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AN EVALUATION OF THE EFFECTS OF MATCHED STIMULI ON BEHAVIORS MAINTAINED BY AUTOMATIC REINFORCEMENT

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The purpose of the current investigation was to extend the literature on matched stimuli to three dissimilar forms of aberrant behavior (dangerous climbing and jumping, saliva manipulation, and hand mouthing). The results of functional analyses suggested that each behavior was automatically reinforced. Preference assessments were used to identify two classes of stimuli: items that matched the hypothesized sensory consequences of aberrant behavior (matched stimuli) and items that produced sensory consequences that were not similar to those produced by the aberrant behavior (unmatched stimuli). The effects of providing continuous and noncontingent access to either the most highly preferred matched or the most highly preferred unmatched stimuli were assessed relative to a condition in which no stimuli were available. Overall results suggested that providing access to items that matched the hypothesized sensory consequences of aberrant behavior may be more effective than simply selecting stimuli either arbitrarily or based on the results of preference assessments alone.

DESCRIPTORS: automatic reinforcement, functional analysis, preference assessment

The term *automatic reinforcement* has been used to describe reinforcement that is produced independent of the social environment (Vaughan & Michael, 1982). Automatically reinforced aberrant behavior presents a special dilemma for the behavior analyst for a number of reasons (Vollmer, 1994). First, automatic reinforcement is a general term that is used to describe what the reinforcer is not (i.e., not a social variable) but does not specify the reinforcer. Prescription of treatment is less clear because the reinforcer is unknown. Second, automatic reinforcers are not typically within the control of a therapist and cannot be directly manipulated. Third, automatic reinforcers are available constantly because the behavior and the reinforcer are inseparable.

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One hypothesis that has been proposed to explain automatically reinforced aberrant behavior is that the response becomes more probable when levels of environmental stimulation are inadequate. Support for this hypothesis is derived from results of studies that have demonstrated that stereotypic behavior occurs more frequently under conditions of low stimulation relative to conditions of higher stimulation (e.g., Berkson & Mason, 1965). For example, Horner (1980) examined the effects of an enriched environment on the adaptive and maladaptive behavior of 5 institutionalized individuals with mental retardation and found that higher levels of adaptive and lower levels of maladaptive behavior occurred when the environment was enriched with toys and objects. Iwata et al. (1994) suggested that one of the defining features of aberrant behavior maintained by automatic reinforcement is higher levels of behavior in the alone condition, in which no environmental stimulation is provided, and relatively lower levels in the play

condition, in which stimulation is provided via toys and adult attention. Finally, Vollmer, Marcus, and LeBlanc (1994) demonstrated that the results of a preference assessment could be used to develop environmental enrichment treatments to reduce aberrant behavior maintained by automatic reinforcement. Collectively, these studies suggest that levels of environmental stimulation may alter the probability of automatically reinforced aberrant behavior.[1]

If levels of sensory stimulation affect the occurrence of some automatically reinforced aberrant behavior, then a more specific approach to treatment is to provide sensory stimulation that is the same or similar to the stimulation produced by the aberrant behavior (i.e., stimulation that "matches" that provided by the aberrant behavior; Vollmer, 1994). For example, Favell, McGimsey, and Schell (1982) hypothesized that the eye poking of 2 individuals was maintained by the visual stimulation it produced and that the hand mouthing and pica of 4 individuals were maintained by oral stimulation. Eye poking was treated by providing participants with toys that produced visual stimulation, and hand mouthing and pica were treated by providing participants with items that provided oral stimulation (e.g., mouthing toys and popcorn).

Recent studies have focused on developing assessment procedures to facilitate the identification of the specific source of automatic reinforcement produced by behavior. Piazza et al. (1998) described the use of functional analysis and preference assessments to identify the specific source of reinforcement for automatically reinforced pica. The results of functional analyses indicated that the pica of 3 participants was maintained at least in part by automatic reinforcement. Next, brief preference trials were conducted in which levels of interaction with stimuli and levels of pica were measured simultaneously. In general, the most highly preferred items that were associated with the lowest levels of pica were items that the participants could mouth (i.e., items that matched the hypothesized sensory consequences of pica). Subsequent analyses were conducted in which the participants had access to matched versus unmatched items (i.e., items that produced sensory consequences that were not similar to those produced by pica). For 2 of the 3 participants, access to matched items produced lower levels of pica than access to unmatched items. Additional preference assessment trials were conducted with these 2 participants to identify the specific aspects of oral stimulation that were preferred. The participants were exposed to a variety of items that differed along several dimensions (e.g., flavor, firmness). Firmness was identified as the stimulus property that most effectively competed with pica, in that pica was lower when participants were provided with access to firm stimuli relative to soft stimuli independent of other dimensions of the stimuli (e.g., flavor).

Even though several studies have examined the effects of matched stimuli on aberrant behavior, there are several limitations in the existing literature that should be addressed. For example, Favell et al. (1982) demonstrated that putatively matched stimuli were associated with lower levels of aberrant behaviors; however, treatments were conducted without the benefit of a functional analysis. Therefore, the role of social reinforcement in the treatment of aberrant behavior was not ruled out as a contributing factor to behavioral maintenance. It is possible that the matched stimuli competed

[1] Note that automatic positive reinforcement is only one possible type of automatically reinforced behavior. Automatic negative reinforcement (e.g., pain attenuation) may also contribute to the maintenance of aberrant behavior (Carr & McDowell, 1980; Cataldo & Harris, 1982; Vollmer, 1994). The focus of this article, however, is on automatic positive reinforcement.

with automatic reinforcement or with other forms of social reinforcement such as attention.

