TREATMENT OF SELF-INJURY AND HAND MOUTHING FOLLOWING INCONCLUSIVE FUNCTIONAL ANALYSES

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Numerous studies have used functional analyses to prescribe interventions for severe behavior disorders. The majority of these studies have focused on behavior that is clearly maintained by socially mediated reinforcement, such as contingent access to attention, tangibles, or escape from instructional demands. However, a significant proportion of functional analyses do not yield conclusive results. We examined interventions for 3 children with severe disabilities following inconclusive functional analyses. First, preferred stimuli were identified for each child via a stimulus preference assessment. Second, a functional analysis was conducted for 2 of the 3 children. High rates of aberrant behavior were seen even (if not especially) in no-interaction sessions. The 3rd child was observed for several consecutive no-interaction sessions; behavior persisted in this condition. Third, interventions based on environmental enrichment were analyzed in an analogue setting. For all of the children, environmental enrichment decreased aberrant behavior if preferred stimuli were used in the procedure. To obtain further reductions in aberrant behavior, explicit reinforcement of toy play was required for 2 children, and a brief (5-s) time-out was necessary with 1 child. Finally, effects of treatment carried over to the school or home environment following teacher or family training. Results are discussed in the context of basic reinforcement principles and future directions for research.

DESCRIPTORS: environmental enrichment, functional analysis, stimulus preference, self-injurious behavior, family training

The use of pretreatment functional analyses has increased the likelihood of successful treatment for severe behavior disorders displayed by individuals with developmental disabilities (Mace, Lalli, & Pinter-Lalli, 1991). When a functional analysis is conducted before intervention, the experimenter or service provider may be able to develop an effective treatment, because variables that maintain a behavior can be identified and rearranged to reduce the likelihood of problem behavior while reinforcing appropriate behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). For example, the intervention known as functional communication training (FCT) involves replacing an undesirable behavior with an appropriate communicative response that serves the same function (Carr & Durand, 1985).

Although interventions based on functional anal-

yses have proven to be successful, the generality of the current literature may be limited because most studies have focused on behavior that is clearly maintained by socially mediated reinforcement (e.g., attention, tangible reinforcement, or escape from instructions). In an epidemiological analysis, Iwata et al. (1994) reported that approximately 5% of their functional analyses of self-injurious behavior were inconclusive, and more than 25% did not show a sensitivity to socially mediated reinforcement; Derby et al. (1992) reported that 34% of their clients displayed aberrant behavior that appeared to be maintained by automatic sensory consequences. Despite these data, disproportionately few studies have focused on the treatment of behavior disorders following undifferentiated results of functional analyses.

The focus on interventions for behavior maintained by socially mediated reinforcement may be because an experimenter or clinician can control social contingencies. For example, if a behavior is maintained by attention, the environment can be arranged so that attention is withheld or delivered at the experimenter's discretion (e.g., Vollmer, Iwa-

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ta, Zarcone, Smith, & Mazaleski, 1993). Similarly, if behavior is maintained by escape, access to escape can be withheld or delivered at the experimenter's discretion (e.g., Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990). However, if a behavior persists independent of the social environment or has been undifferentiated in a functional analysis, an experimenter or clinician is less able to identify, control, or manipulate the relevant variables that maintain the behavior.

Functional analyses may yield undifferentiated results for several reasons. One possibility is that the behavior is maintained by automatic positive or negative reinforcement that occurs independent of social variables (see Vollmer, *in press*, for a recent review). For example, automatic positive reinforcement may take the form of endogenous opiate production (Sandman, Barron, & Colman, 1990); automatic negative reinforcement may result from pain-attenuating behavior such as self-scratching (Carr & McDowell, 1980) and ear hitting (Cataldo & Harris, 1982). A second possibility is that behavior is multiply controlled (Smith, Iwata, Vollmer, & Zarcone, 1993). A third possibility is that discrimination problems may occur due to rapidly alternating conditions or subtle extraneous variables (Vollmer, Iwata, Duncan, & Lerman, 1993). Finally, experimenters may fail to include all relevant variables in the analysis, such as biological factors or idiosyncratic environmental stimuli. In this worst case, the current state of our assessment methodology may not allow identification of all the variables that maintain self-injury for given clients.

