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EXPERIMENTAL ANALYSIS AND EXTINCTION OF SELF-INJURIOUS ESCAPE BEHAVIOR

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Three studies are presented in which environmental correlates of self-injurious behavior were systematically examined and later used as the basis for treatment. In Study 1, 7 developmentally disabled subjects were exposed to a series of conditions designed to identify factors that maintain self-injurious behavior: attention contingent on self-injurious behavior (positive reinforcement), escape from or avoidance of demands contingent on self-injurious behavior (negative reinforcement), alone (automatic reinforcement), and play (control). Results of a multielement design showed that each subject's self-injurious behavior occurred more frequently in the demand condition, suggesting that the behavior served an avoidance or escape function. Six of the 7 subjects participated in Study 2. During educational sessions, "escape extinction" was applied as treatment for their self-injurious behavior in a multiple baseline across subjects design. Results showed noticeable reduction or elimination of self-injurious behavior for each subject and an increase in compliance with instructions in all subjects for whom compliance data were taken. The 7th subject, whose self-injurious behavior during Study 1 occurred in response to medical demands (i.e., physical examinations), participated in Study 3. Treatment was comprised of extinction, as in Study 2, plus reinforcement for tolerance of the examination procedure, and was evaluated in a multiple baseline across settings design. Results showed that the treatment was successful in eliminating self-injurious behavior and that its effects transferred across eight new therapists and three physicians. General implications for the design, interpretation, and uses of assessment studies are discussed.

DESCRIPTORS: avoidance behavior, escape behavior, extinction, functional analysis, negative reinforcement, self-injurious behavior.

Results from a number of studies indicate that self-injurious behavior (SIB), a chronic and serious disorder occurring in approximately 10% of the developmentally disabled population, may be acquired and maintained through a variety of operant mechanisms. Positive, negative, and automatic reinforcement all have been suggested as maintaining variables, and discussion of these topics can be

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found in several published reviews (e.g., Carr, 1977; Mace, Lalli, & Pinter, in press)[1]. Negative reinforcement is of particular interest because it has not been the subject of extensive investigation, and there is evidence indicating that the treatment of negatively reinforced behavior may require additional extension and refinement in the areas of assessment and therapy (Iwata, 1987).

Research on SIB that serves as either escape or avoidance behavior generally falls into two categories. First, assessment research focusing on the experimental analysis of behavioral function has shown differential control over the occurrence of SIB in situations containing aversive events. In some cases, an explicit escape or avoidance contingency, such as time-out from instructional sequences, was arranged for SIB (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982; Steege, Wacker, Berg, Cigrand, & Cooper, 1989). In others, the presentation of discriminative stimuli (e.g., demands or difficult tasks) associated with aversive events was sufficient to produce SIB (Carr & Durand, 1985; Carr, Newsom, & Binkoff, 1976; Romanczyk, Colletti, & Plotkin, 1980; Weeks & Gaylord-Ross, 1981).

The development and evaluation of treatments for negatively reinforced SIB comprise the second category of research. In studies in which no attempt was made to alter the maintaining contingency, self-injurious avoidance or escape behavior has been reduced through punishment (Borreson, 1980; Romanczyk et al., 1980) or alteration of avoidance-producing stimuli to eliminate their aversive or discriminative properties (Carr et al., 1976; Weeks & Gaylord-Ross, 1981). By contrast, other studies have shown that it is possible to disrupt directly the maintaining contingency through extinction, compliance training (which has included an extinction component), or the establishment of an alternative escape response (Carr & Durand, 1985; Heidorn & Jensen, 1984; Steege et al., 1989).

These areas of research—assessment and treatment—are related in that the ability to identify the avoidance or escape function of SIB may influence decisions about treatment selection and its subsequent outcome. This fact was demonstrated recently by Repp, Felce, and Barton (1988). With 1 of their subjects, the authors compared the effects of two interventions; one (extinction through withdrawal of attention) was based on the assumption that SIB was positively reinforced, whereas the other (extinction through continuation of demands, combined with compliance training) was based on the assumption that SIB was negatively reinforced. Their results indicated that "escape extinction" was effective but that "attention extinction" was not, and suggest that pretreatment analyses of behavioral function might assist in the development of more effective intervention programs.

In the present series of experiments, we examined further the role played by negative reinforcement in the maintenance and treatment of SIB. Study 1 provided a systematic replication of Iwata et al. (1982) by demonstrating that avoidance- or escape-motivated SIB responds differentially when negative reinforcement contingencies are applied. The procedures used in Study 1 also exemplified an empirical approach to subject selection based on a functional analysis of behavior. Studies 2 and 3 evaluated the effects of treatment involving direct reversal of the maintaining contingency through extinction of escape or avoidance behavior in two different contexts.

STUDY 1

Method

Subjects and Setting

Seven children and adolescents participated. They were referred from various sources (e.g., parents,

[1] In cases in which one cannot identify an environmental source of reinforcement (positive or negative) maintaining a behavior, terms such as *sensory reinforcement* and *self-stimulation* do not seem adequate as explanatory accounts independent of confirming data. The former limits reinforcement to the realm of physiological feedback, whereas the latter implies that the unidentified function is positive reinforcement. *Automatic reinforcement,* on the other hand, is consistent with the notion that some behaviors are maintained as a result of the natural consequences of responding (one of which is physiological feedback), yet it leaves open the possibility that the contingency could be one of positive or negative reinforcement (Skinner, 1969). An equally appropriate and more commonly used term is *stereotypy,* which expands the area of inquiry to include respondent behavior (Baumeister, 1978).

Table 1
Demographic Characteristics of Subjects

Subject	Sex	Age	Level of retardation	Self-injurious behavior
Suzie	F	5	Moderate	Head banging, face hitting
Nellie	F	4	Moderate	Head banging, hand biting
Lana	F	16	Profound	Hand biting, face hitting
Noreen	F	4	Mild	Head banging, arm biting
Gina	F	16	Profound	Face hitting
Dan	M	5	Profound	Head banging
Donald	M	16	Moderate	Face hitting, hand biting

physicians, teachers) for treatment of SIB, and they entered the study at different times over a 3-year period. All showed evidence of developmental delay and displayed SIB that (a) posed moderate to severe physical risk, ranging from surface tissue damage to potential loss of vision; (b) significantly interefered with their performance of educational and self-care tasks; and (c) could not be managed in their home, school, or institutional settings. Their medical diagnoses were mixed and did not suggest any relationship between SIB and organic pathology. Interviews with parents, caretakers, and/or teachers conducted prior to the study revealed that Lana reliably exhibited SIB during educational sessions, and that Donald and Suzie exhibited SIB when they were "upset"; otherwise, there was no indication of previous attempts to identify environmental correlates of subjects' SIB. None of the subjects had extensive sensory or motor impairments (except for Donald, see below), and their functioning abilities were quite variable. Descriptive information pertaining to each subject is provided in Table 1.

