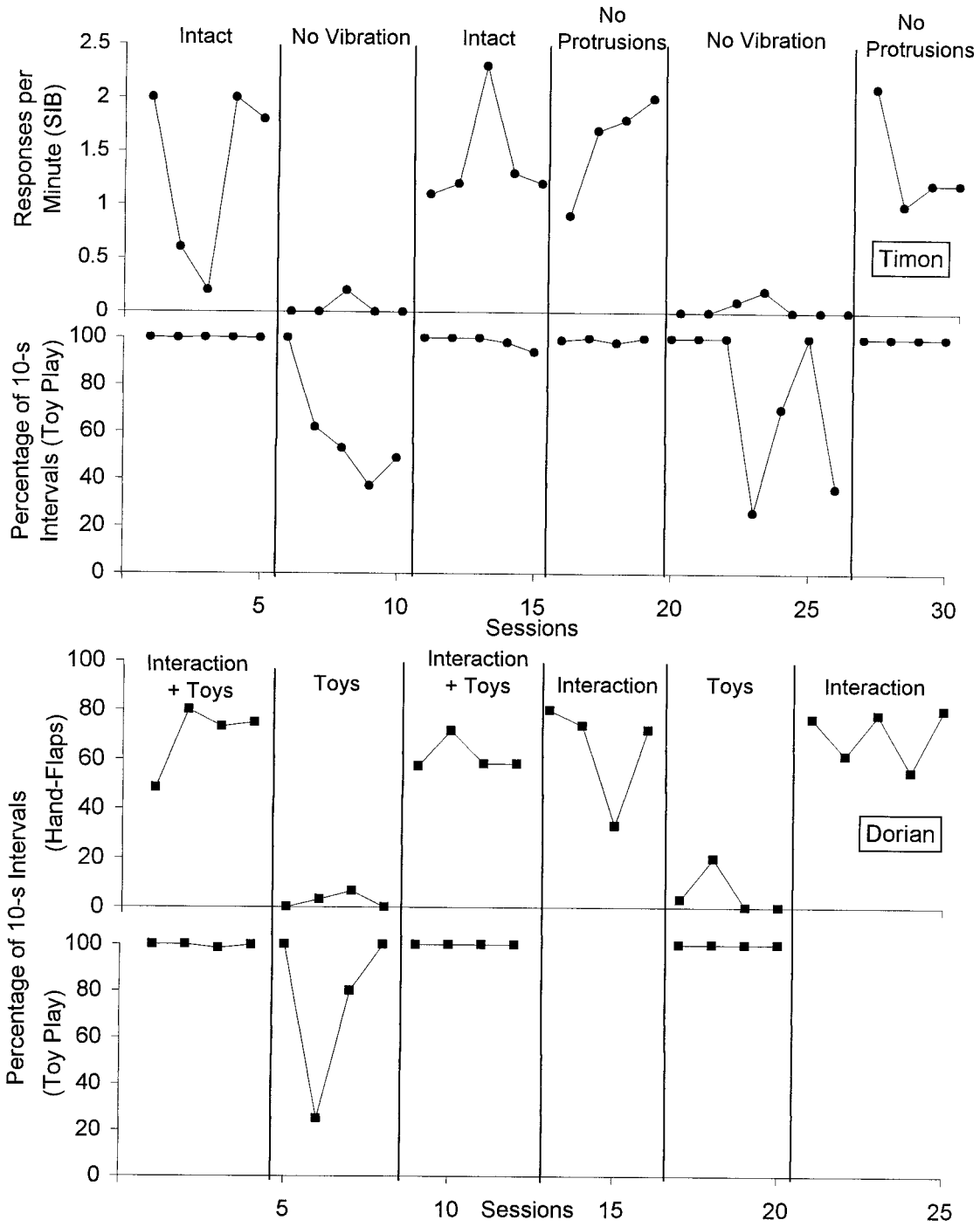

Figure 3. Responses per minute of hand biting (top panel) and percentage of 10-s intervals with toy play (second panel) across sessions of Timon's component analysis; percentage of 10-s intervals with hand flapping (third panel) and toy play (bottom panel) across sessions of Dorian's component analysis.

engaged in other highly stimulating activities (e.g., watching videos). Unlike Timon, levels of toy play and hand flapping were not systematically related. That is, Dorian played with toys nearly 100% of the time, regardless of whether he received social interaction at the same time.

