EFFECTS OF REINFORCER MAGNITUDE ON A FIXED TIME FOOD DELIVERY TREATMENT OF PICA

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The purpose of the current study was to examine the effects of using fixed time schedules with different magnitudes of stimulus delivery as treatment for pica. A functional assessment was conducted, which indicated that pica occurred across experimental conditions and was most frequent in the absence of social stimulation or contingencies. A competing stimulus assessment was then conducted to identify stimuli that could potentially compete with pica during NCR. Subsequently, an evaluation of the effects of reinforcer magnitude on NCR as a treatment of pica was conducted. Treatment results indicated that quantity of reinforcer increased the effectiveness of leaner schedules of reinforcer delivery; however, it was not possible to fade the temporal schedule to one that would have been useful in practice. In addition, limitations and future research are outlined.
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CHAPTER I

INTRODUCTION

Pica, defined as the ingestion of nonfood items, poses a significant health risk. This behavior can lead to tearing of the esophagus or blocking of the intestinal tract (Ausman, Ball & Alexander, 1974; Winton & Singh, 1983), intestinal parasites (Foxx & Martin, 1975), and even death in some cases (McLaughlin, 1988).

Although punishment procedures were initially utilized as interventions to decrease pica, a body of research has and continues to develop addressing more function-based approaches. Through the use of functional analysis and experimental designs examining various reinforcement schedules, advancements continue to be made in identifying function-based treatments for pica.

Some of the first reported interventions included the use of both manual and mechanical restraint (Ausman, Ball & Alexander, 1974; Bucher, Reykdal & Albin, 1976; LeBlanc, Piazza & Krug, 1997; Paniagua, Braverman & Capriotti, 1986; Singh & Baker, 1984; Winton & Singh, 1983). Mechanical restraints typically included both a helmet (similar to a fencing helmet) and a body restraint that inhibited use of the arms. Restraints were applied following occurrences or attempted occurrences of pica. Ausman, Ball and Alexander (1974) reduced rates of pica through the use of mechanical restraint in an individual who had received 7 surgeries to remove intestinal blockages caused by pica. In defense of the use of such an invasive procedure, Ausman and
colleagues asserted, “It was believed that he could not survive an additional surgery. The attainment of behavioral control was literally a life or death matter” (p. 16).

Overcorrection procedures also have been implemented to reduce pica. Such interventions have consisted of forced tooth brushing and cleaning up the general area where pica occurred (Mullick, Barbour, Schroeder & Rojhan, 1980; Singh & Winton, 1985), forced tooth brushing using a toothbrush dipped in mouthwash (Foxx & Martin, 1975), forced tooth brushing using a toothbrush dipped in a water and hot sauce mixture (Matson, Stephens & Smith, 1978), and contingent mouth cleaning using a cloth kept in a bucket of ice (Kalfus, Fisher-Gross, Marvullo & Nau, 1987). These overcorrection procedures were all successful in decreasing future occurrences of pica.

Other interventions have included exposure to aversive substances or situations contingent on occurrences of pica. Rojhan, McGonigle, Curico and Dixon (1987) had individuals smell capsules of ammonia and sprayed mists of water to the face contingent on occurrences of pica. Paisey and Whitney (1989) squirted lemon juice into an individual’s mouth following occurrences of pica. Following a blocked attempt to engage in pica, Duker and Nielen (1993) pressed a piece of the attempted pica item against the lips of an individual for 2 minutes without allowing consumption of the item. Singh and Winton (1984) covered the eyes of the individual following pica attempts. All these approaches were also successful in decreasing future occurrences of pica.

Fisher et al. (1994) used an empirical procedure to identify effective punishers in an attempt to reduce pica in 3 individuals with developmental disabilities. Fisher and colleagues conducted a stimulus avoidance assessment in which the individuals were
exposed to 9 different potential punishers. Negative vocalizations and avoidance movements were used as a measure of nonpreference for each stimulus. A punisher assessment was then conducted, consisting of short sessions in which selected stimuli were presented contingent on occurrences of pica. The most effective punisher was selected based on the lowest rates of pica.

Results of prior research have shown that punishment procedures can be very effective at significantly reducing rates of pica, relative to baseline observations, both during and immediately following treatment. However, few studies have documented long term effects of such procedures following discontinuation of interventions (Bogart, Piersel & Gross, 1995; Duker & Nielen, 1993; Paisey & Whitney, 1989; Rojhan, McGonigle, Curico & Dixon 1987).

Several studies have incorporated discrimination training into treatment packages to address potential deficits in participants’ ability to discriminate food and nonfood substances. Although successful discrimination training between food and nonfood items has been demonstrated (Bogart, Piersel & Gross, 1995; Fisher et al., 1994; Johnson, Hunt & Siebert, 1994; Madden, Russo & Catakal, 1980), aversive procedures were a part of treatment packages in each case; therefore, it is difficult to attribute reduced rates of pica to discrimination training when occurrences of pica were punished.