Piazza et al. (1998) and Fisher, Lindauer, Alterson, and Thompson (1998) conducted functional analyses of participants' aberrant behavior prior to evaluations of matched stimuli. However, in the Fisher et al. study, matched and unmatched stimuli were not compared with 1 participant. For the 2nd participant, no data were presented from the preference assessment regarding preference for the matched and unmatched stimuli or the competition between matched and unmatched stimuli and aberrant behavior. Even though Piazza et al. demonstrated that matched stimuli competed more effectively than unmatched stimuli for 2 participants, the analyses were limited to the behavior of pica. Thus, it is unclear whether matched stimuli would compete effectively with other forms of aberrant behavior.

The purpose of the current investigation was to extend the findings of previous studies on the effects of matched stimuli on automatically reinforced behavior. We conducted pretreatment functional analyses to determine if aberrant behavior was maintained by automatic reinforcement. We then used a systematic method for identifying highly preferred matched and unmatched stimuli that were associated with low levels of aberrant behavior. Finally, we attempted to evaluate the role of sensory match and preference by comparing the effects of highly preferred matched and unmatched stimuli on three dissimilar topographies of aberrant behavior.

METHOD

Participants and Setting

Three individuals had been admitted to an inpatient facility specializing in the assessment and treatment of severe behavior disorders. Betsy was a 6-year-old girl who had been diagnosed with attention deficit hyperactivity disorder (ADHD) and severe mental retardation. Betsy was ambulatory and could follow simple one-step instructions (e.g., "stand up"). She did not use any recognizable means of expressive communication. She had been admitted to the inpatient unit for the assessment and treatment of dangerous behavior (e.g., climbing on furniture, jumping out of windows), aggression, disruption, and self-injury. Her dangerous behavior had resulted in contusions to various parts of her body.

Brad was an 8-year-old boy who had been diagnosed with ADHD and severe mental retardation. Brad was ambulatory and could follow simple one-step instructions (e.g., "stand up"). His expressive communication was limited to the use of a few signs (e.g., eat, bathroom). Brad had been admitted to the inpatient unit for the assessment and treatment of saliva play (spitting saliva on floors, windows, and people and then manipulating the saliva with his hands), aggression, disruption, and self-injury. Windows, floors, furniture, walls, and toys in Brad's home were covered in saliva. His saliva play was unsanitary (increased the exposure of friends and family to saliva-borne pathogens) and limited Brad's opportunities for integration into the community (community members did not want to be exposed to his saliva and the risk of infectious diseases).

Tyrone was a 17-year-old boy who had been diagnosed with profound mental retardation. He was nonambulatory, demonstrated no recognizable means of expressive communication, and did not comply with simple one-step instructions. Tyrone had been admitted to the inpatient unit for the assessment and treatment of self-injurious behavior (SIB), which consisted of hand mouthing. Tyrone's hand mouthing was described as continuous, had resulted in tissue damage to his hand and fingers, and interfered with

his acquisition of academic, vocational, and leisure skills.

Data Collection and Interobserver Agreement

Data were collected for Betsy on the frequency of dangerous behavior (standing on furniture, tipping furniture, jumping off of furniture, and throwing objects at the ceiling) and duration of appropriate stimulus interaction (manipulation of the item in the manner in which it was intended). Appropriate stimulus interaction was defined for each item (e.g., for edible items, interaction was defined as the consumption of the items; for tactile items, interaction was defined as manual manipulation of the items). Betsy also engaged in aggression, self-injury, and disruption. Although none of these topographies of aberrant behavior were addressed in the assessments reported in the current investigation, each was assessed and treated prior to discharge. Data were collected for Brad on the frequency of saliva play (the expulsion of saliva from the mouth and subsequent manipulation with his fingers) and the duration of appropriate stimulus interaction (as defined for Betsy). Saliva play was scored as a frequency measure because Brad rapidly and repeatedly spit and then manipulated the saliva with his fingers. Brad's other topographies of aberrant behavior were not addressed in the assessments reported in the current investigation; however, each was assessed and treated prior to discharge. Data were collected for Tyrone on the frequency of hand mouthing (defined as insertion of any part of the hand past the plane of the lips) and the duration of appropriate stimulus interaction (as defined for Betsy and Brad). Frequency measures (dangerous behavior, saliva play, and hand mouthing) were converted to responses per minute by dividing the number of responses by the number of minutes in the session. The total duration of interaction was scored for each stimulus. Duration of interaction was converted to percentage of intervals by dividing the number of intervals in which the behavior occurred at any point in the interval by the total number of intervals in the session multiplied by 100%.

During all assessments, observers scored participants' target responses on laptop computers. Each session was partitioned into 10-s intervals for the calculation of interobserver agreement coefficients. Two observers simultaneously but independently recorded participant responses during 73%, 50%, and 38% of functional analysis sessions, 71%, 62%, and 36% of preference assessment sessions, and 100%, 39%, and 43% of evaluation of matched and unmatched stimuli sessions for Betsy, Brad, and Tyrone, respectively. Interval-by-interval agreement coefficients were calculated by dividing the smaller number of recorded events by the larger number for each interval. These quotients were then summed across intervals in the session, divided by the total number of intervals in the session, and multiplied by 100%. Interval agreement coefficients for the functional analysis were 98%, 93%, and 87% for Betsy, Brad, and Tyrone, respectively. Interval agreement coefficients for the preference assessments were 99%, 95%, and 85% for aberrant behavior and 94%, 98%, and 86% for stimulus interaction for Betsy, Brad, and Tyrone, respectively. Interval agreement coefficients during the evaluation of matched and unmatched stimuli were 97%, 97%, and 89% for aberrant behavior and 95%, 93%, and 98% for stimulus interaction for Betsy, Brad, and Tyrone, respectively.

Study 1: Functional Analysis

A functional analysis was conducted with each participant using procedures similar to those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). Sessions were 10 min in duration and were conducted in rooms (3 m by 3 m) equipped with one-way mirrors. Demand, social atten-

tion, toy play, tangible (Betsy and Brad only), and alone conditions were alternated in a multielement design. In addition, an extended alone phase was conducted with Tyrone immediately following completion of the functional analysis to determine if Tyrone's aberrant behavior would persist for an extended period in the absence of social consequences.