Phase 3: Treatment Analyses

Results of Timon's component analysis suggested that removing vibrating stimuli from his environment would be an effective treatment for hand biting. However, it was not clear whether all vibrating toys (other than the Bumble Ball®) would have to be restricted, and whether Timon would interact with nonvibrating toys without engaging in hand biting. Thus, in this treatment evaluation, the effects of vibrating and nonvibrating toys on levels of hand biting and toy play were examined. Results of Dorian's component analysis indicated that removing social interaction from his environment would be an effective treatment. However, restricting access to attention in a noncontingent manner did not seem appropriate or feasible. The outcome of his second functional analysis indicated that contingent removal of attention and toys (i.e., time-out) would be an effective treatment. However, it was not clear whether both stimuli had to be removed, or whether the removal of either stimulus would be equally effective. As such, time-out from toys was compared to time-out from attention for his treatment analysis.

Procedure

Two to five sessions were conducted daily, 1 to 5 days per week.

Timon. Two conditions were evaluated in a multielement design. No one interacted with Timon during either condition, and no programmed consequences were provided for hand biting. In the vibrating toys condition, Timon had continuous access to several vibrating toys, including a vibrating train, an oval-shaped vibrating bug, and a small version of the bumble ball with a face, feet, and hair. In the other condition, Timon had continuous access to several toys that did not vibrate, including a See-N-Say®, a musical turtle, and toy trucks. All vibrating and nonvibrating toys were identified as highly preferred via separate stimulus choice preference assessments conducted prior to the treatment analysis (Fisher et al., 1992). All sessions lasted 10 min.

Dorian. Two treatment conditions were alternated in a multielement design. Each treatment was implemented by a different therapist. Neither therapist had conducted sessions with Dorian prior to the treatment analysis. Baseline sessions were first conducted with each therapist to identify any possible differences in levels of hand flapping with the two therapists. Baseline sessions were identical to the play sessions in the initial functional analysis and lasted 10 min. In both treatment conditions, Dorian continued to receive attention, and toys were available. At the start of each time-out (attention) session, Dorian was told that when he flapped his hands, the therapist would turn away briefly, but that he could continue playing with his toys. Contingent on each occurrence of hand flapping, the therapist withdrew her attention for 20 s but did not remove the toys. At the start of each time-out (toys) session, the therapist told Dorian that when he flapped his hands, the therapist would take away his toys but continue to talk with him. Contingent on each flap, the therapist removed the toys for 20 s but continued to interact with Dorian as she had prior to time-out. For example, if they were conversing about his favorite television show when Dorian engaged in hand flapping, the therapist would remove the toys but continue to converse with Dorian about the show. For the treatment sessions, session length was increased by 20 s for each implemen-

tation of time-out to insure that Dorian was exposed to 10 min of attention and toys in each session.

Results and Discussion

Timon. Results of Timon's treatment analysis are shown in the top and middle panels of Figure 4. High levels of hand biting were observed in the vibrating toys condition (M = 1 response per minute), whereas little hand biting was observed in the nonvibrating toys condition (M = 0.01). Timon engaged in toy play nearly 100% of the time across both conditions. These results again indicated that access to vibrating stimuli occasioned hand biting. If treatment had consisted of removing only the Bumble Ball® from his environment, hand biting likely would have occurred in the presence of other vibrating toys. In addition, Timon played with both types of toys, suggesting that nonvibrating toys could be used as leisure items in his classroom or home without the problems associated with vibrating toys. Following this treatment analysis, Timon's teacher was encouraged to remove vibrating objects from his environment; however, follow-up data were not collected in the classroom.