Ethical concerns and potential social stigmatization with the use of aversive or restrictive procedures (Burke & Smith, 1999; Myles, Simpson & Hirsch, 1997) have turned researchers to more function-based interventions and the use of reinforcement procedures to treat pica. Favell, McGimsey and Schell (1982) hypothesized that the pica
displayed by 3 participants in their study was maintained by oral stimulation. In accordance with this hypothesis they provided continuous access to other more appropriate items that produced oral stimulation (popcorn and chewable toys) and reported considerable reductions in rate of pica.

Piazza, Hanley, and Fisher (1996) conducted a functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) that revealed that an individual’s cigarette pica persisted in the absence of social consequences. Further, Piazza and colleagues arranged conditions in which they showed cigarette pica did not maintain when cigarettes contained herbs rather than nicotine. In addition, preference assessments including different parts of the cigarette showed that nicotine was the preferred component compared to other components (i.e., paper, filters). Thus, the authors were able to conclude that this individual’s pica was maintained by positive reinforcement in the form of nicotine. Subsequent treatment included elimination of the maintaining consequence (nicotine) through response blocking. Although the authors attributed the elimination of pica to extinction, studies have shown that blocking may function as either extinction or punishment (Lerman & Iwata 1996; Smith, Russo, & Le 1999) and no attempt to discern which process was responsible for the observed effects was conducted.

Piazza et al. (1998) reported on a procedure to empirically identify stimuli that functionally compete with pica. A functional analysis showed that pica occurred across a range of environmental conditions, suggesting that pica for 3 individuals was maintained by automatic reinforcement. The experimenters then arranged multiple brief preference assessments comparing various stimuli that had both “matched” and “unmatched”
physical properties relative to identified pica items. Matched stimuli included items that potentially provided oral stimulation while unmatched stimuli included items that potentially provided visual, auditory, tactile, or thermal stimulation. Each item was presented individually to the participants in a room containing “baited” pica items. Results indicated that lowest rates of pica occurred when the individuals were presented with “matched” stimuli. Further, Piazza and colleagues were able to select items that most effectively competed with pica from among the “matched” stimuli. During treatment, noncontingent access to “matched” stimuli effectively reduced rates of pica to near zero levels for 2 of the 3 participants. The third individual’s rate of pica was reduced relative to baseline rates; however, a response blocking procedure was also implemented to reduce rates of pica to near zero levels.

Although providing continuous access to food has proven effective to decrease pica, environmental variables placed on certain individuals who engage in pica make such an intervention somewhat impractical. Many of these individuals live where caloric intake and diet are closely controlled and monitored thus making it difficult to provide unlimited access to certain food items. Whereas Piazza and colleagues provided continuous access to “matched” items in attempt to reduce pica, Goh, Iwata, and Khang (1999) as well as Rapp, Dozier, and Carr (2001) delivered reinforcers on a fixed time schedule. Both authors reported reduced rates of pica when schedules of reinforcement were dense (FT 10s). However, results from both studies indicated that reductions in pica were not maintained when attempts were made to thin the schedule of reinforcement.
Research indicates that reinforcement magnitude can influence the therapeutic effect of noncontingent reinforcement schedules (NCR), in which stimuli identified to maintain problem behavior are presented on a response-independent basis. For example, Carr, Bailey, Ecott, Lucker and Weil (1998) investigated the effects of reinforcement magnitude with 5 individuals with developmental disabilities. During baseline sessions, individuals received reinforcers on a variable ratio schedule contingent on placing poker chips in a can. Immediately following baseline, the schedule of reinforcement was switched to a fixed-time schedule and the reinforcers were delivered in small, medium, or large amounts, depending on the session. Results indicated that the rate of response was consistently lower when the reinforcer magnitude was larger. The authors concluded that, “If such differences are negligible, practitioners may opt to deliver lean schedules of high magnitude reinforcers, which would require less response effort than the alternate.”

One possible limitation of this study was the potential effect of reinforcer consumption on the rate of response. That is, it is possible that consumption of reinforcers competed with, or “displaced” target responses, and response rates during non-consumption periods may have been relatively unaffected. Carr and colleagues stated that they anecdotally observed the individuals engaging in target responses while consuming reinforcers; however, no direct data were obtained.

Roscoe, Iwata and Rand (2003) used similar procedures to examine the effects of reinforcer magnitude on NCR. However, these investigators accounted for the effects of reinforcer consumption by deducting time spent consuming reinforcers from total session time. Their findings indicated that even when reinforcer consumption time was
accounted for, NCR with larger magnitudes of reinforcement produced lower rates of responding than smaller magnitudes of reinforcement. The investigators suggested that the procedures should continue to be replicated in clinical contexts to observe whether magnitude of reinforcement has similar effects with other response topographies.