Behavior analysts are frequently asked to identify effective and acceptable interventions in the face of undifferentiated or inconclusive assessment data. At least three general strategies could be examined to increase the likelihood of successful behavioral intervention. First, the quality of the reinforcers in an enriched environment (Horner, 1980) or in a differential reinforcement procedure could be maximized by using methods for ascertaining stimulus preference (e.g., Fisher, Piazza, Bowman, Hagoopian, & Owens, 1992). The higher the quality of alternative reinforcers, the more responding should

shift toward appropriate behavior. Even if biological mechanisms, such as dopamine depletion (Baumeister, Todd, & Sevin, *in press*), are implicated as maintaining factors, behavioral interventions may depend on the potency of the reinforcers used to override the maintaining conditions. Second, "sensory extinction" procedures may allow appropriate behavior to compete with aberrant behavior because some of the stimulus products of aberrant behavior may be attenuated (Lovaas, Newsom, & Hickman, 1987; Rincover, 1978). Third, punishment of aberrant behavior may shift response allocation toward appropriate behavior by increasing the relative value of reinforcement for the appropriate alternative (Deluty, 1976).

In this study we examined the role of stimulus preference in interventions for self-injury and hand mouthing following inconclusive functional analyses. In addition to assessing interventions for behavior problems following undifferentiated results of functional analyses, this study may advance the current literature in the following ways: (a) Stimulus preference assessments are used in conjunction with environmental enrichment and reinforcement-based procedures; (b) the individual and combined effects of treatment packages are assessed; (c) a method is described for systematically adding components to treatment packages to improve overall treatment efficacy; (d) the results have implications for early intervention (the participants were in preschool); and (e) the generality of the procedures was assessed through systematic family training.

GENERAL METHOD

Participants and Setting

Three children who attended a noncategorical preschool participated in the study. The participants were the first 3 children referred to our program for the analysis and treatment of self-injury whose aberrant behavior showed no obvious differential sensitivity to socially mediated reinforcement (see description of functional analysis). The children's parents provided informed consent to participate in the study.

Ron was a 3-year-old boy who had not received a formal diagnosis for his disabilities. He did not have any conventional language skills and had not yet developed self-care skills such as toileting or dressing. He was ambulatory and appeared to enjoy being around other people. Ron was referred for intervention due to self-injurious behavior (SIB) in the form of head hitting, ear poking, and biting and sucking on his fingers. Korey was a 3-year-old boy with multiple disabilities; like Ron, he did not display conventional language or self-care skills. He also had significant visual and auditory impairments. Korey was nonambulatory and was unable to use his wheelchair independently. Some of his fingers were not separated, which limited his grasping ability. Although Korey was frequently unresponsive to social interaction, he would occasionally smile, laugh, or make brief eye contact. Korey was referred for head banging, head hitting, and hand biting. At the time of referral, his behavior was not forceful enough to incur significant tissue damage, but the behavior was reportedly increasing in intensity as he got older. Rhonda was a 4-year-old girl who engaged in many "autistic-like" behaviors such as hand twirling and rocking. She also displayed no conventional communication. She was ambulatory but walked with an unusual and unsteady gait. She had mild visual impairments that were corrected through the use of glasses. Rhonda was referred for treatment because she engaged in chronic hand mouthing that resulted in the application of an arm brace throughout the school day before intervention.

Analogue sessions took place in a classroom at the preschool, but each child was observed without other children in the room. The classroom was equipped with toys and a variety of academic materials that were put away during sessions. The area of the room used for the experimental sessions was approximately 7 m² with a carpeted floor; one wall was lined with large windows. Observers sat at a teacher's desk or at a work table during sessions. Family training sessions took place at the participants' homes, and classroom observations took place in each child's regular classroom. With rare excep-

tions, observational sessions lasted 10 min (see Family Training).

Response Measurement and Reliability

Target behaviors were SIB, hand mouthing, and appropriate behavior. SIB consisted of *head banging* (Korey)—contact of the head against a solid object; *head/face hitting* (Korey, Ron)—forceful contact of a hand or arm with any part of the head or face; *ear picking* (Ron)—scraping of the fingernails against the skin on or in the ear; *hand biting* (Korey)—contact of the teeth with the hand. *Hand mouthing* (Rhonda) was defined as any contact of the hand or fingers with the mouth that broke the plane of the lips. For Korey and Ron, appropriate behavior was defined as contact with toys; for Rhonda, appropriate behavior was defined as contact with toys, food, or therapist (eye contact, touching). Target behaviors were recorded by observers using hand-held computers (Assistant, Model AST 102) or laptop PCs. Observation sessions lasted 10 min, and data were converted into percentage of intervals using a 10-s partial-interval recording procedure.

