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TREATMENT OF PICA THROUGH MULTIPLE ANALYSES OF ITS REINFORCING FUNCTIONS

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We conducted functional analyses of the pica of 3 participants. The pica of 1 participant appeared to be maintained by automatic reinforcement; that of the other 2 participants appeared to be multiply controlled by social and automatic reinforcement. Subsequent preference and treatment analyses were used to identify stimuli that would compete with the automatic function of pica for the 3 participants. These analyses also identified the specific aspect of oral stimulation that served as automatic reinforcement for 2 of the participants. In addition, functional analysis-based treatments were used to address the socially motivated components of 2 of the participants' pica. Results are discussed in terms of (a) the importance of using the results of functional analyses to develop treatments for pica and (b) the advantages of developing indirect analyses to identify specific sources of reinforcement for automatically reinforced behavior.

DESCRIPTORS: automatic reinforcement, pica, multiply controlled behavior, preference assessments, functional analysis

Pica, the ingestion of nonedible substances, is a significant problem for individuals with developmental disabilities. Danford and Huber (1982) reported that 25.8% of persons with mental retardation residing in an institution engaged in pica. Pica has been described as a treatment-resistant behavior that may result in a variety of medical risks including intestinal blockage, parasitic infection, surgery to remove objects from the stomach, lead and other types of poisoning, and even death (Fisher et al., 1994; Foxx & Martin, 1975; Moncrieff et al., 1964). In fact, the risk for death associated with pica may be higher than that for other forms of self-injurious behavior (Foxx & Livesay, 1984; McLoughlin, 1988).

The most commonly investigated treatments for pica have relied on default strategies involving arbitrary reinforcers and punishers (Donnelly & Olczak, 1990; Paisey & Whitney, 1989); however, these procedures have not been demonstrated to be consistently effective (e.g., Bucher, Reykdal, & Albin, 1976). Few studies have included treatment based on the results of systematic behavioral assessments. Two notable exceptions are studies by Fisher et al. (1994) and Mace and Knight (1986). Fisher et al. (1994) reduced the pica of 3 children to near-zero levels using results of a behavioral assessment called empirically derived consequences, in which reinforcers and punishers were empirically derived and used to develop treatment.

Mace and Knight (1986) showed that the amount of available social interaction affected the rates of pica for 1 client: High levels of social interaction were associated with lower levels of pica, and lower levels of social interaction were associated with higher levels of pica. Results of this assessment were used to implement a treatment in which the client was provided with levels of social interaction associated with lower rates of pica.

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Functional analysis (i.e., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) is another form of behavioral assessment that has been used to assess and treat a variety of behaviors such as self-injury (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993), aggression (Fisher et al., 1993; Piazza et al., 1997), tantrums (Carr & Newsom, 1985), and bizarre speech (Mace & Lalli, 1991). Few investigators have applied the functional analysis method to the assessment and treatment of pica. Chapman, Fisher, Piazza, and Kurtz (1993) conducted a functional analysis of life-threatening pill consumption in a dually diagnosed youth and found that pill consumption was maintained by escape from work activities. Treatment consisted of providing the participant with preferred nonwork activities contingent upon completion of scheduled work activities or for turning in pills he found. The consequence for pill consumption was completion of a nonpreferred work activity. This treatment reduced pica to zero.

Piazza, Hanley, and Fisher (1996) conducted a functional analysis with a young man who engaged in cigarette pica. Results indicated that cigarette pica persisted in the absence of social consequences. Piazza et al. hypothesized that the effects of nicotine served as the source of automatic reinforcement for cigarette consumption and provided additional support for this hypothesis through indirect analyses. The individual's cigarette pica was maintained in a condition in which cigarettes contained tobacco with nicotine but was not maintained when cigarettes contained herbs without nicotine. In addition, results of a stimulus preference assessment showed that tobacco was the preferred component of the cigarette relative to other components (e.g., paper, filters). Treatment consisted of interrupting the response–reinforcer relation (i.e., elimination of the effects of nicotine by blocking cigarette pica).

When a response persists in the absence of social consequences and is presumed to be maintained by automatic reinforcement, the reinforcer (e.g., oral stimulation) is often difficult or impossible to separate from the response (e.g., pica) that produces it (Vollmer, 1994). In these cases, indirect methods of assessment may be helpful in identifying stimuli that produce automatic reinforcement by (a) providing supporting evidence for the hypothesis and (b) eliminating competing hypotheses. For example, Piazza, Hanley, and Fisher (1996) used indirect methods (e.g., preference assessment) that supported the conclusion that nicotine was the source of reinforcement for cigarette pica. Similarly, Kennedy and Souza (1995) used indirect methods with a client whose eye poking was hypothesized to be maintained by the visual stimulation it produced. They showed that (a) eye poking was not maintained by social consequences; (b) application of goggles reduced eye poking, presumably because it eliminated the response–reinforcer relation; and (c) providing visual (but not auditory) stimulation significantly reduced eye poking, presumably because this alternative source of visual reinforcement lowered motivation to eye poke. Favell, McGimsey, and Schell (1982) showed that providing mouthing objects (rubber toys) or popcorn resulted in reduction of pica with 3 clients. Favell et al. hypothesized that pica was reduced because alternative sources of oral stimulation were provided to the clients. Finally, Goh et al. (1995) found that the hand mouthing of 10 of 12 participants was maintained by automatic reinforcement. They then showed that hand stimulation was preferred over mouth stimulation for the 4 participants whose preferences were evaluated. Thus, results of these investigations showed that indirect assessment findings may be useful in identifying the sources of reinforcement for behaviors that are maintained independent of social consequences.

The purpose of this investigation was to

identify the operant function of the pica of 3 clients and to determine whether functional analysis–based treatments would be effective in reducing pica that was socially maintained. In cases in which pica was maintained independent of the social environment, indirect assessments were conducted to determine whether (a) stimuli that would compete with pica could be identified and (b) the sensory reinforcement that resulted from pica could be identified.

Study 1 consisted of a functional analysis of each participant's pica and was designed to determine whether this behavior (a) was maintained by social consequences or (b) persisted independent of social contingencies and was potentially maintained by automatic reinforcement. Study 2 was an evaluation of an intervention (noncontingent reinforcement) that was designed to treat socially maintained pica for the participant (Tad) whose behavior appeared to be maintained solely by social reinforcement based on the results of Study 1. Because this treatment was not completely successful, we then conducted a series of alone sessions to determine whether his pica persisted in the absence of social consequences.

Study 3 consisted of a preference assessment and a treatment evaluation. The preference assessment was designed (a) to assess whether stimuli that provided oral stimulation (the hypothesized reinforcer for pica) were preferred over stimuli that did not produce oral stimulation, and (b) to evaluate whether treatments based on the hypothesized source of reinforcement of pica (oral stimulation) were more effective than treatments that were not. Study 4 more systematically evaluated the specific aspects of oral stimulation (e.g., taste vs. texture) that contributed to the maintenance of pica for 2 participants (Mary and Brandy) and consisted of a preference assessment and a treatment evaluation. Finally, Study 5 was an evaluation of interventions (noncontingent reinforcement with tangible items and attention) designed to treat socially maintained pica for the participant (Brandy) whose behavior appeared to be maintained by both automatic and social reinforcement based on the results of Study 1.

METHOD

Participants

The 3 participants were admitted to an inpatient unit for the assessment and treatment of pica. Mary was a 4-year-old girl with profound mental retardation, congenital heart defects, and pulmonary disease who required constant oxygen. Mary was ambulatory and nonverbal, and typically did not respond to simple one-step instructions. Prior to admission, Mary had undergone two hospitalizations to remove objects from her stomach and esophagus. Her typical pica items included furniture, clothing, her oxygen tube, string, and hair. Brandy was a 17-year-old girl who had been diagnosed with severe mental retardation, autism, and Cornelia de Lange syndrome. Brandy was ambulatory and communicated using three signs ("please," "eat," "drink"). Prior to admission, Brandy had undergone five hospitalizations to remove objects from her stomach and esophagus. Her typical pica items included keys, rocks, plastic game pieces, crayons, and coins. Tad was a 5-year-old boy who had been diagnosed with autism, attention deficit hyperactivity disorder, moderate mental retardation, and severe esophagitis. He was ambulatory, could follow one-step instructions, and communicated using one sign. Caregivers reported that Tad's stool frequently contained cloth, paper, pieces of toys, twigs, and rocks. On one occasion, Tad's mother discovered him in the backyard eating a dead squirrel.

Study 1: Functional Analysis

Data Collection and Interobserver Agreement

During all functional analysis sessions, trained observers used laptop computers to record the frequency of pica for all participants. Pica was defined as placing one of the baited items (see below) or any other inedible object not meant to be ingested (e.g., hair, oxygen tube, clothing, carpet) past the plane of the lips. Two observers scored pica simultaneously but independently during 45%, 59%, and 56% of the sessions for Mary, Brandy, and Tad, respectively. Agreement coefficients were calculated by partitioning each session into 10-s intervals and dividing the number of exact agreements on the occurrence of behavior by the sum of agreements plus disagreements multiplied by 100%. Mean exact agreement for pica was 95% for Mary, 93% for Brandy, and 99% for Tad.

