JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1986, 19, 411–416 NUMBER 4 (WINTER 1986)

FUNCTIONAL ANALYSIS AND TREATMENT OF SEVERE PICA

F. CHARLES MACE AND DAVID KNIGHT

LEHIGH UNIVERSITY

A two-phase functional analysis of a profoundly retarded 19-year-old male's pica facilitated the design of an effective intervention containing no aversive components. In the first analysis, frequent staff-client interaction resulted in 25% and 66% less pica than limited and no interaction, respectively. Paradoxical effects were obtained in the second analysis, where no protective helmet resulted in 38% and 26% less pica than the helmet with face shield and helmet without face shield, respectively. On the basis of these analyses, limited interaction and no helmet conditions were combined in an effective, staff-implemented treatment at a medium-sized institution.

DESCRIPTORS: pica, functional analysis, analogue assessment, mentally retarded

Ingestion of inedible objects, or pica, is one of the most prevalent behavior disorders among mentally retarded individuals (Danford & Huber, 1982). The potential for physical injury or death has led to the development of numerous punishment-based interventions aimed at rapidly suppressing the response, including time-out (Ausman, Ball, & Alexander, 1974), physical restraint (Singh & Bakker, 1984), visual screening (Singh & Winton, 1984), and overcorrection (Mulick, Barbour, Schroeder, & Rojahn, 1980). Less restrictive treatments such as discrimination training followed by differential reinforcement of other behavior (DRO) (Finney, Russo, & Cataldo, 1982) have met with mixed results.

The efficacy of less restrictive interventions has been enhanced by pretreatment analysis of the effects of various environmental variables on aberrant behavior (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). In one of only two studies examining environmental influences on pica, Madden, Russo, and Cataldo (1980) assessed mouthing responses of three preschool children of normal intelligence in three settings with varying degrees of environmental stimulation and found mouthing to be four to nine times greater in an impoverished environment (i.e., five household objects and no toys) than in either a group play or enriched individual play environment. In a similar study, Favell, McGimsey, and Schell (1982) found that profoundly retarded adolescents engaged in more nontoy pica when toys were available than when they were unavailable. However, rather than reducing all forms of pica, the availability of toys shifted the object of pica from potentially dangerous items (e.g., cloth, paper) to toys that were too large to be ingested. Hypothesizing that pica was maintained by gustatory reinforcement, Favell et al. (1982) introduced popcorn to the toys and no-toys conditions, resulting in a dramatic decrease in nontoy pica. In a final phase of the study, popcorn was provided contingent on appropriate toy holding, which effected increased toy holding and marked decreases in all forms of pica.

Our study was designed to extend this literature in the following ways. First, the investigation illustrated the application of a specific methodology to analyze functional relations between antecedent and concurrent environmental variables and aberrant behavior. Second, the results of a two-phase analysis were used to develop a highly effective, staff-implemented intervention containing no aversive elements. Third, the findings provided further support for some of the effects reported by Madden et al. (1980) and Favell et al. (1982). Further, paradoxical effects were found in the analysis of different levels of protective equipment (cf. Rojahn, Schroeder, & Mulick, 1980).

Reprint requests may be addressed to F. Charles Mace, Lehigh University, College of Education, 524 Brodhead Avenue, Bethlehem, Pennsylvania 18015.

METHOD

Subject and Settings

The subject was a 19-year-old, nonverbal, profoundly retarded male with moderate spastic quadriplegia. Jim ambulated short distances, had basic self-help skills related to eating, dressing, and hygiene, and responded to simple directives. Jim had a long history of pica for which a physician prescribed the use of a helmet with face shield to control the ingestion of inedible objects. Pica was the subject's dominant behavior during periods of minimum staff supervision. In the absence of pica materials, Jim would consistently search his surroundings until finding clothing or other materials that could be ripped or shredded and wedged between his face and the face shield and engage in pica.

The study was conducted in two settings of the medium-sized institution in which Jim resided. Baseline I, analysis of interaction conditions, and analysis of helmet conditions were conducted in the prevocational classroom. The classroom measured 5 m by 7.5 m, and contained two rectangular tables with chairs, various vocational materials positioned atop the tables, and five clients and two mental health workers. Both treatment phases and Baseline II were conducted in a day area (8 m by 10 m), which contained a table with craft or game activities, several lounge chairs, two benches, and 8 to 10 clients who were supervised by one or two direct-care staff.

