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VARYING RESPONSE EFFORT IN THE TREATMENT OF PICA MAINTAINED BY AUTOMATIC REINFORCEMENT

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Pica is a life-threatening behavior displayed by many individuals with developmental disabilities. In the current study, automatic reinforcement maintained the pica of 3 participants. Following functional analyses of pica, response-effort manipulations were conducted in which the effort to obtain pica or alternative items was varied systematically. Several general relations emerged as a result of the study. First, levels of pica were reduced relative to baseline when alternative items were available independent of the effort required to obtain alternative items or pica. Second, increasing the effort for alternative items resulted in increases in pica relative to when effort for alternative items was low. Third, increasing response effort for pica produced reductions in pica relative to baseline when alternative items were unavailable. Fourth, the highest levels of pica occurred when the effort to engage in pica was low or medium and no alternative items were available. These findings are discussed in terms of the relative effects of quality of reinforcement and response effort on behavior.

DESCRIPTORS: automatic reinforcement, functional analysis, pica, response effort

Pica, the ingestion of nonnutritive substances, is a life-threatening behavior exhibited by approximately 25% of individuals with mental retardation (Danford & Huber, 1982). The deleterious effects of pica may include intestinal blockage, accidental poisoning, parasitic infection, surgical removal of objects, and death (Motta & Basile, 1998). Although the occurrence of pica has been shown to be sensitive to socially mediated reinforcers (e.g., attention; Mace & Knight, 1986), pica frequently has been demonstrated to be maintained by automatic reinforcement (Piazza et al., 1998; Piazza, Hanley, & Fisher, 1996).

The term *automatic reinforcement* is applied to behavior that is maintained independent of social contexts (Vaughan & Michael, 1982). Automatically reinforced be-

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havior presents a special dilemma for practitioners and researchers because automatic reinforcers are not typically under the control of a therapist and cannot be manipulated directly (Vollmer, 1994). That is, the response directly produces the reinforcer. Thus, in most circumstances, an individual has a choice of engaging in behavior that produces automatic reinforcement or engaging in behavior that produces some other reinforcer. In a choice arrangement, response allocation may be affected by several factors (e.g., quality or rate of reinforcement). Therefore, one method of treating automatically reinforced behavior is to alter the parameters of either automatic reinforcement or the reinforcement available from alternative behavior (e.g., Favell, McGimsey, & Schell, 1982; Hagopian & Adelinis, 2001; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Piazza et al., 1998). For example, Piazza et al. (1998, 2000) showed that the quality of reinforcement available for alternative responses differentially affected the level of automatically reinforced destructive behavior.

Response effort is another variable that has been examined in the treatment of automatically reinforced destructive behavior. Evaluation of the effects of response effort on automatically reinforced destructive behavior may be important because the effort to engage in automatically reinforced behavior (e.g., hitting one's head with one's hand) may be lower than the effort associated with alternative behaviors (e.g., walking across the room to obtain a toy). Several investigators have studied the effects of response effort on automatically reinforced destructive behavior.

Shore, Iwata, DeLeon, Kahng, and Smith (1997) manipulated response effort for item interaction as an independent variable and observed changes in item interaction and destructive behavior. Initially, preferred items and self-injurious behavior (SIB) were available concurrently under similar effort requirements, and more responding was allocated toward preferred items. In subsequent phases, the effort required to obtain items was manipulated by altering the distance between the participant and the item such that the participant had to move further to obtain the item. Results showed that altering the effort for preferred items produced decreases in item interaction and increases in destructive behavior. That is, item interaction competed with destructive behavior when the effort to obtain both was equal, but did not compete when the effort to obtain items increased. Similarly, Kerwin, Ahearn, Eicher, and Burd (1995) manipulated effort requirements in the treatment of food refusal by varying the volume of food on a spoon. Although all participants showed varying levels of acceptance associated with the amount of food presented, response rates (bites accepted) were higher when low-effort conditions were presented.

The studies conducted by Shore et al. (1997) and Kerwin et al. (1995) manipulated response effort for appropriate behavior (item interaction and eating) and demonstrated differential effects on the occurrence of destructive behavior (SIB and food refusal). An alternative strategy involves the manipulation of response effort for destructive behavior. Van Houten (1993) and Hanley, Piazza, Keeney, Blakeley-Smith, and Worsdell (1998) used wrist weights to increase the effort to engage in SIB and showed that SIB decreased. Irvin, Thompson, Turner, and Williams (1998) and Zhou, Goff, and Iwata (2000) also manipulated the effort to engage in SIB by applying flexible arm splints to participants who engaged in automatically reinforced hand mouthing. Results showed that levels of SIB decreased when response effort increased. Furthermore, Hanley et al. and Zhou et al. showed that appropriate behavior (i.e., item interaction) was main-

tained or increased when the effort requirements for SIB increased.