To assess interobserver agreement, a second observer concurrently but independently collected data for each participant during at least 20% of the sessions in each condition of each phase (functional analysis, analogue treatment analysis, and family training). Each 10-s interval was scored as either an agreement or a disagreement on the occurrence or nonoccurrence of a behavior. The number of intervals scored as an agreement was divided by the total number of intervals in each session. Mean agreement scores for SIB were 94.3% and 98.3% for Korey and Ron, respectively. Mean agreement for mouthing was 96.0% for Rhonda. Mean agreement scores for appropriate behavior were 93.3%, 84.9%, and 85.2% for Korey, Ron, and Rhonda, respectively. The lowest agreement score during any condition for any of the 3 participants was 81.0% (appropriate behavior for Rhonda during the analogue treatment analysis). Because there was no opportunity for appropriate behavior in the no-interaction baselines (see Procedure below), no

agreement scores for that target response were calculated during that condition.

During family training, interobserver agreement measures were taken for correct antecedent (Korey's family), correct consequence to inappropriate behavior (Rhonda's family), and correct consequence for appropriate behavior (Korey's and Rhonda's family). Interobserver agreement scores for those categories averaged 81.3% (range, 46.7% to 100%), 99.2% (range, 90% to 100%), and 92.1% (range, 80% to 100%), respectively.

Stimulus Preference Assessments

A stimulus preference assessment was conducted prior to the functional analyses using the procedures described by Fisher *et al.* (1992). The child was presented with randomized pairs of stimuli and was asked to select the one he or she wanted. When the child touched one of the two stimuli, the response was scored as a "selection." The experimenter then allowed the child to contact the stimulus for approximately 30 s. For example, if the stimulus was a toy, the child could play with it. At least 10 stimuli were assessed for each child, and each item was paired with all other items at least once. The stimuli used in the assessment were either suggested by the child's teacher or parent or were items that the children routinely contacted at the school, and included food, drinks, auditory toys (e.g., music), visual toys (e.g., lights), tactile toys (e.g., Koosh® ball), and traditional toys (e.g., dolls, cars), among others. Randomized pairs were presented until clear preferences were identified, as defined by the highest percentage of selection per item (for each child, at least two stimuli were selected on over 80% of the trials). Preferred stimuli identified for Ron were toy rubber circles, blocks, and magnets. For Korey, preferred stimuli included a sound-making toy (e.g., See-n-Say®) and a music box. For Rhonda, preferred stimuli included sound-making toys, cookies, and a Koosh® ball. A second stimulus preference assessment was conducted for Korey at a later time (see description of treatment procedures). In the second assessment, Korey showed a preference for sound-making toys, a mirror, and a toy bus.

PHASE 1: FUNCTIONAL ANALYSIS

Procedure

The functional analyses were based on the procedures described by Iwata *et al.* (1982), and included an assessment of sensitivity to tangible positive reinforcement. The stimuli identified during the stimulus preference assessment were used as preferred stimuli in relevant conditions. Sessions were conducted one to four times per day, 4 days per week, depending on the participants' schedules.

Korey and Rhonda were exposed to the following conditions: attention (preferred stimuli were available noncontingently, attention was delivered only contingent on SIB), tangible positive reinforcement (preferred stimuli were delivered contingent on SIB), instructions (academic instructions or tasks were presented once every 30 s using a three-prompt instructional sequence; instructions were terminated contingent on SIB), no interaction (participant was observed in an austere environment; no programmed consequence for SIB), and play (noncontingent access to preferred stimuli, fixed-time 30-s attention, and no programmed consequence for SIB). These conditions were presented during 10-min sessions in a multielement format. Rhonda's arm brace was removed for all sessions.

Before his intervention analysis, Ron was exposed only to the no-interaction condition. We wanted 1 participant to have no explicit social reinforcement history in the analogue setting. A no-interaction baseline is not sufficient evidence to suggest that his behavior was insensitive to social contingencies, but only that the behavior would persist in the absence of programmed contingencies. Between sessions, Ron was given attention only following periods of several seconds without SIB, to reduce the possibility of accidental reinforcement. Previous research has shown that SIB that is maintained by social consequences will extinguish under similar circumstances with repeated no-interaction sessions (Vollmer, Iwata, Duncan, & Lerman, 1993). Also, prior research has shown that the noncontingent attention delivered between sessions should not result in an accidental reinforcement effect (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993).