Response Measures and Data Collection

Pica was defined as any of the following: (a) ripping or shredding cloth (a behavior that consistently preceded pica), (b) wedging pieces of cloth between the subject's face and face shield, and (c) placing an inedible object on or past the lips. This broad definition of pica was used to obtain a more accurate estimate of the response. Because staff were obliged to prevent the ingestion of inedible objects whenever it was observed, limiting the definition of pica to (c) would have resulted in a marked underestimate of pica as it occurred during periods of minimum supervision. *Staff interaction,* a variable investigated during one analysis phase of the study, was defined as (a) talking—a comment or question directed to the subject, and (b) touching—physical contact with the subject's body, clothing, or work materials in the client's possession.

Data on pica and staff interaction were collected by the second author during 15-min sessions using a 10-s partial interval recording procedure. Observations during all but the frequent interaction condition were obtained with the use of a 1-m^2 mirror to avoid eye contact with the subject. A second observer, uninformed of the hypotheses of the study, collected data independently from a position no closer than 2.5 m from the primary observer during a minimum of 30% of the sessions across phases of the study. Mean occurrence agreement on pica during both baseline phases, the first analysis phase, the second analysis phase, and both treatment phases was 91%, 83%, 74%, and 75%, respectively. Nonoccurrence agreement averaged 54% during baseline phases, 80% during the first analysis, 85% during the second analysis, and 88% during treatment phases. Mean total agreement was 92%, 89%, 90%, and 91% in the above phases, respectively (House, House, & Campbell, 1981).

Procedures

Baseline I. The procedures during Baseline I were those that occurred naturally in the classroom. Jim wore his protective helmet with face shield and was seated at a table alone or with one other client. The teacher presented Jim with a familiar vocational task that consisted of separating photographic negatives from their mylar backings. Following initial instructions to work, supervision consisted of the teacher circulating among the clients and providing general instructions in the performance of the task on a variable time (VT) 8-min schedule. When the teacher observed Jim place pieces of cloth or other inedible objects in his mouth, a mild reprimand was issued and the object was removed from his mouth.

Analysis of interaction conditions. The purpose of this phase was to examine the influence of noncontingent social interaction on Jim's pica (cf.

Madden et al., 1980). Preliminary observations suggested that Jim was less likely to engage in pica during periods of interaction with staff. During all sessions in this phase, Jim wore his protective helmet with full face shield and was the only client seated at a classroom table with his vocational task. To avoid repeated ripping of the subject's clothing to obtain pica materials, a sock was placed on the floor near Jim's chair at the beginning of each session. When the subject placed inedible objects on or past his lips, the experimenter removed the object without reprimands and avoided eye contact. For all sessions, staff interaction with the client was prompted by cues on the interval data sheet. Holding the above procedures constant, Jim was exposed to the following interaction conditions. *Frequent interaction* consisted of the experimenter sitting to the left of the subject at the same table. The experimenter provided Jim with almost continuous eye contact and verbal directions related to the vocational task on a VT 15-s schedule. Differential reinforcement of incompatible behavior was not a component of this or other conditions. During the *limited interaction* condition, the experimenter was seated facing away from Jim at a different table interacting with other clients. The experimenter circulated around the room and interacted with each client. Interaction consisted of talking to the subject about work related matters for 15–30 s once every 3 min. The *no interaction* condition simulated the situation frequently observed in the subject's day area (i.e., infrequent staff-client interaction). During this condition, the experimenter was seated facing away from the subject at a different table and provided no eye contact or verbal interaction.

Analysis of helmet conditions. This phase was designed to assess the efficacy of three levels of protective equipment in controlling pica (cf. Rojahn et al., 1980). The protective equipment prescribed by Jim's physician restricted his vision and social interaction. Thus, a goal of this phase was to empirically determine the minimum level of protection needed to discourage pica. Procedures during all sessions in this phase were identical to the limited interaction phase described above, with the following variations in helmet conditions. In the *helmet with face shield* condition, Jim wore a lightweight, padded plastic helmet with a transparent plastic face shield that extended from just below his nose to 4 cm below his chin. A similar helmet was worn without the face shield in the *helmet without face shield* condition. No protective equipment was worn in the *no helmet* condition. Unlike the Rojahn et al. (1980) study, which employed a fencing mask, the present equipment did not entirely prevent the pica response.

