EXPERIMENTAL ANALYSIS AND TREATMENT OF MULTIPLY CONTROLLED SELF-INJURY

RICHARD G. SMITH AND BRIAN A. IWATA

THE UNIVERSITY OF FLORIDA

TIMOTHY R. VOLLMER

LOUISIANA STATE UNIVERSITY

AND

JENNIFER R. ZARCONI

THE UNIVERSITY OF FLORIDA

A functional analysis of the self-injurious behavior (SIB) of 3 adults with profound developmental disabilities showed that each engaged in SIB in more than one assessment condition. Such outcomes may result from a failure to isolate the variable maintaining SIB, or they may reflect multiple sources of control over SIB. In order to identify more clearly the determinants of SIB, each subject was exposed to a series of treatments appropriate to one or both of the apparent functions of SIB. These treatments, applied sequentially on baselines appropriate to each behavioral function, identified the maintaining variables for SIB through differential outcomes across baselines. Results indicated that the SIB of 2 subjects was multiply controlled, confirming the outcomes of the functional analysis. However, the SIB of the 3rd subject was eliminated using a treatment designed for a single function, suggesting spurious results of the original assessment. Alternative interpretations of undifferentiated assessment data are discussed, as are analysis and treatment issues related to multiply determined behavior disorders.

DESCRIPTORS: functional analysis, self-injurious behavior, multiple control

Behavioral research typically characterizes self-injurious behavior (SIB) as learned behavior maintained by its reinforcing consequences. This operant approach suggests that an analysis of the consequences that maintain SIB is possible, and that treatments may be derived from this analysis based on the underlying function of the behavior. This conceptual framework has served as a basis for advances in the assessment and treatment of SIB as well as other behavior disorders (see Iwata, Vollmer, & Zarcone, 1990, and Mace, Lalli, & Pinter Lalli, 1991, for reviews).

The functional properties of SIB can vary among

individuals. Lovaas, Freitag, Gold, and Kassorla (1965) observed an increase in the SIB of a young girl when adults made sympathetic comments contingent upon its occurrence, and concluded that the behavior was sensitive to positive reinforcement in the form of attention. Other studies have shown that SIB can also be maintained by escape from or avoidance of aversive events such as academic demands (e.g., Carr, Newsom, & Binkoff, 1976). Still others suggest that SIB can be maintained by nonsocial consequences such as automatically produced visual, tactile, gustatory, or auditory stimulation (e.g., Favell, McGimsey, & Schell, 1982).

A number of empirical procedures have been developed for identifying the functional properties of SIB. Iwata, Dorsey, Slifer, Bauman, and Richman (1982) described a general method in which individuals were exposed to a set of controlled conditions designed to isolate variables that may maintain SIB. These conditions test the effects of attention from therapists, escape from tasks, and social

This research was supported by a grant from the Developmental Disabilities Planning Council. The authors would like to express their appreciation for the valuable suggestions and assistance from all staff members and volunteers at the University of Florida Center on Self-Injury.

Reprints may be obtained from Brian Iwata, Department of Psychology, University of Florida, Gainesville, Florida 32611.

isolation on rates of SIB. Differential rates of SIB during these conditions are taken as an indicator of behavioral function. For example, elevated rates of SIB in the attention condition, relative to the other conditions, suggest that SIB is maintained by positive reinforcement in the form of attention from adults.

Occasionally, attempts to identify the variables maintaining SIB produce undifferentiated outcomes, with SIB persisting across two or more test conditions. Two factors might account for these findings. First, the assessment may not account for variables that produce unclear results. For instance, SIB maintained by intermittent attention at home may persist in conditions in which no attention is delivered. Also, idiosyncrasies in a given subject's history may affect the outcomes of assessment (e.g., SIB maintained by escape from the presence of others may persist in any experimental condition in which experimenters and/or observers are in proximity). Second, SIB may be sensitive to more than one reinforcement contingency. Skinner (1953) proposed the term *multiple control* to describe the common behavioral effect of two or more operations. Cases of multiply controlled behavior disorders appear rarely in the literature (see Carr & Durand, 1985; Day, Rea, Schussler, Larsen, & Johnson, 1988; Heidorn & Jensen, 1984; and Mace, Webb, Sharkey, Mattson, & Rosen, 1988; for possible exceptions); however, this is probably a function of the difficulty in clearly documenting the influence of multiple control rather than a low prevalence.