Procedure and Design

The functional analyses were conducted using a multielement design for all participants. All sessions were 10 min in duration and were conducted in a room (3 m by 3 m) with a one-way observation window. The session room was "baited" with items identified by the medical team to be safe for mouthing or consumption by the participants. The items included Velcro® strips, tape, paper, a chair cushion, and a blue plastic stick for Mary; paper, birthday candles, uncooked beans and pasta, and rice sticks for Brandy; and paper, a stuffed bear, a cloth towel, a plastic toy, and a Slinky® for Tad. Pica that was attempted with any other object (e.g., oxygen tube, extraneous nonbaited items) was blocked with minimal interaction (Mary only).

Each client was given toys and was instructed to play with them quietly in the social attention condition. Attention was provided in the form of a verbal reprimand (e.g., "Don't do that") if pica occurred. The purpose of this condition was to evaluate whether pica was reinforced by adult attention.

In the demand condition, each client was instructed to complete a series of preacademic and self-care tasks using a three-step prompting procedure consisting of sequential verbal, gestural, and physical prompts. The therapist removed the task materials and ended the instructional sequence for 30 s if pica occurred. The purpose of this condition was to evaluate whether pica was reinforced by escape from instructional sequences.

Brandy and Tad were alone in a baited room in the alone condition. Mary required a constant supply of oxygen; therefore, the therapist remained in a corner of the room during the ignore condition to block pica of her oxygen tubing (i.e., to prevent her from cutting off her oxygen supply) but otherwise did not interact with her. The purpose of the alone (Brandy and Tad) and ignore (Mary) conditions was to determine whether pica was maintained in the absence of social consequences. A 30-min alone session (Brandy) and a 30-min ignore session (Mary) were conducted to observe these participants' pica under conditions in which no social consequences were available for pica over a relatively extended period of time.

In the play condition, highly preferred toys were available for each client. The therapist provided praise to Mary and Tad approximately once every 30 s following the first 5-s period in which no pica occurred. In addition, if the client approached the therapist and made eye contact with or gestured toward the therapist, the therapist responded by delivering physical or verbal attention to the client. Brandy was given continuous, noncontingent attention during the play condition. Pica resulted in no differential consequences for all participants.

A tangible condition was conducted with

Brandy because her parents reported that when she engaged in pica, they frequently offered her cola to encourage her to expel items. In the tangible sessions, Brandy received an ounce of cola contingent on the occurrence of pica.

Results and Discussion

Pica rates were roughly equivalent across all conditions of the functional analysis (social attention, $M = 2.7$ responses per minute; demand, $M = 3.0$; toy play, $M = 2.3$; ignore, $M = 2.9$) for Mary (top panel of Figure 1). These results suggested that pica might have been maintained by automatic reinforcement. An extended ignore session was conducted to test whether pica was maintained in the absence of social consequences (Vollmer, Marcus, Ringdahl, & Roane, 1995). Pica persisted at a steady rate during the extended ignore session.

Rates of pica for Brandy (middle panel of Figure 1) were highest in the tangible condition ($M = 2.8$), followed by alone ($M = 2.6$), social attention ($M = 2.4$), toy play ($M = 1.3$), and demand ($M = 0.5$). These results suggested that (a) pica was maintained by multiple sources of reinforcement (e.g., access to tangible items, adult attention, automatic reinforcement), or (b) pica was maintained by automatic reinforcement because rates of pica were highest in conditions with relatively less stimulation (tangible, social attention, alone) and lowest in conditions in which stimulation was relatively high (demand, toy play). An extended alone session was conducted in which pica was maintained. Thus, pica persisted in the absence of social consequences, which is consistent with the hypothesis that pica was maintained, at least in part, by automatic reinforcement. However, the results of Study 1 did not rule out the possibility that access to tangible items or adult attention also contributed to the maintenance of Brandy's pica.

Results of the functional analysis for Tad (bottom panel of Figure 1) showed that rates of pica were highest in the social attention condition ($M = 3.2$) and were low across all other conditions (demand, $M = 0.2$; toy play, $M = 0.2$; alone, $M = 0.4$). These results suggested that Tad engaged in pica maintained by contingent attention.

The results of Study 1 demonstrated that functional analysis may be an important tool for the assessment of pica. The results for 2 participants were consistent with an automatic reinforcement hypothesis. However, social reinforcement maintained the pica of 1 participant (Tad) and may have contributed to the maintenance of pica for another participant (Brandy), indicating that behavioral function cannot be assumed based on behavioral topography, even when the target response is pica.

Study 2: Treatment of Socially Maintained Pica (Tad)

Data Collection and Interobserver Agreement

During all sessions, trained observers used laptop computers to record the frequency of pica for Tad. Pica was defined as described above. Two observers scored pica simultaneously but independently during 40% of the sessions, and mean exact agreement for pica was 99%.

Procedure and Design

All sessions were 10 min in length and were conducted in a baited room. Baseline sessions were identical to the social attention condition of the functional analysis in which a mild verbal reprimand was provided contingent upon each occurrence of pica. The noncontingent attention (NCA) treatment consisted of continuous verbal (e.g., "Good job playing") and physical (e.g., pats on the back, tickles) attention. No differential consequences were provided for occurrences of

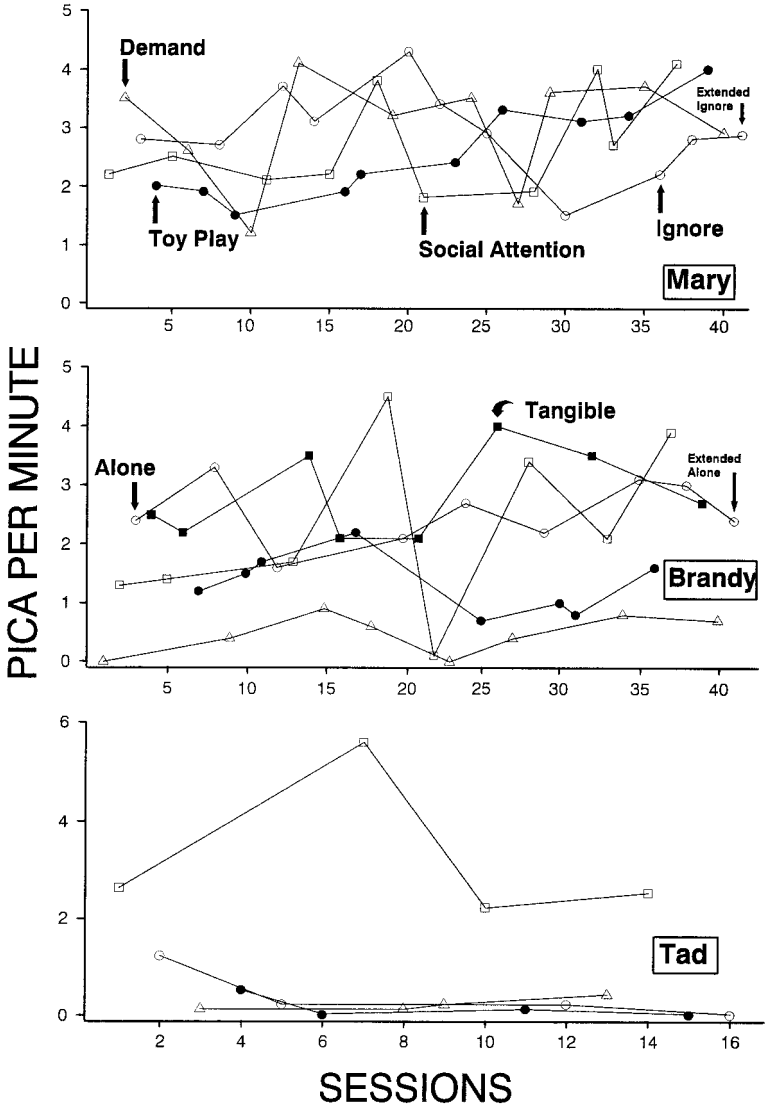

Figure 1. Pica per minute during the analogue functional analyses for Mary (top panel), Brandy (middle panel), and Tad (bottom panel).

pica. The treatment was evaluated using an ABAB design.

Results and Discussion

The results of Tad's treatment are shown in Figure 2. During baseline, rates of pica were high and variable (M = 3.2 responses per minute). When continuous, noncontingent attention was available throughout the session, rates of pica decreased (M = 0.3). During the return to baseline, pica increased (M = 2.3) and decreased again following implementation of the NCA treatment (M = 0.3).