All subjects underwent medical examination prior to the study, and it was determined that they could be allowed to engage in SIB unrestrained for brief durations with little risk of inflicting further injury. In addition, physicians and nurses routinely monitored the subjects' physical status both during and after sessions to ensure that the risk remained within acceptable levels. On seven occasions (no more than two for any subject), a session was terminated prematurely due to excessive self-injury. All sessions were conducted individually in therapy rooms containing one-way observation windows.

Response Measurement and Reliability

Self-injurious responses were defined as follows: ***arm or hand biting***—closure of upper and lower teeth on any portion of the skin extending from fingers to elbow; ***face hitting***—audible contact of an opened or closed hand against the face or head; and ***head banging***—audible contact of any portion of the head against a stationary object (e.g., desk, floor, wall). During each session, an observer recorded the occurrences of SIB using one of two methods. Data for Nellie, Noreen, Lana, and Dan were recorded on paper during continuous 10-s intervals, which were cued by cassette tape. Data for Suzie, Gina, and Donald were recorded continuously on a hand-held computer (Panasonic model RL-H1800), which contained an internal clock and was programmed to capture responses in real time. All data were converted into the percentage of 10-s intervals during which one or more SIBs occurred (Powell, Martindale, & Kulp, 1975). Interobserver agreement was assessed by having a second observer simultaneously but independently record data during 34% of all sessions. Overall, occurrence, and nonoccurrence agreement percentages were calculated based on interval-by-interval comparisons of observers' records; these results are summarized in Table 2.

Data also were taken on a number of experimenter behaviors: frequency of prompts (instructions, modeling, physical assistance) and frequency of attention (noncontingent; contingent on the absence of SIB; contingent on the occurrence of SIB, toy play, or instruction following). These data were used to train experimenters and to ensure their

Table 2
Mean Reliability Percentages for Studies 1, 2, and 3

Subject	Percentage of sessions	Behavior	Overall	Occurrence	Nonoccurrence
Study 1					
Suzie	44	SIB	83	80	92
Nellie	27	SIB	97	91	98
Lana	14	SIB	98	90	98
Noreen	20	SIB	99	84	99
Gina	35	SIB	86	75	96
Dan	15	SIB	99	90	97
Donald	85	SIB	98	72	97
Study 2					
Suzie	40	SIB	98	90	97
		Compliance	87	71	83
Nellie	44	SIB	98	84	88
Lana	15	SIB	98	85	97
		Compliance	85	74	73
Noreen	13	SIB	99	84	99
		Compliance	98	92	99
Gina	31	SIB	94	79	97
		Compliance	99	82	98
Dan	13	SIB	99	85	98
		Compliance	92	87	98
Study 3					
Donald	42	SIB	95	83	98

continued compliance with the protocols. Accuracy percentages, based on interval-by-interval comparisons of experimenter behavior to performance criteria defined by either the passage of time or a subject's response, ranged from 72% to 100%.

Experimental Design

Subjects were exposed to a series of conditions, each presented during 15-min sessions, in a multielement format (Sidman, 1960; Ulman & Sulzer-Azaroff, 1975). A brief description of each condition is provided here; complete details can be found in Iwata et al. (1982).

Attention. This condition was designed to assess the sensitivity of SIB to positive reinforcement in the form of differential attention from an adult. Upon entering the therapy room (which was equipped with a variety of play materials), an experimenter directed the subject toward the materials and proceeded to do paperwork or read a magazine while seated in a chair across the room. Contingent on the occurrence of SIB, the experimenter approached the subject, expressed concern and disapproval (e.g., "Don't do that; you'll hurt yourself."), and provided brief physical contact in the form of response interruption (e.g., removing the subject's hand from his or her mouth) or comfort (e.g., placing the experimenter's hand on the subject's shoulder). All other responses exhibited by the subject were ignored.

Demand. This condition was designed to assess the sensitivity of SIB to negative reinforcement in the form of escape from or avoidance of instructional sequences. Educational tasks were selected for each subject based on information obtained from teachers or caregivers and on informal observations conducted prior to the start of the study. The tasks consisted of a variety of educational activities, all requiring a response such as pointing, sorting, stacking, puzzle completion, or perfor-

mance of a self-care skill. During a session, the experimenter presented these tasks in learning trials to the subject approximately once every 30 s while both were seated at a table. The experimenter initiated each trial with an instruction. Correct responses were followed by praise, which sometimes was paired with pats on the back. Contingent on an incorrect response or no response within 5 s, the experimenter modeled the correct response and, if necessary, physically guided the subject to complete the response during subsequent remedial trials. Contingent on the occurrence of SIB, the experimenter terminated the trial, removed the materials from the table, and turned away from and ignored the subject for 30 s.

Medical. This variation of the demand condition was implemented only with Donald, who rarely exhibited SIB during any of the other conditions. Informal observations suggested that Donald's SIB was most likely to occur in response to medical examination and questioning about his numerous physical handicaps. In fact, Donald was in need of eye surgery, which could not be performed until his face punching was eliminated. After consulting with his pediatrician and studying the manner in which medical exams were performed, we constructed a simulated exam. While Donald was sitting in a chair or lying on a couch, an experimenter asked him specific questions (e.g., "Does your knee hurt?"), directed him to flex and extend his extremities or to hold them out for examination, and palpated various body parts (extremities, head, upper torso, stomach). Periodic praise was provided for compliance with or tolerance of the procedure. Contingent on SIB, the experimenter interrupted the exam and turned away from Donald as in the demand condition.

Alone. This condition approximated a "barren environment," in which SIB might occur as a function of minimal stimulation. The experimenter placed the subject alone in the therapy room, which was devoid of all play and educational materials.