Once identified, treatment of multiply controlled behavior is complicated because treatments appropriate for behavior with certain functional properties may exacerbate behavior maintained in other ways. For example, treating escape-maintained SIB using time-out could result in the inadvertent negative reinforcement of SIB. Similarly, overcorrection may increase SIB maintained by contingent attention. When a behavior problem is multiply controlled, therapists must be sensitive to momentary changes in controlling variables in order to implement the correct treatment and avoid exacerbating

the problem. Thus, the importance of identifying the functional properties of inappropriate behavior is magnified in the case of multiple control.

An examination of reported cases of multiple control illustrates the complexities involved in both assessment and treatment. Heidorn and Jensen (1984) presented a case study of a subject's SIB that apparently was controlled by positive reinforcement (attention), negative reinforcement (escape from tasks), and "physiological disturbances." However, the absence of controlled assessment data and the combined use of treatment procedures that would have had similar effects across SIB functions limited the strength of their conclusion. Day et al. (1988) also presented data suggesting multiple control of 2 subjects' SIB. However, the treatment developed for 1 subject's SIB was inconsistent with one of its presumed functions (David's SIB was assumed to be maintained by both positive and negative reinforcement, but part of his treatment consisted of attention and reinforcer delivery contingent upon episodes of SIB), and in neither case were treatment effects examined in the appropriate contexts. In addition, the results for both subjects did not show clear treatment effects and thus cannot support a conclusion that these were cases of multiple control. Carr and Durand (1985) presented data indicating that the disruptive behavior of 1 of 4 subjects was multiply controlled. That subject engaged in several forms of disruptive behavior (aggression, tantrums, SIB, out-of-seat, and "opposition") that were measured in combination, thus raising the possibility that different behaviors were maintained by different sources of reinforcement. Finally, Mace et al. (1988) presented analysis and treatment data suggesting that both escape and attention from caretakers maintained their subject's bizarre speech; however, the simultaneous introduction and withdrawal of treatments based on these functions tempers this conclusion.

The current study presents three cases in which assessment data showed that SIB occurred in at least two test conditions, and describes a method used to analyze the effects of treatments based on hypotheses of multiple control.

GENERAL METHOD

Subjects and Setting

One male (Marc) and 2 females (Laura and Charlene) participated in the study. All were diagnosed with profound mental retardation and had longstanding histories of severe SIB. There was no indication of an underlying medical etiology for the SIB of any subject. No subject had expressive language skills, but each could follow simple requests. All subjects lived in state or private residential facilities. Additional information is provided in the context of each case study.

Marc's sessions were conducted in a therapy room equipped with one-way observation windows. Sessions for Laura and Charlene were conducted in therapy rooms without observation windows, and data were collected from corners of the therapy room or through an open door. Therapeutic, academic, and recreational materials and furniture were present as appropriate to the various experimental conditions.

Observation Procedures and Interobserver Agreement

Observations were conducted by trained graduate and undergraduate students. Data were collected on hand-held computers (either Hewlett-Packard Model HP71B or Assistant Model A-102) and were calculated as SIB responses per minute. Sessions in all phases of the study lasted 15 min. A second observer scored 41.9% of all sessions, and interobserver agreement scores were calculated using an interval-by-interval method, based on 10-s bins apportioned by the computers. Overall agreement on the occurrence of SIB ranged from 82.2% to 100% across subjects, with a mean of 98.7%. There was little deviation from these scores across subjects.

Functional Analysis of SIB

Each subject was initially exposed to a functional analysis of SIB. A series of conditions, described in detail in Iwata et al. (1982), were presented in a multielement design. A brief description of each condition follows.

Attention. In this condition, leisure materials were present in the room. At the beginning of the session, the therapist directed the subject toward the materials, then did paperwork or read a magazine while remaining in the presence of the subject (e.g., seated in a chair across the room). If the subject engaged in SIB, the therapist provided approximately 5 s of attention in the form of social disapproval or concern and brief physical contact (e.g., response block or interruption). The therapist ignored all responses other than SIB.

Demand. In this condition, training materials were present in the room. Throughout the session, the therapist presented learning trials to the subject approximately every 30 s using graduated prompts (verbal instruction, visual prompt, physical guidance) at 5-s intervals if compliance did not occur. Contingent upon SIB, the therapist terminated the trial and turned away from the subject for 30 s. SIB occurring within 5 s of the next scheduled instruction delayed that instruction for 5 s.