Even though the NCA treatment reduced pica relative to baseline, Tad's rates of pica during NCA were clinically unacceptable given its severity. Therefore, we conducted several alone sessions to assess whether Tad's pica was maintained when social conse-

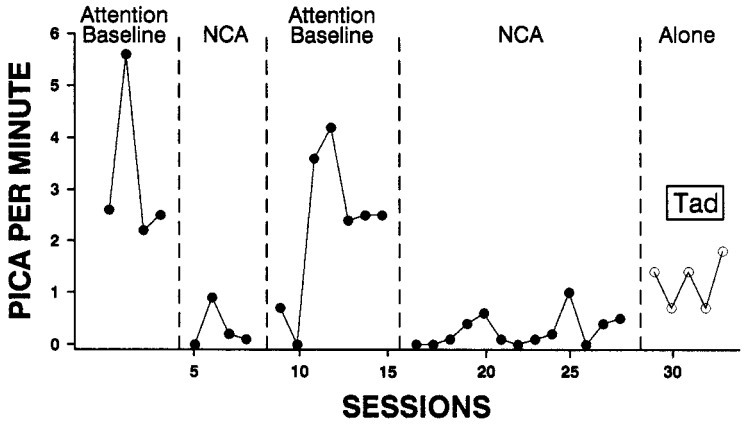

Figure 2. Pica per minute during the treatment evaluation for Tad's attention-maintained pica.

quences were absent. Pica persisted during these repeated alone sessions (M = 1.2). It is unclear why the rates of pica during these repeated alone sessions were higher than the rates observed in the alone condition of the functional analysis, but the fact that Tad's pica persisted in the absence of social consequences suggested that automatic reinforcement contributed to the maintenance of this response.

Study 3: Treatment of Pica Maintained by Automatic Reinforcement

We hypothesized that the pica displayed by the 3 participants was at least partially maintained by the oral stimulation it produced because (a) pica was maintained in the absence of social consequences, and (b) previous research has shown an inverse relation between pica and the availability of alternative forms of oral stimulation (Favell et al., 1982). Therefore, we conducted (a) a preference assessment to determine whether stimuli that produced oral stimulation (i.e., matched stimuli) were preferred over other types of stimuli (i.e., unmatched stimuli) and (b) a treatment evaluation to determine whether noncontingent access to matched stimuli reduced pica more than noncontingent access to unmatched stimuli.

Data Collection and Interobserver Agreement

Duration of item interaction or manipulation (in seconds) for all participants, duration of pica (in seconds) for Mary and Tad, and frequency of pica for Brandy were scored during the stimulus preference assessments. A frequency measure was used with Brandy because her mode of ingestion was a very rapid, distinct response, whereas Mary's and Tad's mode of ingestion often took longer and was less distinct. Pica was defined as described above (placing an inedible object past the plane of the lips). Interaction was defined individually for each item and generally included orientation toward the item, consumption of edible items, or manipulation of the object in the manner for which it was intended (Piazza, Fisher, Hanley, Hilker, & Derby, 1996). Duration of item interaction was calculated as a percentage by dividing the total duration of interaction with the stimulus by the total trial duration. Duration of pica (Mary and Tad) was calculated similarly. Because stimuli were presented more than once to Mary, percentage of trials with interaction and pica was calculated by summing the total duration of interaction or pica across all stimulus presentations and dividing by the total duration in which the stimulus was presented.

Trained observers used timers to record the duration of interaction and pica during each 30-s trial for Mary and during each 5-min trial for Tad. Two independent observers scored target behaviors simultaneously but independently during 41% and 100% of stimulus preference assessments for Mary and Tad, respectively. Agreement coefficients were calculated by dividing the smaller duration by the larger duration and multiplying by 100%. Mean agreement coefficients were 99% for interaction and 99% for pica for Mary, and 93% for interaction and 86% for pica for Tad.

Data were collected on laptop computers during each 5-min trial for Brandy. Two observers scored target behaviors (item interaction and pica) simultaneously but independently during 100% of trials for Brandy. Mean exact agreement was 81% for interaction and 98% for pica.

During subsequent treatment sessions, trained observers used laptop computers to record the frequency of pica for all participants. Two observers scored pica simultaneously but independently during 42%, 72%, and 35% of the sessions for Mary, Brandy, and Tad, respectively. Mean exact agreement for pica was 97% for Mary, 96% for Brandy, and 98% for Tad.

Preference Assessment

During the stimulus preference assessment, 19 items were evaluated with Mary, 20 with Brandy, and 18 with Tad. Items were selected based on (a) caregiver report of client preference using the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996), (b) stimuli that were hypothesized to match the oral stimulation that resulted from pica, and (c) observations of participants' preferences on the living unit. We also attempted to present stimuli from a variety of sensory categories (oral, visual, auditory, tactile, thermal).

The list of items for each participant appears on the *x*-axis labels in the top, middle, and bottom panels of Figure 3 for Mary, Brandy, and Tad, respectively. Items were presented to the participant individually during each trial. Three categories of matched stimuli were evaluated with Mary: food items, nonfood items that she could mouth independently, and items for which oral stimulation was provided by the therapist (e.g., a toothbrush). Multiple categories of matched stimuli were presented to Mary for two reasons. Initially, the number of food items we could present to her was limited because she was thought to be at risk for aspiration (this was later disconfirmed). Second, she had fine motor skill deficits, and we were not certain that she could independently manipulate all the presented stimuli; therefore, we added a category of stimuli for which the therapist provided stimulation. All of the matched stimuli for Brandy were food items, with the exception of one rubber toy. All of the matched stimuli for Tad were food items. Unmatched stimuli for all participants included items that produced a variety of sensory consequences (e.g., cold pack, fan, music).

The participant was allowed to sample the item for 5 s prior to the onset of the trial to ensure familiarity with the item. For Mary, each trial was 30 s in duration, each item was presented 10 times for a total of 190 stimulus presentations, and one item was presented from each category in a counterbalanced order. All sessions were conducted in a baited room. Each matched food and nonfood stimulus was placed approximately 10 cm from Mary's mouth for 30 s during each trial. Unmatched stimuli were placed approximately 10 cm from Mary's midline. If Mary grasped the stimulus, she was allowed to interact with it for 30 s. Items for which a therapist provided Mary with oral stimulation were presented by initiating stimulation (e.g., brushing her teeth) at the

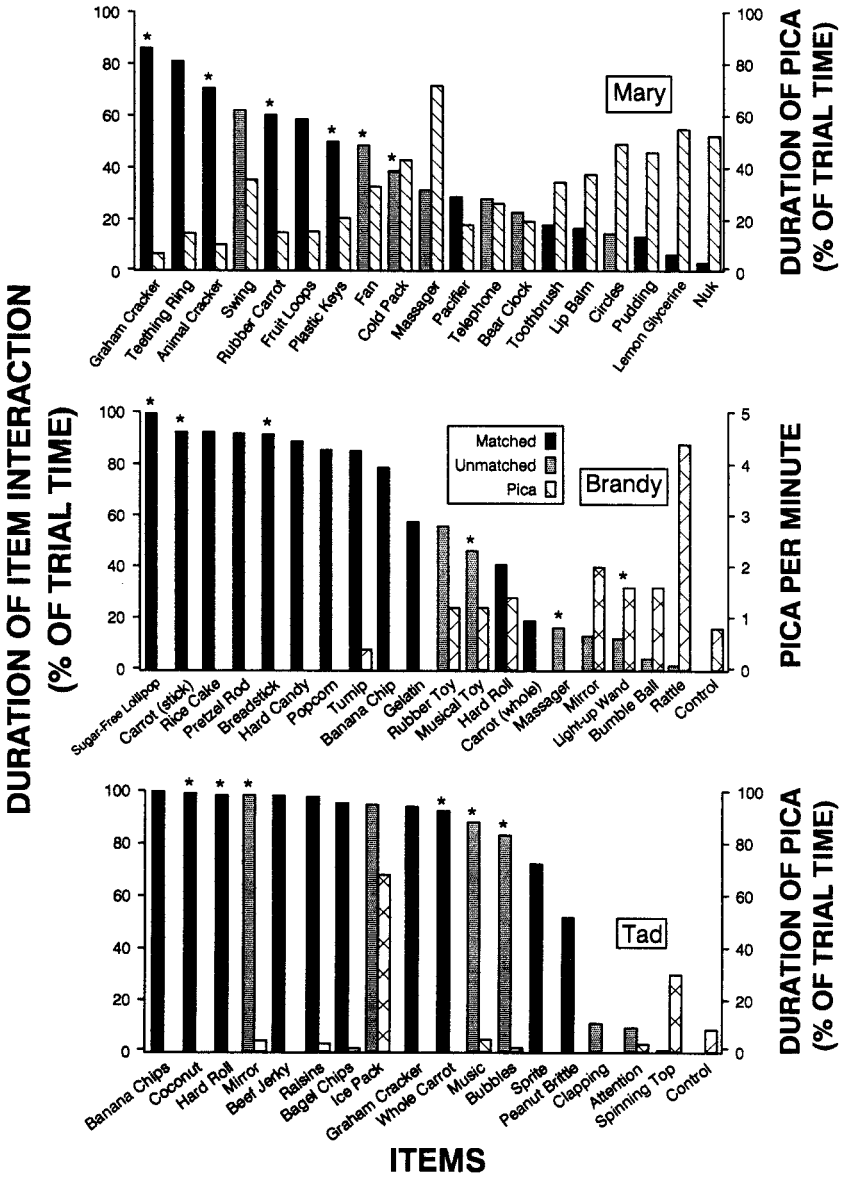

Figure 3. Duration of item interaction (all participants), duration of pica (Mary and Tad), and pica per minute (Brandy) during the stimulus preference assessment for Mary (top panel), Brandy (middle panel), and Tad (bottom panel). Duration of item interaction is represented by the black bars for the matched items and by the gray bars for the unmatched items. Duration or rate of pica is represented by the cross-hatched bars for all stimuli. The items denoted with asterisks were used in the assessments of matched and unmatched stimuli.

onset of the trial and continuing to present stimulation unless Mary (a) bit into the stimulus (scored as pica) or (b) pushed or held the stimulus away. The stimulus was removed after 30 s, and a new trial began. Mary's preference assessment was completed in four 30-min blocks.