Play. This condition served as the control; that is, it provided opportunities for play, social interaction, and positive reinforcement for appropriate behavior, and it did not provide the occasion for demands or reinforcement for the occurrence of SIB. As in the attention condition, the therapy room contained toys and games. After initially directing the subject toward the materials, the experimenter allowed the subject to engage in isolated play, responded to the subject's play initiatives, and/or periodically presented toys to the subject without requiring any type of response. SIB was ignored, whereas the absence of SIB was followed by praise every 30 to 60 s.

Data collection continued until between-condition patterns of responding were readily discernible. As a result, subjects participated in varying numbers of sessions, ranging from 18 to 61 ($M = 35$) over the course of 5 to 14 days ($M = 8$). Theoretically, it would have been possible to complete all data collection in 2 to 8 days, but a number of scheduled sessions could not be run due to subject unavailability or experimenter absence.

Results and Discussion

Session-by-session results for each subject are presented in Figure 1. All subjects engaged in SIB more frequently during the demand condition (the medical condition for Donald), suggesting that this condition contained aversive events whose contingent removal or postponement served as negative reinforcement. Noreen, Donald, Suzie, Lana, and Nellie rarely responded in any condition but the demand condition. Dan and Gina, whose SIB was either uniformly low or quite variable initially, showed a more consistent pattern of responding during the last 20 sessions of their assessment. On a within-subject basis, the mean percentage of intervals of SIB during the demand condition, when expressed as a ratio against mean SIB during the next highest condition, ranged from a low of 2.6:1 (Nellie) to a high of 44.3:1 (Noreen).

Although some differences in the level or stability of SIB were seen across subjects, the general pattern of responding was consistent. We do not suggest, however, that the specific conditions used in this study would produce similar results for all individuals who exhibit self-injurious avoidance or escape behavior. First, although not demonstrated in this study, it is possible that a pattern of responding

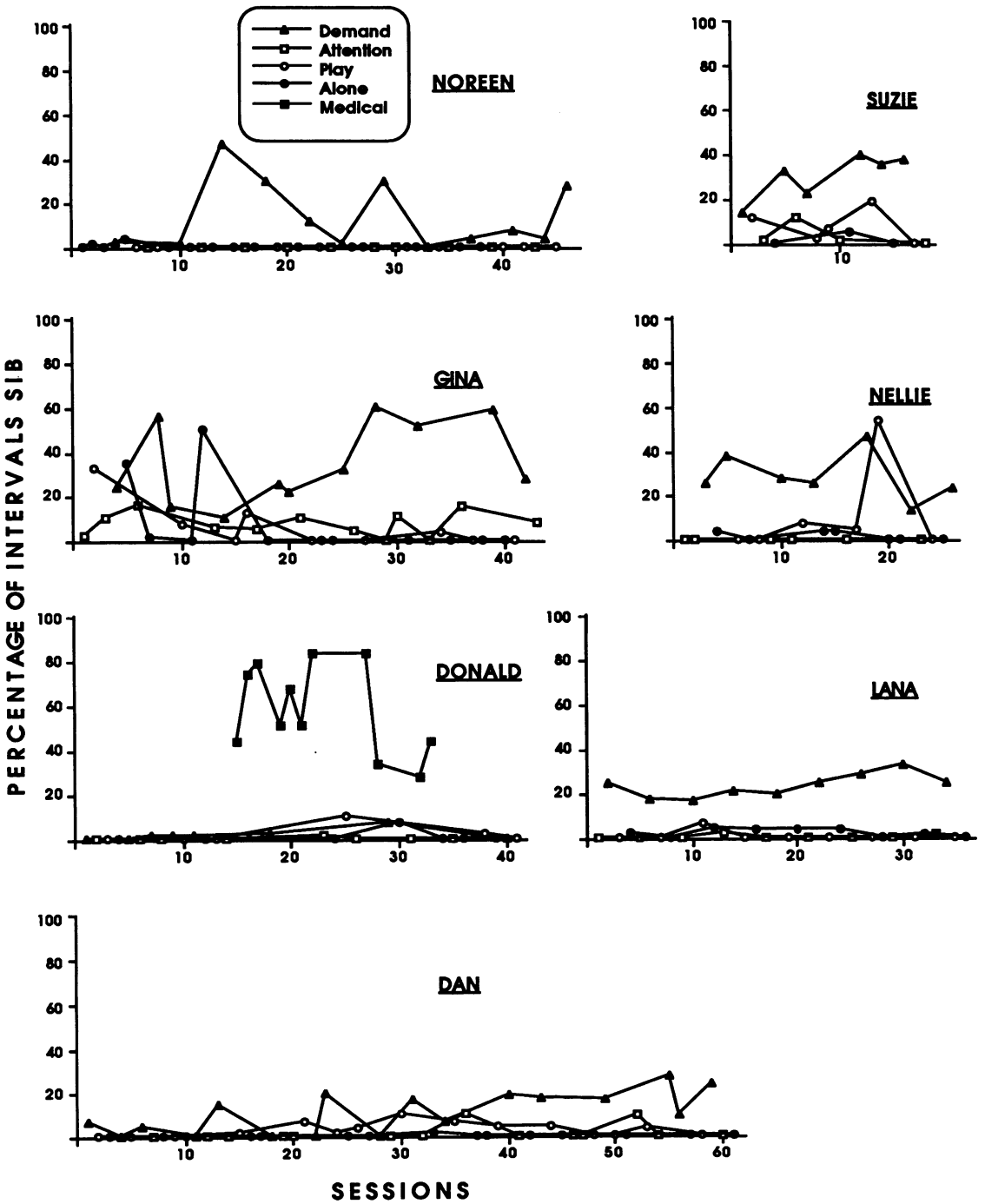

Figure 1. Percentage of 10-s intervals of SIB across subjects and experimental conditions in Study 1.

different than that observed might also suggest negative reinforcement as a maintaining variable. Other research (e.g., Corte, Wolf, & Locke, 1971) has shown that the mere presence of an adult may acquire discriminative properties due to previous pairing with aversive stimulation, and a similar process might occur in the present context. If that had happened, one would expect to see high levels of SIB in all but the alone condition (interestingly, SIB that is under tight stimulus control, but maintained by positive reinforcement in the form of adult attention, might show an identical pattern of responding). Second, a priori assumptions about what constitutes an aversive event for a given individual may be just as erroneous as assumptions regarding positive reinforcers. That proved true for Donald, who exhibited little or no SIB during the academic demand condition. Dan's behavior also revealed some idiosyncrasy in that he rarely engaged in SIB when presented with table tasks (e.g., sorting, pointing, etc.). Instead, his SIB occurred primarily when the task required performance of a motorically effortful response (e.g., dressing, shoe tying), and his demand condition was comprised entirely of these tasks. Our experience with Donald and Dan, as well as with several other individuals who have been exposed to the assessment procedures described in this study, indicates that the term *negatively reinforced SIB* refers to a potentially broad class of behaviors whose specific motivating events may be quite varied.