The room contained a table and three chairs for Betsy's sessions to allow her the opportunity to engage in dangerous behavior. The room also contained numerous mats to prevent injury, which never occurred.

In the social attention condition, a therapist was seated in the room with the participant. Each participant was provided with toys. The therapist engaged in an activity (e.g., reading a magazine) and provided the participant with brief verbal attention (e.g., "Don't do that") following occurrences of aberrant behavior. In the demand condition, a therapist delivered instructions to complete academic and prevocational tasks using a three-step graduated prompting sequence (verbal, gestural, and physical prompts). Compliance following verbal or gestural prompts resulted in the delivery of verbal praise (e.g., "You did a great job"). Aberrant behavior resulted in a 30-s break (i.e., escape) from the task. Prior to the onset of the tangible condition, the participant was provided access to preferred stimuli for 2 min. The preferred stimuli were removed at the onset of the session. Occurrences of aberrant behavior resulted in delivery of the stimuli for 30 s. In the alone condition, the participant was alone in the room. In the toy play condition, a therapist was seated in the room with the participant. Toys were available to the participant, and the therapist provided verbal (e.g., "You're doing a nice job playing with your toys") and physical (e.g., pats on the back) attention to the participant every 30 s immediately following the first 5-s interval in which aberrant behavior did not occur. Otherwise, all occurrences of aberrant behavior were ignored. During Betsy's functional analysis, consequences were manipulated for all inappropriate behaviors (i.e., dangerous behavior, aggression, disruption, and SIB). Consequences during the functional analysis were manipulated only for saliva play for Brad and for hand mouthing for Tyrone.

Results

Results of the functional analyses for Betsy, Brad, and Tyrone are depicted in Figure 1. Because Betsy's dangerous behavior was the focus of the current investigation, her graph depicts dangerous behavior only. Betsy engaged in the highest rate of aberrant behavior in the alone condition ($M = 5.0$). Rates of dangerous behavior were lower during all other conditions ($M = 0.1$, social attention; $M = 0$, toy play; $M = 0.1$, demand; and $M = 0.2$, tangible). These results suggested that Betsy's dangerous behavior was maintained by automatic reinforcement because the behavior persisted in the alone condition in the absence of any social consequences. Rates of saliva play for Brad were elevated across all conditions ($M = 5.0$, alone; $M = 1.4$, social attention; $M = 3.4$, toy play; $M = 4.9$, demand; and $M = 5.7$, tangible), suggesting that Brad's saliva play was maintained by automatic reinforcement. Tyrone also exhibited high rates of hand mouthing across all conditions ($M = 20.0$, alone; $M = 20.8$, social attention; $M = 13.3$, toy play; and $M = 18.2$, demand) and it was maintained at high levels in the extended alone condition, suggesting that his hand mouthing was maintained by automatic reinforcement.

Study 2: Preference Assessment

Stimulus preference assessments were conducted with each participant using the procedures described by Piazza, Fisher, Hanley,