Results

Figure 1 shows the results of the analysis for each participant. For Korey, the level of SIB was undifferentiated across all conditions. The lowest levels of SIB were seen in conditions in which preferred stimuli were available (attention and play). The highest rates of SIB were seen in the conditions in which preferred stimuli were not available (demand, tangible, and no interaction). Korey was observed for 11 consecutive no-interaction sessions, and the SIB persisted (with the exception of one session). For Rhonda, the target behavior occurred at a high level across all assessment conditions and during four consecutive no-interaction sessions. For Ron, with the exception of Sessions 10 and 11, the target behavior persisted at a level above 25% of the intervals despite the absence of social consequences during all of his assessment sessions. The insensitivity of Ron's SIB to social contingencies was further supported in his treatment analysis (see Phase 2).

PHASE 2: ANALOGUE TREATMENT ANALYSIS

Procedure

Baseline and treatment sessions generally lasted 10 min and were conducted one to four times per day, 4 days per week. The baselines were taken from the no-interaction observations reported in Phase 1 (for Korey and Rhonda) and from the last half of Ron's assessment observations in Phase 1. In the descriptions below, the term *enriched environment* will be used to describe the environment in comparison to the no-interaction condition. It is acknowledged that the term should generally refer to an environment enriched with preferred stimuli only.

Ron. The treatment for Ron was analyzed with an ABCBCB reversal design. The A condition was baseline, in which Ron was observed in no interaction (no toys, no therapist present) with no programmed consequence for SIB. An observer was present in the room. The B condition was an enriched environment with preferred stimuli (EE+). The C condition was an enriched environment with nonpreferred stimuli (those selected in less than 20% of the opportunities during the preference

Figure 1. Functional analyses for Korey (upper panel) and Rhonda (center panel) and repeated no-interaction sessions for Ron (lower panel). Target behaviors are expressed as percentage of 10-s intervals observed.

assessment) (EE-). The second C condition also was an enriched environment with nonpreferred stimuli, but Ron was exposed to a single session of each of the conditions described for Korey's and Rhonda's functional analyses (Phase 1). The final

B condition was an enriched environment with preferred stimuli, but Ron was exposed to conditions described for Korey's and Rhonda's functional analyses in Phase 1 (a tangible-item condition was not conducted here because by definition he had free access to preferred stimuli in the enriched environment).

Korey. The treatment for Korey was analyzed using an ABCAC reversal design. The A condition was baseline, in which Korey was observed in no interaction (no toys, no therapist interaction) seated next to a large table with no programmed consequence for SIB. The B condition was an enriched environment with preferred stimuli (placed within arm's reach next to the wheelchair). The only difference between the environmental enrichment and the play conditions during the functional analysis was that toys were always kept within Korey's reach and there was no attention delivered. This was accomplished by seating Korey in front of a larger table and replacing dropped toys immediately. The C condition was an enriched environment combined with reinforcement for toy contact; a therapist activated a toy when Korey touched it. During the final C condition, the stimuli used in the enriched environment were based on a second preference assessment conducted because treatment gains began to decline. At the end of the final C condition, Korey's sound-making toys were activated by a microswitch, eliminating the need for a therapist to complete the response.

Rhonda. Rhonda's arm brace was removed during all sessions. Treatment for Rhonda was analyzed using an ABCDEBE reversal design. The A baseline condition was identical to that of Ron and Korey. The B condition was an enriched environment with nonpreferred stimuli (EE-). The C condition was an enriched environment with preferred stimuli (EE+). As with Korey, EE sessions differed slightly from play sessions. During EE, preferred stimuli were explicitly kept within an approximately 2-m radius (Rhonda almost always elected to stay seated on the carpet during observational sessions). The D condition was positive reinforcement combined with EE+: Hand-mouthing responses were blocked, and stimulus interactions were reinforced by the

therapist assisting Rhonda in completing the response. Because Rhonda's mother and teacher had expressed concern about her lack of social interaction, social contacts such as eye contact and touching were followed by 5 s of verbal praise and arm touching. The E condition was identical to the D condition except that mouthing resulted in 5 s of hands-down time-out, in which the therapist blocked the response and held Rhonda's hands at her side. Blocked responses were scored as an instance of mouthing, and time-out intervals were not calculated as part of the 10-s interval.

