

*AN ANALOGUE EVALUATION OF ENVIRONMENTAL
ENRICHMENT: THE ROLE OF STIMULUS PREFERENCE*

JOEL E. RINGDAHL, TIMOTHY R. VOLLMER,
BETHANY A. MARCUS, AND HENRY S. ROANE

LOUISIANA STATE UNIVERSITY

To evaluate the effects of environmental enrichment on stereotypic self-injurious behavior (SIB), we conducted an assessment of preference for manipulating alternative stimuli rather than engaging in SIB. First, for each of 3 participants, a functional analysis of SIB was conducted in Phase 1. Participants were selected for Phase 2 if the functional analysis showed that SIB persisted in the absence of social consequences. In Phase 2, a preference assessment was conducted in which participants were observed manipulating preferred stimuli in a free-operant format. A measure was taken of time spent manipulating each stimulus and time spent engaging in SIB. In Phase 3, environmental enrichment was evaluated using stimuli that were preferred over the target response, and alternative treatments were evaluated in the event of environmental enrichment failure. Results suggested that the free-operant preference assessment (a) predicted the efficacy or inefficacy of an environmental enrichment procedure and (b) suggested possible treatment alternatives when environmental enrichment was ineffective. Collectively, the results may provide a basis for interpreting the idiosyncratic effects of environmental enrichment and a rationale for treatment selection when behavioral function is unknown.

DESCRIPTORS: functional analysis, environmental enrichment, automatic reinforcement, self-injurious behavior, developmental disabilities

Despite the recent widespread use of functional analysis as a form of behavioral assessment, not all such analyses yield conclusive outcomes (Iwata et al., 1994). One outcome of a functional analysis may be that aberrant behavior persists independent of social reinforcement contingencies (Vollmer, Marcus, Ringdahl, & Roane, 1995). Although it may be informative to identify this outcome, the specific contingencies of reinforcement remain undetected. A failure to identify and control the maintaining reinforcers for aberrant behavior may lead to less effective treatment (Vollmer, 1994). If socially mediated reinforcement is identified, treatment can be conducted in a straightforward fashion; the relevant reinforcers can be withheld (extinction) and presented contin-

gent on alternative behavior (differential reinforcement). If socially mediated reinforcement is not evident, reinforcers can neither be withheld easily nor presented differentially.

Despite recent epidemiological data indicating that approximately 24% to 26% of referred self-injurious behavior (SIB) cases do not appear to be socially mediated (Derby et al., 1992; Iwata et al., 1994), relatively few studies have carefully evaluated interventions for such behavior. Thus, a need exists for further evaluation of behavior that persists independent of social reinforcement.

Reinforcement-based treatment for stereotypy and stereotypic SIB has taken two general forms: (a) noncontingent access to alternative sources of reinforcement (Horner, 1980) and (b) access to alternative stimuli contingent on the occurrence of appropriate behavior or the absence of inappropriate behavior (Poling & Ryan, 1982). In either case, treatment involves arranging a compe-

Joel E. Ringdahl and Timothy R. Vollmer are now at Children's Seashore House.

Requests for reprints may be sent to Timothy R. Vollmer, Children's Seashore House, 3405 Civic Center Blvd., Philadelphia, Pennsylvania 19104.

tition between one or more alternative sources of stimulation and the stimulation provided by aberrant behavior. If treatment is successful, stimulation produced by manipulation of the alternative item must be more reinforcing than the stimulation produced by the aberrant behavior. Given idiosyncratic preferences for alternative stimuli (Fisher *et al.*, 1992), it is not surprising that the efficacy of environmental enrichment is often idiosyncratic. For example, Vollmer, Marcus, and LeBlanc (1994) examined the effects of environmental enrichment with 3 children whose aberrant behavior was not sensitive to socially mediated variables and found varying degrees of success; the mixed effects may have resulted from varying degrees of preference for alternative items used in the enriched environment. Thus, if a preference for alternative stimuli relative to aberrant behavior could be established prior to the development of treatment, a degree of guesswork would be eliminated in developing enrichment-based procedures.

Recently, researchers have included measures of aberrant behavior as a dependent variable during stimulus preference assessments. For example, Derby *et al.* (1995) used latency to aberrant behavior as a dependent measure to help in identifying preferred items. By delivering the identified items using a differential-reinforcement-of-other-behavior (DRO) schedule, decreases in aberrant behavior were obtained. Piazza, Fisher, Hanley, Hilker, and Derby (1996) found that some preferred items were correlated with an increased rate of SIB, whereas others were correlated with a decrease in SIB. In addition, it appeared that although some preferred items may have served as a reinforcer for a simple behavior such as head turning, they did not serve as a reinforcer for the omission of SIB. If reinforcement-based procedures are used to reduce aberrant behavior with no apparent social function, a procedure for specifically investigating pref-

erence for aberrant behavior relative to preferred stimuli is needed. The Piazza *et al.* study provides a measure of aberrant behavior relative to interaction with preferred stimuli. However, Piazza *et al.* did not use the same recording system for both behaviors (*i.e.*, duration vs. frequency). Thus, a direct comparison of preference for aberrant behavior relative to preferred items was not possible. A more efficient procedure that directly compares duration of aberrant behavior and item manipulation may provide such a measure of relative preference.