Very little additional research has been conducted on the use of NCR as a treatment for pica, possibly due to an inability to lean NCR schedules to the extent that they can be practically implemented by parents or caregivers. The current study extends research on the relationship between reinforcer magnitude and NCR to the treatment of pica. A functional assessment was conducted, which indicated that pica occurred across experimental conditions and was most frequent in the absence of social stimulation or contingencies. Next, a competing stimulus assessment was conducted to identify stimuli that could potentially compete with pica during NCR. Finally, an evaluation of the effects of reinforcer magnitude on NCR as a treatment of pica was conducted. Treatment components were presented in the middle component of a three-component schedule within sessions, which permitted an evaluation of both the immediate and subsequent effects of the intervention (Atcheson, 2006; Blevins, 2003; Cherryholmes, 2007; Rapp, 2006; Rapp, 2007; Simmons et al., 2003; Soderlund, 2003; Walker, 2009).
CHAPTER II

METHOD

General Procedures

Participant and Setting

Leroy was a 41 year-old male diagnosed with profound mental retardation, who engaged in pica. He resided at a large, long-term state residential and training facility for persons with developmental disabilities. He was ambulatory, nonverbal, and typically did not respond to simple instructions. According to historical records, Leroy had an extensive history of engaging in pica. By the age of 3, Leroy’s parents reported that he began chewing on his clothes and buttons. Leroy currently walks freely around his, home, work, and outside area and on occasion will insert nonfood items into his mouth. Leroy has not suffered any documented illness or injury as a result of pica. Other than response blocking, no documented interventions have been employed in the past specifically targeting pica. Response blocking has proven somewhat ineffective as a staff member is not always with Leroy to block all attempts at pica. All assessments were conducted in a clinic room located on the campus of the facility. The clinic room was 3.7m by 3.7m with a two-way mirror for unobtrusive observation and data collection. The room contained a 1.2m by 0.8m table, a 0.9m by 0.7m table, one stationary chair, one rolling chair, and other supplies as needed. Handheld computers and data collectors were present outside the clinic room during all sessions.

Response Definitions, Measurement, and Interobserver Agreement (IOA)
The dependent variable was pica, operationally defined as the insertion of a simulated pica item into the mouth. The independent variable during the treatment assessment was tangible delivery. During the functional analysis, task completion (participant) and delivery of demands or attention (therapist) were scored.

All data were recorded by trained observers using handheld computers. The target behavior (pica), delivery of tangible items by the therapist, delivery of demands by the therapist, and task completion by the participant were scored using event recording. Attention delivered by the therapist was scored using duration recording.

Interobserver agreement (IOA) was assessed by apportioning session time into 1-s intervals, dividing the number of intervals in which primary and secondary observers agreed on the occurrence or absence of problem behavior by the number of intervals in the session, and multiplying the result by 100. IOA was taken in 85.7% of the functional analysis sessions and the mean agreement was 97.75% (range = 94.1% to 100%). For baseline sessions IOA was taken in 69.2% of the sessions and the mean agreement was 98.65% (range = 96.2% to 99.4%). For treatment sessions IOA was taken 43.9% of the sessions and the mean agreement was 98.8% (range = 98% to 99.4%).

Identification of Pica Items and Selection of Simulated Pica Items

Direct contact staff who worked with Leroy were interviewed to identify pica items Leroy typically inserted into his mouth. Items identified included paper, dry leaves, and small rocks. Simulated pica items having similar physical properties to identified pica items were used throughout all phases of the study. Simulated items included onion skin, rice paper, and raw fettuccine noodles.
Functional Analysis

A functional analysis similar to that described by Iwata et al. (1994) was conducted. Sessions were conducted in a clinic located at the residential facility 3-6 days/week, 1-4 times/day. Sessions lasted for 10 min and occurred between the hours of 9:00 a.m. and 10:00 a.m. Throughout all sessions simulated pica items were present on the table and were scattered on the floor. Sessions were presented in a multielement format, with cycles of conditions in the following order:

*Alone.* In the alone condition Leroy was in the therapy room by himself. No activities or leisure items were present during this condition.

*Attention.* In the attention condition Leroy was in the room with the therapist. Leisure items were available throughout the session. The therapist was seated in the corner of the therapy room and had a magazine to read. At the beginning of the session, the therapist gave 5s to 10s of response-independent attention to Leroy (e.g., “I’ll be over here in the corner reading my magazine”) and then said nothing else until pica occurred. Each time Leroy engaged in pica the therapist delivered attention in the form of disapproval or concern (e.g., “Stop, don’t eat that!”) for 5s to 10s. If Leroy continued to engage in pica during attention delivery the therapist continued to deliver attention until pica ceased.