In recognizing the idiosyncratic nature of motivating stimuli, some researchers have suggested a functional classification of behavioral disorders such as SIB based on specific events. For example, Durand and Crimmins (1988) make a categorical distinction between positive reinforcement that is tangible (i.e., food and materials) versus that which is social. Although such systems have the advantage of being highly descriptive, their generality is limited in three respects: (a) event-based systems will never be complete until all potential sources of reinforcement have been identified; (b) by focusing on within-class differences (food vs. attention), we may lose sight of general principles and operations that apply across all stimuli within the class; and (c) the very principle of idiosyncrasy makes it entirely possible that the same stimulus might serve as a positive reinforcer for the behavior of one individual but as a negative reinforcer for the behavior of another. Similarly, a stimulus delivered by one individual (e.g., attention from a parent) might not have the same effect as the same stimulus delivered by another (e.g., teacher). Therefore, it seems more desirable to classify behaviors such as SIB through reference to the more general contingency (i.e., positive reinforcement, negative reinforcement, automatic reinforcement) rather than to stimuli that apply in any given case. The task then becomes one of identifying the range of stimuli entering into the contingency for an individual or a group (e.g., Day, Rae, Schussler, Larsen, & Johnson, 1988). A number of procedures have been developed to assess preference for specific positive reinforcers (e.g., Pace, Ivancic, Edwards, Iwata, & Page, 1986; Wacker, Berg, Wiggins, Muldoon, & Cavanaugh, 1985); these could be adapted easily for the purpose of determining negative reinforcers.

This raises the question of identifying the specific aspects of the demand condition that served as aversive events, because several may have been functional: the mere presentation of demands by the experimenter, the behavioral requirements of the task itself, or the remedial trials and physical prompting that occurred following an incorrect response. Given that all of these are included in most teaching routines, the isolation of one as the critical element may not seem important from a practical standpoint. However, identifying the specific aversive event within the demand condition may allow one to determine whether the resulting SIB is escape or avoidance behavior. If the demand per se is aversive, it probably serves as an establishing operation for escape; if the task or the consequences of incorrect responding are aversive, the demand serves as a discriminative stimulus for avoidance behavior (see Michael, 1982, for a discussion of establishing and discriminative stimuli). The distinction is a fine one, yet it provides additional information on features of the instructional situation whose alteration may have a noticeable impact on behavior. We made no attempt to distinguish between escape and avoidance, and our use of the term *self-injurious escape behavior* merely indi-

cates that the SIB exhibited by our subjects may reflect an attempt to terminate any or all aspects of the situation.

In summary, the response patterns exhibited by subjects in this study identified an environment–behavior relationship whose known properties have direct implications for treatment. Behavior maintained by negative reinforcement might be reduced or eliminated in a number of ways, including alteration of response-producing cues through discriminative stimulus manipulations, elimination of the contingency through escape extinction, attenuation of the aversive stimulus, or use of the existing contingency to establish an alternative escape or avoidance response (see Iwata, 1987, and Mace et al., in press, for further discussion of these strategies). Conversely, traditional uses of extinction or time-out involving contingent termination of the ongoing situation are contraindicated as treatment of negatively reinforced behavior because they directly strengthen the behavior through avoidance or escape. The potential value, therefore, of identifying the maintaining variables for SIB and other behavioral disorders is that it allows one to match the function of treatment (independent of its specific operations) with the function of the response (independent of its topography).

STUDY 2

Extinction is the most direct method of reducing the frequency of a reinforced behavior. In the case of negative reinforcement, extinction involves continued presentation of the aversive event and its related cues while eliminating the possibility of escape or avoidance (Hineline, 1977). Procedures based on this type of extinction were used by Heidorn and Jensen (1984) and Repp et al. (1988), and a similar treatment was evaluated in Studies 2 and 3.

Method

Subjects, Setting, Response Measurement, and Reliability

Six of the 7 subjects from Study 1 (Dan, Gina, Lana, Nellie, Noreen, and Suzie) participated. As in Study 1, all sessions were conducted individually in therapy rooms and lasted for 15 min each.

Self-injurious responses were defined and recorded as in Study 1. For 5 subjects (Dan, Gina, Lana, Noreen, and Suzie), data also were taken on compliance to instructions, which was defined as a response by the subject that corresponded to the experimenter's vocal instruction or gestural cue. Compliance data for Nellie are not presented because they were taken sporadically and were not subject to reliability checks. A second observer simultaneously but independently recorded data on SIB and compliance during 26% of all sessions. Overall, occurrence, and nonoccurrence agreement percentages were calculated as in Study 1, and the results are summarized in Table 2.

Experimental Design

The effects of treatment on subjects' SIB and compliance were evaluated in a multiple baseline across subjects design. Because subjects entered the study at different times, data were collected nonconcurrently (Watson & Workman, 1981).

Baseline. Procedures in effect during baseline were identical to those in the demand condition of Study 1. The experimenter presented learning trials, provided social reinforcement for correct responses, and interrupted the instructional sequence with a 30-s time-out following the occurrence of SIB.

Extinction plus physical guidance. Instructions and reinforcement continued as in baseline. The time-out for SIB, however, was replaced with physical guidance to complete the target response. That is, physical guidance, contingent only on incorrect responses (or no response) during baseline, was also contingent on the occurrence of SIB.

Extinction plus guidance plus response blocking. This condition, implemented only for Lana, differed from the extinction condition in one respect. Instead of waiting for Lana to actually complete the self-injurious response before physically guiding her to comply with the instruction, the experimenter interrupted the SIB just as she was about to bite or strike (i.e., just as her hand reached her face) and initiated the physical prompt. These blocked responses were recorded as occurrences of SIB.