One such procedure might involve measuring the relative frequency of concurrently available responses (*e.g.*, manipulating a toy, displaying SIB) in a free-operant format. For example, Windsor, Piche, and Locke (1994) demonstrated that group presentation of items provided valuable information about individuals' preferences. Similarly, DeLeon and Iwata (1996) demonstrated that a modified group-presentation procedure produced results similar to those of a paired choice procedure (Fisher *et al.*, 1992). In addition, the group presentation procedures are often more time efficient in identifying preferred items than are paired choice procedures (DeLeon & Iwata, 1996; Windsor *et al.*, 1994). To the extent that preference is correlated with time spent engaging in a behavior (Premack, 1959), partial-interval recording of all occurrences of engagement in various activities may provide an index of the relative value. That is, if a client spends relatively more time engaged with a vibrator and less time engaging in SIB or looking at a magazine, then it would be reasonable to conclude that the vibrator is preferred over the other two alternatives.

In this study, (a) individuals whose SIB was seemingly maintained independent of social consequences were identified via a functional analysis, (b) a method was developed in which contact with preferred items was measured relative to engagement in SIB, and

(c) interventions were developed based on the information obtained in the assessments.

GENERAL METHOD

Participants and Setting

Three children with developmental disabilities participated in all three phases of the study. Participants were recruited based on referral from a noncategorical public preschool and a public school for children with developmental disabilities. All sessions were conducted at the children's schools in separate therapy rooms. Criterion for participation in Phase 1 was a referral from a teacher, principal, or parent for assessment and treatment of SIB. Criteria for Phase 2 and Phase 3 included (a) an undifferentiated functional analysis (from Phase 1) and (b) persistent SIB in the absence of social consequences. Three of the first 4 children meeting these criteria participated in Phase 2 and Phase 3; the 4th child received a different form of intervention for idiosyncratic reasons.

Martha was a 3-year-old girl who had been referred for assessment and treatment of SIB including face scratching, head banging, and face slapping. She was nonverbal and nonambulatory, used a wheelchair, and was totally dependent for self-care. David was a 4-year-old boy who had been referred for assessment and treatment of face slapping. David was ambulatory with the aid of a walker; however, during the analysis and treatment sessions, he remained in a mobile chair with a detachable tray. David was nonverbal and totally dependent for self-care. Barry was a 5-year-old boy who had been referred for assessment and treatment of hand and body hitting and hand biting. Barry was nonambulatory, and all of his sessions were conducted while he was in a wheelchair. Barry was nonverbal and totally dependent for self-care.

General Procedure

Data collection. Data were collected using hand-held computers (Assistant Data Acquisition System), and trained graduate and undergraduate students served as observers for all sessions. An observer was considered to be trained to collect data for a specific participant when he or she reached 90% agreement with a previously trained observer on all dependent measures for two consecutive sessions. When the trainee reached this criterion for 2 participants, he or she was considered to be trained for observation of any subsequent participant.

Response measurement. For each participant, target aberrant behavior topographies were defined. These behaviors were measured as responses per minute during Phase 1. Target behaviors included face scratching (Martha: contact between the fingernails and the face with downward movement of the hand), head banging (Martha: forceful, audible contact between head and stationary object), face slapping (Martha and David: forceful, audible contact between the hand and face), hand or body hitting (Barry: forceful, audible contact between one hand and the other or the body), and hand biting (Barry: closure of the upper and lower teeth on any part of the hand). Data on therapists' behavior were also recorded. These behaviors included attention delivery, instruction delivery, and tangible reinforcer delivery.

During Phase 2, data were collected on engagement in target aberrant behavior and item manipulation. These data were recorded as percentage of 10-s intervals within a 10-min session, using a partial-interval recording method (Cooper, Heron, & Howard, 1987).

During Phase 3, data were collected on rate (responses per minute) of target aberrant behavior for all participants and appropriate communication for 2 participants (Martha and David). Appropriate communication

was defined as touching the therapist's hand (Martha) or extending a hand across a taped line on a table (David). Item manipulation was recorded during environmental enrichment treatment sessions using partial-interval recording.

Interobserver agreement. Two independent observers recorded data simultaneously but independently during at least 20% of all sessions for each participant. For SIB, agreement percentages were calculated based on interval-by-interval comparisons of the observers' records, in which the smaller number of responses in each 10-s interval was divided by the larger number of responses. These fractions were then summed across all intervals and divided by the total number of intervals in the session to obtain the percentage agreement between the two observers. For item manipulation (see Phases 2 and 3), an interval-by-interval procedure was used to calculate agreement. Using this procedure, an agreement was scored if both observers agreed that the behavior occurred at least once during a 10-s interval or if both observers agreed that the behavior did not occur at all during a 10-s interval. Agreements were then summed across all intervals and divided by the total number of intervals in the session to obtain the percentage agreement. For SIB, the mean agreement coefficients were 99.3% (range, 92.6% to 100%), 94.2% (range, 90% to 100%), and 96.9% (range, 73.3% to 100%) for Martha, David, and Barry, respectively. For item manipulation, the coefficients were 91% (range, 80.0% to 100%), 91.5% (range, 78.3% to 100%), and 85.3% (range, 46.7% to 100%) for Martha, David, and Barry, respectively. The therapists' behavior rarely deviated from the protocol.