*Play.* In this condition, the therapist and Leroy were in the therapy room. Leisure materials were present on the table, and the therapist sat across from Leroy. The therapist interacted with Leroy every 30s. All occurrences of pica were ignored, and if pica occurred at the scheduled time of interaction the interaction was delayed by 10s.
**Demand.** In this condition, the therapist and Leroy were in the therapy room. The therapist provided a verbal request to Leroy to place a poker chip in a cup every 30s. If he did not place the poker chip in the cup within 5s, the therapist provided a visual (modeling) prompt. If he did not place the poker chip in the cup within 5s following the modeling prompt, the therapist physically guided Leroy to place the poker chip in the cup. If Leroy engaged in pica at any time between the initial prompt and completion of the task, the demand was terminated and he was told, “You don’t have to,” or “Never mind,” while the therapist backed away from him. The demand was presented again at the next 30-s interval. If Leroy was engaging in pica at the time a demand was scheduled the demand was not delivered.

**Competing Stimulus Assessment**

A competing stimulus assessment similar to that described by Piazza et al. (1998) was conducted. The purpose of the competing stimulus assessment was to identify a food item that, when continuously available, effectively suppressed rates of pica. All sessions took place in the clinic, were 5 min in length, conducted across 6 days, and began between 9:00 a.m. and 10:00 a.m. A total of 8 food items were presented individually across 8 sessions each day. Simulated pica items were present on the table and scattered on the floor during all sessions. At the beginning of each block of 8 sessions the therapist escorted Leroy into the room and directed him to sit down in a chair. A tray containing a sufficient amount of the food item to allow for continuous access throughout the session was placed on a table in front of Leroy. Then the therapist left the room. After the session was over, the therapist replaced the tray with a new tray containing a different
food item and exited the room. This process was repeated until all 8 food items had been presented. The order of presentation of food items was randomized each day.

Treatment

*General Procedures.* Reinforcer magnitudes were parametrically evaluated with escalating values of a fixed-time (FT) schedule using a mixed schedule design. Throughout all sessions, simulated pica items were present on the table and scattered on the floor. Sessions were 60-min in length and divided into three components. The first and third components of each session were identical to the alone condition of the functional analysis and were 10-min in length. The second component consisted of the delivery of animal crackers on a FT schedule and was 40-min in length. The FT values varied over the course of the experiment. One 60-min session was conducted per day and every session began between 9:00 a.m. and 10:00 a.m.

*Baseline.* During baseline, procedures identical to the alone condition of the functional analysis were presented during all 3 components of the mixed schedule. Baseline conditions were conducted initially as well as following the first seven treatment sessions.

*Fixed-Time Crackers.* During treatment sessions, animal crackers were delivered on a response-independent basis in the second component of the mixed schedule. The therapist entered the room at scheduled intervals, placed an animal cracker directly into the participant’s mouth, and exited the room. Initially, one cracker was delivered every 30s (FT 30s). The schedule of cracker delivery was increased by 30s following an 85% or greater reduction in the rate of pica (during the second component) relative to baseline
rates, for three consecutive sessions. The FT value was decreased by 15s following a reduction of less than 85% in the rate of pica (during the second component) relative to baseline rates, for three consecutive sessions or if neither of the previously mentioned criteria were met after 10 consecutive sessions. If criterion was met to increase the FT value, following a previous decrease in the FT value, then the previous FT value was repeated.

*Cracker Magnitude.* If the criterion to increase the FT value was not met following a previous decrease in the FT value, then a parametric analysis of the number of animal crackers delivered per interval was initiated. Between 2-4 crackers were delivered according to FT values. Subsequently, the number of crackers delivered and FT values were manipulated so as to sample potentially effective combinations. If a given number of crackers per interval did not produce criterion-level decreases in pica, analyses of larger values of cracker delivery were conducted. When criterion was met following increases in the number of crackers, the interval was lengthened while holding the previous number of crackers constant.
CHAPTER III
RESULT

Pre-Treatment

Functional Analysis

Results of the functional analysis are presented in Figure 1. Pica occurred throughout all sessions. In the alone condition, the mean frequency of pica was 8 (range = 1 to 13). In the attention condition, the mean frequency of pica was 6.2 (range = 2 to 9). In the play condition, the mean frequency of pica was 3.8 (range = 1 to 8). In the demand condition, the mean frequency of pica was 1.2 (range = 0 to 3). The results of this assessment indicate that Leroy’s pica was maintained independent of social consequences. The outcomes also indicated that conditions with fewer therapist-to-client interactions produced higher rates of pica. It is possible that these interactions served as “distracters,” setting the occasion for behaviors that “competed with” or “displaced” pica.

Competing Stimulus Assessment

Results of the competing stimulus assessment are presented in Figure 2. The lowest levels of pica during the assessment were observed during the presentation of animal crackers. The mean frequency of pica during sessions including the presentation of animal crackers was 0.3 (range = 0 to 1). During sessions where cocoa puffs were presented, the mean frequency of pica was 0.6 (range = 0 to 2). During sessions where saltines were presented the mean
frequency of pica was 1.1 (range = 0 to 4). During sessions where goldfish were presented, the mean frequency of pica was 1.1 (range = 0 to 3). During sessions where marshmallows were presented, the mean frequency of pica was 1.1 (range = 0 to 4). During sessions where cookies were presented the mean frequency of pica was 1.5 (range = 0 to 4). During sessions where mints were presented the mean frequency of pica was 1.6 (range = 0 to 4). During sessions where peanuts were presented the mean frequency of pica was 1.6 (range = 0 to 6). The results of this assessment indicated that animal crackers competed with pica more effectively than other identified food items; therefore, animal crackers were selected for use in treatment sessions.