Previous studies have manipulated response effort for a single target behavior (i.e., either destructive or appropriate behavior). Less is known about the effects of response-effort manipulations when response effort is varied for destructive and appropriate behavior simultaneously. Nevertheless, it is more likely in natural environments that the response effort to engage in destructive and appropriate behavior fluctuates from moment to moment. Therefore, controlled manipulations of response effort on destructive and appropriate behavior may be helpful in examining how responding shifts as response effort for either destructive or appropriate behavior changes.

The purpose of the current study was to extend previous research on the treatment of automatically reinforced pica by manipulating the response effort for pica and alternative behavior. Response effort for pica and alternative items was varied systematically to assess the effects of these manipulations when both pica and alternative items were available concurrently.

METHOD

Participants and Settings

Three females who had been admitted to the Neurobehavioral Unit at the Kennedy Krieger Institute participated. All participants were ambulatory, could engage in some self-help skills (e.g., grooming) with moderate assistance, and communicated through idiosyncratic signs or gestures. The primary reason for admission was pica. Brandy was a 19-year-old girl who had been diagnosed with severe mental retardation, autism, and Cornelia de Lange syndrome. She had been treated previously on this unit for her pica. She had been readmitted to the hospital for modifications of her treatment in anticipation of a change in her residential placement. Prior to her first admission, Brandy had ingested a variety of inedible objects, including car keys, rocks, sticks, dirt, rubber gloves, and alkaline batteries. Sara was a 14-year-old girl who had been diagnosed with severe mental retardation and Sanfilippo syndrome. The items ingested previously by Sara (e.g., dirt, sticks, rocks, plastic) had led to the development of an infection in her intestinal tract, which resulted in severe gastroesophageal reflux. Sue was a 15-year-old girl who had been diagnosed with severe mental retardation and autism. She had a history of ingesting a variety of harmful objects, including rocks, sticks, dirt, cloth, feces, and soap.

All sessions were conducted in rooms (3 m by 3 m) equipped with one-way mirrors located on the hospital unit. The rooms contained a table as well as other items that varied across conditions. In addition, each room was baited with materials that were deemed by the medical staff to be safe for mouthing or consumption. Due to potential health risks associated with the consumption of the objects typically ingested by the participants, we attempted to identify materials that had properties (e.g., appearance, texture) similar to the materials typically ingested. The materials were placed throughout the room (i.e., on the floor, furniture, windowsills, table) during all sessions, and included uncooked pasta, uncooked beans, paper, onion skins, shredded uncooked turnip and collard greens, plastic blocks, candles, Playdoh®, and crayons.

With the exception of the extended-length alone sessions and the preference assessments, all sessions were 10 min long. Ten to 12 sessions were conducted daily.

Data Collection and Interobserver Agreement

During all sessions, observers used laptop computers to record the frequency of pica and the duration of item interaction (in the preference assessments and response-effort

analyses). Pica was defined as placing one of the baited pica items from the session room past the plane of the lips. The frequency of pica was converted to a rate by dividing the number of occurrences of pica by the length of the session in minutes. Item interaction was defined as manipulating each item in the manner in which it was intended (e.g., looking at a strobe light) or consumption of edible objects. Duration of item interaction was converted to a percentage of session by dividing the total duration of interaction in seconds by the total duration of the session multiplied by 100%.

Two observers simultaneously but independently recorded participant responses during 62% of functional analysis sessions, 55% of preference assessment trials, and 49% of response-effort sessions. Each session was partitioned into 10-s intervals for the calculation of interobserver agreement coefficients. Exact agreement coefficients were calculated for pica by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An exact agreement was defined as both observers recording the same frequency of a target response in a given 10-s interval. Total agreement for item interaction was calculated by dividing the smaller of the two duration measures by the larger and multiplying by 100%.

Mean exact agreement for pica during the functional analysis was 85.4% for Brandy, 94.7% for Sara, and 87.5% for Sue. The agreement coefficients for item interaction during the preference assessments were 76.6% for Brandy, 76.5% for Sara, and 82.4% for Sue. Mean exact agreement for pica during the preference assessments was 93.6% for Brandy, 94.4% for Sara, and 92.9% for Sue. Agreement coefficients were 88.1% for pica and 89.6% for item interaction for Brandy, 96.8% for pica and 93.8% for item interaction for Sara, and 98.1% for pica and 89.6% for item interaction for Sue during the response-effort analysis.