Results and Discussion

Ron. Figure 2 shows the results of Ron's treatment analysis. His SIB persisted ($M = 43.1\%$; range, 5% to 73.3%) in the absence of programmed reinforcement contingencies (baseline). When provided with preferred stimuli (EE+), the percentage of intervals with SIB decreased markedly ($M = 2.8\%$; range, 0% to 23.3%); most of his time was spent holding or playing with the preferred stimuli ($M = 93\%$; range, 55% to 100%). When the preferred stimuli were replaced with nonpreferred stimuli (EE-), SIB increased ($M = 49.6\%$; range, 1.7% to 88.3%) and appropriate behavior decreased ($M = 14.2\%$; range, 0% to 56.7%). The effects of EE+ were replicated when a reversal to that condition was conducted (M for SIB = 0.2%; M for appropriate = 99.4%). Finally, exposure to conditions identical to the functional analyses for Korey and Rhonda resulted in high rates of SIB only when toys were unavailable (M when unavailable = 52.1%; M when available = 0.2%). These results demonstrate the value of a preintervention stimulus preference assessment; it was not the availability of stimulation per se that resulted in a decrease in SIB; preferred stimuli were required. In addition, there was an inverse relation between appropriate behavior and SIB, suggesting that reinforcement derived from the preferred stimuli may have overridden the variables that maintained SIB. Finally, the limitations of Ron's pretreatment assessment were addressed by demonstrating that social contingencies did not influence his SIB.

Following the analogue intervention, recom-

Figure 2. Upper panel: Percentage of intervals with SIB and appropriate behavior for Ron during baseline (no interaction), enriched environment (preferred stimuli) (EE+), enriched environment (nonpreferred stimuli) (EE-), and enriched environment (EE+). Finally, functional analyses were conducted in the context of EE- versus EE+. Center panel: Percentage of intervals with SIB and appropriate behavior for Korey during baseline (no interaction), enriched environment (preferred stimuli) (EE+), EE+ and positive reinforcement, baseline, EE+ and positive reinforcement, and EE+ and positive reinforcement following an updated stimulus preference assessment. Lower panel: Percentage of intervals with hand mouthing and appropriate behavior for Rhonda during baseline, enriched environment (nonpreferred stimuli) (EE-), enriched environment (preferred stimuli) (EE+), EE+ and positive reinforcement, EE+ and positive reinforcement plus time-out, EE-, and EE+ and positive reinforcement plus time-out.

mentations were made to enrich Ron's classroom environment during free time (i.e., make preferred toys available). Ron's teacher was taught to conduct daily abbreviated stimulus preference assessments, and she then made the preferred toys available to Ron on a nearly continuous basis (except at times when toys would interfere with learning activities). Follow-up data were collected after 4.5 months in Ron's classroom during six separate 10- to 15-min observations (not depicted in Figure 2). Follow-up observations during regular ongoing classroom activities showed that SIB remained at low levels when preferred toys were available ($M = 2.2\%$ of intervals). Follow-up data in the classroom also showed that SIB remained at high levels when preferred stimuli were unavailable ($M = 57.0\%$). Before observations with stimuli unavailable, preferred toys were removed from the room by an experimenter.

Korey. Figure 2 shows that Korey's SIB also decreased relative to baseline (baseline $M = 48.8\%$; range, 0% to 80%) as a function of an environment enriched with preferred stimuli (EE+) ($M = 13.9\%$; range, 6.7% to 21.7%); however, there was a slight increasing trend in SIB correlated with a sharp decreasing trend in appropriate behavior (M for appropriate = 57.1%; range, 36.7% to 85%). It was noted anecdotally that Korey was unable to manipulate the preferred toys effectively due to his extensive motor and physical disabilities. When the therapist began activating the toy contingent on toy contact (EE+ /Sr+), the percentage of intervals with appropriate behavior increased ($M = 82.6\%$; range, 70% to 97%) with a concurrent decrease in SIB ($M = 3.8\%$; range, 1.7% to 8.3%). Following a reversal to baseline ($M = 46\%$; range, 16.7% to 73.3%), the EE+ /Sr+ condition was reimplemented; however, treatment effects began to deteriorate (SIB $M = 18\%$; range 0% to 33.3%; appropriate $M = 69.7\%$; range, 25% to 88.3%). After conducting a second stimulus preference assessment, Korey's SIB was again reduced ($M = 3.8\%$; range, 0% to 13.3%) with a concurrent increase in appropriate behavior ($M = 88\%$; range, 75% to 100%). Finally, when Korey was able to activate his sound-making toys, SIB stayed at a

low level and appropriate behavior stayed at a relatively high level.