Alone. In this condition, the subject was in a therapy room alone, with no toys or other materials.

Play. This was a control condition, in which the experimenter provided attention approximately every 30 s (contingent upon a 5-s absence of SIB), and the subject had continuous access to toys and games. No demands were placed on the subject in this condition, and SIB was ignored.

These sessions were conducted until it became apparent that SIB continued to occur in at least two conditions with no downward trend in any of those conditions. Each subject was then exposed to a series of conditions designed to treat SIB and to elucidate more clearly its functional properties. Treatments appropriate for each hypothesized function from the functional analysis were sequentially applied on baseline conditions, thus permitting a verification of function via differential effects.

MARC

Subject Information and Assessment Results

Marc was a 19-year-old male who was non-ambulatory but could propel his wheelchair with

some difficulty. Marc's mobility was further limited by a severe visual impairment. His SIB consisted of face slapping and ear flicking, and had caused contusions and discoloration on his face, permanent thickening of skin near his cheeks, and "cauliflower ears." Although records from Marc's residential facility documented a history of SIB dating back at least 5 years, anecdotal reports indicated an earlier onset. Several interventions had been attempted, including verbal reprimands, response blocking, time-out, and functional movement training, without substantial effect.

Marc's functional analysis was conducted as previously described. In the play and attention conditions, toys and recreational materials identified as preferred through an assessment procedure (Pace, Ivancic, Edwards, Iwata, & Page, 1985) were suspended by a string on a metal ring attached to a pole affixed to Marc's wheelchair. The results of Marc's functional analysis are shown in the top panel of Figure 1. Marc's SIB occurred almost exclusively in the alone and attention conditions. The alone condition produced high but variable rates of responding, and the attention condition produced lower, but increasing, rates. Rates of SIB in the demand and play conditions were consistently at or near zero. Based on these outcomes, treatments for multiply controlled SIB, maintained by contingent attention and by automatically reinforcing consequences, were implemented.

Treatment Conditions and Experimental Design

To reduce SIB maintained by attention, a differential-reinforcement-of-other-behavior (DRO) schedule of attention and extinction was implemented (Vollmer & Iwata, 1992). The therapist delivered 5 s of attention contingent upon the absence of SIB for a specified duration. Occurrences of SIB were ignored and reset the DRO interval, which was set initially at 15 s and was increased on the basis of low levels of SIB to 30, 60, and finally 120 s.

To treat SIB presumed to be maintained by automatic reinforcement, an "enriched environment" condition was implemented (Horner, 1980).

The toys and recreational items used in the play and attention baseline conditions were present. This condition differed from that described by Horner in that no therapist was present and there were no social consequences for any behavior.

The effects of these interventions were assessed using components of multielement, reversal, and multiple baseline experimental designs. All conditions of the functional analysis continued in a multielement design throughout the experiment, although sessions not relevant to the apparent functions of SIB (demand and play) were conducted at a reduced frequency. Treatment conditions were implemented sequentially across the attention and alone baselines.

Results and Discussion

The results of Marc's treatment are presented in Figure 2, with baseline data from the original assessment (Figure 1) shown prior to the first toy manipulation. The top panel of Figure 2 shows the effects of treatment on the attention baseline. To assess whether the presence of toys affected SIB in the attention baseline condition, toys were removed on the 13th session. This produced an immediate increase in SIB from a condition mean of 3.3 responses per minute with toys available to a mean rate of 9.1 responses per minute in the absence of toys. Toys were reinstated in the 23rd session, and SIB was reduced to rates comparable to those seen in the original attention baseline, with a condition mean of 4.4 responses per minute. The DRO schedule was then implemented, and an immediate reduction in SIB occurred. With the DRO schedule still in effect, toys were again withdrawn, and a moderate increase in SIB resulted. Reinstatement of the toys again reduced SIB to near-zero levels, a reduction that was maintained throughout the remainder of the experiment.

The middle panel of Figure 2 shows the effects of the presence of toys on the alone baseline. Toys were made available from the 25th through the 32nd alone sessions, and again from the 52nd session through the end of Marc's treatment. In each case, immediate and large decreases in SIB were seen, from mean rates of 8.0 and 6.25 responses

Figure 1. Results of multielement functional analyses for Marc (top panel), Laura (middle panel), and Charlene (bottom panel).