Results and Discussion

Figure 2 shows the results obtained for all subjects. Baseline levels of SIB were generally variable, with 4 of the 6 subjects exhibiting no SIB during some sessions and high rates of SIB during others. Compliance during this condition was either variable or consistently low. Following the implementation of extinction, the SIB of Suzie, Nellie, Noreen, Gina, and Dan decreased to zero or near-zero rates, and noticeable increases in compliance were seen.

Lana's behavior during the extinction condition was quite different than that of the other subjects. Her SIB, which was relatively stable during baseline, became highly variable and increased above its baseline level, while her compliance remained essentially at zero. It is not clear why these effects were obtained, although informal analysis indicated that a subtle change had occurred in the topography of her SIB. During baseline, Lana typically exhibited one SIB (usually one bite to her hand) following an instruction. This pattern continued during extinction, but she also began to exhibit more responses per instruction, often in rapid succession (i.e., several bites to her hand per arm movement). Response maintenance, chaining, and facilitation—similar to that shown by Lana—have been reported in laboratory studies on avoidance behavior, in which it was demonstrated that aversive stimuli can acquire eliciting properties following their use as negative reinforcers (Kelleher, Riddle, & Cook, 1963; Powell & Peck, 1969; Sidman, Herrnstein, & Conrad, 1957). These results suggest that the physical guidance provided by the experimenter during treatment may have served to occasion the very behavior being extinguished. Although it is possible that extinction might have brought about a reduction in SIB if continued long enough, no therapeutic change was evident after 21 sessions, and it was felt that an additional intervention was warranted. One method of facilitating extinction of avoidance behavior consists of response blocking (Schiff, Smith, & Prochaska, 1972); a derivative of this procedure, brief response interruption, has been shown to be effective in reducing SIB when combined with other treatments (Azrin, Besalel, & Wisotzek, 1982; Slifer, Iwata, & Dorsey, 1984). When response blocking was combined with extinction in this study, the changes seen in Lana's behavior (a gradual decrease in her SIB and a corresponding increase in her compliance) resembled very closely those observed for the other subjects.

Upon completion of the study, a maintenance and generalization program was designed and implemented for each subject and was based on continued use of the extinction procedure in ongoing instructional sessions, combined with reinforcement techniques selected in consultation with the subjects' regular teachers and therapists. These teachers and therapists initially observed procedural implementation by experimenters, later conducted sessions under experimenter supervision, and finally integrated the procedures into the subjects' regular programs. Follow-up data varied considerably in both quality and quantity (e.g., some subjects moved out of state); in each case, however, the overall program was judged to be "completely effective" or to have reduced SIB to a "clinically significant degree" by the referring parties.

Although the results of this study were relatively clear, the exact mechanisms responsible for observed behavior changes are not. With respect to SIB, two procedural modifications occurred from baseline to treatment. First, instructional sequences were not terminated contingent on the occurrence of SIB. This operation is consistent with extinction of negatively reinforced behavior, in which responding no longer produces avoidance or escape. Second, SIB also may have been punished as a result of physical guidance (or blocking plus guidance for Lana) provided by the experimenter immediately following the occurrence of a self-injurious response. We included the physical guidance component to eliminate the possibility that SIB following an experimenter's initial instruction might be reinforced by delaying subsequent events (i.e., remedial trials and physical guidance). In doing so, the relative effects of extinction versus punishment may have been obscured. The data shown in Figure 2, however, provide support for an extinction effect. Response reduction during treatment was gradual for 4 of the 6 subjects (Suzie, Lana, Noreen, and Dan) and was preceded by an increase in SIB for 3 subjects (Suzie, Noreen, and Dan). These effects