Subsequent to our treatment analysis, Korey's teacher conducted abbreviated preference assessments and provided continuous access to preferred stimuli during free time at school. The EE classroom was equipped with switch-activated toys as well as other toys (such as Korey's mirror and bus). Two 10-min follow-up observations (not depicted in Figure 2) were conducted in Korey's new classroom 5 months after completion of our analogue treatment analysis. Follow-up observations were unannounced and occurred during regular classroom activities. He displayed no SIB and showed high rates of appropriate behavior ($M = 75\%$ of intervals). One observation was conducted during switch-toy play and no teacher interaction, and a second observation was conducted during other toy play and teacher interaction. Additional generalization and follow-up data for Korey are reported in Phase 3.

Korey's results further demonstrate the utility of a preintervention stimulus preference assessment. Not only did access to preferred stimuli reduce occurrences of SIB, but those reductions were apparently a function of a current preference for the stimuli. Thus, stimulus preferences may need to be updated on a frequent basis (Mason, McGee, Farmer-Dougan, & Risley, 1989). The results also illustrate that, if a child is unable to manipulate his or her preferred stimuli in an enriched environment, explicit reinforcement or assistance from a therapist may be required.

Rhonda. Figure 2 shows that an enriched environment had only a moderate effect on Rhonda's hand mouthing (baseline $M = 87.2\%$; EE- $M = 52.9\%$). The enriched environment containing preferred stimuli (EE+) reduced mouthing slightly more than the enriched environment with nonpreferred stimuli (EE-) ($M = 47.5\%$; range, 28.3% to 65%). EE+ also resulted in an increase in appropriate behavior when compared with EE- ($M = 42.5\%$ vs. 21.4%). Despite the reduction, mouthing still occurred at high levels. When positive reinforcement was implemented (EE+ /Sr+), appropriate behavior was further increased ($M =$

66.6%; range, 58.1% to 85%) with concurrent decreases in mouthing ($M = 29.3\%$; range, 11.7% to 51.9%). However, mouthing still occurred at fairly high levels and showed a gradual increasing trend. Finally, when response blocking (one component of the EE+/Sr+) was replaced with a 5-s time-out, mouthing decreased ($M = 11.1\%$; range, 0% to 48.3%) with concurrent increases in appropriate behavior ($M = 73.9\%$; range, 41.7% to 96.7%). These effects were replicated following a reversal to EE-. Follow-up data and additional evidence of experimental control are reported for Rhonda in Phase 3. Following family and teacher training, her arm brace was permanently removed at home and at school.

Rhonda's results point to some limitations of interventions that rely on competition between reinforcers delivered by the environment and unknown variables maintaining aberrant behavior. Specifically, preferred stimuli apparently were not potent enough to compete with the variables that maintained Rhonda's hand mouthing. Despite a modest reduction in mouthing during the enriched environment condition, it was not until a time-out contingency was implemented that satisfactory changes in behavior were observed. It is unknown whether the hands-down time-out was effective because of contingent aversive stimulation (punishment) or a contingent loss of opportunity to obtain sensory reinforcement (time-out). As with Ron and Korey, Rhonda's behavior showed a strong inverse relation between appropriate and inappropriate responding. Thus, mild punishment did not result in a generalized suppression of behavior.

PHASE 3: FAMILY TRAINING

Procedure

Rhonda, Korey, and their families participated in the family-training component at their homes; Ron and his family were unable to participate. Family training visits were usually conducted once per week for approximately 1 hr per family for 7 weeks (not including follow-up). During baseline and posttraining observations, 5-min blocks of time were randomly selected for observation during the

visit. One to four observation blocks were dispersed throughout the hour. Although reactivity to observers was expected, reactive effects were held constant across baseline and treatment as much as possible.

Rhonda. Rhonda's mother and older sister (12 years old) participated in the training. Rhonda's mother identified the most problematic times of day as before and after dinner when Rhonda's mother was cooking or her sister was cleaning. Thus, the hour before or after dinner was targeted for implementation of the procedure.

During baseline, the experimenters placed preferred stimuli in the room, but otherwise did not alter the typical family environment. Following a series of baseline observations alternating between the mother and sister in the family room with Rhonda, training was conducted. Rhonda's mother was trained before her sister, and the procedure was the same as that used in the terminal condition of Phase 2 (EE+/Sr+/time-out). First, the experimenter demonstrated an abbreviated version of the stimulus preference assessment, which allowed Rhonda to select preferred stimuli for that evening. Second, training consisted of a verbal description of our findings in the analogue setting. Although the family was generally aware of the procedures we used, baseline data showed that the family was not conducting the procedure at home. Third, the procedure was modeled by an experimenter for 10 min with accompanying verbal descriptions and explanations. Fourth, about 1 min of role playing was conducted between the trainee and the experimenter. Fifth, the mother and sister conducted the procedure for 10 min with immediate feedback from the experimenter (e.g., "She just put her hand in her mouth, be sure to hold her hands down now"; "Good, you turned on the toy for her when she touched it"). Sixth, a 10-min session was conducted by the mother and sister with the experimenter providing feedback after the completion of the session (e.g., "There was one instance when you forgot to put her hands down"). The family was asked to conduct the procedure every night, and posttraining observations commenced the following week.