PHASE 1: FUNCTIONAL ANALYSIS

Procedure

The functional analysis conditions were based on the procedures described by Iwata,

Dorsey, Slifer, Bauman, and Richman (1982/1994). Sessions were conducted 1 to 4 days per week, and one to four sessions were conducted each day, depending on the participants' schedules.

Participants were exposed to the following conditions during the functional analysis. During escape, academic instructions or tasks were presented once every 30 s using a three-prompt instructional sequence (verbal, model, and physical guidance), and instructions were terminated contingent on SIB. During attention, preferred stimuli were available noncontingently, and attention was delivered contingent on SIB. During tangible positive reinforcement, preferred stimuli were withdrawn at the beginning of the session and were returned contingent on SIB. During no interaction, participants were observed in an austere environment; that is, no items were available and there was no programmed consequence for SIB. This condition was similar to the alone condition described by Iwata *et al.* (1982/1994); however, the therapist was present in the room. During play, participants had noncontingent access to preferred stimuli and brief attention once every 30 s, and no programmed consequence was delivered for SIB. Initially, these conditions were presented during 10-min sessions in a multielement format. When the results of the multielement analysis were deemed inconclusive, several consecutive no-interaction sessions were conducted to assess behavioral persistence in the absence of social contingencies (Vollmer *et al.*, 1994).

Results and Discussion

Figure 1 displays the results of the functional analysis for each participant. Martha's SIB occurred in each of the separate analogue conditions, although the rate (responses per minute) was relatively low during play ($M = 0.27$ for play and 0.89 for all other conditions). Further, the behavior

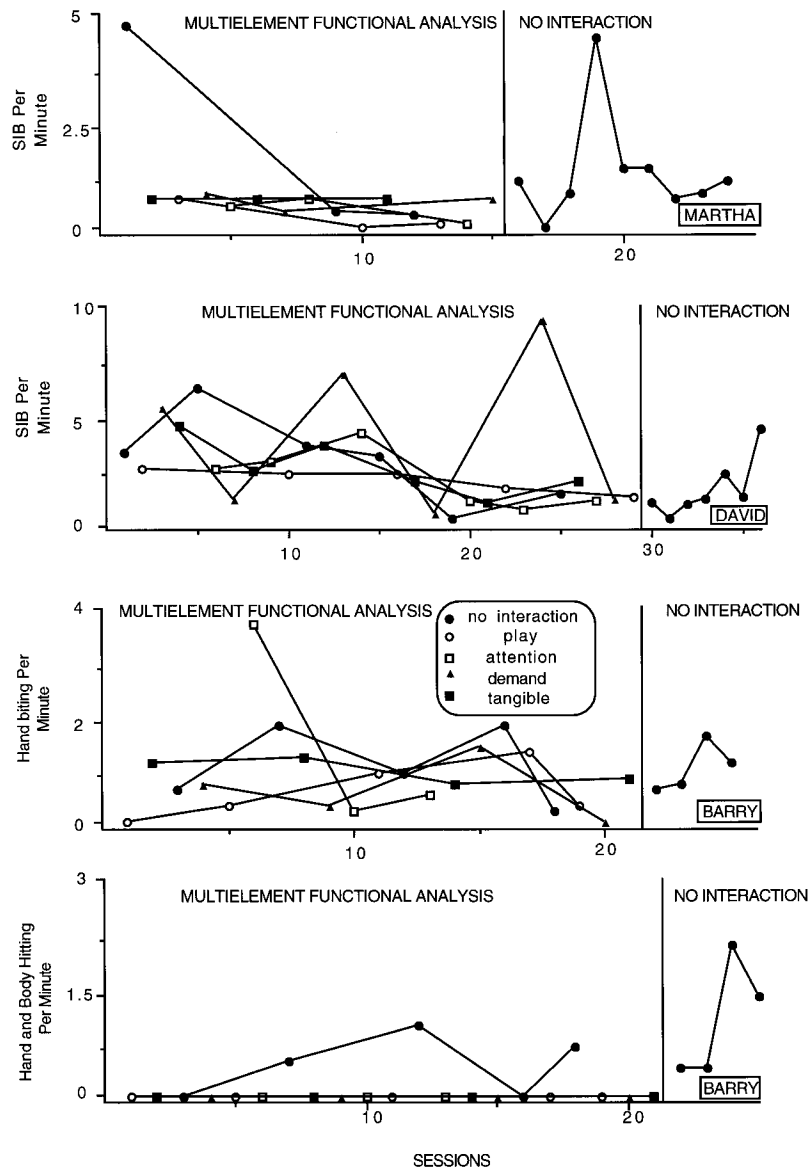


Figure 1. Functional analyses for Martha, David, and Barry. Target behaviors are expressed as responses per minute.

persisted after nine consecutive no-interaction sessions ($M = 1.3$). These data suggest that her SIB was maintained independent of social reinforcement contingencies.