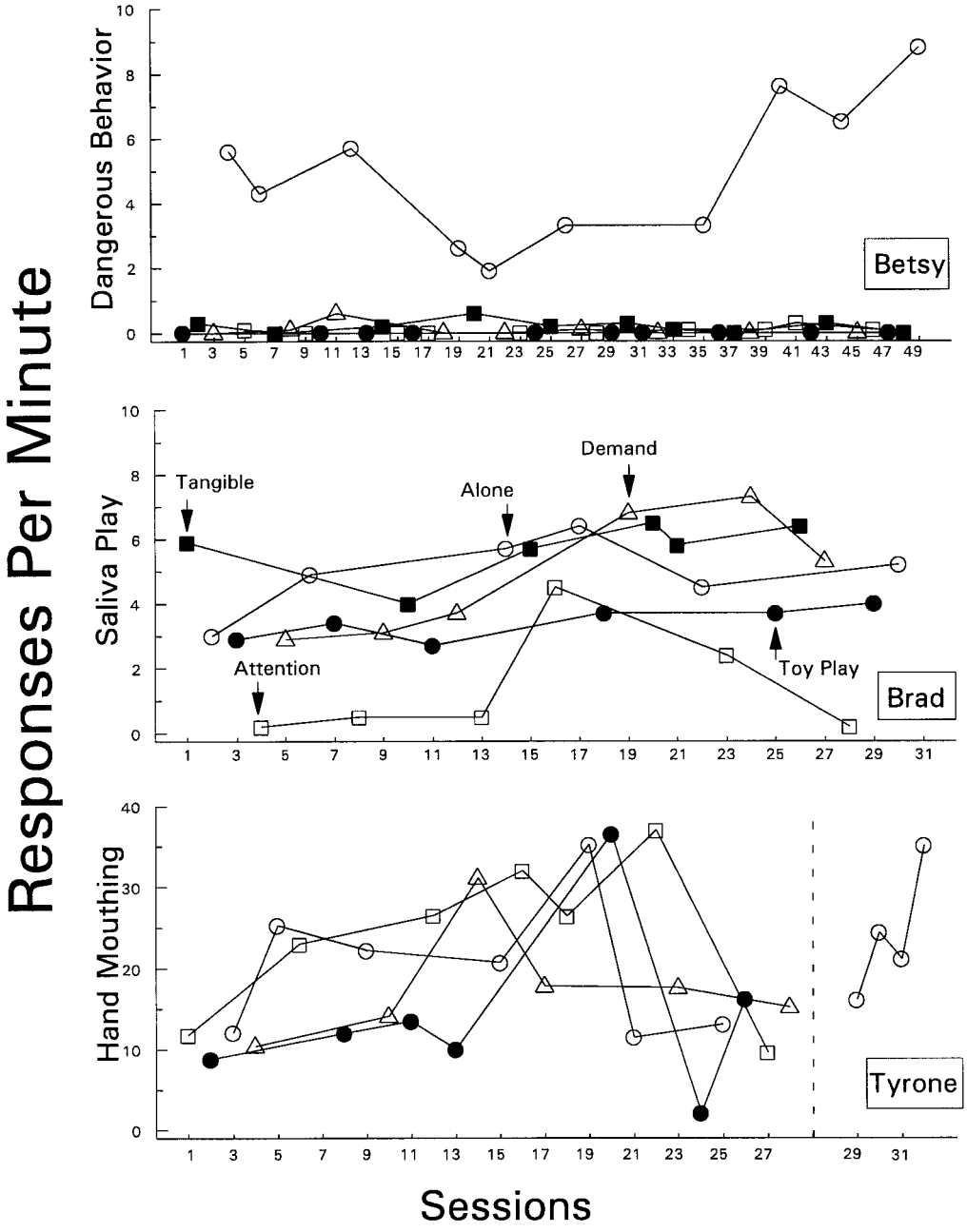

Figure 1. Aberrant behaviors per minute during the analogue functional analyses for Betsy (top panel), Brad (middle panel), and Tyrone (bottom panel).

Hilker, and Derby (1996). Items included in the preference assessment were selected based on the extent to which they matched or did not match the hypothesized sensory consequences of the participants' aberrant behavior. A list of matched items was produced by the experimenters, and a description of those items is available upon request.

Matched items were defined as stimuli that appeared to provide the same or similar sensory consequences as the aberrant behavior. We hypothesized that kinesthetic stim-

ulation was the reinforcing consequence of Betsy's dangerous behavior. Therefore, selected matched items appeared to provide kinesthetic consequences from jumping or bouncing (e.g., green ball) or from side-to-side or circular movement (e.g., rocking dinosaur). We hypothesized that the manipulation of a viscous substance on a smooth surface was the reinforcing consequence of Brad's saliva play; therefore, we selected matched items that appeared to produce similar sensory consequences (e.g., placing shaving cream on a mirror). We hypothesized that Tyrone's hand mouthing produced mouth stimulation, hand stimulation, or both (Goh et al., 1995). Therefore, matched items produced stimulation to the mouth (e.g., Twizzlers®) or to the hand (e.g., hand massager).

Unmatched items were those that provided sensory consequences (e.g., a radio provides auditory stimulation), but the sensory consequences were not similar to the hypothesized sensory consequences of the aberrant behavior. Unmatched items were selected based on parent nomination via the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) or through direct observation of the participants' preferences on the living unit. Control sessions in which no stimuli were available were conducted with Betsy and Tyrone to serve as a baseline from which to compare levels of aberrant behavior relative to when matched and unmatched stimuli were available. No control sessions were conducted with Brad due to a miscommunication among therapists.

The number of matched and unmatched stimuli evaluated for each client varied, depending on (a) the number of items that could be identified that appeared to match the hypothesized sensory consequences of the behavior, (b) the number of items generated via the RAISD, and (c) the extent to which items could be identified based on direct observation of participant behavior. Six matched and six unmatched stimuli were evaluated for Betsy, nine matched and 13 unmatched stimuli were evaluated for Brad, and 16 matched and nine unmatched stimuli were evaluated for Tyrone. Prior to the onset of the session, each participant sampled the item being presented. Sampling consisted of giving the item to the participant and activating the item when necessary (e.g., turning on a radio). One item was presented in each session. The order of item presentation was determined randomly. Each item was presented three times for Tyrone and Brad and once for Betsy. The room contained a table and three chairs during Betsy's session to allow her to engage in dangerous behavior; however, a therapist was not present. The room also contained numerous mats on the floor to prevent injury, which never occurred. During each session, Brad was alone in the room with the item. A therapist was in the room with Tyrone. The stimulus was placed in the middle of the room such that Betsy and Brad could interact with the stimulus at any time and in any manner. Sessions were 5 min in length for Betsy and 2 min for Brad and Tyrone.

Stimulus presentation procedures were modified for Tyrone such that he could interact with each stimulus in only one sensory modality. We arranged the method of stimulus presentation such that we were able to prevent multiple modes of interaction without the use of blocking. For example, when the strobe light was presented, we allowed Tyrone to look at it but not to touch it by holding it out of his reach. When the hand massager was presented, we allowed Tyrone to hold it but not put it in his mouth by attaching the massager to a string that prevented Tyrone from placing the massager in his mouth. We wanted to isolate the type of sensory stimulation (e.g., visual, auditory) that most effectively competed with Tyrone's hand mouthing. We hypothesized that al-

lowing Tyrone to interact with stimuli through only one sensory modality might help us to better identify the specific property of hand mouthing that was reinforcing (e.g., stimulation to the hand vs. stimulation to the mouth). For example, if we allowed Tyrone to hold and to mouth an object, it would be difficult to determine whether the preferred aspect of the item was stimulation to his hand or stimulation to his mouth.

Results

The results of the preference assessment for Betsy, Brad, and Tyrone are depicted in Figure 2. Stimuli are ordered based on the associated rates of aberrant behavior (lowest to highest) except that the control condition (no stimulus present) for Betsy and Tyrone appears as the first bar.

In general, items associated with the lowest levels of aberrant behavior and the highest levels of interaction were selected from each category for the subsequent evaluation of matched and unmatched stimuli. The matched items selected for Betsy were the green ball, the air mattress, and the balance board. The unmatched items were the turtle, the teddy bear, and the blocks. Across all selected matched stimuli, mean rate of aberrant behavior was zero and mean level of interaction was 77%. Across all selected unmatched stimuli, mean rate of aberrant behavior was 0.13 and mean level of interaction was 46%.