Stimulus preference trials for Brandy were 5 min in duration, and one trial was conducted for each stimulus for a total of 20 trials. The length of trials differed for each patient according to his or her baseline rate of pica. Brandy was alone in a baited session room. The stimulus being assessed was lo-

cated on a tray in the center of the room. After the 5-min trial, the stimulus was removed. Approximately four trials were conducted per day, and the preference assessment was completed in 5 days.

Stimulus preference trials for Tad were 5 min in duration, and one trial was conducted for each stimulus for a total of 18 trials. A therapist remained in the room with Tad for all trials and interacted with Tad only during trials that required adult mediation (access to clapping, social attention, and bubbles). All sessions were conducted in a baited room, and the stimulus being assessed was located in the middle of the room. After the 5-min trial, the stimulus was removed. Approximately nine trials were conducted per day, and the preference assessment was completed in 2 days.

Results and Discussion

The results of the preference assessments for Mary, Brandy, and Tad appear in the top, middle, and bottom panels of Figure 3, respectively. The highest percentages of interaction and the lowest levels of pica during the preference trials for Mary were associated with food (M = 54.5% of the trial for interaction and 19.7% of the trial for pica) or with nonfood stimuli that she could place in her mouth (M = 47.5% of the trial for interaction and 23.6% of the trial for pica). Items for which a therapist provided Mary with oral stimulation were associated with low levels of interaction (M = 11.0% of the trial) and higher levels of pica (M = 45.1% of the trial). Unmatched stimuli were associated with moderate levels of interaction (M = 35.7% of the trial) and moderate levels of pica relative to the other stimuli assessed (M = 36.0% of the trial).

The highest percentages of interaction (M = 75.5% of the trial) and the lowest rates of pica (M = 0.2 responses per minute) during the preference trials for Brandy were associated with the matched stimuli. Unmatched stimuli were associated with lower levels of interaction (M = 15.7% of the trial) and higher rates of pica (M = 1.8 responses per minute).

Similarly, for Tad the highest percentages of interaction (M = 89.8% of the trial) and the lowest levels of pica (M = 0.5% of the trial) were associated with the matched stimuli. Unmatched stimuli were associated with lower levels of interaction (M = 54.9% of the trial) and higher levels of pica (M = 15.9% of the trial).

One of the predominant theories regarding pica is that the behavior is maintained by the oral stimulation it produces (Favell et al., 1982). To test this hypothesis indirectly, a treatment analysis was conducted in which we evaluated the effects of stimuli that matched the consequences of pica (i.e., stimuli that could be placed in the mouth) versus stimuli that provided sensory consequences (e.g., a fan) but were not matched to the hypothesized consequence of pica.

Matched and unmatched stimuli were identified for use in the subsequent treatment analysis for each participant based on the results of the preference assessment and practical considerations. The specific matched and unmatched items selected for each participant are marked with asterisks in Figure 3. In general, we attempted to select the stimuli from each group (i.e., matched and unmatched) with the highest levels of interaction and the lowest levels of pica during the preference assessment; however, there were a few exceptions due to practical considerations. The teething ring was not used for Mary because it did not maintain integrity when bitten during the preference assessment. The swing was not used with Mary because it was unavailable in the session room. Several of the more preferred items for Brandy (e.g., rice cakes) and Tad (e.g., banana chips) were not used because their parents found these stimuli unacceptably messy.

Treatment Analysis

All treatment analysis sessions were 10 min in length and were conducted in a baited room. Pica of the oxygen tube was blocked for Mary; otherwise, no differential consequences were delivered for pica for any participant. The effects of access to matched and unmatched stimuli were compared using a combination of multielement and ABAB designs for all participants.

Baseline. A different baseline condition was used for each child because of their different patterns of responding in the analogue functional analyses. Mary's pica was high across all functional analysis conditions; therefore, the toy play condition was selected as the baseline. She was given constant access to preferred toys (see 'n' say, pop-up toy, toy phone) with therapist attention (pats on the back) and praise ("Great job") contingent upon each occurrence of toy play or social contact. Every 30 s Mary was offered a toy (e.g., the therapist picked up the pop-up toy and said, "Here's your pop-up toy"). If Mary took the toy from the therapist's hand, she received praise. If not, the therapist returned the toy to the floor. The toys and pica items were located throughout the room. At the beginning of each session, Mary was positioned in the center of the room equally distant from all items. All items were easily accessible during the entire session.

The alone condition of the functional analysis was used as the baseline for Brandy because her mother reported that it was difficult to constantly supervise Brandy because of the presence of five siblings in the home ranging in age from 3 to 15 years old. Therefore, we wanted to develop a treatment that would be effective even when Brandy was unsupervised. Brandy was alone in a room baited with pica materials as described for the functional analysis.

The NCA treatment described in Study 2 was selected as the baseline for Tad because pica persisted at unacceptable levels during NCA. The room was baited with pica materials, and the therapist provided continuous noncontingent verbal and physical attention.

Matched versus unmatched stimuli. Conditions during the matched and unmatched stimuli sessions were identical to those of baseline. In addition, each child had continuous access to either the matched or unmatched stimuli described above. The matched or unmatched stimuli were equally accessible to each participant.

Either matched or unmatched stimuli (depending on the condition) were continuously available to Mary, and the therapist offered Mary one of the items every 30 s by holding the object near her hand if she was not already holding one of the stimuli. If she did not grasp the item, the item was returned to the designated place in the room. The items were alternated in presentation. No additional programmed consequences other than those described for baseline occurred for any behavior for any participant.

Matched stimuli plus response blocking (Mary only). Because the inclusion of unmatched items did not result in a reduction in the rate of Mary's pica, evaluation of this condition was discontinued. Access to matched food and nonfood items resulted in lower rates of pica relative to baseline; however, pica was not reduced to clinically acceptable levels. Therefore, the effects of response blocking were evaluated in both matched stimuli conditions. If Mary attempted to place one of the baited pica objects beyond the plane of her lips, the therapist removed the object from Mary's grasp and returned it to the floor. In addition, Mary was physically removed to another area of the room (typically the center) equally distant from toys, matched items, and baited pica items. If Mary attempted to ingest her own hair, clothing, or oxygen tube, the item was removed from her grasp and the thera-

pist attempted to make the object less accessible. For example, the therapist might readjust Mary's oxygen tube to fit more securely and to remain out of her visual field. The effects of response blocking were evaluated in an ABAB design.

Results and Discussion

The results from the matched and unmatched stimuli analysis appear in the top, middle, and bottom panels of Figure 4 for Mary, Brandy, and Tad, respectively. During the two baseline phases for Mary, the mean rate of pica was 3.6 responses per minute. Providing Mary with access to either type of matched stimuli (food or nonfood) was effective in reducing pica across the phases in which it was implemented (M = 0.9 and 0.6 for food and nonfood, respectively). However, providing Mary with access to the unmatched stimuli across the two phases had no effect on pica (M = 3.6). Even though the matched stimuli effectively reduced pica, the level of reduction was not clinically acceptable due to its life-threatening nature. Therefore, a response blocking procedure was implemented, which interrupted the hypothesized response–reinforcer relation and reduced pica to near-zero levels (M = 0.2). Both types of matched stimuli (food and nonfood) reduced pica substantially. The unmatched stimuli, on the other hand, had no effect on pica. One limitation of the results for Mary is that the effects of response blocking alone were not evaluated.

During baseline for Brandy, pica was maintained at high rates (M = 1.5). Providing Brandy with access to either matched or unmatched stimuli reduced pica to zero in the first phase in which these stimuli were introduced. Pica increased when baseline was reintroduced (M = 1.5). Pica decreased to zero in the second phase in which matched stimuli were evaluated, but pica was more variable in the second phase with unmatched stimuli (M = 0.5). These results suggested that oral stimulation was more effective than other types of sensory stimulation in reducing Brandy's pica. We hypothesized, therefore, that oral stimulation was an important component of pica for Brandy.