Figure 2. Treatment results for Marc. The top panel shows interventions (toys, DRO) on the attention baseline, the middle panel shows intervention (toys) on the alone baseline, and the bottom panel shows the demand and play baselines.

per minute in the first and second baselines, respectively, to mean rates of 0.66 and 0.42 responses per minute during the first and second toys conditions, respectively. These results represent a 92.5% overall decrease in mean rates of SIB.

The outcomes of the demand and play baselines are shown in the lower panel of Figure 2. Very little SIB was observed in these conditions, with rates never exceeding one response per minute and usually occurring at or near zero.

The outcomes of Marc's assessment and treatment series demonstrate that his SIB was maintained by multiple sources of reinforcement. The automatic-reinforcement account of Mark's SIB is supported from two sources. First, the persistence of SIB in the alone baseline indicates that the behavior was not maintained by social reinforcement (either contingent attention or escape from tasks). Second, several replications of the effects of toys on both the alone and the attention baselines indicate that the mere availability of other responses having nonsocial consequences reduced the frequency of SIB. Thus, neither the maintenance nor the reduction of SIB was related to social stimulation.

The final series of experimental conditions on the attention baseline provided a means of demonstrating the positive social reinforcement function of Marc's SIB. The two DRO-with-toys treatments may be compared with the two baseline-with-toys conditions; comparison of overall condition means shows a decrease from a mean rate of 3.93 responses per minute in baseline to 0.63 responses per minute in treatment (results in the final DRO with toys alone were of even greater magnitude, yielding a condition mean of 0.23 responses per minute). This represents an 84% reduction in overall mean rates of SIB. Similarly, the DRO-without-toys treatment may be compared with the baseline without toys, revealing a decrease in mean rates of SIB from 9.07 to 2.9 responses per minute. This represents a 68% decrease. Thus, because withdrawal of an attention contingency for SIB and implementation of a schedule of attention contingent on its omission produced reliable decreases in rates of SIB in both the presence and absence of toys, it can be concluded that a portion of Mark's SIB was maintained by attention from adults.

LAURA

Subject Information and Assessment Results

Laura was a 37-year-old woman with Down syndrome. Although her SIB was documented over most of her life, she had never received psychotropic medications. Her SIB consisted of slapping and punching of her face and body, resulting in contusions and swelling.

The results of Laura's functional analysis are shown in the middle panel of Figure 1. SIB was observed primarily in the alone and demand conditions. SIB in the demand condition, although variable, occurred throughout the assessment. SIB in the alone condition occurred infrequently in early sessions but increased to over 20 responses per minute in the final assessment session. SIB was rarely seen in either attention or play conditions. Based upon these results, treatments for multiply controlled SIB maintained by escape from demands and automatic reinforcement were developed.

Treatment Conditions and Experimental Design

To treat automatically reinforced SIB, Laura was presented with toys that she could manipulate. She had previously been observed to twirl and manipulate a string of beads, and it was hypothesized that this response might compete with SIB. This approach is conceptually similar to the enriched environment approach, in which reinforcing events are noncontingently available as alternatives to maladaptive behavior. No social interactions, other than initial presentation of the items, were required to implement this treatment.

To treat SIB maintained by escape from tasks, a stimulus-fading-with-extinction procedure was implemented, in which instructions were faded gradually into the experimental context over a number of sessions (Pace, Iwata, Cowdery, Andree, & McIntyre, 1993). The frequency of instructional trials was reduced initially to one per 15-min session, and was subsequently increased by one per session, based on a rate of SIB at or below 0.5 responses per minute in the previous session. The escape-extinction component involved guidance to

Figure 3. Treatment results for Laura. The top panel shows interventions (toys) on the alone baseline, the middle panel shows interventions (toys, instructional fading, escape extinction) on the demand baseline, and the bottom panel shows the attention and play baselines.

complete the task contingent on SIB. In this way, escape from instructional trials through SIB was not possible. Escape extinction alone (i.e., with instructions presented at baseline rates) was used in the final phase of Laura's treatment.

As with Marc, Laura's experimental arrangement involved aspects of multielement, reversal, and multiple baseline designs. Baseline conditions continued in a multielement design, although attention and play sessions occurred at a reduced frequency. Treatment conditions were implemented sequentially across the alone and demand baselines.

Results and Discussion

The results of Laura's treatment are shown in Figure 3. As with Marc, assessment data are shown prior to the first toy intervention. The upper panel shows the effects of the availability of toys (string of beads) on SIB in the alone baseline. The toys were made available following an initial baseline, and an immediate interruption of increasing SIB in baseline was observed, with SIB decreasing to near-zero levels. A return to baseline resulted in an increase in both the frequency and variability of SIB. When the toys were again made available, SIB returned to stable, near-zero levels that were maintained on the alone baseline.