Treatment

The results of the treatment analysis are presented in Figures 3 - 6. In Figure 3, open squares represent data values from component 1, closed triangles represent data values from component 2, and open diamonds represent data values from component 3.

In the initial baseline, rates were undifferentiated across all three components. The mean rpm/component, of pica across Components 1, 2, and 3, respectively, was 1.14 rpm (range = 0.60 to 1.90), 0.93 rpm (range = 0.52 to 1.40), and 0.96 rpm (range = 0.30 to 1.90).

Following the initial baseline, treatment sessions were initiated in which 1 animal cracker was delivered on an FT 30 s schedule. The mean rpm of pica in component 1 was 0.82 rpm (range = 0.50 to 1.50). The mean rpm of pica in component 2 was 0.07 rpm (range = 0.025 to 0.30). The mean rpm of pica in component 3 was 0.50 rpm (range = 0.20 to 0.70). Thus, component 2 showed immediate treatment effects relative to
component 1 with a 91.72% (range = 76.92% to 95.83%) reduction in the mean rpm of pica. Component 3 showed a 33.94% (range = 0.00% to 60.00%) reduction in the mean rpm of pica relative to component 1.

Following initial NCR treatment sessions, baseline sessions were initiated again. The mean rpm, per component, of pica across Components 1, 2, and 3, respectively, was 0.83 rpm (range = 0.50 to 1.30), 0.86 rpm (range = 0.62 to 1.12), and 0.70 rpm (range = 0.60 to 0.90). Similar to the initial baseline, rates were undifferentiated across all 3 components.

Following the second baseline, the FT 30s treatment condition was repeated. The mean rpm of pica in component 1 was 1.00 rpm (range = 0.90 to 1.10). The mean rpm of pica in component 2 was 0.03 rpm (range = 0.025 to 0.05). The mean rpm of pica in component 3 was 0.43 rpm (range = 0.30 to 0.50). Component 2 again showed an immediate treatment effect relative to component 1 with a 96.65% (range = 95.00% to 97.73%) reduction in the mean rpm of pica. Component 3 showed a 57.07% (range = 50.00% to 66.67%) reduction in the mean rpm of pica relative to component 1. Criterion for moving forward with thinning the interval schedule was met at FT 30s.

Following the second implementation of a FT 30s delivery of 1 animal cracker, the schedule of cracker presentation was changed to FT 60s. The mean rpm of pica in component 1 was 0.52 rpm (range = 0.20 to 1.00). The mean rpm of pica in component 2 was 0.22 rpm (range = 0.10 to 0.45). The mean rpm of pica in component 3 was 0.33 rpm (range = 0.00 to 0.80). There was a 37.82% (range = 0.00% to 95.83%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 35.56% (range =
0.00% to 100.00%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was not met at FT 60s.

Following implementation of the FT 60s schedule, the interval schedule was changed to FT 45s. The mean rpm of pica in component 1 was 1.16 rpm (range = 0.90 to 1.60). The mean of pica in component 2 was 0.32 rpm (range = 0.175 to 0.40). The mean rpm of pica in component 3 was 0.66 rpm (range = 0.50 to 0.90). There was a 71.85% (range = 42.36% to 80.56%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 42.36% (range = 33.33% to 50.00%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was not met with a FT 45 s delivery of 1 cracker.

Following the implementation of the FT 45s schedule with one cracker (hereafter, FT 45 s (1 cracker)), the number of animal crackers per delivery was increased to 2. The mean rpm of pica in component 1 was 1.03 rpm (range = 0.60 to 1.60). The mean of pica in component 2 was 0.19 rpm (range = 0.15 to 0.22). The mean rpm of pica in component 3 was 0.66 rpm (range = 0.60 to 0.80). There was a 77.78% (range = 62.50% to 87.50%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 31.94% (range = 0.00% to 62.55%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was not met with FT 45 s (2 crackers).

Following sessions with the FT 45s (2 crackers) condition, the schedule of cracker delivery was changed to FT 45s (3 crackers). The mean rpm of pica in component 1 was 0.83 rpm (range = 0.50 to 1.20). The mean of pica in component 2 was
0.04 rpm (range = 0.02 to 0.05). The mean rpm of pica in component 3 was 0.60 rpm (range = 0.30 to 0.90). There was a 94.86% (range = 93.75% to 95.83%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 30.00% (range = 25.00% to 40.00%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was met at FT 45 s (3 crackers).