Dorian. Results of Dorian's treatment analysis are depicted in the bottom panel of Figure 4. Moderate, variable levels of hand flapping were observed in the baseline sessions with each therapist (M = 36% and M = 35%). Both time-out conditions produced similarly low levels of hand flapping (M = 3.6% and M = 4.3%). These results indicated that contingent removal of either toys or attention was effective in treating hand flapping. Thus, time-out could be implemented when Dorian's parents or teachers would not be able to withhold their attention or when they were not interacting with him during "time-in." Likewise, time-out from attention could be implemented when his parents or teachers would be unable to remove his toys or when he was not playing with his toys. After discharge from the program, Dorian's parents and grandmother were taught to implement time-out at home. Data collected during follow-up sessions at Dorian's home indicated that the caregivers were implementing the treatment correctly and that incidence of hand flapping remained low.

GENERAL DISCUSSION

Results of functional analyses with 2 young children identified atypical antecedents for problem behavior that persisted in the absence of social contingencies. Further analysis of these antecedent stimuli indicated that the presence of vibration (Timon) or social interaction (Dorian) set the occasion for high levels of hand biting or hand flapping. Treatments consisting of the contingent or noncontingent removal of these stimuli were effective for both participants.

This study illustrates two cases in which response patterns under commonly used functional analysis conditions—alone and play—were unlike those typically observed for problem behavior that persists in the absence of social consequences (i.e., behavior that is presumably maintained by automatic reinforcement). The alone or no-interaction condition is designed to identify behavior that is maintained by automatic reinforcement. It is assumed that the absence of all potential sources of reinforcement (e.g., social interaction, leisure materials) produces deprivation from sensory stimulation, increasing the likelihood of behavior maintained by sensory consequences. Previous research findings have shown that levels of responding in the alone condition are differentially higher than or similar to those in the other test conditions when problem behavior is maintained by automatic reinforcement (Iwata et al., 1994). Conversely, the play condition, during which the individual has noncontingent access to leisure items and at-