The selected matched items for Brad were the shaving cream, the shampoo, and the bubble soap. We selected shampoo because it was associated with lower levels of saliva play even though it was less preferred than the lotion or the jelly. The unmatched items were the plastic toys, the toy car, and the plastic ball. Across all selected matched stimuli, mean rate of aberrant behavior was 0.9 and mean level of interaction was 76%. Across all selected unmatched stimuli, mean rate of aberrant behavior was 2.7 and mean level of interaction was 70%.

The selected matched oral items for Tyrone were the Tootsie Roll®, Twizzler®, Bit O' Honey®, and the mouth guard. The matched tactile items were water play, hand massager, ice pack, and heating pad. The unmatched items for Tyrone were the pinwheel, bubbles, the top, and the strobe light. We selected the top and the strobe light instead of the television because they were associated with higher levels of interaction even though they were associated with higher levels of hand mouthing and they were more portable than the television. Across all selected matched oral stimuli, mean rate of aberrant behavior was 8.5 and mean level of interaction was 57%. Across all selected matched tactile stimuli, mean rate of aberrant behavior was 20.5 and mean level of interaction was 23.6%. Across all selected unmatched stimuli, mean rate of aberrant behavior was 34 and mean level of interaction was 75.3%.

Results for each participant suggested that items that appeared to match the hypothesized sensory consequences of aberrant behavior were associated with lower levels of aberrant behavior during the preference assessment sessions relative to the levels of aberrant behavior associated with unmatched stimuli. However, these sessions were brief (2 to 5 min), and some participants showed preferences for unmatched stimuli (e.g., the strobe light for Tyrone). Therefore, in the next study, we evaluated the extent to which matched and unmatched stimuli would effectively reduce aberrant behavior during sessions conducted over a longer period.

Study 3: Evaluation of Matched and Unmatched Stimuli

The effects of matched and unmatched stimuli on aberrant behavior were evaluated using a multielement design for Betsy and a combination of reversal (ABAB) and multi-

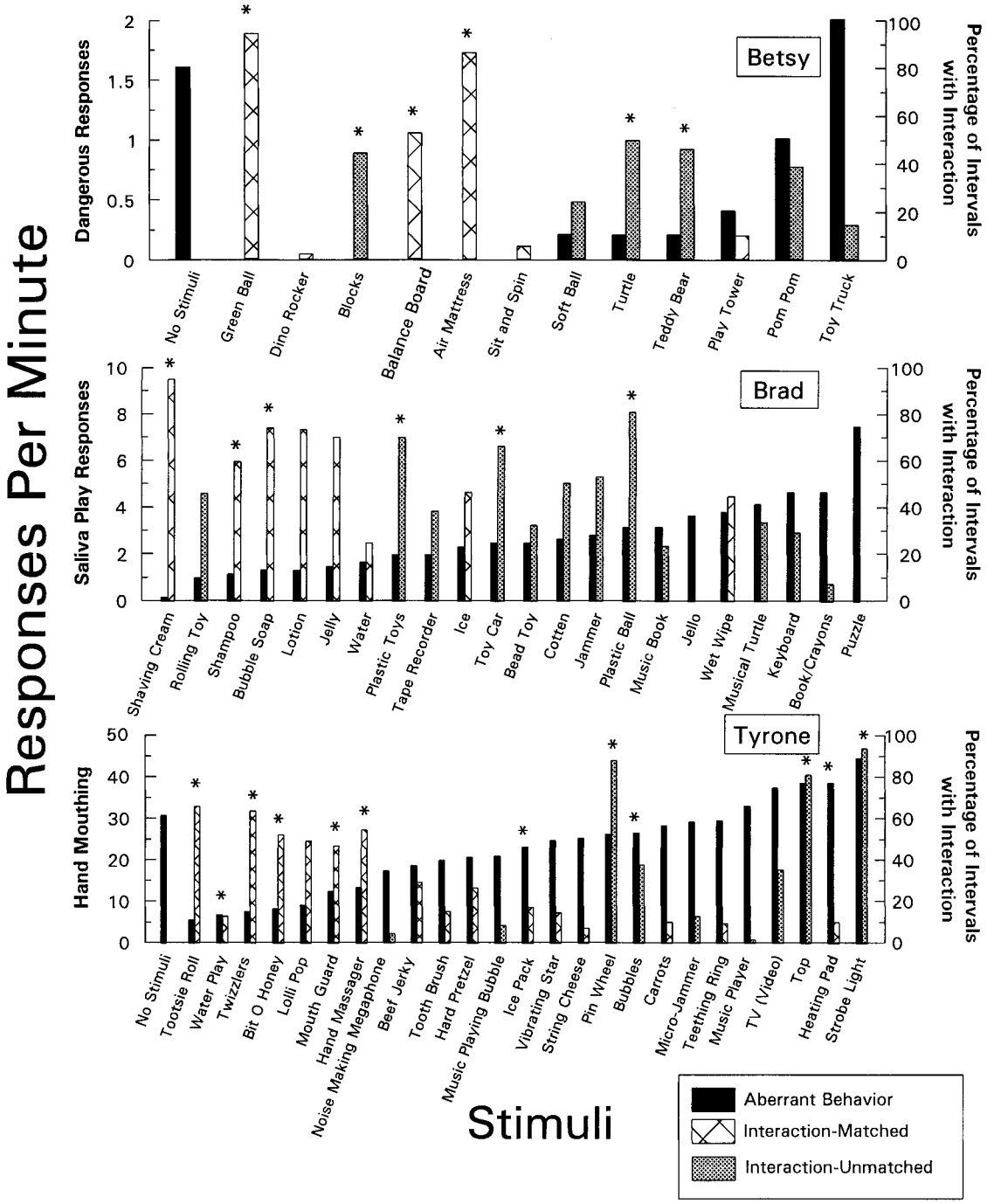

Figure 2. Aberrant behaviors per minute (solid bars), duration of item interaction with matched stimuli (hatched bars), and duration of item interaction with unmatched stimuli (dotted gray bars) during the stimulus preference assessments for Betsy (top panel), Brad (middle panel), and Tyrone (bottom panel). The items denoted with asterisks were used in the evaluation of matched and unmatched stimuli.

element designs for Brad and Tyrone, in which the baseline phase (A) was followed by a comparison of matched and unmatched stimuli conditions (B). During all sessions for Betsy, the room contained three chairs and a table. The room also contained numerous mats on the floor to prevent injury, which never occurred. During all sessions for Tyrone, a therapist was in the room. Sessions were 10 min in duration for all participants.