Treatment: No helmet plus limited interaction. The results of the two analysis phases suggested that an effective and practical treatment for use in the day area would be a combination of limited interaction and no protective helmet. Data derived from the analysis of helmet conditions caused the physician to discontinue the order for protective equipment; thus, no protective equipment was worn during this phase. Jim was seated on the floor or in a lounge chair with several large toys and a sock positioned within 1 m. A direct-care staff person was instructed to remain facing the subject from a distance of 3–5 m. The staff member was further instructed to make eye contact for 5–10 s on a VT 1-min schedule and to speak to Jim about the toy he was playing with on a VT 3-min schedule. A visual cue was used to prompt staff interaction on this schedule. Pica materials were matter-of-factly removed from the subject's mouth without reprimands or eye contact.

Baseline II. The setting and materials were identical to the treatment condition with the following exceptions: (a) the helmet and face shield described above were reintroduced, and (b) the direct-care staff member was positioned 3–5 m from the subject and did not make eye contact, touch, or speak to the client during the 15-min sessions. The latter procedure was representative of time blocks of 15 min or more in the day area.

Supplemental data. Functional relations identified during the analyses generated hypotheses regarding possible mechanisms responsible for this subject's differential rates of pica. The association of low levels of pica with social interaction and the absence of protective equipment suggested the pos-

sibility that (a) under natural conditions, staff-client interaction was greater when Jim was not wearing the helmet due to close staff supervision to protect Jim from ingestion of inedible objects; and (b) a consequence of closer staff supervision may have been that a higher proportion of pica responses resulted in punishment (i.e., reprimands). Data pertaining to these two hypotheses were collected by a single observer in the subject's day area under naturally occurring conditions. In this condition, the subject was seated in a lounge chair or on the floor with several large toys available within 1–3 m. One or two direct-care staff and 8 to 10 clients were also seated or standing in the day area. No instructions were provided to the staff regarding their interaction with Jim or other clients. Concerning hypothesis (a), staff interaction with Jim (defined above) was measured using 10-s partial interval recording during twelve 15-min sessions (six with protective equipment and six without). Regarding hypothesis (b), similar data were collected for pica and pica-contingent reprimands (defined as a vocal statement disapproving pica) during eleven 15-min sessions in the day area (five with protective equipment and six without).

Experimental Design

An alternating treatments design was used to compare conditions in both analysis phases of the study. The subject was exposed to each of the three experimental conditions within each analysis phase on a daily basis. The sequencing of conditions was determined randomly each day. The effectiveness of the treatment implemented in the day area was evaluated using a B-A-B reversal design.

RESULTS

Figure 1 shows the results of the baseline, analysis, and intervention phases. Percent intervals of pica during Baseline I conducted in the vocational classroom averaged 89.0%, ranging from 82%–95%. During the analysis of interaction conditions, pica was observed an average of 76.8% of the intervals when no interaction occurred between the subject and experimenter. Engaging in limited interaction with the subject resulted in substantially less pica (M = 45.5%; range, 39%–53%), and frequent interaction produced an additional, though less dramatic, decrement in pica, averaging 34.3% intervals (range, 29%–41%). Holding interchange constant at the level of limited interaction, differentiation among data series also occurred during analysis of helmet conditions. Mean percent intervals of pica when the subject wore his helmet with face shield was 39.3%, with a range of 27%–52%. Paradoxically, levels of pica decreased when less protective equipment was worn. Pica averaged 32.7% intervals (range, 25%–40%) under helmet without face shield conditions and 24.3% intervals (range, 19%–30%) when no helmet was worn.