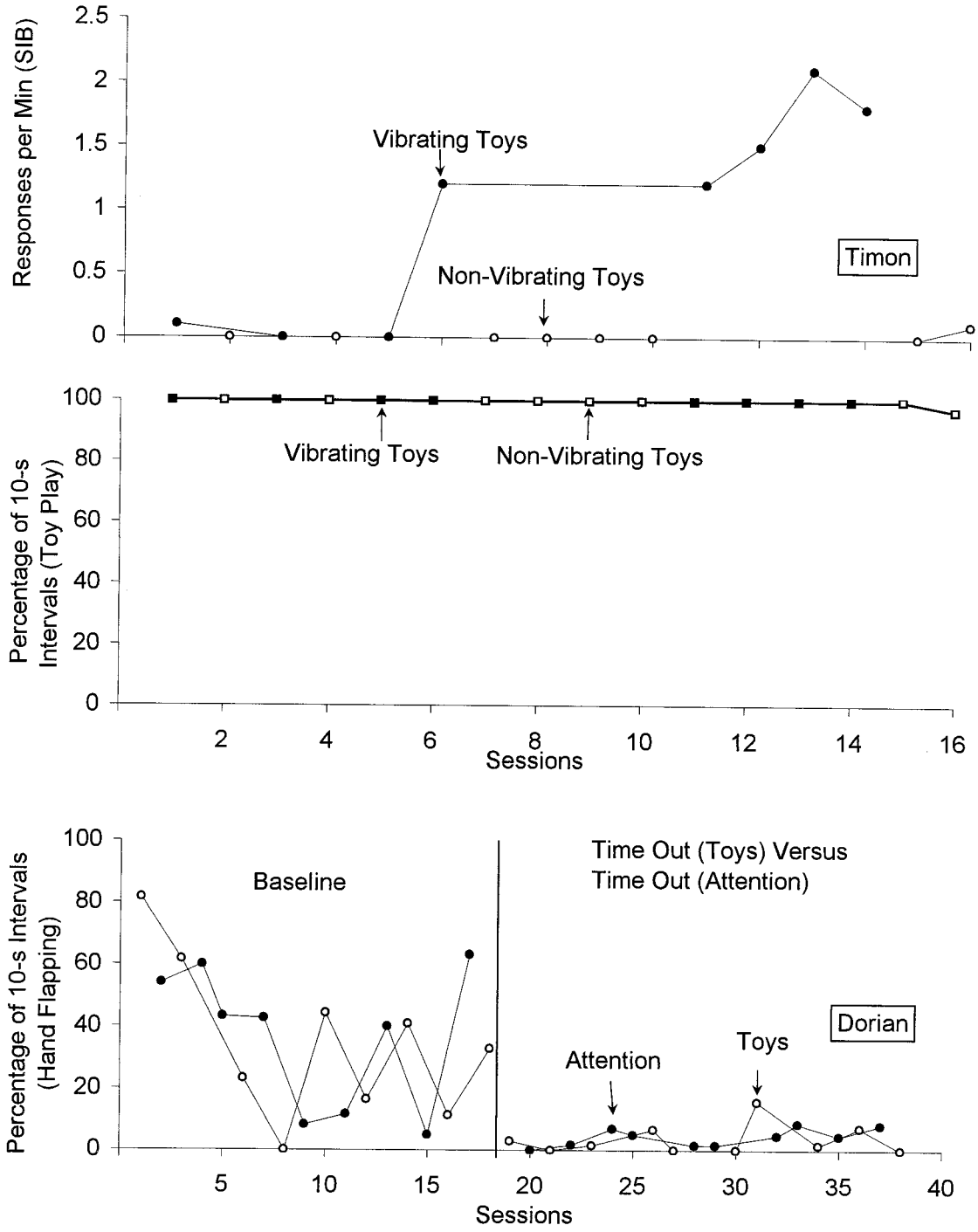

Figure 4. Responses per minute of hand biting (top panel) and percentage of 10-s intervals with toy play (middle panel) across sessions of Timon's treatment analysis; percentage of 10-s intervals with hand flapping across sessions (bottom panel) of Dorian's treatment analysis.

tention, is expected to produce low levels of responding. Nevertheless, differentially low levels of problem behavior occurred in the alone condition for both participants because, as typically designed, this condition did not contain the relevant antecedents for their behavior (i.e., the presence of the ball or social interaction). Furthermore, the highest levels of problem behavior were observed in the play condition of the initial functional analysis because certain alternative sources of stimulation occasioned responding.

Although results of the analyses clearly identified the functional antecedents of problem behavior, the precise sources of reinforcement that maintained the behavior were not determined. However, these findings and those reported by others (e.g., E. G. Carr et al., 1997; Fisher et al., 1998) illustrate the importance of identifying idiosyncratic antecedents of problem behavior when conducting functional analyses. For example, participants in Carr et al. exhibited problem behavior only when atypical stimuli were present (e.g., when puzzles were present during the demand condition). Similarly, the participants described in the current study engaged in problem behavior only when certain stimuli were included in the functional analysis conditions. These findings are important because problem behavior must occur during the functional analysis to determine the consequences that maintain the behavior. The study also extends Carr et al. by demonstrating a methodology for evaluating functional relationships between atypical events and problem behavior. Results of the functional analyses and component analyses were used to identify potential variables that maintained the participants' problem behavior and to develop effective treatments.

However, it is not clear why these stimuli occasioned problem behavior. One possible explanation is that the ball or attention served as an establishing operation. That is, the presence of these stimuli may have increased the potency of the automatic reinforcer produced by hand biting or hand flapping. For example, the vibration of the ball may have produced an aversive sensation in Timon's hand that was alleviated by hand biting even though other consequences of ball play reinforced toy interaction. However, the increase in toy play displayed by Timon in the presence of the vibrating ball also suggests that vibration functioned as an establishing operation.