The results for Brandy also are important because pica was reduced to zero when Brandy was left alone with matched stimuli. Many treatments for severe behavior problems (e.g., differential reinforcement, functional communication training) require adult supervision in order to be implemented. However, severe behavior problems such as pica may be most dangerous in the absence of supervision because the individual may ingest hazardous materials such as poisons without caregiver knowledge. Thus, the risk of serious injury or death from pica may be increased in these situations because first aid or medical interventions (e.g., inducing vomiting) may be delayed or do not occur. In fact, an X ray of Brandy's stomach upon hospital admission revealed that a number of objects were present in her stomach (paper clips and coins), which her family was unaware that she had ingested. Therefore, it is significant that the results of a stimulus preference assessment were used to identify stimuli that effectively competed with a dangerous behavior that was maintained in the absence of social consequences.

During the baseline NCA condition for Tad, the mean rate of pica was 1.2. The mean rate of pica was zero with the matched stimuli and 0.1 with the unmatched stimuli. Pica increased during the return to NCA (M = 1.0). Rates of pica were initially high but then decreased to near-zero levels with unmatched stimuli (M = 0.7) and were consistently near zero with matched stimuli (M = 0.1). The matched stimuli were only slightly more effective than the unmatched stimuli in reducing Tad's pica. Pica was maintained under conditions of NCA, but

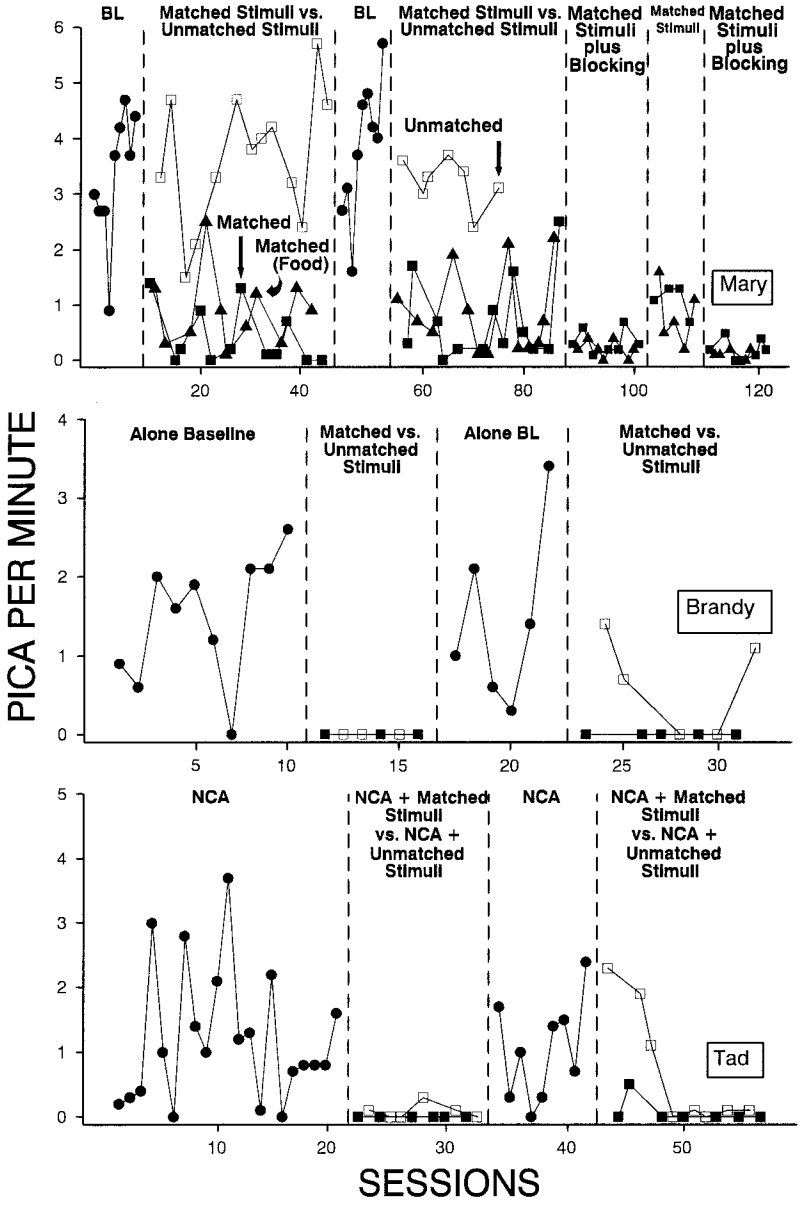

Figure 4. Pica per minute during the assessment of matched and unmatched stimuli for Mary (top panel), Brandy (middle panel), and Tad (bottom panel). BL = baseline, NCA = noncontingent attention.

it was reduced to near-zero levels with the addition of stimulation (either oral or nonoral). Thus, it appeared that any type of stimulation, rather than oral stimulation per se, was important to the reduction in Tad's pica. Even though a specific source of automatic reinforcement was not identified for Tad, the findings for Tad replicate those of Vollmer, Marcus, and LeBlanc (1994) and Ringdahl, Vollmer, Marcus, and Roane (1997) in that preference assessments were useful for identifying stimuli that compete with behaviors that persist in the absence of social contingencies.

Study 4: Further Evaluation of the Sensory Properties of Pica

Results of Study 3 for Mary and Brandy suggested that oral stimulation was an important component of pica. However, it was not entirely clear what aspect of oral stimulation (e.g., taste, texture) served as reinforcement. Study 4 attempted to identify the specific aspects of oral stimulation that contributed to the maintenance of pica for the 2 participants. Because Tad's pica was reduced equally well by matched and unmatched stimuli, we felt that a more fine-grained analysis was unnecessary.

First, hypotheses were generated regarding the specific aspects of oral stimulation that appeared to be important. Next, stimulus preference assessments were conducted with different categories of stimuli to determine which stimuli were associated with high levels of interaction and low levels of pica. Finally, the effectiveness of these stimuli in reducing pica was evaluated during treatment analyses.

We hypothesized that firmness was the important component of pica for both participants, based on the results of (a) the preference assessment, (b) observations of the kinds of items that the participants tended to ingest when they engaged in pica, and (c) reports from caregivers regarding preferred pica items. When Mary engaged in pica, she often placed an item between her teeth and then pulled on the item with her hands. She appeared to prefer items that provided resistance and remained relatively intact during this process (e.g., leather items). Brandy sought out firm objects such as game pieces, rocks, and keys. Based on this information, we attempted to manipulate the firmness of stimuli to evaluate whether firmness was important to the maintenance of pica.

Data Collection and Interobserver Agreement

Duration of item interaction and pica were defined during the stimulus preference assessments for Mary and Brandy as described in Study 3. Data were collected on laptop computers during each 30-s trial for Mary and during each 5-min trial for Brandy. Two observers scored target behaviors (item interaction and pica) simultaneously but independently during 30% and 88% of the trials for Mary and Brandy, respectively. Mean exact agreement was 98% and 89% for interaction and 90% and 97% for pica for Mary and Brandy, respectively.

During the subsequent sessions, trained observers used laptop computers to record the frequency of pica for Mary and Brandy. Two observers scored pica simultaneously but independently during 47% and 80% of the sessions for Mary and Brandy, respectively. Mean exact agreement for pica was 98% for Mary and 96% for Brandy.

Preference Assessment

During the stimulus preference assessment, four categories of food items were evaluated: (a) firm and flavored, (b) firm and unflavored, (c) soft and flavored, and (d) soft and unflavored. The specific items (e.g., tofu) were selected because they fit within the category definition (e.g., soft and unflavored). Eight items were evaluated with Mary, and seven items were evaluated with Brandy. The items are listed on the *x* axis in the top and bottom panels of Figure 5 for Mary and Brandy, respectively.