Procedure

Functional analysis. A multielement functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) was conducted for each participant in a room that was baited with the pica materials described above. In the demand condition, instructions were presented using a three-step prompting sequence (verbal, modeled, and physical prompt). Instructions were terminated for 30 s following the occurrence of pica. In the attention condition, the participant had access to toys and was instructed to play quietly while the therapist was engaged in another activity (e.g., paperwork). The therapist provided a brief verbal reprimand (e.g., "Don't do that") following occurrences of pica. In the alone condition, each participant was observed alone in the baited room and no social consequences were provided for pica. In the toy play condition, the participant had continuous access to preferred stimuli, received noncontingent social attention from the therapist every 30 s, and no instructions were delivered. No differential consequences were arranged for pica. All conditions were presented in a random order. Following each participant's functional analysis, a series of extended (20-min) alone sessions were conducted to assess the persistence of pica in the absence of social consequences over an extended period of time (Vollmer, Marcus, Ringdahl, & Roane, 1995).

Preference assessment. Following the functional analysis, a stimulus preference assessment (Piazza, Fisher, Hanley, Hilker, & Derby, 1996) was conducted to identify items that would compete with the occurrence of pica. Each participant was observed alone in a room that contained pica materials, the target item, a table, and a plastic tray. One target item was available on the tray during

each trial. To ensure familiarity with each item, the participant was allowed to sample the item prior to the assessment and before each trial began. Throughout the trial, the participant had continuous access to the item on the tray and the baited pica items were dispersed throughout the room (e.g., on the floor, windowsill, table). At the end of the trial, the item and the participant were removed from the room and a new item was placed on the tray. No differential consequences were provided for either pica or item interaction throughout this assessment.

During the preference assessment, 18 items were evaluated for Brandy, 27 items were evaluated for Sara, and 39 items were evaluated for Sue. A control condition also was conducted in which no alternative item was available. Items were selected for the preference assessment based on the results of the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) and on the specific stimulus properties of the items (i.e., items that produced oral, visual, auditory, or proprioceptive stimulation). Each item and the control condition were presented in a random order for a total of three presentations (trials) per item. Trial length was 2 min for Brandy, 5 min for Sara, and 3 min for Sue. Trial length for the preference assessment was based on the levels of pica in the functional analysis (Piazza et al., 1998).

Response-Effort Analysis

A multielement design was used to assess the effects of response effort on pica and alternative items. Sessions were conducted in rooms containing pica items, a table, a tray, and alternative items (when appropriate). A therapist was present in all sessions to replenish pica or alternative items, but delivered no differential consequences following pica or item interaction. Following an initial baseline phase, response effort for pica and alternative items was varied systematically.

The effort manipulations for Brandy and Sue for pica were based on what might occur in natural environments. That is, individuals who engage in pica forage for items on the floor or other surfaces (i.e., a table). Potential pica items (e.g., medicines, paper clips) often are stored in places that are difficult to reach (e.g., a drawer or cabinet). Therefore, pica items were placed in an opaque plastic container with a closed lid in the high-effort conditions for Brandy and Sue. Pica items were placed on the table and the floor in the low-effort condition.

The response-effort manipulation for Sara was based on our observation that she almost never bent down to obtain pica items. That is, she engaged in pica only with items that were above her waist (i.e., on a table or windowsill). Therefore, pica items were placed below the waist (e.g., on the floor or on a chair) in the high-effort (pica) condition and above the waist in the low-effort (pica) condition. We also conducted a medium-effort pica condition for Sara in which pica items were available throughout the room (above and below the waist).

Alternative items were placed in a plastic container (identical to the one used in the pica high-effort condition) in the high-effort conditions for Brandy and Sue. The high-effort (alternative items) response for Sara consisted of pressing a microswitch that played a tape recording ("more please"). The therapist then handed Sara alternative items for 20 s. The low-effort response for all participants for alternative items consisted of continuous presentation of the items by the therapist (i.e., placing the item in the participant's hand). The adult did not otherwise interact with the participant when delivering alternative items (e.g., make eye contact, vocal, or physical responses). We also included a medium-effort condition for alternative items for all participants in which alternative

items were available throughout the room, as in our original treatment preparation (Piazza et al., 1998). The procedures employed in each condition are described below.

Pica (low)/no alternative. The baseline phase for Brandy and Sue was the low-effort pica condition in which pica items were available throughout the room. No alternative items were available.

Pica (medium)/no alternative. In the baseline phase for Sara, pica items also were available throughout the room (i.e., above and below the waist). No alternative items were available.