The middle panel of Figure 3 shows the effects of treatment conditions on the demand baseline. Baseline continued until the second implementation of the toy condition on the alone baseline, when toys also were made available on the demand baseline. This resulted in a reduction, but not complete elimination, of SIB in the demand context, during which SIB still produced escape. SIB, which had occurred at a mean rate of 10.3 responses per minute in the demand baseline, occurred at a mean rate of 4.5 responses per minute when toys were available. Fading with extinction was then implemented (instructions were faded from one to three presentations over three sessions), and an 80% reduction in SIB (condition mean = 0.89 responses per minute) was observed. A reversal resulted in an increase in SIB to levels seen in the first demand baseline with toys, with a mean rate of 4.8 responses per minute. Fading with extinction was again im-

plemented, during which the frequency of instructional trials was increased from one to six per session over 12 sessions. An 80% reduction in SIB was again observed, with a condition mean of 0.94 responses per minute. At this time, Laura was absent from the treatment center for extended periods due to illness. Upon her return to the experiment, escape extinction (with toys) was implemented using baseline instructional frequencies. This treatment resulted in a condition mean rate of 0.49 responses per minute in the presence of 30 demands per session.

The lower panel of Figure 3 shows SIB in the attention and play baseline conditions. SIB was seldom observed in these conditions throughout the experiment.

Laura's results suggest that her SIB was multiply controlled by a combination of automatic reinforcement (self-stimulation) and social negative reinforcement (escape from tasks). Her SIB persisted in conditions of stimulus deprivation (the alone baseline) and was reliably reduced when alternative nonsocial reinforcers were made available. A similar effect was observed in the demand baseline; when toys were made available with no changes in the escape contingency, SIB was reduced (although not eliminated).

The escape function of Laura's SIB was evident in the virtual elimination of SIB when the frequency of instructional trials was reduced. Further evidence of an escape function was seen in the final condition of her treatment; with the escape contingency for SIB eliminated, very little SIB occurred even though instructions were presented at baseline rates.

CHARLENE

Subject Information and Assessment Results

Charlene was a 40-year-old woman who, although ambulatory, often was placed in a wheelchair due to a very unstable gait and frequent falls. Her SIB included head slapping and punching and head banging against hard objects that resulted in contusions, swelling, and occasional lacerations. (Charlene also exhibited occasional hand mouthing

and biting that did not produce injury and therefore was not included in the present analysis.)

The bottom panel of Figure 1 shows the results of Charlene's functional analysis. SIB was seen almost exclusively in the alone and attention conditions. SIB was most frequent and showed an increasing trend in the alone condition and occurred at low, steady rates in the attention condition. Based on these assessment results it was hypothesized that Charlene's SIB was multiply controlled by automatic reinforcement and contingent attention.

Treatment Conditions and Experimental Design

An enriched environment intervention was developed to treat automatically reinforced SIB. This treatment involved conducting sessions in a larger area that permitted free roaming, allowed access to more visual stimuli via windowed walls, and contained a greater variety of stimulus materials with which to interact. No social interactions took place during these sessions in the alone condition; however, therapist presence and attention contingent upon SIB remained in effect throughout the attention condition.

The enriched environment was implemented in a reversal design on the alone baseline and in a modified multiple baseline design on the attention baseline, with treatment initiated on the attention baseline simultaneously with the second reversal from the alone baseline.

Results and Discussion

The results of Charlene's treatment are shown in Figure 4. Unlike Marc and Laura, new baselines were established for Charlene because of an intervening condition unrelated to this study. Following an alone baseline, during which SIB averaged 1.3 responses per minute (upper panel), the first implementation of the enriched environment suppressed SIB completely. SIB was again observed upon a return to baseline. A second treatment condition replicated the suppressive effects of the intervention (SIB occurred in only two of nine sessions).

Attention baseline conditions, maintained concurrently through the alone baseline reversal, produced moderate and relatively stable rates of SIB, with a condition mean of 1.3 responses per minute. The enriched environment was implemented simultaneously with the treatment reversal on the alone baseline. As in the alone condition, the enriched environment produced almost total suppression of SIB in the attention condition (only one self-injurious response was observed during nine treatment sessions).