Following the FT 45s (3 crackers) condition, FT 60s (3 crackers) was implemented. The mean rpm of pica in component 1 was 1.33 rpm (range = 1.10 to 1.50). The mean of pica in component 2 was 0.30 rpm (range = 0.25 to 0.35). The mean rpm of pica in component 3 was 0.60 rpm (range = 0.00 to 1.60). There was a 77.50% (range = 76.67% to 78.57%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 61.90% (range = 0.00% to 100.00%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was not met at FT 60 s (3 crackers).

Following the FT 60s (3 crackers) condition, FT 60s 4 crackers) was implemented. The mean rpm of pica in component 1 was 1.33 rpm (range = 0.10 to 1.90). The mean of pica in component 2 was 0.26 rpm (range = 0.10 to 0.67). The mean rpm of pica in component 3 was 0.97 rpm (range = 0.30 to 1.40). There was a 80.75% (range = 65.00% to 94.12%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 28.87% (range = 0.00% to 70.00%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was met at FT 60 s (4 crackers).
Following the FT 60s (4 crackers) condition, FT 90s (4 crackers) was implemented. The mean rpm of pica in component 1 was 0.96 rpm (range = 0.40 to 1.60). The mean of pica in component 2 was 0.23 rpm (range = 0.17 to 0.35). The mean rpm of pica in component 3 was 0.43 rpm (range = 0.20 to 0.70). There was a 71.64% (range = 56.25% to 80.56%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 44.68% (range = 0.00% to 77.78%) reduction in the mean rpm of pica in component 3 relative to component 1. Criterion for thinning the interval schedule was not met at FT 90 s (4 crackers).

Following the FT 90s (4 crackers) condition, FT 75s (4 crackers) was implemented. The mean rpm of pica in component 1 was 1.02 rpm (range = 0.70 to 1.30). The mean rpm of pica in component 2 was 0.25 rpm (range = 0.10 to 0.32). The mean rpm of pica in component 3 was 0.74 rpm (range = 0.00 to 1.20). There was a 74.45% (range = 63.89% to 88.89%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 32.31% (range = 0.00% to 100.00%) reduction in the mean rpm of pica in component 3 relative to component 1. The criterion to fade the interval schedule was not met at FT 75 s (4 crackers), and it was determined not to increase the number of animal crackers delivered as the participant had met a threshold for safe consumption of animal crackers. That is, delivery of more than 4 crackers at one time would represent a potential choking hazard for this participant. However, prior to terminating the experiment, three additional combinations of FT and magnitude values were probed.
During FT 120s (4 crackers), the mean rpm of pica in component 1 was 0.62 rpm (range = 0.20 to 1.60). The mean rpm of pica in component 2 was 0.36 rpm (range = 0.35 to 0.60). The mean rpm of pica in component 3 was 0.28 rpm (range = 0.10 to 0.60). There was a 18.33% (range = 0.00% to 83.33%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 47.50% (range = 0.00% to 75.00%) reduction in the mean rpm of pica in component 3 relative to component 1.

During FT 90s (3 crackers), the mean rpm of pica in component 1 was 0.52 rpm (range = 0.20 to 0.70). The mean rpm of pica in component 2 was 0.33 rpm (range = 0.25 to 0.45). The mean rpm of pica in component 3 was 0.46 rpm (range = 0.30 to 0.70). There was a 22.62% (range = 0.00% to 57.14%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 14.20% (range = 0.00% to 42.86%) reduction in the mean rpm of pica in component 3 relative to component 1.

During FT 60s (2 crackers), the mean rpm of pica in component 1 was 0.94 rpm (range = 0.70 to 1.50). The mean rpm of pica in component 2 was 0.28 rpm (range = 0.07 to 0.55). The mean rpm of pica in component 3 was 0.30 rpm (range = 0.10 to 0.70). There was a 69.91% (range = 50.00% to 91.07%) reduction in the mean rpm of pica in component 2 relative to component 1 and a 68.28% (range = 30.00% to 87.50%) reduction in the mean rpm of pica in component 3 relative to component 1.

Figures 4 and 5 display mean percentage, per treatment value, of reductions in pica from component 1 to component 2. These figures show that both FT and cracker magnitude values affected decreases in pica. When the FT schedule was held constant, reductions of pica in component 2 relative to component 1 corresponded with increases in
reinforcer magnitude. Similarly, for equal numbers of cracker values, consistent increases in pica were observed as FT values increased.