Similar to Martha's assessment, David's SIB persisted across all conditions of the multielement functional analysis. One difference is that his rate of SIB was slightly lower in the play condition ($M = 2.3$ for

play and 3.0 for all other conditions). In the extended no-interaction phase of the functional analysis, David's SIB was initially low but increased across sessions ($M = 1.7$). These results suggest that David's SIB was maintained independent of the social environment.

The third and fourth panels of Figure 1 show the results of simultaneous functional

analyses for Barry's hand biting and hand and body hitting, respectively. Hand biting occurred across all conditions during the multielement analysis ($M = 1.9$). Further, hand biting persisted during the no-interaction phase ($M = 1.0$). During the multielement functional analysis, hand or body hitting was evident only during the no-interaction condition ($M = 0.4$ during no interaction and 0 for all other conditions). During the extended no-interaction phase, the behavior persisted ($M = 1.1$), suggesting a nonsocial function.

In Phase 1, 3 individuals were identified with SIB that persisted independent of social reinforcement. Had SIB been maintained by socially mediated positive or negative reinforcement, SIB rates should have been differentially elevated in one or more of the test conditions (Iwata *et al.*, 1982/1994) and would have been extinguished in the absence of those contingencies (Vollmer *et al.*, 1995).

PHASE 2: FREE-OPERANT PREFERENCE ASSESSMENT

Procedure

The purpose of Phase 2 was to obtain relative measures of stimulus engagement and SIB to serve as indices of relative preference. During 10-min free-operant sessions, a measure was taken of the percentage of 10-s intervals in which each participant was engaged with stimulus items (e.g., toys), SIB, or both. Item engagement was defined as the participant appropriately touching an item. Participants were observed alone (individually) in a therapy room in which access to items was continuously available during sessions. Stimulus items had been identified prior to the functional analysis during a stimulus preference assessment based on the methods of Fisher *et al.* (1992) and by direct observation and teacher interview. During the free-operant assessment, no instructions

were presented, and no programmed consequences were delivered for target aberrant behavior or item manipulation. The measure of relative preference was obtained by recording any occurrence of each behavior (stimulus engagement and SIB) during each 10-s interval of a 10-min session using partial-interval recording. Two 10-min sessions were conducted during this phase for each participant. In addition, levels of SIB that were observed during the free-operant phase were compared to mean levels that had been observed during the no-interaction sessions from the functional analysis.

Results and Discussion

Figure 2 shows the results of the free-operant preference assessments for each of the 3 participants. In baseline (no interaction), Martha's SIB occurred during an average of 8.76% of the intervals. In the two free-operant assessment sessions, SIB was reduced to 0% of intervals in the first session and 3.3% in the second session ($M = 1.67\%$). Percentages for item engagement (85% and 98.3%) were much higher than those for SIB (0% and 3.3%) during both sessions. The outcome of this assessment suggested that environmental enrichment alone might reduce Martha's SIB. Further, because engagement with toys was such a high-probability response, contingent access to toys possibly could be used to strengthen an alternative response (Premack, 1959).

The results of David's free-operant preference assessment showed that, when compared to the average baseline percentage, the percentage of intervals with SIB remained virtually unchanged ($M = 19.0\%$ in baseline and 18.4% in the free-operant preference assessment). However, in the free-operant preference assessment, David spent more time playing with the piano than engaging in SIB ($M = 67.8\%$ for piano play and 18.4% for SIB). The results of David's free-operant preference assessment yielded two