The persistence of Charlene's SIB in relatively stimulus-deprived contexts and its suppression through the presence of alternative nonsocial stimulation support an automatic-reinforcement interpretation of her SIB. The reduction of her self-injury through a nonsocial intervention, even in a condition in which a discriminative stimulus for attention was present and social interaction was contingent on SIB (the attention baseline), supports the conclusion that contingent attention was not a maintaining variable for SIB. Although it may be argued that an enriched environment may compete effectively with, and thus reduce, SIB maintained by contingent attention, it is unlikely that its total suppression in the presence of discriminative stimuli for attention, as was seen in this case, would occur.

An automatic-reinforcement account of Charlene's SIB, however, requires an explanation for assessment data showing the occurrence of SIB in both alone and attention conditions but not in play and demand conditions. The presence of SIB in attention baseline conditions may have been a function of relative stimulus deprivation; although play stimuli were present and therapist attention was available in the attention baseline, the results suggest that those stimuli may not have been sufficiently reinforcing to compete with SIB (i.e., their presence did not constitute, for Charlene, significant enrichment of her environment). The absence of SIB in the play condition may be explained by the presentation of noncontingent social interaction along with play stimuli, and its absence in the demand condition may be a function of competing activity required in that context. Thus, although Charlene's SIB occurred in two of four assessment

Figure 4. Treatment results for Charlene. The effects of intervention (enriched environment) are shown on the alone (top panel) and attention (bottom panel) baselines.

contexts, treatment data suggest that her SIB may have been maintained solely by automatically produced consequences.

GENERAL DISCUSSION

This study illustrates a systematic approach for investigating the source of unclear assessment data in the functional analysis of behavior disorders and for demonstrating multiple control of SIB. Treatments derived through hypotheses of behavioral function confirmed or disconfirmed those hypotheses when applied sequentially on functional anal-

ysis baselines. Evidence about the variables maintaining the problem behavior was provided through differential treatment effects on these baselines.

Several methods may be used to identify the source of unclear assessment results. Extremely variable data suggest inadequate control by the experimental procedures. Variables that may produce these results include failures to identify idiosyncratic contingencies of reinforcement, interaction effects between assessment conditions, and intermittent schedules of reinforcement in the natural setting. In these cases, refinement of some aspect of the functional analysis may be necessary to reduce the

confounding effects of extraneous variables or to increase control by the experimental arrangement. Specific approaches may include the addition of assessment conditions to reveal idiosyncratic contingencies and sequential presentation of assessment conditions to limit interaction effects (e.g., Carr & Durand, 1985).

If some patterning is present in the data (i.e., responding is stable in more than one condition), multiple control of SIB may be suspected. There are at least two additional approaches to verify the functional properties of SIB in this case. Individuals often engage in multiple topographies of SIB, which may serve more than one function. If so, a functional analysis may be applied to each topography separately, and results can then be validated by matching treatment to topography and function. If, on the other hand, only one topography is present, or if responses are not functionally independent, then the strategy presented in the current experiment may be used.

This methodology employs a multiple baseline design to examine the effects of intervention based on the suspected maintaining variables on functional analysis baselines.

Treatment is imposed in one condition while baseline contingencies are maintained in other conditions of the assessment. If a treatment effect is observed, the intervention may be applied on another baseline, or a different intervention, appropriate to a different function of SIB, may be imposed on its relevant baseline. Reversals can be used to demonstrate treatment effects within a function, and treatments may be combined when appropriate.

Self-injury maintained by both contingent attention and escape from aversive situations would be indicated by the persistence of SIB in both the attention and demand conditions of the functional analysis. To identify conclusively the determinants of SIB in this case, treatments appropriate to each function (e.g., escape extinction and extinction of attention-maintained SIB) would be imposed on the relevant baselines. Because the treatments are uniquely suited to a particular behavioral function, and because carryover of function between condi-

tions is unlikely in this case (i.e., no escape-maintained SIB should occur in the attention condition, and vice versa), demonstration of multiple control is relatively straightforward through the sequential application of treatments only on relevant baselines.