Implementation of the analysis-derived treatment (limited interaction plus no helmet) in the subject's day area resulted in lower levels of pica than either of the two conditions produced alone during the analysis phases. Pica decreased during the first intervention phase from a high of 44% intervals to a low of 13% intervals at the end of the phase (M = 29.3%). Withdrawal of the treatment resulted in an immediate increase in pica to a mean of 51.4% intervals (range, 44%–57%). Reintroduction of the treatment reduced pica to an average of 14.8% (range, 5%–26%).

The supplemental data collected under natural conditions in the day area to shed light on possible mechanisms responsible for lower levels of pica under social interaction and no protective equipment conditions tended to support hypotheses (a) and (b). During the first 12 sessions, staff interacted (spoke to or touched, excluding reprimands) with Jim 3.44 times more (0.94% vs. 3.24% intervals) when he was not wearing his helmet with face shield than when the protective equipment was worn. In the subsequent 11 sessions, the ratio of percent intervals pica-contingent reprimands to percent intervals pica was 0.29 when no protective equipment was worn compared to only 0.04 when Jim wore the helmet with face shield. These supplemental data should be interpreted with caution because no variables were manipulated and interobserver agreement data are unavailable.

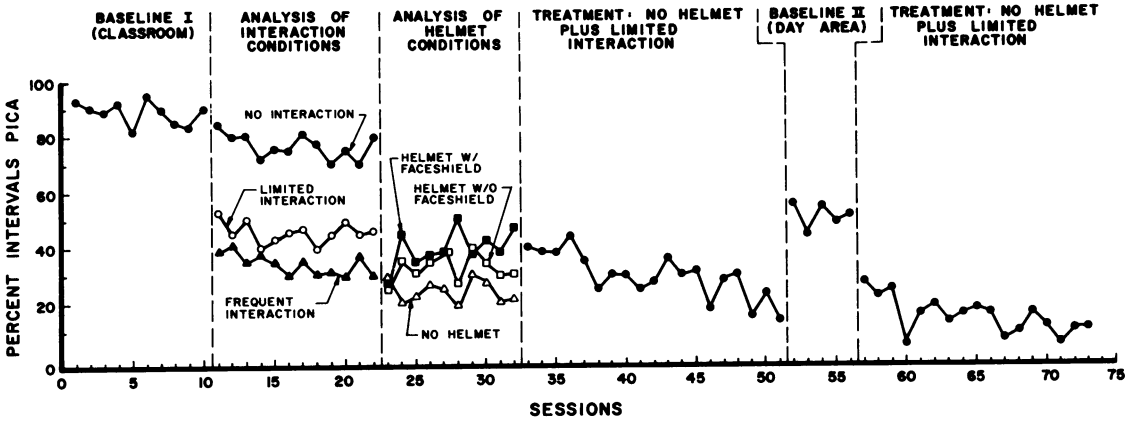

Figure 1. Percent 10-s intervals pica across baseline, analysis, and treatment conditions.

DISCUSSION

Functional relations were observed between both amounts of interaction and types of protective equipment and a profoundly retarded males's pica. These analyses provided the basis for the design of a practical and effective intervention that, unlike the majority of treatment approaches to pica, contained no aversive components. Data patterns during analysis of interaction conditions tend to support previous research by Madden et al. (1980) showing an inverse relationship between pica and environmental enrichment. However, Madden et al. concluded that lower levels of pica when social interaction and toys were present were due to the availability of more reinforcing alternatives to pica. Interpretation of our data differs in that social interaction appeared to correlate with different probabilities of contingent reprimands (rather than causing competing behavior), thus permitting the subject to predict the conditions in which pica could be safely emitted. Unlike the interaction analysis, the paradoxical findings from analysis of helmet conditions contrast those of Rojahn et al. (1980), who found protective equipment (i.e., a fencing mask) to effectively reduce both pica and, for some subjects, prepica behavior (e.g., searching, tearing, or shredding). These findings are likely due to differences in protective equipment used in this and the Rojahn et al. study. Rather than preventing or effectively discouraging pica, the helmet with face shield in this study correlated positively with lower levels of staff supervision and lower probabilities of pica-contingent reprimands. Thus, a plausible hypothesis appears to be that both interaction and the protective equipment may influence pica by enhancing discrimination of the consequences for the behavior.