Pica (high-low)/no alternative. In this phase, we alternated between conditions in which the effort to engage in pica was either high or low. No alternative items were available in either condition. The purpose of this phase was to assess the level of pica when only the effort to engage in pica was manipulated.

Pica (high-low)/alternative (medium). In this phase, we alternated between conditions in which the effort to engage in pica was either high or low. Alternative items were available on trays throughout the room (e.g., on a table or on the floor) in both high- and low-effort pica conditions.

Pica (high-low)/alternative (low). In this phase, we alternated between conditions in which the effort to engage in pica was either high or low. The effort to obtain the alternative items was low across both high- and low-effort pica conditions.

Pica (high-low)/alternative (high). In this phase, we alternated between conditions in which the effort to engage in pica was either high or low. The effort to obtain the alternative items was high across both high- and low-effort pica conditions.

Pica (low)/alternative (high-low). In this phase, we alternated between conditions in which the effort to engage in alternative items was either high or low. Pica items were available throughout the treatment room (e.g., on a table or on the floor), as in our original baseline preparation (Piazza et al., 1998), in both high- and low-effort alternative-items conditions.

Pica (medium)/alternative (high-low). In this phase (Sara only), we alternated between conditions in which the effort to engage in alternative items was either high or low. Pica items were available above and below the waist, as in our original baseline preparation, in both high- and low-effort alternative-items conditions.

RESULTS

Functional analysis. The results for the functional analysis are depicted in Figure 1. Rates of pica for Brandy were highest in the alone condition (*M*s = 5.9, alone; 4.4, attention; 3.6, toy play; and 0, demand), suggesting that Brandy's pica was maintained by automatic reinforcement. Next, five extended alone sessions were conducted, and pica persisted across these sessions ($M = 4.4$), supporting the conclusion that pica was maintained by automatic reinforcement.

Similar results were observed for Sara. Variable rates of pica were observed in the functional analysis (*M*s = 4.4, attention; 3.3, alone; 3.4, toy play; 1.6, demand), suggesting that Sara's pica was maintained by automatic reinforcement. The persistence of Sara's pica across six extended alone sessions ($M = 3.5$) supported this conclusion.

Results of the functional analysis for Sue showed that pica occurred more frequently in the alone condition (*M*s = 5.6, alone; 3.0, attention; 2.3, toy play; 1.0, demand). High rates of pica also were observed during two extended alone sessions ($M = 5.6$). Thus, results of Sue's functional analysis also supported the conclusion that her pica was maintained by automatic reinforcement.

Preference assessment. Several items were identified for each participant during the preference assessment that were associated