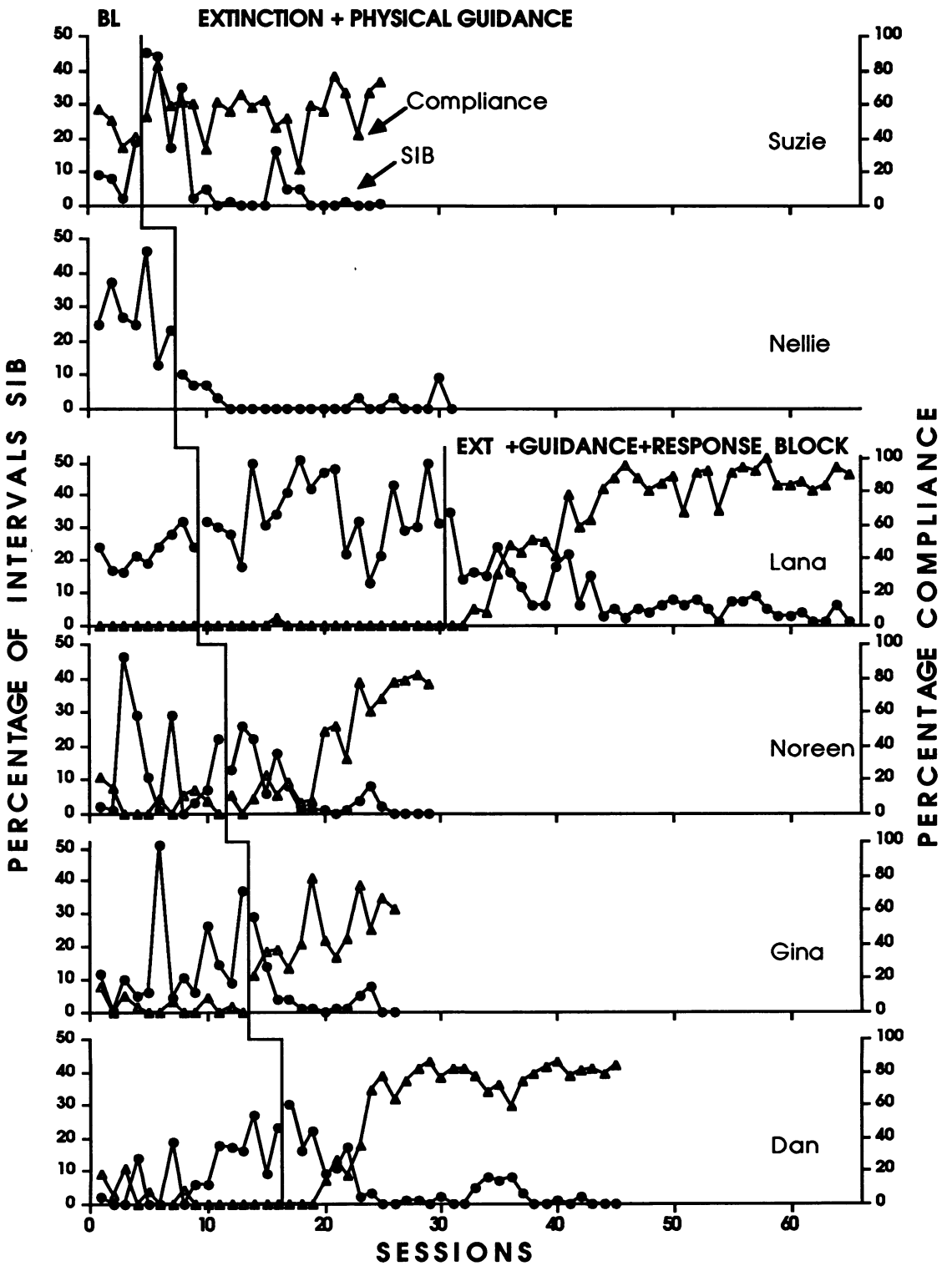

Figure 2. Percentage of 10-s intervals of SIB and percentage of trials of compliance across subjects and experimental conditions in Study 2.

are more likely to be observed during extinction than during punishment.

The improvements noted in compliance with instructions also are subject to several interpretations. One possibility, that compliance increased as a function of positive reinforcement alone, is unlikely because the contingency was in effect during baseline as well as during treatment. A second explanation, derived from research on response covariation among compliant and inappropriate behaviors (e.g., Parrish, Cataldo, Kolko, Neef, & Egel, 1986), suggests that compliance was more likely to occur and contact the already existing contingency (positive reinforcement) once the interfering behavior (SIB) decreased. Some support for this explanation can be found in the data for Lana, Noreen, and Dan, whose compliance increased only after reductions in SIB. Increased compliance for Suzie and Gina, on the other hand, was rather abrupt and apparently independent of their SIB. Thus, a third explanation is that increases in compliance were directly affected by a contingency. One difference between baseline and treatment was that subjects rarely experienced remedial trials and physical guidance during baseline because their SIB interrupted the instructional sequence and was followed by time-out. Indeed, the consequences of incorrect responding may have been the aversive events that were avoided through SIB. By contrast, all subjects experienced these events during treatment, because SIB no longer produced time-out and the only way to avoid remedial trials and physical guidance was through compliance. A number of examples can be found in the applied literature where behavioral acquisition can be attributed to avoidance or escape (see Iwata, 1987, for a review), and this interpretation is most consistent with the data shown in Figure 2, the subjects' previous history (i.e., behavioral sensitivity to negative reinforcement), and the fact that physical guidance — the event avoided through SIB during baseline— was the same event that could be avoided through compliance during treatment.

Thus, although not conclusively demonstrated, it appears that the active components of treatment in this study involved the manipulation of two distinct negative reinforcement contingencies. First, negative reinforcement for SIB (via escape from or avoidance of tasks) was eliminated by continuing to present task-related stimuli independent of behavior. Second, compliance with experimenter instructions, which did not respond to positive reinforcement in the form of praise during baseline, was increased during treatment through the use of an avoidance contingency. Both of these operations were suggested, and their outcomes predictable, based on subjects' behavior during Study 1, which indicated that escape or avoidance played a prominent role in the maintenance of their behavior problems.

STUDY 3

METHOD

Subject, Setting, Response Measurement, and Reliability

Donald, the remaining subject from Study 1, participated. Although his SIB was functionally similar to that of the other subjects, the context in which it occurred (medical examination instead of instructional situation) was quite different. Therefore, the details of his treatment program are reported separately. Sessions lasted for 15 min and were conducted primarily in two different treatment rooms, except as noted below.

Self-injurious responses were defined and recorded as in Study 1, and interobserver agreement was assessed during 42% of his sessions. Overall, occurrence, and nonoccurrence agreement percentages were calculated as in Study 1 and are presented in Table 2.

Experimental Design

A multiple baseline across settings design was used. Initially, all sessions in both settings were conducted by one experimenter (Therapist 1). After treatment had been implemented in both settings, generalization was assessed and programmed across eight additional experimenters (Therapists 2 through 9). Finally, periodic probes, consisting of actual physical exams using either baseline or treatment

contingencies, were conducted by three physicians. Probes conducted by a pediatrician occurred in one of the original treatment settings (Setting 1), whereas probes conducted by a cardiologist and ophthalmologist occurred in their respective clinics.

Baseline. This condition was identical to the medical demand condition in Study 1. In addition to sessions conducted by Therapist 1, one physician probe was conducted by a pediatrician.

Extinction plus differential reinforcement of other behavior (DRO). Questions about physical status, instructions, extremity palpation, and reinforcement for compliance with an instruction continued as in baseline. The time-out for SIB, however, was eliminated, and the experimenter continued with the physical exam independent of Donald's behavior. In these respects, Donald's treatment closely resembled that of the other subjects (Study 2). However, because much of the session consisted of the experimenter moving and palpating various body parts, there were fewer opportunities for Donald to comply with an instruction and, therefore, fewer opportunities for the experimenter to reinforce appropriate behavior. *Tolerance,* or the absence of interfering behavior, more accurately describes the appropriate response that was expected of Donald, and it appeared that this could be strengthened through the use of DRO. An edible reinforcer (soda) was used to make the contingency more salient. Initially, Donald was given a sip of soda at the end of every 1-min interval during which no SIB occurred. This schedule was then extended to 2, 4, and 15 min. During the final treatment condition (extinction plus DRO 15 min), soda was withheld for the entire session. If no SIB had occurred by the end of the session, Donald was given 50¢ to purchase a can of soda from a vending machine.

Results and Discussion

Figure 3 shows the results obtained for Donald. During baseline, his SIB was quite variable, with percentage of intervals of occurrence ranging from 3% to 47%. It is interesting to note that his SIB during the physician probe was approximately 20% higher than that observed during all but one other baseline session. The procedures used by the experimenter and physician were almost identical; the only differences were that the physician wore his lab coat and used a stethoscope during the exam.