During the baseline condition, Betsy was in the room with the table and chairs, Brad was alone in the room, and Tyrone was in the room with the therapist who did not interact with him. The matched condition was identical to baseline except that matched stimuli were continuously and noncontingently available. A mirror was available for Brad during matched stimuli sessions. The unmatched condition was identical to baseline except that unmatched stimuli were continuously and noncontingently available. During the matched condition for Tyrone, stimulus interaction was restricted to one mode of interaction (i.e., either oral or manual manipulation), as described in the preference assessment. Across all conditions, no programmed social consequences were provided for Tyrone's hand mouthing.

Results

The results of Study 3 are presented in Figure 3. The mean rates of dangerous behavior for Betsy during the baseline, unmatched, and matched conditions were 2.7, 1.2, and 0.03, respectively. The mean rates of saliva play for Brad during the baseline, unmatched, and matched conditions were 6.3, 3.9, and 0.3, respectively. The mean rates of hand mouthing for Tyrone during baseline, unmatched, matched tactile, and matched oral conditions were 26.4, 22.6, 5.5, and 2.5, respectively. Stimuli categorized as matched were associated with the lowest rates of aberrant behavior for all participants. Both the matched oral and matched tactile stimuli were associated with lower levels of hand mouthing for Tyrone; however, oral stimuli were associated with lower levels of hand mouthing than tactile stimuli.

DISCUSSION

These results extend the literature on the treatment of automatically reinforced behavior in several important ways. First, even though previous studies (e.g., Favell et al., 1982; Rincover, Cook, Peoples, & Packard, 1979) have shown that putatively matched stimuli were associated with lower levels of aberrant behavior, those studies were conducted without the benefit of pretreatment functional analyses. Therefore, the role of social reinforcement was not ruled out as a contributing variable to behavior maintenance. Thus, it is unclear whether reductions in aberrant behavior were a function of sensory match or competition with social reinforcement. In the current investigation, pretreatment functional analyses conducted with each of the participants suggested that aberrant behavior was maintained by automatic reinforcement. Thus, the effects of matched stimuli appeared to be a function of the sensory properties rather than the social properties of the stimuli.

Second, the results of the current investigation highlight the potential importance of selecting stimuli based on the results of systematic preference assessments. That is, the results of the preference assessments showed that not all matched stimuli were equally preferred, suggesting that some matched stimuli would be more effective in reducing aberrant behavior than other matched stimuli. Thus, arbitrary selection of stimuli may not result in the identification of the most highly preferred or most effective stimuli for use in treatment.

In addition, Tyrone's data showed that different types of sensory consequences may