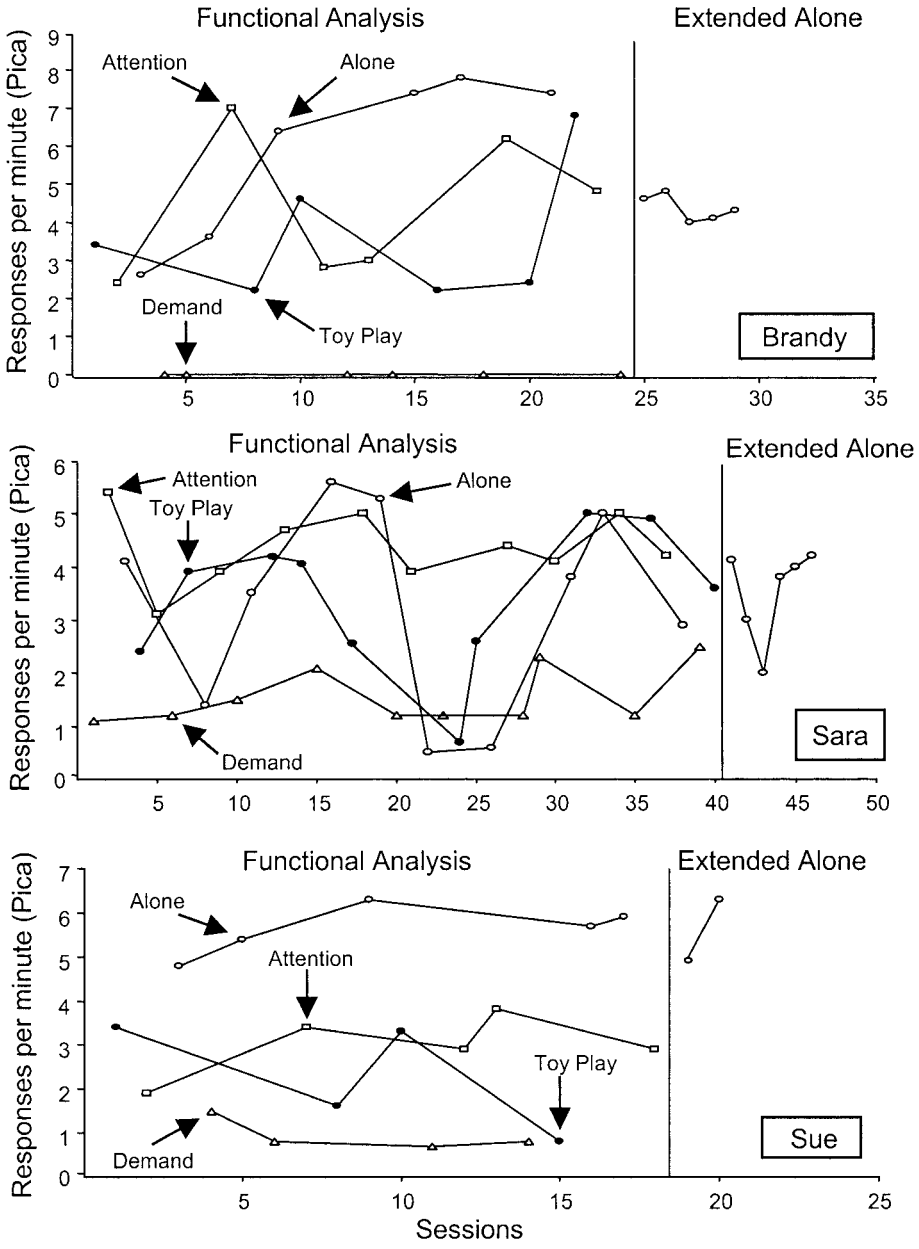

Figure 1. Pica responses per minute during the functional analysis for Brandy (top panel), Sara (middle panel), and Sue (bottom panel).

with near-zero levels of pica and high levels of item interaction relative to the levels of interaction associated with other items (Piazza, Fisher, Hanley, Hilker, & Derby, 1996; Piazza et al., 1998). The alternative items included fruit snacks, a cereal bar, and dried fruit for Brandy. The alternative items for Sara were cornflakes, Goldfish® crackers, Three Musketeers®, a frozen teether, a vibrating teether, and a mouth guard. The alternative items for Sue were Skittles® and marshmallows.

Response-effort analysis. The results from the response-effort analysis for Brandy ap-