The preference assessment was conducted with Mary while she was seated in a high chair. One food item from each category was presented five times in a counterbalanced order for a total of 40 presentations or trials. A trial began by placing a small piece of the food item in Mary's mouth to ensure familiarity with the taste and texture of the item. Next, a baited pica item and a food item were placed on the high chair in front of Mary for 30 s. The positions of the food and pica items were randomly alternated between left and right positions by trials. The

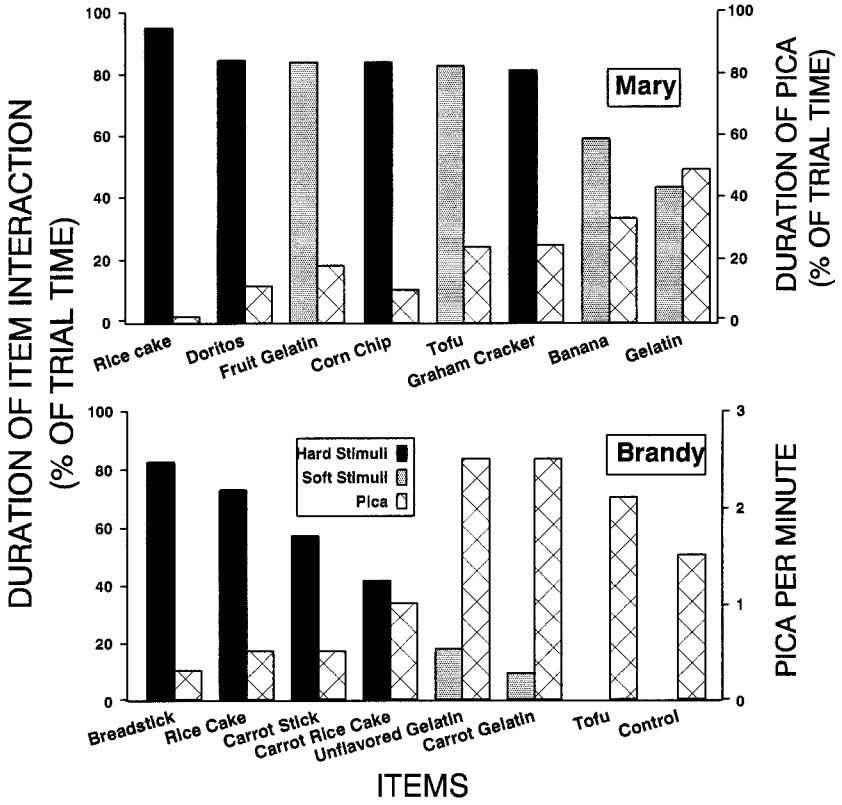

Figure 5. Duration of item interaction (both participants), duration of pica (Mary), and pica per minute (Brandy) during stimulus preference assessments for Mary (top panel) and Brandy (bottom panel). The duration of item interaction is represented by the black bars for the firm items and by the gray bars for the soft items. The duration of pica is represented by the cross-hatched bars for all stimuli. The stimuli are arranged in order from most to least preferred for both participants.

two items were removed after 30 s, and the next trial began (if time permitted). The stimulus preference assessment was completed in 1 day during two 20-trial blocks.

The preference assessment for Brandy was conducted while she was alone in a baited room (as described for the alone condition of the functional analysis). Each food item was presented three times according to a random order for a total of 21 presentations or trials. The food item was placed on a tray in the middle of the room for the 5-min trial. The trial ended after 5 min, and a new trial began (if time permitted). Approximately eight trials were conducted per day. A control condition was also conducted in which Brandy was alone in the baited room with no additional food stimulus available. The control condition was conducted to observe the rate of pica in the absence of any potential competing food stimulus.

Results and Discussion

Results of the preference assessment are shown in Figure 5. In general, the stimuli that were associated with low levels of pica were firmer in texture (i.e., rice cake, breadstick), and the stimuli that were associated with higher levels of pica were softer (i.e., gelatin, tofu) for both participants. The exception to this was the graham cracker for Mary. Stimuli that were associated with lower levels of pica were also more highly preferred by Brandy. The relation between pref-

erence and levels of pica was less clear for Mary.

Even though we hypothesized that firmness was the important aspect of pica, ingested items (historically and during the preference assessment) differed along a number of dimensions other than firmness (e.g., flavor). Therefore, in the subsequent analysis, we attempted to further evaluate the relation between firmness of stimuli and levels of pica.

Firmness Analysis: Procedure and Design

To determine whether firmness was an important aspect of oral stimulation, two types of food items were evaluated with Mary: a firm item (rice cakes) and a soft item (gelatin). In addition, we matched the firm and soft items along the dimension of flavor to evaluate whether flavor contributed to the extent to which oral stimuli would compete with pica. The flavor evaluated was strawberry and was selected based on a preference assessment conducted with a variety of different flavored items (data available from the authors upon request). Thus, four types of stimuli were evaluated: (a) unflavored gelatin, (b) strawberry gelatin, (c) unflavored rice cakes, and (d) strawberry rice cakes.

Because of time constraints, only firmness was evaluated with Brandy (i.e., flavor was not evaluated in order to reduce the number of assessed conditions). Therefore, all items used in the subsequent analysis were relatively unflavored or bland. The two firm items were plain breadsticks and plain rice cakes, and the two soft items were unflavored gelatin and tofu.

The firmness analysis was conducted using a combination of ABAB and multielement designs for Mary and a multielement design for Brandy. All sessions were 10 min in length. Both participants were in a room baited with pica items across all conditions.

In the baseline (toy play) condition, Mary was given free access to preferred toys as well as therapist attention (pats on the back) and praise ("That's great playing with the toys") contingent upon each occurrence of toy play or social contact, and no differential consequences were delivered for pica. During the noncontingent food (NCF) condition, the contingencies described for baseline were implemented. In addition, one type of food item (either strawberry rice cakes, plain rice cakes, strawberry gelatin, or plain gelatin) was continuously available in a bowl on a tray placed in the center of the room. Every 30 s, the therapist offered the food item to Mary if she was not already consuming it. Food contact and consumption were praised. The type of food was alternated across sessions in a random order.

Brandy was alone in the baited room during baseline, and no differential consequences were delivered for pica. During the NCF conditions, Brandy was alone in the baited room with constant access to either the two firm, unflavored food items (plain breadsticks, plain rice cakes) or the two soft, unflavored food items (unflavored gelatin, tofu) located on a tray in the center of the room.

Results and Discussion

Results for the firmness analysis are shown in Figure 6. During baseline, Mary engaged in high rates of pica ($M = 2.9$ responses per minute). Pica decreased when she had access to the plain rice cakes ($M = 0.3$) or the strawberry rice cakes ($M = 0.4$). Pica was higher when she had access to the plain gelatin ($M = 1.9$) or the strawberry gelatin ($M = 1.8$). Pica increased during the return to baseline ($M = 2.3$). Pica again decreased when we returned to the plain rice cakes ($M = 0.03$) and the strawberry rice cakes ($M = 0.5$) conditions. The gelatin conditions were not replicated because they were not associated with low rates of pica. Firm items were associated with the lowest rates of pica (M

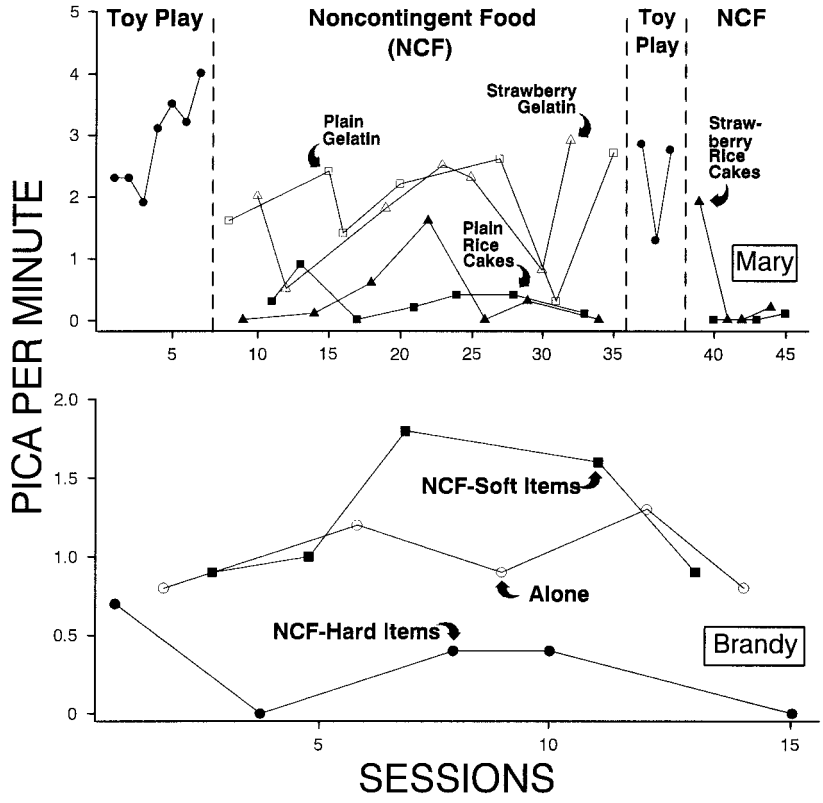

Figure 6. Pica per minute during the assessment of noncontingent food (NCF) for Mary (top panel) and Brandy (bottom panel).

= 0.3 responses per minute) relative to soft items (M = 1.3) or no items (M = 1.0) during the multielement analysis for Brandy.

The results of the preference assessments were used to evaluate the relation between the firmness of stimuli and levels of pica. Levels of pica were lower for Mary and Brandy as the firmness of the stimuli increased. Firmness was concluded to be the important component because the stimuli evaluated during the preference assessment did not consistently share any other characteristic, such as shape, size, color, and so forth. The results of the treatment analysis supported those of the preference assessment. That is, the lowest rates of pica were associated with the firm stimuli (e.g., rice cakes), and the soft stimuli (e.g., gelatin) had minimal effect on pica. In addition, because flavor may be an important component of oral stimulation, the two sets of stimuli (rice cakes and gelatin) were matched along the dimension of flavor during Mary's analysis. Flavor did not exert an effect over pica independent of firmness for Mary.