Some may argue that analysis of antecedent and concurrent variables is one level removed from identifying the consequences that maintain behavior. However, some behaviors may be a function of stimuli that are either inaccessible or exceptionally difficult to manipulate. To the extent that behaviors such as pica, stereotypy, and self-injury are controlled by sensory consequences, direct observation and manipulation of these variables is problematic. One strategy in such cases has been to infer the functional consequences of a behavior by masking sensory consequences (e.g., Rincover, Cook, Peoples, & Packard, 1979, in the case of stereotypy) or elimination of consequences other than sensory (e.g., Iwata et al., 1982, in the case of self-injury). An alternative demonstrated in this study is the identification of antecedent and concurrent stimuli that reliably predict different levels of an aberrant behavior. Such an analysis facilitates achievement of the same goal as analysis of consequent variables, namely, the development of effective treatment procedures.

Our findings suggest further research on the

variables affecting pica that may be productive. First, this study, along with Madden et al. (1980) and Favell et al. (1980), indicates that enriching the environment with social interaction and alternative activities results in lower levels of pica. However, the mechanism underlying this effect requires greater elucidation. In our investigation, the association between increased social interaction and higher levels of pica-contingent reprimands suggests that environmental enrichment may have functions other than causing behaviors that compete with pica. Additional research examining possible discriminative functions of enriching stimuli is needed to supplement the differential reinforcement hypothesis. A second area for further study concerns the mechanism responsible for the paradoxical effects of protective equipment apparent in this investigation. The finding that the lowest rates of pica accompanied the absence of the helmet with face shield challenges the ubiquitous efficacy of protective equipment in the control of pica. Additional research is needed to support the discriminant function suggested in this study by the relationship between staff interaction (including use of reprimands) and the presence of protective equipment. Finally, enthusiasm for the subject and setting generality of a single-case investigation awaits replication. Of greater generality than the specific interaction and protective equipment variables is, we believe, the method of analyzing functional relations that leads to effective and parsimonious interventions.

REFERENCES

Ausman, J., Ball, T. S., & Alexander, D. (1974). Behavior therapy of pica with a profoundly retarded adolescent. *Mental Retardation,* **12,** 16–18.

Danford, D. E., & Huber, A. M. (1982). Pica among mentally retarded adults. *American Journal of Mental Deficiency,* **87,** 141–146.

Favell, J. E., McGimsey, J., & Schell, R. (1982). Treatment of self-injury by providing alternate sensory activities. *Analysis and Intervention in Developmental Disabilities,* **2,** 83–104.

Finney, J., Russo, D., & Cataldo, M. (1982). Reduction of pica in young children with lead poisoning. *Journal of Pediatric Psychology,* **7,** 197–207.

House, A., House, B., & Campbell, M. B. (1981). Measures of interobserver agreement: Calculation formulas and distribution effects. *Journal of Behavioral Assessment,* **3,** 37–58.

Iwata, B. A., Dorsey, M., Slifer, K., Bauman, K., & Richman, G. (1982). Toward a functional analysis of self-injury. *Analysis and Intervention in Developmental Disabilities,* **2,** 3–20.

Madden, N. A., Russo, D., & Cataldo, M. F. (1980). Environmental influences on mouthing in children with lead intoxication. *Journal of Pediatric Psychology,* **5,** 207–216.

Mulick, J. A., Barbour, R., Schroeder, S., & Rojahn, J. (1980). Overcorrection of pica in two profoundly retarded adults: Analysis of setting effects, stimulus, and response generalization. *Applied Research in Mental Retardation,* **1,** 241–252.

Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcment principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis,* **12,** 221–233.

Rojahn, J., Schroeder, S. R., & Mulick, J. A. (1980). Ecological assessment of self-protective devices in three profoundly retarded adults. *Journal of Autism and Developmental Disorders,* **10,** 59–66.

Singh, N. N., & Bakker, L. (1984). Suppression of pica by overcorrection and physical restraint: A comparative analysis. *Journal of Autism and Developmental Disorders,* **14,** 331–341.

Singh, N. N., & Winton, A. (1984). Effects of a screening procedure on pica and collateral behaviors. *Journal of Behavior Therapy and Experimental Psychiatry,* **15,** 59–65.

Received December 19, 1985
Final acceptance June 30, 1986