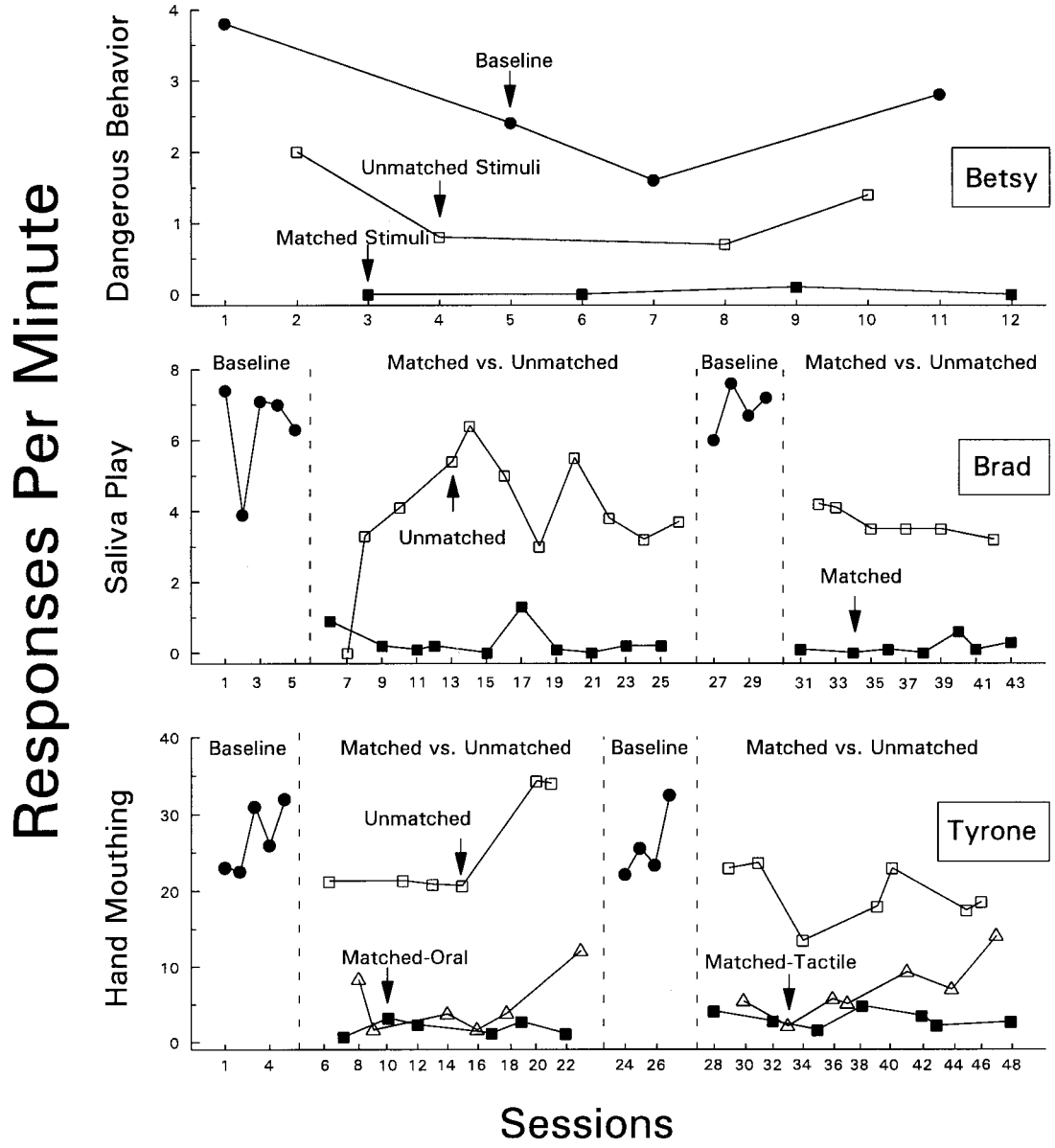

Figure 3. Aberrant behaviors per minute during the assessment of matched and unmatched stimuli for Betsy (top panel), Brad (middle panel), and Tyrone (bottom panel).

differentially affect aberrant behavior. Providing Tyrone with access to matched tactile stimulation reduced levels of hand mouthing below baseline, suggesting that tactile stimulation may have contributed to the maintenance of hand mouthing. However, matched oral items were associated with even greater reductions in hand mouthing, suggesting that oral stimulation was the more important sensory consequence that contributed to the maintenance of hand mouthing. Similarly, Piazza et al. (1998) used the results of a preference and treatment evaluation to determine that firmness was the important attribute of oral stimuli that contributed to the maintenance of the

pica of 2 participants. These results suggest that treatment outcomes may be enhanced not only by identifying the broad class of sensory consequences (e.g., tactile stimulation) that is important to the maintenance of aberrant behavior but also by identifying the specific dimension of sensory stimulation (e.g., tactile stimulation with vibrating objects) that maintains aberrant behavior.

Third, even though several studies (e.g., Favell et al., 1982; Rincover et al., 1979) have shown that providing participants with access to stimuli that matched the hypothesized sensory consequences of aberrant behavior can produce reductions in such behavior, few studies have compared the effects of matched and unmatched stimuli directly. Fisher et al. (1998) compared matched and unmatched stimuli for 1 participant; however no data were presented on the relative preferences of the participant for matched and unmatched stimuli. In addition, data were not presented on the relative competition between preferred stimuli and aberrant behavior. Piazza et al. (1998) showed that matched stimuli were associated with lower levels of aberrant behavior than unmatched stimuli for 2 of 3 participants. However, the Piazza et al. study was limited to individuals who engaged in pica. In the current investigation we extended the work of Piazza et al. beyond oral stimulation and pica by showing that (a) the preference assessment described by Piazza et al. (1996) could be used to identify matched and unmatched stimuli for three dissimilar topographies of aberrant behavior, (b) the preference assessment accurately predicted the effects of matched and unmatched stimuli for all three aberrant behaviors, and (c) matched stimuli were more effective than unmatched stimuli in reducing aberrant behavior other than pica.

In the current investigation, we integrated the results of the functional analysis with observations of the structural characteristics of the behavior in order to develop treatment. A number of studies have shown that the effects of treatment for aberrant behavior are improved when treatment is based on the results of a functional analysis. By contrast, structural approaches (e.g., ones focused on a diagnosis or description of the problem) to treatment of aberrant behavior have not been demonstrated to be consistently effective. However, when the results of the functional analysis suggest that behavior is maintained by automatic reinforcement, identification of the structural characteristics of the behavior may be helpful in treatment development. In the current investigation, we generated hypotheses about the specific source of automatic reinforcement by observing the structural characteristics of the behavior. We then integrated the results of the functional analysis and the structural observations to develop treatment components for a variety of topographies of aberrant behaviors (climbing, saliva play, and hand mouthing).

There are several reasons why matched stimuli may be effective in reducing behaviors maintained by automatic reinforcement. Matched stimuli may function as an establishing operation. An establishing operation is a stimulus that alters the effectiveness of reinforcement (Michael, 1982). Presumably, matched stimuli provide the same or similar consequences as those produced by aberrant behavior. Thus, motivation to obtain reinforcement via aberrant behavior may be reduced when reinforcement is freely available via the matched stimuli. By contrast, the establishing operation (deprivation from automatic reinforcement derived from aberrant behavior) continues to be present when the individual has access to unmatched stimuli that do not provide reinforcement similar to the reinforcement produced by aberrant behavior.

The effectiveness of matched stimuli may be a function of preference rather than sen-

sory match. The results of studies on environmental enrichment show that highly preferred stimuli that do not necessarily match the sensory consequences of aberrant behavior can produce reductions in aberrant behavior (Vollmer et al., 1994). Presumably, the reinforcer that maintains aberrant behavior is highly effective and highly preferred; thus, it may be difficult to identify stimuli that are more highly preferred than stimuli that produce the same or similar consequences as those produced by aberrant behavior. In the current investigation, we evaluated a number of stimuli for all participants in an attempt to identify highly preferred matched and unmatched stimuli. Matched stimuli were more highly preferred than unmatched stimuli for Betsy. For Brad, matched stimuli were generally more highly preferred than unmatched stimuli with the exception of the plastic ball, which was ranked second on the preference assessment. By contrast, the most highly preferred stimuli for Tyrone were all unmatched stimuli. It may be worth noting that there were some inconsistencies in the manner in which stimuli were selected for the evaluation of matched and unmatched stimuli. In general, we attempted to identify the most highly preferred stimuli that also were associated with the lowest rates of aberrant behavior. For Brad, we selected the shampoo rather than the lotion or jelly because the shampoo was associated with lower levels of aberrant behavior. For Tyrone, we selected the strobe light and the top rather than the television due to issues of portability. It is possible that for Tyrone, we biased the analysis in favor of the matched stimuli because the strobe light and top were associated with higher levels of aberrant behavior than the television. However, the results for matched and unmatched stimuli were consistent across participants, suggesting that sensory match rather than preference was the important component of the stimuli. Future investigations should focus on comparing the effects of equally preferred matched and unmatched stimuli on aberrant behavior to determine if sensory match or preference plays a greater role in treatment outcome.