Study 5: Additional Analyses of the Function of Pica

The results of Brandy's functional analysis suggested that pica was multiply maintained or solely maintained by automatic reinforcement. A treatment based on the hypothesis that pica was maintained by automatic reinforcement was effective in reducing Brandy's pica. However, it was possible that Brandy's pica was maintained not only by automatic reinforcement but also by social reinforcement (access to tangible items, attention, or both). Therefore, the purpose

of Study 5 was to evaluate the potential social functions of Brandy's pica.

Data Collection and Interobserver Agreement

Trained observers used laptop computers to record the frequency of pica for Brandy during all treatment analysis sessions. Two observers scored pica simultaneously but independently during 71% of the tangible analysis sessions and during 100% of the social attention analysis sessions for Brandy. Mean exact agreement for pica was 97% during the tangible analysis and 96% for the social attention analysis.

Procedure and Design

All sessions were 10 min in length and were conducted with Brandy and a therapist in a baited room with no toys available. The baseline for the tangible analysis was similar to the tangible condition of the functional analysis. Brandy received a half-ounce of cola contingent on the occurrence of pica. Subsequently, a treatment phase of noncontingent access to tangible items (NCT) was evaluated. During NCT, a half-ounce of cola was delivered response independently approximately once every 15 s. No differential consequences were delivered for pica or other behaviors.

The baseline for the social attention analysis was identical to the social attention condition of the functional analysis in which a brief verbal reprimand was provided contingent upon pica. Next, the effects of continuous noncontingent access to attention (NCA) were evaluated. The therapist provided continuous verbal and physical social interaction by talking, praising, and clapping with Brandy during NCA. Because NCA was not effective in reducing Brandy's pica, a third phase was conducted in which the therapist provided continuous noncontingent attention, and the matched items (sugar-free lollipops, carrot sticks, and breadsticks) identified in Study 3 were continuously available.

Results and Discussion

The results for the tangible analysis appear in the top panel of Figure 7. During the baseline tangible condition, the mean rate of pica was 1.6. Providing Brandy with access to noncontingent cola resulted in low rates of pica ($M = 0.1$). When baseline was reintroduced, pica increased ($M = 1.8$) and decreased again when access to cola was provided noncontingently ($M = 0.3$).

The results of the attention analysis appear in the bottom panel of Figure 7. During baseline, rates of pica were high ($M =$ 2.5 responses per minute). Providing Brandy with access to continuous noncontingent attention resulted in a small decrease in pica ($M = 1.2$); however, the rates of pica in the NCA condition were maintained at clinically unacceptable levels. When Brandy was provided access to the matched stimuli, pica decreased to zero. Pica increased again during the second NCA phase ($M = 1.2$) and decreased to zero when the matched stimuli were present.

Smith, Iwata, Vollmer, and Zarcone (1993) suggested that the effectiveness of treatment analyses can be used to confirm the validity of functional analysis results. Smith et al. evaluated treatments for the self-injurious behavior (SIB) of 3 participants using procedures that were matched to results of functional analyses (e.g., noncontingent attention for attention-maintained SIB) or that were not matched to the function of SIB (e.g., providing noncontingent access to toys for attention-maintained SIB). When the matched treatment was effective in reducing SIB, Smith et al. concluded that the results of the functional analysis were correct. If the matched treatment failed to reduce SIB, Smith et al. concluded that the results of the functional analysis were spurious.

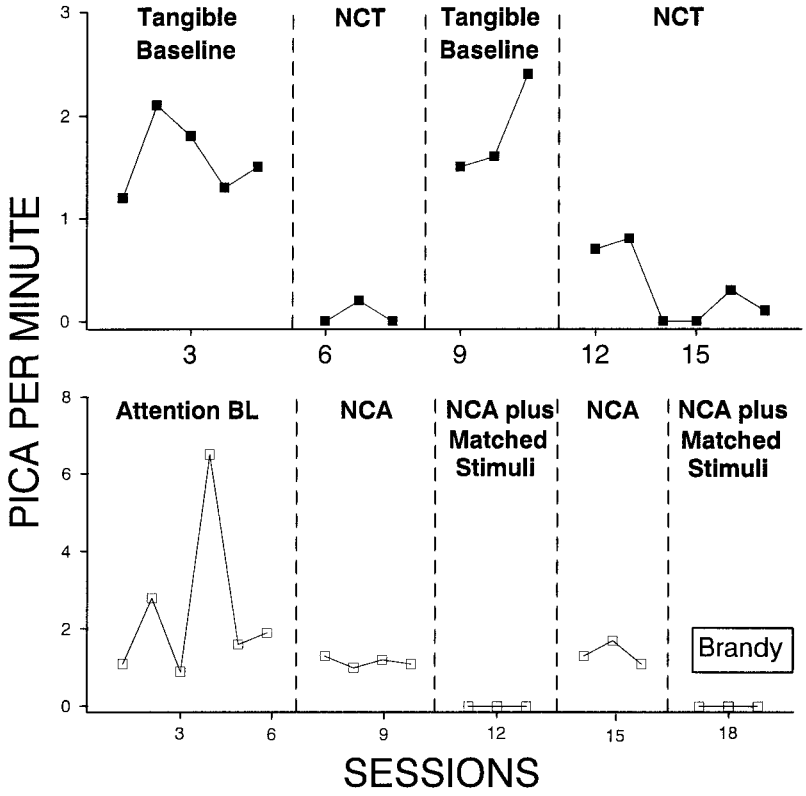

Figure 7. Pica per minute during the treatment evaluation for Brandy's pica maintained by access to tangible items (top panel) and during the treatment evaluation for attention-maintained pica (bottom panel). NCT = noncontingent access to the tangible item, NCA = noncontingent attention.

Similarly, we used the results of the treatment analysis to test the potential social functions of Brandy's pica. The tangible treatment (noncontingent access to the tangible item) resulted in low levels of pica. However, the effectiveness of this treatment could be explained in at least two ways: (a) Brandy's pica was maintained in part by access to cola, or (b) cola effectively competed with the oral stimulation provided by pica. We believed, however, that cola was a functional reinforcer rather than a substitutable oral stimulus for several reasons. First, the results of Study 4 showed that firm stimuli were more effective than softer stimuli in reducing Brandy's pica. Second, Brandy's mother frequently gave her cola following occurrences of pica but otherwise withheld it. Third, we showed that cola functioned to increase a simple, arbitrary response in a separate reinforcer assessment (data available from the authors upon request). However, without further evaluations of multiple liquid and nonliquid stimuli, this conclusion remains speculative.

The treatment for attention-maintained pica, NCA, reduced pica minimally. In the baseline condition of the attention analysis, the putative establishing operations for social reinforcement (the absence of adult attention) and automatic reinforcement (absence of oral stimulation) were present, both social and automatic reinforcement were available, and high rates of pica were observed. In the NCA condition, the establishing operation for the social reinforcement of pica (attention) was presumably removed by providing continuous noncontingent attention. How-

ever, the putative establishing operation for automatic reinforcement (absence of oral stimulation) and availability of automatic reinforcement (oral stimulation in the form of pica) were still available, and pica was maintained. When stimuli were added that appeared to match the stimulation provided by pica, presumably removing the establishing operation for oral stimulation as reinforcement, pica was reduced to zero. These results suggest that pica occurred at high levels in the attention condition primarily because of the absence of oral stimulation during this condition and to a lesser extent (if at all) as a function of the contingent relation between pica and adult attention.

GENERAL DISCUSSION

In the current investigation, a series of analyses was conducted to evaluate and treat putative social and automatic reinforcement functions of pica with 3 participants. The results of Studies 1 and 2 led to the hypothesis that automatic reinforcement was either primarily (Mary) or partially (Brandy and Tad) responsible for the maintenance of pica. The results of Study 3 provided additional evidence for this hypothesis by showing that (a) matched stimuli (those that produced oral stimulation) were generally preferred over unmatched stimuli for all 3 participants, and (b) treatments based on the hypothesized function of pica (provision of matched stimuli that provided oral stimulation) were more effective than treatments that were unrelated to the hypothesized function for 2 of 3 participants. The results of Study 4 provided additional evidence for the hypothesis that Mary's and Brandy's pica was maintained by the oral stimulation it produced and that texture was an important determinant of preference and treatment efficacy (i.e., firm food items were more preferred and were more effective in reducing pica than were soft food items). The results of Study 5 provided evidence suggesting that Brandy's pica was multiply maintained by social and automatic reinforcement because noncontingent presentation of tangible reinforcement (cola) produced substantial reductions in pica. By contrast, noncontingent delivery of attention reduced pica only marginally.