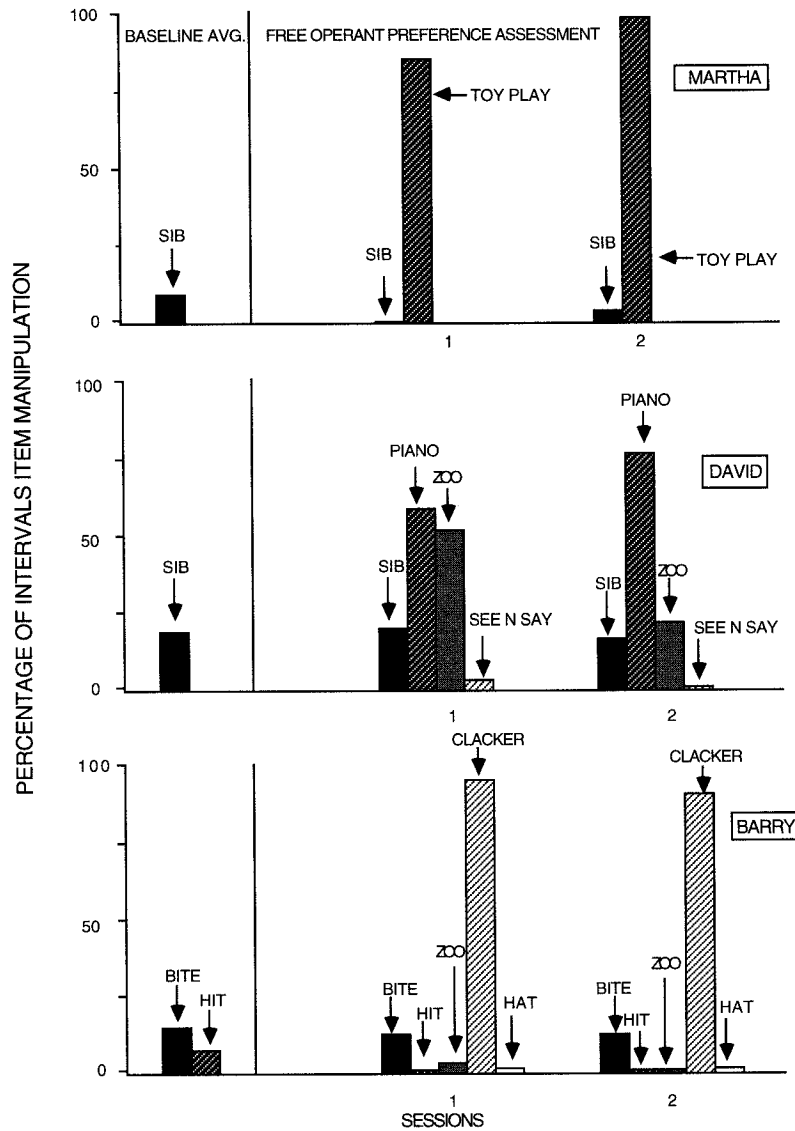


Figure 2. Baseline averages and free-operant preference assessment for Martha, David, and Barry. Target behaviors are expressed as percentage of 10-s intervals of item manipulation or SIB.

hypotheses. First, environmental enrichment alone might not be sufficient to reduce occurrences of SIB for David. Second, because piano play was a highly preferred activity, access to it contingent on alternative behavior (DRA) or contingent on the omission of SIB (DRO) might reduce SIB (Premack, 1959; Timberlake & Farmer-Dougan, 1991).

Barry's hand and body hitting (Figure 2)

was reduced from 7.5% in baseline to 0% in each of the two free-operant preference assessment sessions. Levels of hand biting did not change during the free-operant assessment sessions ($M = 15\%$) when compared to baseline ($M = 15\%$). Manipulation averaged 92.5% for a clacker, 0% for a zoo toy, and 1.7% for a hat. These results indicated that environmental enrichment (which would include a clacker) might reduce hand

and body hitting but not hand biting and that differential reinforcement (which would include the clacker) might reduce hand biting.

To summarize, the results of the free-operant preference assessment phase of the study suggested that, for Martha and Barry (hand and body hitting only), environmental enrichment alone might reduce occurrences of aberrant behavior. Results for David and Barry (hand biting only) suggested that environmental enrichment would not substantially reduce aberrant behavior. These predictions were investigated in Phase 3.

PHASE 3: ANALOGUE TREATMENT

Procedure

Each of the 3 children participated in baseline, environmental enrichment, and differential reinforcement. One child, Barry, participated in environmental enrichment plus time-out (hands down).

Baseline. This condition consisted of no-interaction sessions identical to those conducted during the functional analysis. No preferred stimuli were available, and there was no programmed consequence for aberrant behavior.

Environmental enrichment (EE). Preferred items were placed in front of the participants and were available noncontingently. The items consisted of the same set of stimuli that were available during the free-operant preference assessment. A therapist was present in the room but did not interact with the participant during EE sessions. This condition was included to test the predictions made for each participant regarding the efficacy of environmental enrichment.

Differential reinforcement. This condition consisted of the presentation of stimuli that were more preferred than aberrant behavior contingent on (a) the absence of aberrant behavior for a prespecified period of time or (b) appropriate requesting (defined individ-

ually). The logic of this condition was that contingent access to high-frequency behaviors (e.g., item manipulation) might increase the frequency of an arbitrary response and decrease aberrant behavior (Charlop, Kurtz, & Casey, 1990; Premack, 1959). DRA was used for David and Martha because there was an alternative appropriate behavior that occurred at some low frequency during observation. For Martha and David, training sessions were conducted prior to the DRA treatment conditions, during which they were taught the contingent relationship between the alternative response and access to the preferred item. During DRA, the target appropriate behavior for Martha was defined as independently touching the therapist's hand; this response was reinforced by 20 s of toy access. During the DRA conditions for both Martha and David, stimuli were presented following the appropriate response regardless of the presence of the inappropriate behavior. However, for David, a DRA + DRO condition was included. In this condition, 10 s of no inappropriate behavior prior to the appropriate behavior was required to receive reinforcement. If inappropriate behavior occurred, the first appropriate response preceded by 10 s with no inappropriate responding was reinforced. For Barry, no replacement behavior was apparent, and thus DRO was selected. During DRA with David, appropriate requests (reaching beyond a line on a table where he sat) were reinforced with 20 to 30 s of toy access. During DRA + DRO, reinforcement (access to a small piano) was delivered only if he did not exhibit SIB for at least 10 s prior to the appropriate reach response. Differential reinforcement was included to test whether stimuli that had been demonstrated to be relatively more preferred during the free-operant preference assessment could be used to reduce aberrant behavior when presented differentially.