An advantage of using noncontingent access to matched stimuli is that the treatments were fairly easy to implement and required minimal effort on the parts of caregivers. In fact, treatment for 2 of the participants consisted of giving them stimuli that they could manipulate when alone. These results are important because some behavior problems pose their greatest risk to the individual when the behavior occurs while the individual is unsupervised (Piazza et al., 1998). For example, the functional analysis results for Betsy showed that she engaged in dangerous behavior primarily when she was left unattended. One potential treatment, therefore, would have been to provide Betsy with careful supervision. However, providing an individual with continuous, uninterrupted supervision may be unrealistic for some caregivers, and in fact, increasing independent play is an important and appropriate goal. The results of the current investigation suggest that identification of highly preferred matched stimuli may provide an alternative to interventions that require constant supervision on the part of caregivers.

A disadvantage of matched stimuli is that the identified stimuli may result in less socially typical or acceptable forms of play. For example, Brad's matched stimuli consisted of pouring or spraying a substance (e.g., shaving cream) on a mirror and manipulating it with his hand. Of the 3 participants, Brad's matched stimuli resulted in less socially typical forms of play. Nevertheless, Brad's caregivers indicated that the matched stimuli were more acceptable and were associated with fewer health risks than his saliva play. By contrast, matched stimuli for Tyrone and Betsy involved more socially typical behaviors (i.e., eating edible items or interacting

with a hand massager, an ice pack, water play, and a heating pad for Tyrone and playing with a variety of toys such as a green ball, a Sit and Spin®, and a rocking dinosaur for Betsy). It is worth noting that the information derived from the current investigation was only one part of a more comprehensive treatment package that addressed the participants' behavioral challenges. However, in cases in which matched stimuli result in less socially acceptable forms of behavior, it may be important to identify ways to use the information from the evaluation of matched and unmatched stimuli to develop more socially acceptable treatments (e.g., using matched stimuli to increase more appropriate play).

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STUDY QUESTIONS

1. What are the main difficulties in developing treatments for problem behavior maintained by automatic reinforcement?

2. Construct a table depicting topographies of problem behavior targeted for each participant, the hypothesized source of stimulation (putative reinforcer), and the specific matched and unmatched stimuli whose effects were evaluated.

3. Describe the two different response patterns observed during the functional analyses. Why are these diffferent patterns consistent with the interpretation that participants' problem behaviors were maintained by automatic reinforcement?

4. What modifications were made to Tyrone's preference assessment? Why were these modifications made?

5. Briefly describe the results of the treatment evaluation for all participants. What did Tyrone's results suggest about the source of stimulation that maintained his aberrant behavior?

6. Why might an analysis of response topography be more helpful in assessing behavior maintained by automatic reinforcement than in assessing behavior maintained by social reinforcement?

7. What reasons do the authors provide for the superiority of the matched stimulus conditions?

8. What are some advantages and disadvantages associated with the treatment approach used in this study?

Questions prepared by Eileen Roscoe and April Worsdell, The University of Florida

SQAB

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Annual Meeting, May 26–27, 2000

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Friday, May 26, *Room Wilson A/B*

Gene Fisch, *Yale University,* Evaluating Data from Behavioral Analysis: Visual Inspection or Statistical Models? (Early Bird Breakfast Tutorial)

William Uttal, *Arizona State University,* Some Questions Concerning the Accessibility, Analyzability, and Reducibility of Cognitive Processes

Allan Stubbs, *The University of Maine,* Graphs, Tables, and Equations, Data Practices in Psychology and Other Areas

William Timberlake, *Indiana University,* Biology and Behavior, Some Thoughts on Integration

M.E. Bitterman, *University of Hawaii,* Classical conditioning (procedure and process) in retrospect

Ben Williams, *University of California at San Diego,* The critical dimensions of the response-reinforcer contingency

Donald Blough, *Brown University of Utah,* Historical, theoretical, and cultural perspectives on 'choice behavior'

Charles Shimp, *The University of Utah,* Historical, theoretical, and cultural perspecives on 'choice behavior'

Edmund Fantino, *University of California at San Diego,* Choice and Foraging, "It's the Context, Stupid"

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Saturday Morning, May 27, *Room Wilson A/B*

Gene Fisch, *Yale University,* Evaluating Data from Behavioral Analysis, Visual Inspection or Statisical Models? (Early Bird Breakfast Tutorial)

Thomas Zentall, *University of Kentucky,* Animal cognition: Emergent relations or representations?

Russell Church, *Brown University,* Animal cognition, 1900–2000

Peter Killeen, *Arizona State University,* Sigma sub n=1938 sup n=2000

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Invited Preeminent Tutorials

Saturday Afternoon, May 27, *Room Wilson A/B*

			Chair
G. Burghardt	*University of Tennessee*	Evolution, Behavioral Variation and Plasticity	*W. Timberlake*
Peter Balsam	*Columbia University*	Pavlovian Conditioning	*M.E. Bitterman*
Jennifer Higa	*Texas Christian University*	Timing	*Peter Killeen*
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