Results of the current investigation extend research on the assessment and treatment of pica in several ways. First, the functional analysis results for Tad clearly showed that social reinforcement (attention) played a significant role in the maintenance of his pica. The results for Brandy were inconclusive regarding the role of social reinforcement, but they at least raised the possibility that tangible consequences and attention played a role in the maintenance of her pica. These findings are significant because pica is often presumed to be maintained by automatic reinforcement, but these results show that social consequences may play a role in the pica of some individuals.

Second, these results indicate that indirect analyses such as those conducted in Studies 3 and 4 may be useful for assessing and treating pica when it is maintained independent of the social environment. The functional analysis results led to the hypotheses that pica was either solely maintained by automatic reinforcement (Mary) or multiply maintained by social and automatic reinforcement (Brandy and Tad). In Study 3, preference assessments were used to identify stimuli that effectively competed with the automatically reinforced pica of all 3 participants in subsequent treatment analyses. In addition, the results of the preference assessments and treatment evaluations implicated a potential source of automatic reinforcement (oral stimulation with firm objects) and indicated that stimuli that specifically matched this hypothesized source of automatic reinforcement were important treat-

ment components for 2 of the 3 participants.

Prior to the development of functional analysis methodologies, treatment of destructive behavior was often based on default strategies such as differential reinforcement using arbitrary stimuli and punishment procedures (Iwata et al., 1994). The development of methods for identifying the function of destructive behavior (e.g., Iwata et al., 1982/1994) led to more effective treatments because the source of reinforcement, once identified, could be withheld (extinction) or delivered contingent on appropriate behavior (e.g., differential reinforcement). The use of function-based treatments for socially motivated behaviors has reduced reliance on default interventions (Iwata et al., 1994), and this could potentially occur for behaviors that are maintained by automatic reinforcement if a technology is developed to identify the specific source of reinforcement. In the current investigation, identification of the source of automatic reinforcement for pica allowed us to deliver (provide access to alternative oral stimulation) and withhold (block pica) reinforcement.

The combination of functional and indirect analyses like those used in the current investigation may also be important in treating automatically reinforced behavior because they provide a potential means of identifying the establishing operations for destructive behavior. We showed that when 2 of the participants were provided with stimulation (e.g., a radio) that did not match the sensory properties of pica, pica was maintained, presumably because the establishing operation (i.e., the absence of oral stimulation) was unaffected by the presence of alternative stimulation. That is, the establishing operation for the automatic reinforcement of pica (deprivation from oral stimulation) continued to be present. By contrast, pica was reduced when participants had access to the matched stimuli, presumably because the establishing operation for the automatic reinforcement derived from pica was abolished through the provision of specific alternative stimulation (e.g., oral stimulation).

Vollmer (1994) suggested that successful identification of specific sources of automatic reinforcement may be time and labor intensive because an extensive number of hypotheses may need to be tested before specific reinforcers are identified. Previous investigators (Derby et al., 1992; Piazza, Fisher, Hanley, Hilker, & Derby, 1996; Ringdahl et al., 1997; Vollmer et al., 1994) have shown that preference and choice assessments can be used to develop reinforcement-based treatments for behaviors maintained by automatic reinforcement. These types of preference assessments are useful because a large number of stimuli can be assessed in a short period of time to predict which stimuli will effectively compete with destructive behavior. Nevertheless, the assessments and treatment evaluations conducted in the current investigation certainly were lengthy and laborious. On the other hand, once stimuli were identified that effectively competed with pica, the amount of effort required for ongoing treatment was minimal. In fact, for 1 of the 3 participants (Brandy), treatment consisted of simply providing her with alternative stimulation, which she could manipulate independently. Only Mary required the addition of a response-blocking procedure. In fact, matched stimuli reduced Brandy's pica to zero in a condition in which she was left alone. This is important because she apparently ingested dangerous objects at times when she was not directly observed by caregivers. Thus, for some individuals with life-threatening pica who cannot be closely monitored at all times, it may be worth the time and effort required to identify the specific source of automatic reinforcement.

The preference assessment in Study 3

showed that very few stimuli competed with Mary's pica, and her behavior proved to be the most difficult to treat, requiring high-preference matched stimuli in combination with response blocking. The preference assessment for Brandy showed that the vast majority of matched and even a few unmatched stimuli competed with her pica, and both types of stimuli reduced her pica during the treatment evaluation, although the matched stimuli produced more consistent reductions. Finally, for Tad, the preference assessment showed that a wide variety of matched and unmatched stimuli competed with pica, and both types of stimuli reduced this behavior to near-zero levels during the treatment evaluation.

Identifying the specific source of automatic reinforcement was most important for Mary, the participant whose pica persisted at high rates across all functional analysis conditions. By contrast, identifying the specific source of automatic reinforcement was not critical for Tad, whose pica persisted in the absence of social contingencies only when a series of consecutive alone sessions were conducted. Thus, the results of the functional analysis in combination with those of the preference assessment predicted which participants required a highly specific source of alternative stimulation (Mary, and to a lesser extent Brandy) and which one did not (Tad).

There are several limitations regarding the conclusion that oral stimulation was important to the maintenance of pica for Mary and Brandy. First, the type of stimuli evaluated during the preference assessments may have biased the results in the direction of the oral stimulation hypothesis. That is, during the first preference assessment, a preponderance of matched stimuli were tested relative to the number of unmatched stimuli. The unmatched stimuli may have failed to compete with Mary's and Brandy's pica because unmatched stimuli were not highly preferred. The unmatched stimuli that were tested were the ones nominated by caregivers as being highly preferred and those the participant was observed to manipulate on the living unit. This method of identifying an individualized pool of potential reinforcers for inclusion in a systematic preference assessment has been shown to be superior to using a standard set of stimuli across participants (Fisher et al., 1996). Nevertheless, if we had evaluated a wider range of unmatched stimuli, we may have identified ones that competed with pica for these 2 participants. We purposely used more oral items because it seemed logical that pica was maintained by the oral stimulation it produced. Future investigators may wish to evaluate a wider array of stimuli from more sensory categories in order to control for this bias. A second limitation of using only oral items is that participants may become satiated on these items over time, particularly if oral stimulation is limited to food. Future investigators may wish to examine the extent to which treatment effects for pica are maintained when food is used as the competing source of oral stimulation.

The same criticism can be applied to the conclusion that firmness was the important aspect of oral stimulation for Mary and Brandy. That is, we evaluated stimuli that we hypothesized to differ on the dimension of firmness. However, the stimuli also differed in other ways (e.g., taste, texture). Therefore, it is possible that had we evaluated more characteristics of the stimuli, we may have reached a different conclusion. We evaluated the dimension of firmness based on the results of the preference assessment and reports and observations of the types of stimuli with which the participants engaged in pica. Future investigators may wish to evaluate a wider array of stimulus characteristics to identify which are important to the maintenance of pica.

A second limitation is that conclusions

about the source of automatic reinforcement for pica were derived from indirect analyses. Therefore, cause–effect relations between the response and its hypothesized reinforcer cannot be assumed because indirect analyses are correlational (Kennedy & Souza, 1995). Nevertheless, such analyses provide a plausible explanation of the response–reinforcer relation, and a number of investigations have demonstrated that indirect analyses are useful in developing treatments for aberrant behavior that is hypothesized to be maintained by automatic reinforcement (Kennedy & Souza, 1995; Piazza, Hanley, & Fisher, 1996). Future investigators may wish to further evaluate the effectiveness of indirect analyses for assessing and treating behaviors maintained by automatic reinforcement.

Finally, future research should be directed toward determining why oral stimulation is such a differentially potent reinforcer for some individuals with pica. It makes sense from a biological standpoint that oral stimulation in the form of food would function as an effective reinforcer. However, it remains unclear why consumption of nonedible items such as rocks, car keys, or paper clips occurs at such dangerously high rates despite the hazards associated with ingestion of these items.

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STUDY QUESTIONS

1. What items did the participants typically ingest, and how were the authors able to observe pica without putting the participants in danger?

2. Summarize the results obtained from the functional analyses.

3. Although the authors were able to reduce Tad's pica during Study 2, they felt that the outcome was not clinically acceptable. They subsequently hypothesized that his pica was also partially maintained by automatic reinforcement, which was consistent with data obtained during Tad's alone sessions. What additional strategies, based on the results of Tad's original functional analysis, could have been used to treat his pica?

4. What was the purpose of Study 3? How were matched and unmatched stimuli defined?

5. Based on the findings of Study 3, the authors concluded that oral stimulation was an important component of pica for Mary and Brandy. Taking into account the results of the preference assessments, give an alternative explanation of their findings.

6. Describe the four categories of food items evaluated during the preference assessment in Study 4. What results were obtained for each of these categories?

7. In Study 5, providing Brandy with noncontingent access to a tangible item (i.e., cola) produced low levels of pica. What two interpretations did the authors provide for these results and how might they have determined which interpretation was correct?

8. What were the main contributions of this study?

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