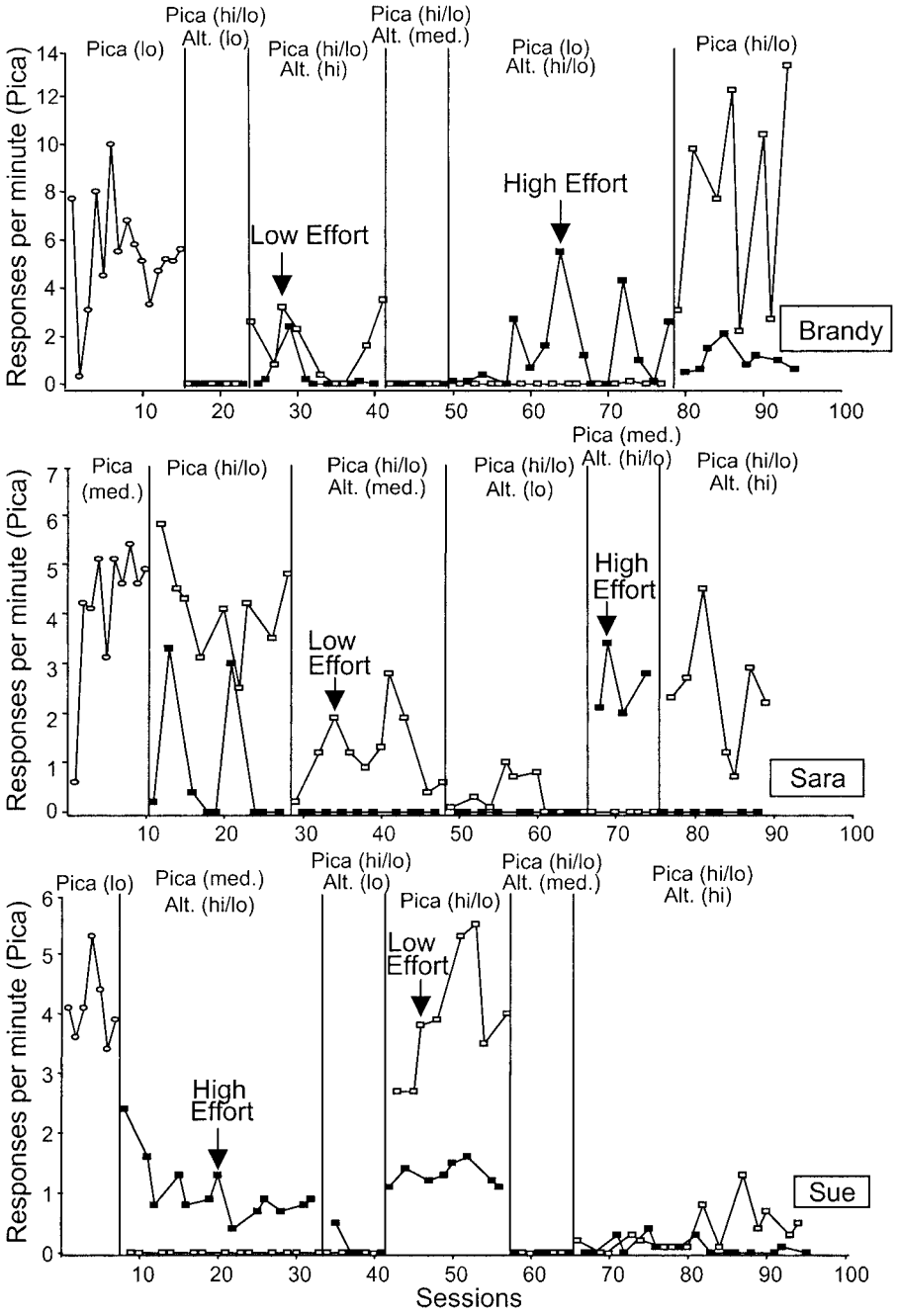

Figure 2. Pica responses per minute during the response-effort analysis for Brandy (top panel), Sara (middle panel), and Sue (bottom panel) (hi = high response effort, lo = low response effort, med = medium response effort, alt = alternative items).

pear in Figure 2. In the baseline phase, when the effort to obtain pica items was low (pica low/no alternative), mean rate of pica was 5.4 responses per minute. In the second phase (pica high-low/alternative low), the effort to engage in pica was alternated between high and low and the effort to obtain alternative items was low. Rates of pica dropped

to zero, regardless of the effort manipulation for pica. During the third phase (pica high-low/alternative high), the effort to engage in pica was alternated between high and low and the effort to obtain alternative items was high. Rates of pica were relatively low in the high-effort pica condition (M = 0.3), whereas pica persisted in the low-effort pica condition (M = 1.6). In the fourth phase (pica high-low/alternative medium), the effort to engage in pica was alternated between high and low and the effort to obtain alternative items was medium. Rates of pica were zero, regardless of the effort manipulation for pica, when alternative items were available. In the fifth phase (pica low/alternative high-low), the effort to engage in pica was low and the effort to obtain alternative items was alternated between high and low. Near-zero rates of pica were observed when the effort for pica was low and the effort for alternative items was low (M = 0.01). By contrast, higher levels of pica were observed when the effort for alternative items was high (M = 1.4). During the final phase (pica high-low/no alternative), only the effort for pica items was varied. Higher rates of pica were observed when response effort for pica was low (M = 7.7) relative to when response effort for pica was high (M = 1.0).

Figure 2 also shows the outcome of the response-effort manipulations for Sara. Mean rate of pica was 4.2 in baseline when the effort to obtain pica items was medium and no alternative items were present. In the second phase (pica high-low/no alternative), the effort for pica was varied between high and low and no alternative items were present. Higher rates of pica were observed when response effort for pica was low (M = 4.1) relative to when response effort for pica was high (M = 0.8). In the third phase (pica high-low/alternative medium), the response effort for pica was alternated between high and low and response effort for alternative items was medium. Pica was zero when response effort for alternative items was medium and the effort for pica was high. However, pica was elevated (but lower than baseline) when the response effort for alternative items was medium and the effort for pica was low (M = 1.2). In the fourth phase (pica high-low/alternative low), the effort for pica was alternated between high and low and the effort to obtain alternative items was low. Pica was zero in the pica high-effort condition, and pica increased then decreased to zero in the pica low-effort condition (M = 0.3). In the fifth phase (pica medium/alternative high-low), the effort to obtain pica items was medium (pica items were distributed equally throughout the room as in our original preparation) and the effort for alternative items was alternated between high and low. Pica was high when the effort for alternative items was high (M = 2.6) and was zero when the effort for alternative items was low. In the sixth phase (pica high-low/alternative high), the effort to engage in pica was alternated between high and low and the effort for alternative items was high. Pica increased when the effort for pica was low and the effort for alternative items was high (M = 2.4), but was at zero when the effort for pica and alternative items was high.