Environmental enrichment plus hands down

(*EE + HD*). Preferred items were placed in front of Barry and were available noncontingently. Following each instance of SIB, Barry's hands were placed in his lap for a period of 10 s. This condition was included in the event that other reinforcement-based treatments were demonstrated to be ineffective.

Results

Martha. The effects of EE and differential reinforcement were investigated using an ABAC reversal design (A = baseline, B = EE, and C = DRA). The first panel of Figure 3 shows the results of Martha's treatment analysis. During baseline, Martha's rate of SIB persisted ($M = 1.35$; range, 0 to 5.9). During EE, the rate of SIB decreased substantially ($M = 0.2$; range, 0 to 0.8); item manipulation averaged 82.9% (range, 73.3% to 88.3%). Following a reversal to baseline, positive effects resulted from DRA ($M = 0.25$; range, 0 to 2). In addition, although not shown in the figure, appropriate communication averaged 0.2 responses per minute (range, 0 to 0.4).

The results of Martha's treatment analysis support the predictive utility of the free-operant preference assessment. Specifically, the presence of stimuli that were relatively more preferred than SIB were sufficient to reduce SIB to low levels. In addition, access to preferred items, contingent on the omission of SIB and emission of an alternative response, also reduced SIB. However, these results should be interpreted with some caution because they were not replicated.

David. EE and differential reinforcement effects were evaluated using an ABCADC design (A = baseline, B = EE, C = DRA + DRO, and D = DRA only). The second panel of Figure 3 shows the results of David's treatment analysis. During baseline, his rate of SIB persisted ($M = 2.35$; range, 0.4 to 6.3). During EE, SIB remained somewhat consistent with baseline levels ($M = 1.67$; range, 0.4 to 3.1). During the ensuing DRA

+ DRO condition, the rate of SIB decreased substantially ($M = 0.45$; range, 0 to 1.4). Following a reversal to baseline during which SIB returned to higher levels ($M = 1.25$), DRA was conducted without the DRO component; this resulted in a higher level of aberrant behavior than the subsequent DRA + DRO condition ($M = 1.5$ for DRA; range, 0.6 to 4.6; $M = 0.4$ for DRA + DRO; range, 0.1 to 0.8). Thus the DRA + DRO condition resulted in lower levels of SIB compared to baseline, even though the second baseline condition resulted in lower levels of SIB compared to the initial baseline.

The results of David's treatment analysis support the predictive utility of the free-operant assessment. Specifically, environmental enrichment alone did not reduce SIB, and differential reinforcement led to a reduction in SIB.

Barry. Barry's treatment involved simultaneous evaluations for hand and body hitting and hand biting. In both evaluations, the effects of EE, DRO, and HD on SIB were evaluated using an ABABCABDAD design (A = baseline, B = EE, C = DRO, and D = EE + HD). During DRO, omission of hand biting for 10 s produced access to preferred items. During EE + HD, items were available noncontingently; however, a 10-s hands down was administered following each instance of hand biting (Vollmer et al., 1994). Because the HD procedure prevented all target responses, session length was increased by 10 s for each instance of HD, such that there were still 10 min of opportunity to engage in hand biting.

The third and fourth panels of Figure 3 show the results of Barry's treatment analyses. His rate of hand and body hitting decreased relative to the initial baseline ($M = 0.7$; range, 0 to 2.1) as a function of environmental enrichment ($M = 0.01$; range, 0 to 0.1). Following a brief reversal to baseline, during which hitting reemerged ($M = 4.55$; range, 1.1 to 8.0), the behavior decreased