Self-injury maintained by both escape from aversive stimulation and some type of automatic reinforcement would be indicated if SIB was observed in the demand and alone conditions of the functional analysis. Isolation of the maintaining variables is somewhat difficult in this case because (a) it is very difficult to identify and directly control the source of automatic reinforcement and (b) there may be some carryover of the automatic function into the escape condition (i.e., some automatically maintained SIB may occur in the demand condition). If identification of the automatic reinforcer for SIB is possible, then extinction or differential reinforcement using a similar stimulus could be imposed on the alone baseline. Otherwise, a reasonable approach would be to intervene on the alone baseline by providing alternative nonsocial stimulation that may compete with the automatic reinforcement. If this intervention resulted in a decrease in SIB, then it may also be imposed on the demand baseline. If there is no carryover of function between these conditions (i.e., if no automatically maintained SIB occurs in the demand condition), then no effect will be observed. If, however, there is a carryover, a decrease, but not a complete elimination, of SIB in the presence of demands should occur. Escape extinction, a treatment corresponding specifically to the escape function (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990), would be applied on the demand baseline. This general approach was used in the investigation of Laura's SIB in the current experiment.

The case of SIB maintained by contingent attention and automatic reinforcement would be suspected if SIB was observed in the attention and alone conditions of the functional analysis. This is the most difficult of functional combinations to verify, primarily because interventions appropriate to the treatment of attention maintained SIB may also be appropriate to the treatment of automatically reinforced SIB (e.g., frequent presentation of

attention, as in noncontingent reinforcement, will reduce the general condition of deprivation that may motivate automatically reinforced SIB). Although this can expedite the development of clinically effective treatments, conclusive identification of the functional properties of SIB is precluded when a common treatment is applied in a case of suspected multiple control. Thus, the form of treatment imposed on the alone baseline would most appropriately be nonsocial stimulation that may compete successfully with SIB. This treatment, applied on the attention baseline, would likely result in a reduction, but not complete elimination, of SIB. A treatment for attention-maintained SIB would be implemented on the attention baseline. Extinction of attention-maintained SIB would be contraindicated, because this would result in a virtual replication of the alone condition (in which SIB also was observed). Delivery of attention (e.g., DRO, differential reinforcement of alternative behavior, and even noncontingent reinforcement) may be appropriate treatments on this baseline (see Vollmer & Iwata, 1992, for further discussion of these procedures). When combined with treatment for automatically reinforced SIB, this approach should result in very low rates of SIB. This method was used in the present study to examine the variables maintaining Marc's SIB.

A cautionary note on the interpretation of automatically reinforced behavior is in order. Although socially mediated consequences for behavior disorders may be directly controlled, automatically produced consequences are less amenable to experimental manipulation. Thus, automatic reinforcement is typically inferred rather than directly analyzed, as was the case in the current experiment. Other interpretations may be tenable; for example, the concept of *reinforcer substitution* suggests that the reinforcing effects of one stimulus can be displaced by those of a qualitatively different stimulus (see Green & Rachlin, 1991, for a recent example). Thus, it is possible that the general reinforcing effects of enriched environment treatments may be substitutable for attention in situations in which attention maintains SIB. However, the persistence of SIB in the absence of social consequences and

its reduction through nonsocial interventions increase confidence in an automatic-reinforcement interpretation in the current study.

The importance of methods for identifying multiple determinants of SIB is seen in the difficult challenge presented when SIB enters into more than one functional relation. Treatment procedures entirely appropriate for one behavioral function may exacerbate SIB having other functions (e.g., Lovaas et al., 1965). In the case of multiple control, this problem is compounded. For example, if an individual's SIB is maintained by escape from aversive social stimuli, an appropriate treatment such as escape extinction (Iwata, Pace, Kalsher, Coudery, & Cataldo, 1990) would involve the continued presentation of those stimuli contingent upon emission of SIB. Treatment for SIB maintained by contingent attention, however, would involve withholding or withdrawing attention contingent upon the response. If sensitivity to both of these maintaining conditions is present within an individual, two very incompatible treatment courses would be indicated; in an attempt to solve one problem, a second problem may be inadvertently exacerbated. In this case, identification of the stimulus conditions associated with each functional class of SIB is critical for the development and implementation of a comprehensive and effective treatment program.

The current study offers an extension of functional assessment methodology for the analysis and treatment of complex cases of SIB. Future research may further extend this methodology for a better understanding of other behavior disorders. Its apparent flexibility to accommodate complex situations and its generality to novel problems suggest that many applications of functional analysis remain to be discovered, and argue for creative research efforts toward that end.

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Received August 11, 1992

Initial editorial decision November 23, 1992

Revisions received January 22, 1993; February 12, 1993

Final acceptance February 12, 1993

Action Editor, F. Charles Mace