Figure 2 also depicts the response-effort evaluation for Sue. High rates of pica occurred during baseline (M = 4.1) when the response effort for pica was low and no alternative items were available. In the second phase (pica low/alternative high-low), the response effort for pica was low and the effort for alternative items was alternated between high and low. Pica occurred when the effort for alternative items was high (M = 1.0) but did not occur when the effort for alternative items was low. In the third phase (pica high-low/alternative low), the effort to engage in pica was alternated between high and low and the effort to obtain alternative items was low. Near-zero rates of pica were observed in both conditions. In the fourth phase (pica

high-low/no alternative), we manipulated the effort for pica only. Higher rates of pica were observed when response effort for pica was low ($M = 3.9$) relative to when response effort for pica was high ($M = 1.3$) and no alternative items were available. In the fifth phase (pica high/low/alternative medium), the effort for pica was alternated between high and low and the effort for alternative items was medium. No pica occurred in either condition. During the final phase (pica high-low/alternative high), the effort for pica was alternated between high and low and the effort for alternative items was high. In this phase, higher rates of pica occurred when pica items were available for a low-effort response ($M = 0.3$) relative to when pica items were available for a high-effort response ($M = 0.1$).

For all participants, when response effort for alternative items was low, mean percentage of item interaction was 98.3% (range, 91.9% to 99%). When response effort for alternative items was high, mean percentage of item interaction decreased ($M = 42.3\%$; range, 15.3% to 63.9%). When response effort for alternative items was medium, mean percentage of item interaction was 95.0% (range, 81.4% to 98.5%).

DISCUSSION

The results of this investigation demonstrate the importance of considering behavior in the context of concurrently available reinforcers (Neef & Lutz, 2001; Neef, Shade, & Miller, 1994) in several ways. Levels of pica were lower than baseline when alternative items were available, independent of whether the response effort for pica was low or high, suggesting that the alternative items produced a higher quality of reinforcement than pica. However, alterations of the response effort for pica and the alternative items interacted with the effects of reinforcement quality, thereby changing the levels of response allocation.

The relation observed between alternative-item consumption and pica can be interpreted using behavioral economic theory (e.g., Kerwin et al., 1995). Briefly, behavioral economics suggests that consumption (i.e., response rate) varies as a function of cost (i.e., response requirements). Participants consumed more alternative items than pica items, even when the "cost" of the two items was equal. This relation was disrupted, however, as the cost of (i.e., the effort to gain access to) the alternative items increased.

When the effort to gain access to alternative items was increased, some amount of pica emerged for all participants under most conditions and levels of interaction with alternative items decreased. However, the level of the shift in responding depended on the extent to which the effort to engage in pica was low, medium, or high. When the response effort for pica was high, only small (Brandy and Sue) or no (Sara) increases occurred in pica when the response effort for alternative items was high. When the response effort for pica was low or medium (Sara) and the response effort for alternative items was high, all participants engaged in pica. Note, however, that the levels of pica remained lower than baseline even when the effort to obtain alternative items was high. Similarly, Shore et al. (1997) found that levels of automatically reinforced SIB were lower than baseline when leisure items were available, even when the response effort to obtain the leisure items was increased slightly. Neef et al. (1994) found that students allocated their time to math problems associated with a higher quality of reinforcement even when those problems were associated with higher response effort. Taken together, these results suggest that quality may often be a more influential dimension of reinforcement than response effort.

One exception to this finding was that

Sara engaged in some pica during the conditions in which the response effort for pica was low and the response effort for alternative items was low or medium. These results suggest that for some individuals, it may be difficult to suppress pica to zero or near-zero levels if the response effort for pica is low even when alternative items are available.

Response effort exerted influence over levels of pica even in the absence of alternative items. That is, when the response effort for pica was increased and no alternative items were available, levels of pica were reduced relative to baseline. These findings replicate the results of a number of studies that have demonstrated that simply increasing response effort may be an effective method of decreasing aberrant behavior maintained by automatic reinforcement (Hanley et al., 1998; Irvin et al., 1998; Van Houten, 1993). Even though pica was reduced when response effort was increased in the current investigation, the levels of pica were clinically unacceptable. Thus, it was important to include an additional component, in this case providing access to alternative items, to reduce pica to zero or near-zero levels. Reducing pica to zero is important because one episode of the behavior could be life threatening (Motta & Basile, 1998).