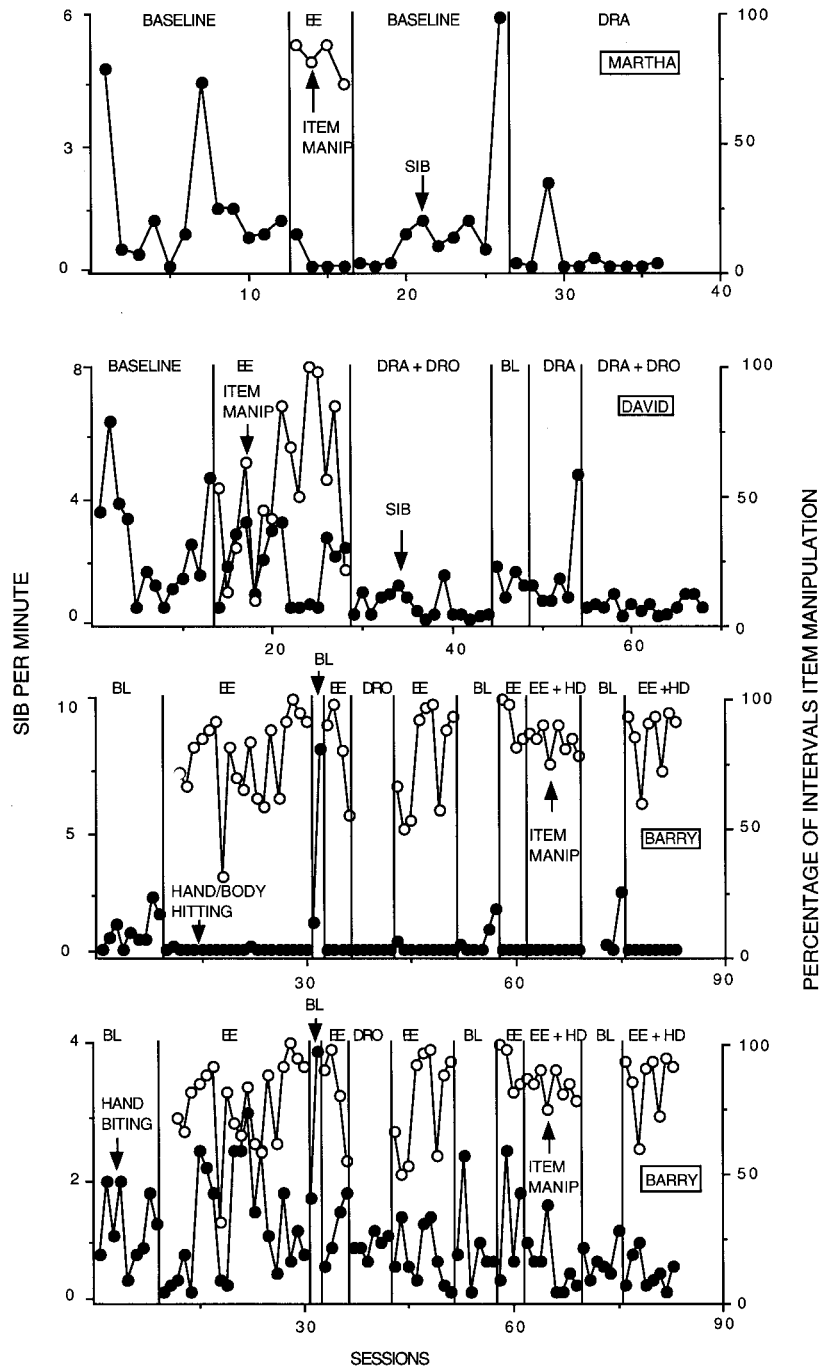


Figure 3. The effects on self-injurious behavior (SIB) of environmental enrichment (EE), used alone or in combination with differential reinforcement of alternative behavior (DRA), differential reinforcement of other behavior (DRO), or hands down (HD).

immediately upon reimplementa-tion of EE ($M = 0$). During each of the DRO and EE + HD conditions, hand and body hitting remained at 0. In the final baseline phase, hand and body hitting was evident at levels similar to the previous baseline conditions ($M = 0.97$). It should be noted that data on hand and body hitting were inadvertently not collected on the first three sessions of this baseline condition.

The results of the treatment for Barry's hand biting (Figure 3) showed that environmental enrichment ($M = 0.99$; range, 0 to 2.9) was ineffective in reducing the rate of SIB relative to baseline conditions ($M = 1.0$; range, 0 to 1.8). Similarly, DRO did not substantially reduce SIB ($M = 0.77$; range, 0.5 to 1). The combination of EE and HD decreased hand biting somewhat ($M = 0.45$; range, 0 to 1.6), but hand biting was never completely suppressed.

Barry's results were partially compatible with the outcome of his free-operant preference assessment: For hand and body hitting, environmental enrichment resulted in almost complete suppression; for hand biting, environmental enrichment was ineffective, and further steps had to be taken to reduce occurrences of this behavior. Although we had hypothesized that differential reinforcement would reduce hand biting based on the results of the free-operant assessment, the behavior was never substantially reduced. Indeed, even EE + HD did not produce complete suppression of hand biting, which seemed to be on a general downward trend across the final three conditions of the treatment analysis. Perhaps the most interesting finding for Barry was that EE was effective for one response topography but not for another. Disparate results across topographies indicate a high preference for one aberrant behavior relative to another. The behavior with the higher preference (biting) necessitated a treatment pack-

age that included more than environmental enrichment alone.

GENERAL DISCUSSION

Three participants whose SIB was maintained independent of the social environment were identified via a functional analysis. Next (Phase 2), each child participated in a free-operant preference assessment to identify relative preferences for aberrant behavior versus stimuli that had been identified through a preference assessment. Results showed that 2 individuals selected preferred stimuli over aberrant behavior (Martha and Barry, hand and body hitting only). Two individuals showed clear preferences for preferred stimuli, but engagement with the items did not replace engagement in aberrant behavior (David and Barry, hand biting only). Treatment analyses were then conducted for each participant (Phase 3). For all participants, the free-operant preference assessment correctly predicted the success or failure of environmental enrichment to decrease aberrant behavior. For each participant, the assessment also predicted that, based on Premack's principle, differential reinforcement would be effective because stimuli had been identified that were preferred over SIB. This principle held in some cases but not in others. For example, DRA reduced SIB for Martha but not for David. The combination of DRO and DRA reduced SIB for David. Finally, Barry's hand and body hitting remained at zero during DRO, but hand biting remained at levels similar to baseline. The free-operant assessment may have predicted the results of EE better than it predicted the results of differential reinforcement because it was identical to the EE condition.