When treatment (extinction plus DRO) was implemented in Setting 1, Donald's SIB gradually decreased, eventually reaching zero. A more rapid reduction in SIB was observed initially when treatment was introduced in Setting 2, again by Therapist 1. Two physician probes were then conducted in Setting 1, and Donald's SIB remained high, even though the physician used the same intervention procedures. As a result, we decided to use Setting 2 for the purpose of programming generalization. Sessions by Therapists 2 through 9, all using the treatment procedure described previously, were interspersed among those conducted by Therapist 1. Noticeable increases in SIB were observed initially during sessions conducted by these new therapists. For example, between Sessions 55 and 81 (Setting 2), SIB averaged 10.9% for Therapists 2 through 7 compared to 2.3% for Therapist 1; thereafter, SIB remained generally low. Following the introduction of novel therapists in Setting 2, their inclusion in Setting 1 had no disruptive effect on Donald's behavior, and similar results were obtained during subsequent physician probes. The final three probes were conducted by novel physicians (cardiologist and ophthalmologist) and in novel settings (two different clinics).

The elimination of Donald's face punching was a necessary prerequisite for his required eye surgery. As an additional preparation, he was taught to wear an eye patch without poking at it or attempting to remove it. When these two goals had been achieved, Donald was admitted to a hospital for the surgery. Prior to admission, medical staff were instructed in the procedures, with response blocking added to the extinction and differential reinforcement components. Response blocking was added as a protective measure because the risks due to face punching during recovery from surgery were much greater than those prior to surgery. Although the nursing staff did not keep systematic records of Donald's

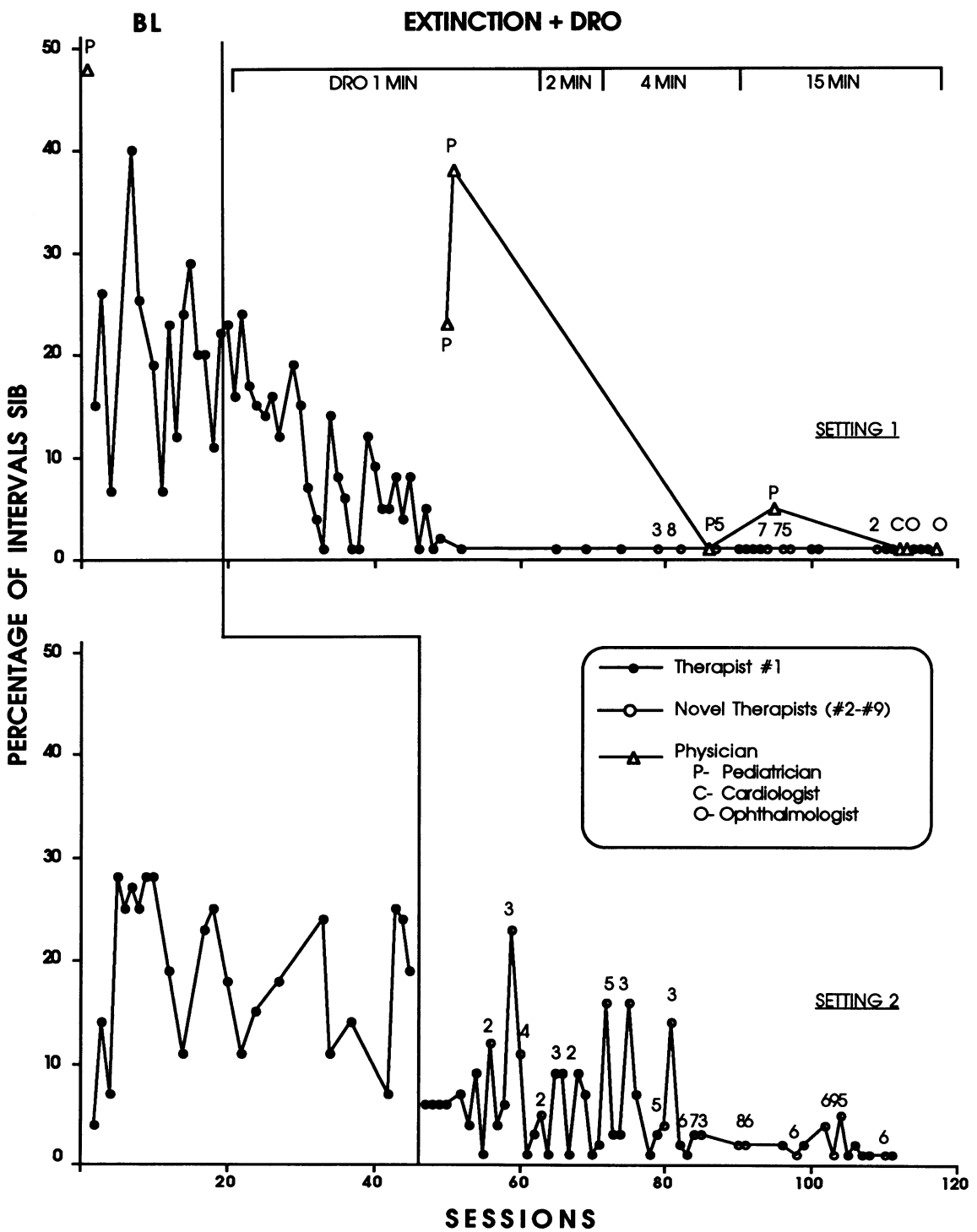

Figure 3. Percentage of 10-s intervals of SIB exhibited by Donald during simulated and actual medical examinations in Study 3.

SIB or interfering behaviors, they reported that no SIB and only minor instances of interference occurred during his inpatient stay.

As in Study 2, the use of escape extinction—continued presentation of aversive events and/or their correlated stimuli—was very effective in eliminating Donald's SIB, which previously (Study 1) was shown to serve an avoidance or escape function. One aspect of Study 2 that posed interpretive difficulty was the inclusion of physical assistance to complete tasks contingent on SIB, which may have amounted to punishment. Donald's treatment, which produced results similar to those seen in other subjects, did not contain this component. It did, however, contain a different component, a potentially more potent DRO than that used during baseline (i.e., praise plus soda vs. praise alone), that may have influenced the results. Nevertheless, two features of Donald's data, the gradual reduction seen in his SIB and the initial differences in his behavior across therapists (especially the physician, whose appearance was most suggestive of situations that Donald previously found intolerable), are consistent with an extinction effect.