Figure 6 shows mean percentage, per treatment value, of reductions in pica from component 1 to component 3. These outcomes show that mean rates of pica in component 3 were lower than rates of pica component 1 across all manipulations of both FT and cracker magnitude values. However, increasing reinforcer magnitudes in component 2, while holding FT values constant, did not consistently produce greater reductions of pica in component 3 relative to component 1. For example, relative to component 1, mean reductions of pica in component 3 increased at FT 60 s when 2 crackers were delivered (68.28% reduction) relative to the delivery of 1 cracker (35.56% reduction). However, as the number of crackers continued to increase at FT 60 s, mean reductions of pica in component 3 decreased. The delivery of 3 crackers at FT 60 s resulted in a mean reduction of 61.9%, while the delivery of 4 crackers at the same schedule resulted in a mean reduction of 28.87%. With that said, consistent decreases in rates of pica in both components 2 and 3, relative to component 1, suggest that the intervention utilized in component 2 was acting as an abolishing operation for pica in components 2 and 3.
CHAPTER IV

DISCUSSION

The purpose of the current study was to examine the effects of using fixed time schedules with different magnitudes of stimulus delivery as treatment for pica. Functional analysis outcomes indicated that pica persisted in the absence of social consequences and occurred most frequently when ambient stimulation was lower. An alternative stimulus was empirically identified (Piazza et al., 1998) that, when continuously available, effectively reduced rates of pica to near zero levels. A subsequent treatment analysis indicated that, when fixed time schedules were held constant, larger reinforcer magnitudes produced greater reductions in rate of pica. When reinforcer quantity was held constant, denser schedules of stimulus delivery produced greater reductions in rate of pica. Although it was thus shown that using a greater quantity of crackers increased the effectiveness of leaner schedules of reinforcer delivery, it was not possible to fade the temporal schedule to one that would have been useful in practice. Because it was not possible to safely present more than 4 crackers at once, the resulting schedule at which clinically significant results were obtained remained too dense for practical implementation by caretakers in the natural environment.

The current study extends the current literature on the effects of magnitude of reinforcement on NCR to problem behavior maintained by automatic reinforcement. Previous studies evaluated reinforcer magnitude with simple motor responses that were shaped and reinforced on variable-ratio schedules during baseline (Roscoe, Iwata &
Rand, 2003; Carr, Bailey, Ecott, Lucker & Weil, 1998). These studies also evaluated NCR with an extinction component (i.e., the stimulus presented following target responses during baseline was withheld during treatment). The current study differs in that the pica was automatically reinforced for Leroy. This reinforcer could potentially be withheld during treatment sessions by blocking attempts at pica; however, the participant was allowed to engage in pica at anytime during the sessions. Although extinction has been shown not to be a necessary component in applications of NCR to reduce problem behavior (Hagopian, Crockett, van Stone, DeLeon, & Bowman 2000; Lalli, Casey, & Kates, 1997), Hagopian and colleagues (2000) reported that, when NCR schedules were thinned, reductions were maintained only during extinction conditions. The current study suggests that reductions can be maintained while fading NCR schedules if the magnitude of reinforcement is increased.

In the current study, at FT 45s, delivery of 1 cracker produced a 72% reduction in the mean rpm of pica; 2 crackers produced a 78% reduction, and 3 crackers produced a 95% reduction. At FT 60s, delivery of 1 cracker produced a 38% reduction in the mean rpm of pica; 2 crackers produced a 70% reduction; 3 crackers produced a 77% reduction, and 4 crackers produced an 81% reduction. At FT 90s, 3 crackers produced a 23% reduction in the mean rpm of pica and 4 crackers produced a 72% reduction. In summary, increasing reinforcer magnitudes resulted in an additional 23% reduction in the mean rpm of pica at FT 45s (1 cracker to 3 crackers), an additional 43% reduction at FT 60s (1 cracker to 4 crackers), and an additional 49% reduction at FT 90s (2 crackers to 3 crackers). Also useful with this type of analysis is the ability to compare relative
reductions in pica across treatment values. For example, for Leroy to obtain a 70% to 72% reduction in the mean rpm of pica, he would need to receive 1 cracker delivered on a FT 45s schedule, 2 crackers delivered on a FT 60s schedule, and 4 crackers delivered at a FT 90s schedule.

There are possible explanations as to why it was not possible to produce clinically significant outcomes with leaner schedules of stimulus presentation during the current study. An individual’s preference to or the effectiveness of a competing alternative reinforcer may change over time due to satiation, habituation, or other abolishing operations (Michael, 1993; Vollmer & Iwata, 1991). Egel (1980) found that bar pressing increased and responses occurred more rapidly when reinforcers were varied compared to conditions when reinforcers were held constant. Bowman, Piazza, Fisher, Hagopian and Kogan (1997) found similar results with 4 of 7 individuals. It is thus possible that greater reductions in pica were not observed in the current study due to a decrease in the effectiveness of the crackers as a substitute for pica. Future research should examine procedures to maintain reinforcer effectiveness, such as presenting various stimuli or conducting presession competing stimulus assessments to select currently powerful replacement stimuli.

The three-component schedule has not reportedly been used prior to the current study to investigate the effects of NCR on pica. This schedule arrangement proves to be useful due to the evaluation of immediate and immediately subsequent effects of NCR. For example, the response reduction hypothesis predicts that when behavior is restricted below free operant levels, subsequent increases in behavior will occur following the
removal of the restriction (Timberlake & Allison, 1974). If the reinforcer used in NCR is not functionally equivalent to the reinforcer maintaining the problem behavior, subsequent increases could be seen in rate of the problem behavior following removal of NCR. Conversely, if the reinforcer is functionally equivalent to the reinforcer maintaining the problem behavior, rate of the problem behavior following the removal of NCR should either be similar to or less than preintervention levels (Rapp, 2006, 2007).