The methodology in this study may provide a means of identifying stimuli that are substitutable for or relatively more preferred than aberrant behavior. This information

may be used in predicting the efficacy of environmental enrichment procedures on an individual basis. Stimuli that are identified as preferred in a free-operant preference assessment may be effective in reducing the behavior via either environmental enrichment (if substitutable) or differential reinforcement (if relatively more preferred than the aberrant response). When no stimuli are identified as preferred, the efficacy of reinforcer-based procedures may be limited.

The study may advance the literature on severe behavior disorders that are maintained independent of social consequences in several additional ways. First, it further replicated the use of functional analysis as a pretreatment assessment for stereotypic SIB. Second, the free-operant preference assessment incorporated SIB, which has not been previously accomplished with paired choice procedures or group choice procedures. Third, the study provided predictive information regarding the idiosyncratic results of environmental enrichment as a treatment for nonsocially mediated SIB. Finally, the study illustrated a treatment strategy for evaluating interventions for problem behavior that is not socially mediated.

Several limitations to the current study should be discussed. First, the reinforcers that maintained the participants' aberrant behavior were not identified. When a target behavior is not maintained by social reinforcement, it is very difficult to isolate specific maintaining contingencies. Second, the free-operant methodology as presented in this study allows only a brief sampling of behavior, which may lead to premature predictions about the sustained efficacy of environmental enrichment (e.g., satiation effects or preference changes may not be evident). However, the brevity of the free-operant sessions (10 min) permits frequent assessments, which could be conducted at the beginning of each school day or at the beginning of free-time or training periods. Third, the def-

inition used for item engagement in this study permits potentially inappropriate item manipulation to be scored as a positive target behavior. For example, it was possible that a participant could hold the toy in his or her hand while mouthing it. Because the toy was being held, the technical definition of item engagement would have been met. However, mouthing the toy, although it may result in reducing the target behavior, may not be an acceptable alternative behavior. In future studies, the definition of item engagement may need to be more specific. Finally, because items were presented in groups and not singly, the effect of any one item on aberrant behavior might have been obscured. Piazza *et al.* (1996) demonstrated that different stimuli may have opposite effects on the level of aberrant behavior exhibited by an individual. One way to address this limitation would be to conduct several free-operant preference assessments comparing one item to aberrant behavior. This method would permit the measurement of unobserved levels of aberrant behavior and item manipulation.

The results of this investigation suggest at least three general directions for future research. First, the free-operant preference assessment should be established as a viable reinforcer assessment method by testing reinforcement effects in an acquisition paradigm (Roane, Vollmer, Ringdahl, & Marcus, 1996). Second, the sustained effects of environmental enrichment should be further evaluated. Specifically, adaptation and satiation effects should be investigated to ascertain how often preference assessments should be conducted and when new reinforcers should be identified. Also, perhaps item access could be faded gradually to provide a participant with necessary stimulation while progressively increasing exposure to other important activities (such as academic instruction). Third, environmental enrichment may be used to reduce behavior prob-

lems that are sensitive to social reinforcement. For example, would continuous access to alternative items reduce instances of escape-related aggression? Allowing continuous access to preferred items may serve to reduce the aversiveness of the instructional situation (Carr, Newsom, & Binkoff, 1980). Similarly, if aberrant behavior is maintained by attention, it may be possible to reinforce appropriate behavior with access to substitutable stimuli (toys, etc.) when attention is requested at inopportune times.

To summarize, we evaluated relative preferences for stereotypic SIB and alternative activities. The information obtained in the assessment was useful in predicting the efficacy of environmental enrichment. Although limitations exist with the analysis, this study should be viewed as a step toward analyzing functional relationships between stereotypic SIB and the availability or unavailability of alternative stimulation. Further, the assessment method may be applied in future research to evaluate a series of questions related to stimulus substitutability and stimulus preference (Green & Freed, 1993).

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STUDY QUESTIONS

1. What is the major difference in developing reinforcement-based interventions for behavior problems that are maintained by social versus nonsocial (i.e., automatic) reinforcement?
2. In light of the above, why is preference perhaps an important determinant of successful treatment for behavior problems that are maintained by automatic reinforcement?
3. What two characteristics of the data from the functional analyses indicated that the participants' SIB was not maintained by social reinforcement?
4. How was preference for potential reinforcers assessed?
5. What predictions about treatment were made by the authors based on the results of the preference assessment?
6. Describe the key elements of the treatment conditions (environmental enrichment, DRO, DRA, and hands down), and indicate which treatments (singly or in combination) were effective for each participant.
7. The authors indicated that results of the preference assessment seemed to be more predictive of effects observed for environmental enrichment than for differential reinforcement. More specifically, differential reinforcement was less effective than predicted. Given the difference between these two procedures (noncontingent vs. contingent reinforcement), why might the former be more effective than the latter in suppressing behavior generally?
8. The authors also suggested that the efficacy of reinforcement-based interventions may be limited when individuals with behavior problems do not exhibit strong preferences for other types of reinforcers. It is possible that this problem could be encountered frequently when treating individuals who have profound disabilities and who engage in very little adaptive behavior. Describe several intervention strategies that might be attempted under such circumstances.

Questions prepared by Eileen Roscoe and Michele Wallace, University of Florida