The results of this investigation extend the literature on alternative items and response effort in a number of ways. First, this study involved the systematic manipulation of response effort for both problem and appropriate behavior. Previous studies have either altered the response effort for appropriate behavior (e.g., Kerwin et al., 1995; Shore et al., 1997) or for problem behavior (e.g., Van Houten, 1993; Zhou et al., 2000). In natural situations, it is likely that response effort for problem and appropriate behavior fluctuates from moment to moment. Thus, it is important to understand the changes in behavior that occur as response effort for concurrently available options is manipulated simultaneously.

Even though the study was conducted in an analogue situation, these findings also have clinical relevance. For example, if alternative items are available only from a caretaker (high response effort), an individual may engage in pica by eating objects on the windowsill (a low-effort response). In this situation, reducing the effort required to obtain competing items (e.g., handing pieces of food to the participant) may decrease the occurrence of pica. In other situations, when response effort for pica is low because pica items are available readily (e.g., during outdoor play), providing continuous access to alternative items (e.g., placing items in a pouch around the individual's waist) should decrease the occurrence of pica effectively. Subsequent to the current investigation, treatment for the participants involved placement of alternative items in a fanny pack such that the alternative items were available continuously. Caregivers also were taught to inspect the environment and place hazardous materials in locked cabinets.

There are several limitations to the current findings. First, the variations in effort were not the same across responses (pica and alternative items) and participants. That is, response effort for pica consisted of either placing items on the floor or above the waist (Sara) or in or out of a box (Brandy and Sue). It is possible that rates of responding for the alternative items and pica were affected differentially by these differences in the response-effort manipulations. For example, obtaining items from a box may be more difficult than emitting a communication response; thus, the high- and low-effort conditions for pica and alternative items may not have been equivalent.

There were several reasons why the response-effort manipulations were different across behaviors and participants. First, different response-effort manipulations were

used for the different participants based on clinical observations of the participants' or the caregiver's behavior. The response-effort manipulation for Sara was placing items above the waist or on the floor. This manipulation was selected because we observed different levels of pica when baited items were above or below the waist; this led to the conclusion that bending over was a more effortful response (she rarely did it). The high-effort response for pica for Brandy and Sue was placing items in a box. This manipulation is analogous to interventions that are used by many parents to prevent ingestion of dangerous substances (e.g., placing medicine in a locked cabinet or placing items out of reach).

The high-effort manipulation for alternative items for Brandy and Sue also involved placing the items in a box. We selected this manipulation to make it similar to the high-effort response for pica. Communication was selected as the high-effort response for the alternative items for Sara because it allowed us to train an appropriate alternative to pica. Thus, the intervention provided an additional clinical benefit.

The low-effort response for alternative items was handing the items to the participant. We selected this response to maximize the effectiveness of treatment. Ethical considerations precluded us from placing pica items in the participant's hands in the low-response-effort condition for pica, as was done with the alternative items. However, placing alternative items in the participants' hands may have been a lower effort response than the low-effort condition for pica. Future investigations should equate the level of effort for the responses to determine the effects of identical response-effort manipulations on pica and interaction.

This study also is limited because treatment effects were not evaluated over extended periods of time or in natural environments. Previous investigations (e.g., Bowman, Piazza, Fisher, Hagopian, & Kogan, 1997; Egel, 1981) have shown that reinforcer preference may vary over time. Thus, it is possible that the effectiveness of alternative items may wane with repeated use. Future investigations should study the extent to which stimulus variation improves the effectiveness of treatment with alternative items. Similarly, none of the current treatments were evaluated in the participants' natural environment. Therefore, the external validity of these findings is unknown. Future investigations should extend the results of treatments for pica into the natural environment. Finally, preference assessments were lengthy. Future investigators should evaluate the extent to which briefer preference assessments (e.g., Roane, Vollmer, Ringdahl, & Marcus, 1998) could be used to identify alternative items.

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STUDY QUESTIONS

1. What two complementary strategies involving the manipulation of response effort to decrease problem behavior were illustrated in the studies cited in the introduction?

2. What precautions did the authors take to reduce the health risks associated with pica?

3. Given that pica rarely has been found to be maintained by social contingencies, can you suggest a more efficient method for conducting the functional analysis than that used in the current study?

4. How did the preference assessment differ from procedures typically used in research on reinforcer identification?

5. Describe how the high- and low-effort conditions were operationalized.

6. Summarize the results of the effort analysis.

7. What data in the current study suggest that quality may have been a more influential dimension of reinforcement than effort?

8. What are some practical implications of the current study?

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