The three-component schedule design allows for an empirical evaluation of whether stimuli used in NCR are functionally equivalent to consequences maintaining pica by comparing component 1 (pre-intervention) and component 3 (post-intervention). Rapp (2006) showed an increase in stereotypy, relative to baseline rates, with a boy diagnosed with autism and mental retardation immediately following a blocking intervention. A decrease in stereotypy, relative to baseline rates, was shown immediately following an intervention consisting of noncontingent access to preferred items that appeared to produce similar stimulation as the stereotypy. Rapp (2006) concluded that blocking may have produced deprivation for the stereotypic behavior, thus acting as a motivating operation for stereotypy. On the other hand, access to items providing similar stimulation provided functionally similar stimulation, thus acting as an abolishing operation for stereotypy.

Results of the current study showed that occurrences of pica in component 3 were typically equal to or less than occurrences of pica in component 1. This suggests that NCR in component 2 was functionally equivalent to the maintaining consequence of pica or, in other words, NCR acted as an abolishing operation for subsequent occurrences of
pica in both components 2 and 3. These outcomes are unique in that they are the first to empirically show that NCR appears to be a function-based treatment for automatically maintained pica (i.e., that, in the current study, the consequence for engaging in pica was functionally equivalent to or substitutable for the consequence of eating food).

A limitation to the current study is that no observations or procedures took place in the natural environment. It is possible that increased rates of pica were an artifact of the experimental arrangement. Piazza et al. (2002) showed that alterations of the response effort required to obtain pica items affected the rate at which pica occurred. Within the current experimental arrangement, pica items were continuously and readily available to Leroy (on the table and floor next to him). Thus, there was a very low response effort required to obtain pica items. In the natural environment, a higher response effort is typically required to obtain pica items relative to the conditions arranged during the current experiment. Although this may have inflated rates of pica during the current study, doing so may have facilitated the experimental analyses of maintaining variables, competing stimuli, and immediate and immediately subsequent treatment effects. Conversely, inflated rates of pica might have interfered with an externally valid evaluation of the interactive effects of NCR schedules and magnitudes; if pica occurred at lower rates in the natural environment it is possible that large magnitudes of cracker delivery may have produced clinically significant effects at leaner FT values.

Another limitation in the current study is that reinforcer consumption time was not recorded or accounted for. Anecdotally, it did not appear that reinforcer consumption competed with pica, as Leroy would often engage in pica immediately following the
delivery of crackers into his mouth (prior, apparently, to swallowing the crackers).

Roscoe, Iwata, and Rand (2003) accounted for reinforcer consumption time when measuring the effects of reinforcer magnitude on NCR schedules and reported that NCR with larger magnitudes of reinforcement continued to produce lower rates of responding than smaller magnitudes of reinforcement.

It can be extremely difficult to prevent all occurrences of individuals engaging in automatically maintained pica due to the subtle, and in some cases, covert nature of the behavior. Thus, it is important to identify durable and generally effective approaches to treatment that can effectively reduce pica. Pica has also been described as difficult to treat due to the inability to separate or manipulate the maintaining nonsocial consequence from the behavior (automatic reinforcement). The results of the current study indicate that FT delivery of crackers was functionally equivalent to or substitutable for pica maintained by automatic reinforcement. As such, NCR may function as an abolishing operation for pica, competing effectively with pica and reducing future occurrences through satiation and/or habituation. The current line of this function-based treatment of pica can be extended through continued examination of potentially interactive effects among treatment variables such as reinforcer magnitude, schedule of stimulus presentation, and stimulus variety in both clinical and natural environments.
Figure 1. Results of the functional analysis for Leroy. Data are displayed as frequency of pica during each session for all conditions.
Figure 2. Results of the competing stimulus analysis for Leroy. Data are displayed as total frequency of consumption of pica and food items across 6 sessions.
Figure 3. Results of the treatment analysis for Leroy. Data are displayed as responses per minute of pica for all components. Component 1 is represented by closed squares. Component 2 is represented by closed diamonds. Component 3 is represented by open squares.
Mean Reduction in Pica from Component 1 to Component 2

Figure 4. Results of the treatment analysis for Leroy. Data are displayed as running mean percent reduction of pica, per treatment value, from component 1 to component 2 for all treatment values.
Figure 5. Results of the treatment analysis for Leroy. Data are displayed as mean percent reduction of pica from component 1 to component 2 for all treatment values.
Mean Reduction in Pica from Component 1 to Component 3

Figure 6. Results of the treatment analysis for Leroy. Data are displayed as mean percent reduction of pica from component 1 to component 3 for all treatment values.
REFERENCES


Burke, L., & Smith, S. L. (1999). Treatment of pica: Considering least intrusive options when working with individuals who have a developmental