The dependent measures for Rhonda and her mother or sister were percentage of intervals with hand mouthing, percentage of intervals with appropriate behavior, percentage of correct responses to hand mouthing (hands down for $5\text{ s} \pm 1\text{ s}$, calculated as a percentage of opportunity given the initiation of hand mouthing), and percentage of correct responses to appropriate behavior (toy play contingent on toy touch or social interaction contingent on eye contact or touching, calculated as a percentage of opportunities given the initiation of appropriate behavior). Interobserver agreement measures were reported in the General Method section above.

Korey. Korey's 2 brothers (7 and 9 years old) participated in family training. Preliminary observations showed that Korey's mother interacted with him in a manner consistent with our procedure (she had discovered that toy play and other stimulation resulted in low rates of SIB; also, she allowed him to select stimuli by pointing from an array). We were unable to observe Korey interacting with his father, but his mother reported that their interactions were consistent with our program. An interview with Korey's mother indicated that she had time to play with him and take him on walks through the neighborhood after school, but that before and after dinner were problematic times because his brothers did not interact well with him. We recommended that the family purchase switch-activated toys to use during this time. Although she agreed that switch-activated toys would be beneficial, Korey's mother expressed an interest in encouraging his brothers to play with him at least 1 hr per day before or after dinner.

Following a series of baseline observations with both brothers in the room (Korey's preferred stimuli were available but were not placed within his reach), training was conducted. Training followed the same sequence used with Rhonda's family; however, both brothers were trained as a pair, with either child delivering the antecedents (toys within arm's reach) and consequences (activation or manipulation of toys contingent on touching). Post-training observations commenced the week after the training session. Although it was not pro-

grammed, Korey's parents occasionally prompted the older siblings to play with him. The observers never prompted play or interaction.

The dependent measures for Korey and his brothers were percentage of intervals with SIB, percentage of intervals with appropriate behavior, percentage of intervals with correct antecedent (toys within arm's reach), and percentage of correct responses to appropriate behavior (toy activation or play contingent on toy touching, calculated as a percentage of the opportunities given an initiation of appropriate behavior). Interobserver agreement measures were reported in the General Method section above.

Results

Training was conducted for Rhonda's mother, Rhonda's sister, and Korey's brothers sequentially in a multiple baseline design. Figure 3 shows the results of training for each dyad or triad. In each case, clear reductions in the target behavior and concurrent increases in appropriate behavior were correlated with the completion of family training. These results replicate those seen in the analogue treatment analysis.

Figure 3 also shows the results of 1- and 5-month follow-up observations with Rhonda's family. Korey's family was not available for follow-up observations. Both families reported that the procedures were conducted virtually every evening that the family was home.

Treatment integrity measures showed improvement for both families from baseline to posttraining. Rhonda's mother never provided the correct consequence for mouthing in baseline, but that measure increased to a mean of 76.6% of opportunities following training (range, 10% to 100%). Her correct consequences for appropriate behavior increased from a mean of 55% during baseline (range, 42.9% to 66.7%) to 89.5% following training (range, 69.2% to 100%). During baseline, Rhonda's sister rarely provided the correct consequence for mouthing ($M = 0.8\%$; range, 0 to 3.3%), but this measure increased to a mean of 87.4% following training (range, 69.2% to 100%). During baseline, Rhonda's sister responded cor-

Figure 3. Effects of family training on aberrant and appropriate behavior for Rhonda with her mother (upper panel) and sister (center panel) and for Korey with his brothers (lower panel). Target behaviors are expressed as percentage of 10-s intervals observed.

rectly to appropriate behavior during an average of 42.3% of the opportunities (range, 25% to 55.5%), which increased to a mean of 90.7% after training (range, 65.2% to 100%). During baseline, Korey's brothers never provided correct antecedents or correct consequences for appropriate behavior. Following treatment, they provided correct antecedents during an average of 77.8% of the intervals (range, 60% to 96.7%) and correct consequences for appropriate behavior for a mean of 77.3% of the opportunities (range, 11.1% to 100%).