GENERAL DISCUSSION

The results of Study 1 replicate and extend previous research indicating that the systematic manipulation of environmental events can provide, on a pretreatment basis, important information about the functional properties of SIB. Similar approaches have been applied to other behavioral disorders, such as stereotypy (Durand & Carr, 1987), aggression (Mace, Page, Ivancic, & O'Brien, 1986), and multiple aberrant behaviors (Sturmey, Carlsen, Crisp, & Newton, 1988). The consistency of findings across studies, in spite of wide variation in response topography, suggests that behavioral classification according to function may have greater relevance to treatment than classification according to topography. For example, treatment programs for the elimination of self-injurious and aggressive escape behavior are likely to contain more elements in common than do programs for the elimination of escape and attention-getting SIB. A functional classification of behavior disorders has heuristic value as well, in that it may provide an empirical and parsimonious model for processes that historically have been subsumed under the label of *symptom substitution,* such as the appearance of a second inappropriate behavior following treatment of the first.

The methodologies used in conducting functional analyses, although similar, have differed in a number of potentially important respects. Among these are the manipulation of deprivation states with respect to the supposed reinforcer, the use of discriminative stimulus manipulations only, the provision of reinforcement or extinction for the target behavior, reinforcement of the target behavior on continuous or intermittent schedules, and the presence or absence of reinforcement for competing behavior. These variables can greatly affect the outcome, yet it may be impossible to control all of them within a single analysis. Even if such control were possible, there are practical tradeoffs to consider. For example, the use of intermittent reinforcement schedules might produce greater response differentiation during assessment; in doing so, however, it may increase an already existing problem to an unacceptable level. To date, there has been no discussion of the relative influence of deprivation, reinforcement schedules, and so on, on the assessment process; these variables should be considered in future research. Based on data from a number of sources, one might expect the greatest response differentiation under the following conditions: (a) relative deprivation of the reinforcer, (b) the pairing of different contingencies with distinct discriminative stimuli, (c) continuous reinforcement of the target behavior so as to make the contingency even more discriminable, and (d) no reinforcement for a competing behavior. Not surprisingly, these very conditions probably account for the initial development of many behavior disorders, not just SIB.

The many complexities involved in experimental analyses of behavioral function have led some researchers to suggest that experimental approaches may be either too time consuming or unnecessary for the purpose of intervention (e.g., Axelrod, 1987;

Durand & Crimmins, 1988). As alternatives, anecdotal information, rating scales, and quantitative data of a descriptive nature are unquestionably superior to no information whatsoever and may actually lead to an accurate conclusion about the functional properties of behavior. If so, their occasional use in applied situations might be appropriate. Controlled manipulation is essential, however, to verify suspected or even obvious environment–behavior relationships or to detect potentially subtle ones. Accordingly, the term *functional analysis,* when used in reference to the identification of a behavior's maintaining contingencies, is appropriate only to the extent that a cause–effect relationship is demonstrated empirically. This use of the term is most consistent with the experimental approach and the basic dimensions of our field described by Baer, Wolf, and Risley (1968), who noted that " . . . a non-experimental (functional) analysis is a contradiction in terms" (p. 92).

The data obtained in Study 1 served two distinct purposes, which became more evident after having fully described Studies 2 and 3. First, they provided an empirical means of selecting individuals whose SIB was maintained by negative reinforcement. Had we implemented Studies 2 and 3 on a randomly selected sample of self-injurious individuals, the results probably would have been less consistent. This illustrates a problem in formulating conclusions about the effectiveness of various interventions based on their application with individuals whose behavior problems are subject to control by unidentified contingencies. For example, the general conclusion that attention withdrawal is relatively ineffective as extinction for SIB may be based on a number of published reports in which the SIB was, in fact, maintained by negative and not positive reinforcement. Future research on treatment evaluation will be enhanced through a demonstrated functional match between the response in question and the intervention.

The results from Study 1 also suggested a number of potential treatments for our subjects' SIB and contraindicated the use of others. Our choice of extinction was based solely on the fact that it is the most direct means of disrupting the maintaining contingency. Results from Studies 2 and 3 showed that the extinction procedure was quite effective; these findings are consistent with data provided by Heidorn and Jensen (1984) and Repp et al. (1988). In particular, the baseline and treatment conditions in Study 2 provided a direct comparison of two extinction procedures similar to that conducted by Repp et al. During baseline, SIB was followed by brief removal of both task and experimenter, which amounted to extinction for behavior maintained by positive reinforcement. During treatment, task presentation continued independent of behavior.

Additional data collected in Study 2 suggested that compliance with instructions successfully displaced SIB when the negative reinforcement contingency was shifted to that response. Not all of the results were positive, however. Evidence of a brief "extinction burst" was observed in 3 subjects, which is undesirable when treating severe SIB. Another subject's SIB increased and maintained when extinction was applied, a finding that is unique to the extinction of negatively reinforced behavior (i.e., response maintenance is not seen during extinction of positively reinforced behavior). We cannot speculate on the generality of these somewhat negative results, but their appearance in Study 2 suggests that caution should be used when undertaking extinction programs for avoidance or escape behavior.

An alternative to extinction might consist of complete elimination of aversive events, to the extent that it is possible, during the initial stage of treatment. This strategy should have the effect of quickly eliminating SIB. Reestablishment of the original stimulus situation might then be possible by using a variety of stimulus-fading techniques (e.g., Weeks & Gaylord-Ross, 1981). One potential limitation of this procedure is that the behavior may remain functional and occur in other contexts. The combined application of extinction plus stimulus fading might then be necessary. A second alternative to extinction might involve directly reinforcing a competing behavior (e.g., compliance) through escape or avoidance. This approach was included as a component of treatment in Study 2,

in that compliance with instructions avoided the consequences of an incorrect response (additional prompting, physical assistance, etc.). It is possible to make the contingency even more salient during the early stages of treatment through significant session shortening; some support for the potential effectiveness of this procedure can be found in basic research on avoidance. For example, Mellitz, Hineline, Whitehouse, and Laurence (1983) found that the contingent reduction of avoidance-session durations accelerated ongoing avoidance behavior.

The present studies reflect a growing interest in the analysis of behavioral function and its use as a screening and prescriptive tool. Many of the methodological details involved in these types of studies are yet to be resolved. Furthermore, research on the behavioral etiology of disorders such as SIB will continue to be both difficult and tentative because one simply cannot gain access to all of the relevant details that comprise an individual's history. Nevertheless, to the extent that existing relationships are generally consistent with the manner in which behavior originally developed, through continued research we may be able to verify empirically a model of behavioral disorders that already exists in theory.

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