The increase in aberrant behavior displayed by both Timon and Dorian in the presence of attention or toys is also consistent with descriptions of reinforcer complementarity, which could be conceptualized as a type of establishing operation. Green and Freed (1993) defined complementary reinforcers as stimuli that are consumed jointly; that is, an increase in the consumption of one reinforcer is associated with an increase in the consumption of another (e.g., an increased consumption of pancakes elevates the consumption of syrup). In a similar manner, an increase in Bumble Ball® play was associated with an increase in hand biting for Timon, and an increase in social interaction was associated with an increase in hand flapping for Dorian. However, this interpretation is speculative because neither the ball nor social interaction was shown to be a reinforcer, data on the consumption of these stimuli were not collected for both participants, and exposure to the stimuli was not systematically increased and decreased to determine if consumption of the maintaining reinforcer would correspondingly change.

Another potential limitation is the interpretation of Dorian's functional analysis, which indicated that his behavior was not maintained by escape from attention. An alternative interpretation is that the punishing effects of time-out from toys overrode the reinforcing effects of escape because both stimuli were removed contingent on hand

flapping. Results of the subsequent treatment analysis were inconsistent with this alternative interpretation because hand flapping decreased when time-out involved the removal of attention only. However, results of the treatment comparison could have been influenced by interaction effects. That is, the punishing effects of time-out from toys could have carried over into the sessions involving time-out from attention. Anecdotally, the therapist noted that Dorian attended to, reciprocated, and initiated social interaction during these sessions. Data on these behaviors, in addition to more objective measures of affect, could have been collected to determine if attention was aversive to Dorian.

Further research on idiosyncratic stimuli that affect functional analyses results is needed. Specifically, the exact nature of these stimulus–behavior relations should be examined. Future studies also should examine methods for identifying these idiosyncratic stimuli prior to the functional analysis. Interviews with caregivers and direct observation in the natural environment might be useful for identifying potentially relevant events that are not typically included in the functional analysis (e.g., Fisher et al., 1998). Most structured indirect assessments (e.g., The Motivation Assessment Scale; Durand & Crimmins, 1988) and formal descriptive analyses (e.g., Lerman & Iwata, 1993) focus on events that are commonly associated with problem behavior, such as the contingent delivery of attention and escape from demands. Thus, these assessments could be modified so that information about idiosyncratic stimuli could be obtained (see O'Neill et al., 1997, for an example). Such assessments could be conducted routinely or when results of functional analyses indicate that idiosyncratic stimuli may be affecting the outcomes. For example, E. G. Carr et al. (1997) suggested that atypical stimuli may be relevant when there is a discrepancy between functional analysis outcomes and information obtained via caregiver interview or when results of the functional analysis vary across different settings or days.

Results of this study highlight the importance of evaluating idiosyncratic variables that are not commonly assessed in functional analyses. The relations described in this study are highly unusual; however, the methods used to evaluate these relations may be replicated and refined in further research on idiosyncratic establishing conditions for problem behavior.

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STUDY QUESTIONS

1. What two response patterns in a functional analysis suggest maintenance by automatic reinforcement? What alternative accounts are possible for these response patterns?

2. Under what conditions might the alone condition be an inadequate test for maintenance by automatic reinforcement?

3. What were the dependent variables in this study, and how was each measured?

4. Describe the unusual results of the initial functional analyses and the sources of reinforcement that were ruled out in the second functional analysis for both participants.

5. What variables were manipulated in the component analyses (Phase 2)? What were the results of these analyses, and what did they suggest about the controlling variables for participants' problem behaviors?

6. What is meant by the term *reinforcer complementarity,* and how might this phenomenon be relevant to the present data?

7. How were the results of the component analyses used to design treatments for Timon and Dorian, and what results were obtained with these treatments?

8. Although the play condition is typically considered the control condition of the functional analysis, why might high levels of problem behavior be observed occasionally in this condition?

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