A booster training session was conducted for Rhonda's mother after Session 8 and for Rhonda's sister after Session 10. Booster sessions replicated the initial training, but with 5-min rather than 10-min modeling and feedback sessions. The sessions were conducted because of decreasing trends in the integrity of treatment implementation. The trends were reversed following the boosters. Korey's brothers did not receive further training after the initial session, but the parental prompting was first noted in Session 16; these prompts may have served the function of a booster session.

GENERAL DISCUSSION

The results of this study show that, despite inconclusive functional analyses, aberrant behavior can be treated using interventions based on environmental enrichment. Treatment packages were highly individualized, due to idiosyncratic preferences for reinforcers across participants. With each participant, the introduction of preferred stimuli into the environment also resulted in increases in appropriate behavior. For Ron, the enriched environment competed with unknown variables maintaining SIB. For Korey, the enriched environment competed with unknown variables when alternative responding was explicitly reinforced and when stimulus preference was regularly reassessed. The enriched environment with preferred stimuli competed with Rhonda's aberrant behavior only to a degree; responding was allocated about equally between aberrant and appropriate behavior. It was not until responding produced time-out that a re-

duction in hand mouthing was clinically significant. Collectively, these results indicate that the application of a preintervention stimulus preference assessment may help to override unknown maintaining variables.

From a conceptual standpoint, the results of this study are relevant to an understanding of variables that maintain aberrant behavior. In all three cases, concurrent reductions in SIB or mouthing and increases in appropriate behavior showed an inverse relation. Neef, Mace, and Shade (1993) suggested that functional analyses may examine not only the type of reinforcement contingencies but also individual sensitivities to different reinforcement dimensions. For Ron, the relative quality of his preferred stimuli appeared to compete effectively with aberrant behavior. However, when the quality of the stimuli was reduced (as defined by lower preference in the assessment), behavior was allocated almost exclusively to the unknown schedule maintaining aberrant behavior. Presumably some moderately preferred stimulus would have resulted in response allocations somewhere between the two extremes, as with Rhonda during her EE+ and EE- conditions.

For Rhonda, the relative quality of the preferred stimuli appeared to approximate the potency of the reinforcers or other variables that were maintaining hand mouthing (see EE+ condition). When a time-out contingency was introduced, responding shifted further to appropriate behavior. This finding is compatible with basic research showing shifts in response allocation on concurrent schedules when punishment is introduced (Deluty, 1976). Alternatively, the time-out contingency may have been effective because of a reduced probability of reinforcement for aberrant behavior.

Limitations of this study should be pointed out. First, although a functional analysis was conducted, the specific maintaining variables for SIB were not identified for each child; thus, behavioral reduction based on overriding the maintaining variables rather than eliminating them may not result in long-term reduction of behavior.

A second limitation is the possibility that socially

mediated sources of reinforcement were maintaining the behavior on intermittent schedules that were not identified or detected in our analysis. Although we were careful not to provide explicit consequences for the behavior, the intermittency of reinforcement schedules is never certain in naturalistic contingencies. More extended no-interaction sessions may be required in future investigations, but ethical considerations (given the age, educational environment, and undifferentiated analyses for the participants in this study) precluded further observation in austere environments. Despite this limitation, our results are consistent with other studies showing behavioral insensitivity to social reinforcement (e.g., Mazaleski, Iwata, Rodgers, Vollmer, & Zarcone, 1994; Van Houten, 1993).

A third limitation is that, on a practical level, it would have been difficult to conduct some of the procedures on a 24-hour basis. For the children involved in family training, it appeared that the procedures were implemented at home at appropriate times, but future research may incorporate observational data to isolate problem periods for which labor-intensive interventions can be implemented most stringently. One potential problem with enriched environment treatments is that continuous exposure to preferred stimuli may result in eventual satiation. However, satiation effects were not pronounced in this investigation. We interpret the absence of obvious satiation as primarily a function of updating stimulus preference, and teachers and families allowing a wide range of choices. Varying reinforcers to avoid satiation is consistent with previous accounts of maintaining reinforcer efficacy (e.g., Egel, 1981).

Finally, more exhaustive functional analyses are required to identify specific maintaining variables for undifferentiated SIB and stereotypy; such analyses may require greater interaction among biological and behavioral scientists. Until these methods are developed, environmental enrichment, differential reinforcement, and mild punishment appear to be viable treatment options for behavior disorders that produce inconclusive results from a functional analysis.

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